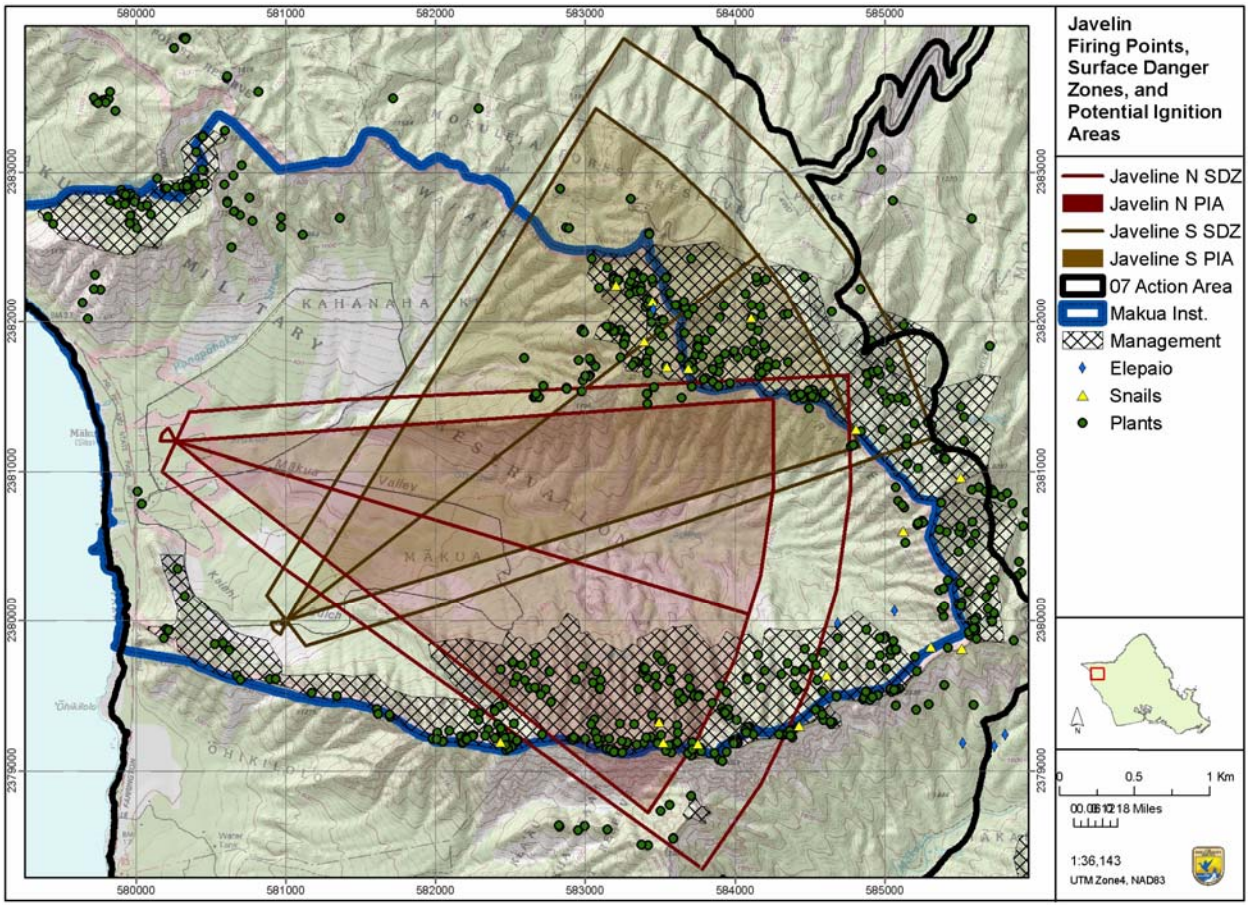

Figure PD 29. Javelin 1:1 million surface danger zones and potential ignition areas for northern and southern firing points.

TOW Missile

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

in 1972 and 1973 indicates that 82 percent of TOW missiles hit their targets, 18 percent missed their target, including seven percent which missed their target due to a malfunction (http://www.redstone.army.mil/history/tow/tow_chronology.htm.).

Restrictions

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

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

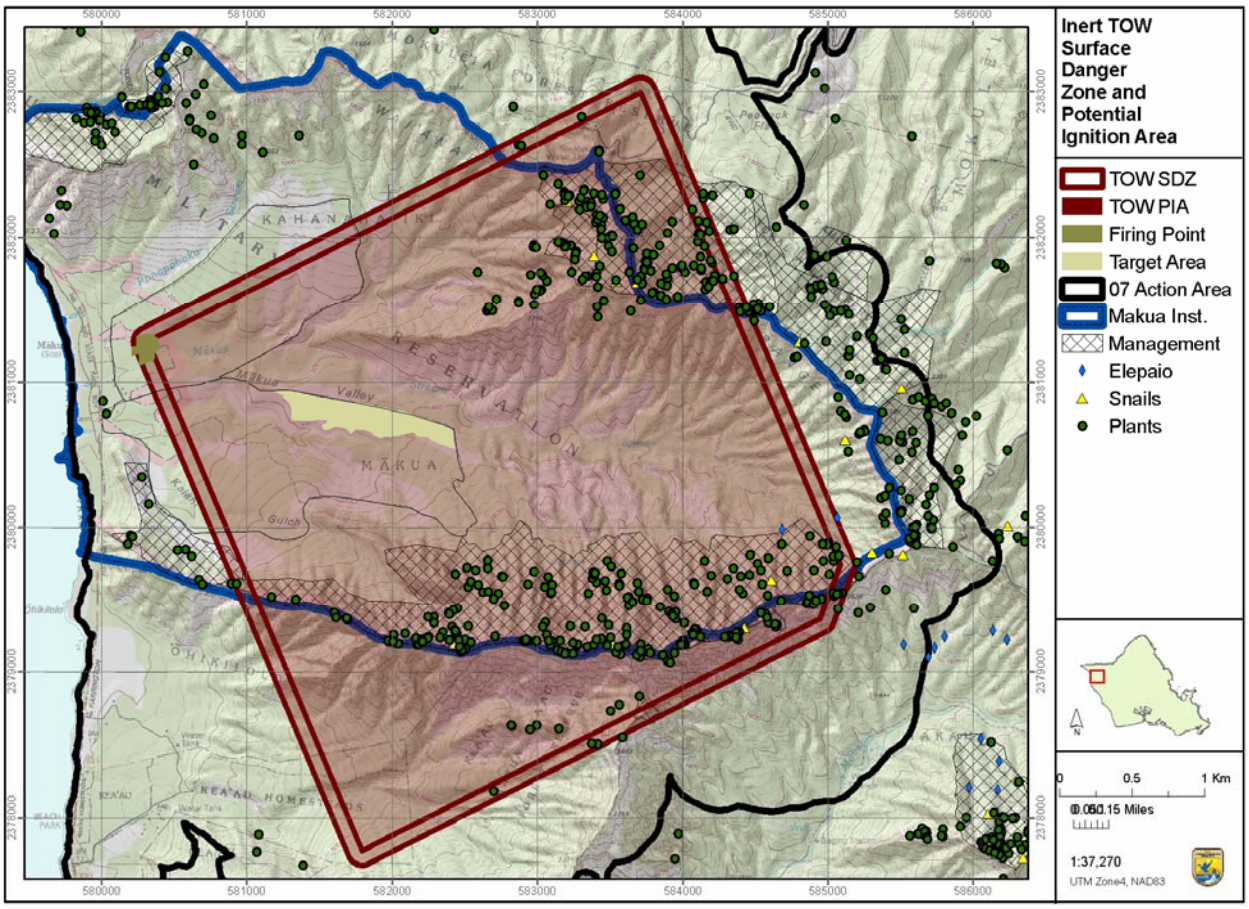

Figure PD 31. Surface danger zone and potential ignition area for inert TOW with concrete warhead, fired from within north lobe of firebreak road, targeted at Objective Deer.

9. Guinea Grass Fuel Model and Anticipated Fire Behavior Details

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

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

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

green leaves, following substantial rainfall events. The WIMS uses the National Fire Danger Rating System algorithm for calculating live herbaceous fuel moisture based on precipitation.

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

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

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

At the time when the helicopter staffing requirements table was developed, limited fire behavior information was available for fires burning in guinea grass, particularly for grass with WIMS-calculated live herbaceous fuel moisture greater than 100 percent. Army wildland fire management staff are collaborating with fire behavior researchers from the U.S. Forest Service Pacific Southwest Research Station, the State, and the Center for Environmental Management of Military Lands to gather rate of spread data for headfires burning in mature guinea grass under various live herbaceous fuel moisture conditions. Actual rates of spread are expected to be lower than the rates of spread used to develop these helicopter staffing requirements under

high live herbaceous fuel moisture conditions. When the Army has documented guinea grass rates of spread with various WIMS-calculated live herbaceous fuel moistures, particularly under high live herbaceous fuel moisture conditions, the Army will forward the updated fuel model information to the Service for review. Given mutually agreed upon fuel model parameters, the Army will develop updated fire suppression helicopter staffing requirements which provide for the containment of fires outside the firebreak road at acreages equal to or smaller than those which are predicted to occur given the current helicopter staffing requirements. The CONTAIN module of BehavePlus will be used to compare predicted fire acreages using the new fuel model and helicopter staffing, to the acreages in Table PD 11. Fire acreages at all wind speeds and fuel moisture conditions would be equal to or less than those presently predicted in Table PD 11. The updated helicopter staffing requirements will be submitted to the Service for review and concurrence. Updated helicopter staffing requirements, agreed to in writing by the Service field supervisor, will be appended to the Biological Opinion and will replace the requirements currently specified in Table PD 5. Updated helicopter staffing guidelines will not be instituted at Makua without this prior written approval of the Service.

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

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

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

and weather conditions. Examples of the results from these simulations are presented in Table PD 11.

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

Color shading in tables:

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

Guinea grass fire: Live Herbaceous Fuel Moist 200%, Live Woody Fuel Moisture 200%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope
Fire Suppression Helicopter staffing: 22 ch/hr (0-5 mph winds), 33 ch/hr (6-10 mph), 41 ch/hr (11-15 mph), 42 ch/hr (>16 mph)

	1-hour fuel moisture				
20-ft wind	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	**Contained 6.1 ac**	**Contained 5.4 ac**	**Contained 4.8 ac**	**Contained 4.4 ac**	**Contained 4.0 ac**
2 mph	**Contained 6.4 ac**	**Contained 5.7 ac**	**Contained 5.1 ac**	**Contained 4.6 ac**	**Contained 4.2 ac**
4 mph	**Contained 7.6 ac**	**Contained 6.6 ac**	**Contained 5.9 ac**	**Contained 5.4 ac**	**Contained 4.9 ac**
6 mph	**Contained 7.7 ac**	**Contained 6.8 ac**	**Contained 6.1 ac**	**Contained 5.6 ac**	**Contained 5.2 ac**
8 mph	**Contained 9.7 ac**	**Contained 8.6 ac**	**Contained 7.7 ac**	**Contained 7.1 ac**	**Contained 6.5 ac**
10 mph	**Contained 12.4 ac**	**Contained 10.8 ac**	**Contained 9.7 ac**	**Contained 8.8 ac**	**Contained 8.1 ac**
12 mph	**Contained 13.8 ac**	**Contained 12.2 ac**	**Contained 11.0 ac**	**Contained 10 ac**	**Contained 9.1 ac**
14 mph	**Contained 17.0 ac**	**Contained 14.9 ac**	**Contained 13.3 ac**	**Contained 12.1 ac**	**Contained 11.0 ac**
16 mph	**Contained 20.4 ac**	**Contained 17.7 ac**	**Contained 15.8 ac**	**Contained 14.4 ac**	**Contained 13.0 ac**
18 mph	**Escaped**	**Contained 21.7 ac**	**Contained 18.9 ac**	**Contained 17.0 ac**	**Contained 15.4 ac**
20 mph	**Escaped**	**Escaped**	**Escaped**	**Contained 20.8 ac**	**Contained 18.2 ac**

Guinea grass fire: Live Herbaceous Fuel Moist 150%, Live WDY FM 150-200%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope
Fire Suppression Helicopter staffing: 28 ch/hr (0-5 mph winds), 42 ch/hr (6-10 mph), 50 ch/hr (11-15 mph), 52 ch/hr (>16 mph)

20-ft wind	**1-hour fuel moisture**				
wpeed	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	**Contained 9.1 ac**	**Contained 7.9 ac**	**Conatined 7.1 ac**	**Conatined 6.5 ac**	**Contained 6.1 ac**
2 mph	**Contained 9.6 ac**	**Contained 8.3 ac**	**Conatined 7.5 ac**	**Conatined 6.8 ac**	**Contained 6.4 ac**
4 mph	**Contained 11.3 ac**	**Contained 9.8 ac**	**Conatined 8.8 ac**	**Conatined 8 ac**	**Contained 7.5 ac**
6 mph	**Conatined 14.5 ac**	**Contained 9.6 ac**	**Contained 9.1 ac**	**Conatined 8.4 ac**	**Contained 7.9 ac**
8 mph	**Contained 21.2 ac**	**Contained 12.1 ac**	**Contained 11.5 ac**	**Contained 10.6 ac**	**Contained 9.9 ac**
10 mph	**Contained 10.1 ac**	**Contained 15.3 ac**	**Contained 14.6 ac**	**Contained 13.3 ac**	**Contained 12.4 ac**
12 mph	**Contained 21.5 ac**	**Contained 18.8 ac**	**Contained 16.8 ac**	**Contained 15.4 ac**	**Contained 23.3 ac**
14 mph	**Contained 26.5 ac**	**Contained 23 ac**	**Contained 20.5 ac**	**Contained 18.8 ac**	**Contained 14.4 ac**
16 mph	**Contained 31.9 ac**	**Contained 27.4 ac**	**Contained 24.3 ac**	**Contained 22.2 ac**	**Contained 20.7 ac**
18 mph	**Escaped**	**Contained 35.3 ac**	**Contained 29.3 ac**	**Contained 26.5 ac**	**Contained 24.5 ac**
20 mph	**Escaped**	**Escaped**	**Escaped**	**Escaped**	**Contained 29.5 ac**

Guinea grass fire: Live Herbaceous Fuel Moist 120%, Live WDY FM 120-190%,10-hr = 1hr+1, WAF = .5, wind across 60% slope
Fire Suppression Helicopter Staffing: 34 ch/hr (0-5 mph winds), 49 ch/hr (6-10 mph), 60 ch/hr (11-15 mph), 62 ch/hr (>16 mph)

	1-hour fuel moisture				
20-ft wind	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	**Conatined 12.3 ac**	**Conatined 10.6 ac**	**Conatined 9.4 ac**	**Contained 8.6 ac**	**Contained 8.2 ac**
2 mph	**Contained 13 ac**	**Contained 11.2 ac**	**Conatined 9.9 ac**	**Conatined 9 ac**	**Contained 8.6 ac**
4 mph	**Contained 15.4 ac**	**Contained 13.2 ac**	**Conatined 11.7 ac**	**Conatined 10.6 ac**	**Contained 10.1 ac**
6 mph	**Contained 16.1 ac**	**Contained 13.9 ac**	**Contained 2.5 ac**	**Conatined 2 ac**	**Contained 1.8 ac**
8 mph	**Contained 20.6 ac**	**Contained 17.8 ac**	**Contained 15.8 ac**	**Contained 14.4 ac**	**Contained 13.3 ac**
10 mph	**Contained 26.4 ac**	**Contained 22.7 ac**	**Contained 20 ac**	**Contained 18.1 ac**	**Contained 16.8 ac**
12 mph	**Contained 29.9 ac**	**Contained 25.8 ac**	**Contained 22.9 ac**	**Contained 20.8 ac**	**Contained 19.2 ac**
14 mph	**Contained 37 ac**	**Contained 31.7 ac**	**Contained 28 ac**	**Contained 25.4 ac**	**Contained 23.5 ac**
16 mph	**Contained 44.7 ac**	**Contained 37.9 ac**	**Contained 33.4 ac**	**Contained 30.1 ac**	**Contained 27.8 ac**
18 mph	**Escaped**	**Contained 49 ac**	**Contained 40.2 ac**	**Contained 36 ac**	**Contained 33 ac**
20 mph	**Escaped**	**Escaped**	**Escaped**	**Escaped**	**Contained 39.4 ac**

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

Guinea grass fire: Live Herbaceous Fuel Moist 80%, Live WDY FM 80-150%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter staffing: 98 ch/hr (0-5 mph winds), 150 ch/hr (6-10 mph), 182 ch/hr (11-15 mph), 197 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	6%	8%	10%	12%	14%
0 mph	Contained 87.3 ac	Contained 74.0 ac	Contained 64.3 ac	Contained 9.9 ac	Contained 7.9 ac
2 mph	Contained 94.4 ac	Contained 79.8 ac	Contained 69.3 ac	Contained 61.4 ac	Contained 9.6 ac
4 mph	Contained 119.8 ac	Contained 100.8 ac	Contained 87.1 ac	Contained 77.0 ac	Contained 69.4 ac
6 mph	Contained 129.2 ac	Contained 110.3 ac	Contained 96.4 ac	Contained 86.0 ac	Contained 78.0 ac
8 mph	Contained 175.0 ac	Contained 148.8 ac	Contained 129.6 ac	Contained 115.3 ac	Contained 104.3 ac
10 mph	Contained 234.3 ac*	Contained 197.8 ac	Contained 171.5 ac	Contained 152.0 ac	Contained 137.2 ac
12 mph	Contained 274.3 ac*	Contained 232.9 ac*	Contained 202.6 ac*	Contained 180.1 ac	Contained 162.9 ac
14 mph	Contained 349.3 ac*	Contained 293.8 ac*	Contained 254.4 ac*	Contained 225.4 ac*	Contained 203.4 ac*
16 mph	Contained 417.6 ac*	Contained 348.8 ac*	Contained 301.5 ac*	Contained 267.0 ac*	Contained 240.9 ac*
18 mph	Escaped	Contained 453.7 ac*	Contained 367.8 ac*	Contained 322.7 ac*	Contained 289.9 ac*
20 mph	Escaped	Escaped	Escaped	Contained 406.7 ac*	Contained 347.7 ac*
* BehavePlus/CONTAIN assumes headfire burning in guinea grass on a 60% slope over the entire fire area. The south aspect of C-Ridge has an average percent slope of 60%, but it is only 200 acres in area. Fires larger than 200 acres will hit fuelbreaks and turn into flanking and backing fires once they crest C-Ridge. Therefore, fire acreages larger than 200 acres, and acreages of fires ignited close to the top of C-Ridge are overestimated by the model.					

Guinea grass fire: Live Herbaceous Fuel Moist 60%, Live WDY FM 60-130%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopters: 120 ch/hr (0-5 mph winds), 183 ch/hr (6-10 mph), 223 ch/hr (11-15 mph), 236 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	6%	8%	10%	12%	14%
0 mph	Contained 128.6 ac	Contained 108.6 ac	Contained 93.3 ac	Contained 13.4 ac	Contained 10.7 ac
2 mph	Contained 139.0 ac	Contained 117.2 ac	Contained 101.2 ac	Contained 89.3 ac	Contained 12.6 ac
4 mph	Contained 176.6 ac	Contained 148.1 ac	Contained 127.5 ac	Contained 112.0 ac	Contained 100.2 ac
6 mph	Contained 191.2 ac	Contained 162.8 ac	Contained 141.7 ac	Contained 125.7 ac	Contained 113.1 ac
8 mph	Contained 259.5 ac*	Contained 219.9 ac*	Contained 190.7 ac	Contained 168.7 ac	Contained 151.5 ac
10 mph	Contained 347.9 ac*	Contained 292.8 ac*	Contained 252.8 ac*	Contained 222.8 ac*	Contained 199.6 ac
12 mph	Contained 406.6 ac*	Contained 344.3 ac*	Contained 298.4 ac*	Contained 263.9 ac*	Contained 237.0 ac*
14 mph	Contained 518.2 ac*	Contained 434.6 ac*	Contained 374.9 ac*	Contained 330.4 ac*	Contained 296.0 ac*
16 mph	Contained 620.5 ac*	Contained 516.7 ac*	Contained 445 ac*	Contained 391.9 ac*	Contained 351 ac*
18 mph	Escaped	Contained 668.7 ac*	Contained 542.8 ac*	Contained 473.7 ac*	Contained 422.5 ac*
20 mph	Escaped	Escaped	Escaped	Contained 587.1 ac*	Contained 505.9 ac*
* BehavePlus/CONTAIN assumes headfire burning in guinea grass on a 60% slope over the entire fire area. The south aspect of C-Ridge has an average percent slope of 60%, but it is only 200 acres in area. Fires larger than 200 acres will hit fuelbreaks and turn into flanking and backing fires once they crest C-Ridge. Therefore, fire acreages larger than 200 acres, and acreages of fires ignited close to the top of C-Ridge are overestimated by the model.					

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

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

STATUS AND ENVIRONMENTAL BASELINE OF SPECIES AND CRITICAL HABITAT - OVERVIEW

Introduction

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

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

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

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

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

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

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

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

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

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

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

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

General Environmental Baseline Factors

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

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

Other past and present human activities in the action area include fires set by human carelessness and arson, habitat lost to development, and trampling of native vegetation along roads and trails. Major threats to listed resources in the action area related to human activities are non-native plants and animals introduced by Polynesian and Euro-American settlers. These invasive species include ungulates (pigs, goats, cattle, and sheep), rodents (rats and mice), insects (black-twig borer, Chinese rose beetle, two-spotted leaf hopper, long-legged ant, white fly, and scales), other invertebrates (snails and slugs), disease pathogens (avian malaria and avian pox), and hundreds of invasive weed species that compete with native plants for growing space, light, water, and soil

nutrients. These threat factors are tabulated for each species in Appendix E and are discussed in the "General Effects" section. Details on unique or particularly dangerous threats are discussed as appropriate in the species-specific status and baseline descriptions.

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

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

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

and invasive weeds. All non-Army lands within and adjacent to the action area have been impacted by agricultural and ranching activities, habitat loss and development, trampling of native vegetation along roads and trails, and fires set by carelessness and arson.

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

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

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

For the critical habitats covered in this Biological Opinion, the best available scientific and commercial information is insufficient to determine their current condition within the action area and range-wide. In general, however, most native Hawaiian ecosystems are threatened by the same suite of factors related to habitat loss and the introduction and spread of non-native invasive species. Because these threats are fairly uniform, they are described in general below

and are not discussed in the species-specific status and baseline descriptions. Likewise, conservation needs of critical habitat are much the same for all covered species, and are not discussed in the species-specific descriptions.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Environmental Baseline of the Species

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

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

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

Ongoing Conservation Actions for the Species No conservation actions are currently being implemented specifically for *Abutilon sandwicense* in the Makua action area. However, this species benefits from ecosystem-level management in the fenced Kaluakauila Management Unit where non-native ungulates and weeds are controlled. In addition, fuels modification along the Kaluakauila ridgeline reduces the risk of fire in the management unit (K. Kawelo, pers. comm. 2004; Service 2004a). This species is represented in the following *ex situ* collections: 45 leaf

samples in micropropagation (Harold L. Lyon Arboretum), 42 plants in botanical garden collections (Amy Greenwell Ethnobotanical Garden and Waimea Valley Audubon Center), 457 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and five seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Alectryon macrococcus* var. *macrococcus, w*hich are

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

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

Environmental Baseline of the Species

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

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

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

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Alectryon macrococcus* var. *macrococcus*

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

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

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

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

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

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

Listing Status *Bonamia menziesii* was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. A recovery plan for multi-island plants included this species (Service 1999a), and critical habitat was designated on June 17, 2003 (68 FR 35950).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The primary constituent elements for the units on Oahu include dry ridges, upper slopes, or ridges in lowland mixed mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Bobea* sp., *Carex wahuensis*, *Chamaesyce multiformis*, *Coprosma*

foliosa, *Diospyros sandwicensis*, *Eragrostis variabilis*, *Gahnia beecheyi*, *Leptecophylla tameiameiae*, *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Psychotria* sp., or *Psydrax odorata*. *Cenchrus agrimonioides* grows on Oahu at elevations between 357 and 874 m (1,171 and 2,867 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cenchrus agrimonioides* var. *agrimonioides* because no stabilization populations that meet minimum numeric criteria exist outside the Makua action area. Three population units have been identified for stabilization. This taxon will be stabilized because fewer than three stabilization population units exist outside of the Army action area. To be considered numerically stabilized *C. agrimonioides* var. *agrimonioides* must meet the criteria required for stability

of a short-lived perennial including 50 mature, reproducing individuals per population and threats abated. Species stabilization measures include: habitat and population management of three population units, augmentation of existing populations, collection of full *ex situ* representation of wild stock on Oahu; non-native plant control, and ungulate control (U.S. Army Garrison 2003b).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Threats to the Species *Chamaesyce celastroides* var. *kaenana* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under "General Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The major threats to *C. celastroides* var. *kaenana* are listed as effects of recreational activities *(*U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950). It is not known if non-native *Chamaesyce* species present in Hawaii could possibly hybridize with the native taxa (Service 1998a; U.S. Army Garrison 2003b). In addition, *C. celastroides* var. *kaenana* is vulnerable to trampling by humans along trails in the Kaena Point Natural Area Reserve and habitat degradation from stochastic events such as landslides, hurricanes, and flooding (68 FR 35950). *Chamaesyce celastroides* var. *kaenana* is vulnerable to extirpation

from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; Service 1999b). Thus, *C. celastroides* var. *kaenana* has a high background risk of extinction, and any additional threats could eliminate expectation of its long-term persistence.

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

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

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

Critical Habitat Description A total of 520 ha (1,284 ac) on the island of Oahu has been designated for this species in five separate units. This land was designated to reach the recovery

goal of 8 to 10 populations for this species. Critical habitat has been designated on State land (Kaena Point State Park, Kuaokala Forest Reserve, and Waiane Forest Reserve) and private land. Three of the designated units provide habitat for one population each and two units provide habitat for two populations each of 300 mature, reproducing individuals of *Chamaesyce celastroides* var. *kaenana* (68 FR 35950).

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

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

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

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

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

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

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kaena to Keawaula, Kaena, Waianae Kai and Makua population units, which contain approximately 60 percent of the total remaining individuals of *Chamaesyce celastroides* var. *kaenana* on Oahu, are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b. Of the 41 ha (102 ac) of critical habitat in the action area, five percent (0.4 ha; 1 ac) is within the Kaluakauila Management Unit. Several ongoing actions being conducted by the Army Natural Resources Staff will benefit both the species and the critical habitat in the Makua action area. Fuel modification is being

conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire to the site. The Army is conducting fuel modification, habitat restoration, and non-native plant control around the population in Makua at Kaluakauila. Seeds have been collected from some of the populations on Oahu, but additional collection is still necessary. There are 102 plants represented in the seed bank from five population units for *C. celastroides* var. *kaenana*. Seed is currently the best method for genetic storage for this taxon due to its good storage potential (U.S. Army Garrison 2006c). Surveys found additional populations between the Makua and Puaakanaoa Ridge and also within Waianae Kai and Keawaula Management Units (U.S. Army Garrison 2003b; K. Kawelo pers. comm. 2004). Non-native plants and rats are controlled within the vicinity of the Kaluakauila Management Unit. A fence is not needed around the habitat because it is on steep cliffs which ungulates are unable to access.

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

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

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

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

Trends in abundance indicate that *Chamaesyce herbstii* has undergone a major decline, and currently totals approximately 87 individuals in the Kapuna to Pahole population unit (U.S. Army Garrison 2006d). Current numbers represent a major decline from almost 200 total individuals in 1996 (Table SB 7). This decline likely is due to habitat degradation by non-native ungulates and plants, and low on-site germination (U.S. Army Garrision 2005b). The Kapuna to Pahole population unit contains at least 25 mature, reproducing individuals (the minimum

number required for stabilized population for long-lived perennials defined in the Makua Implementation Plan). This population unit also is located within the very low fire risk zone for training-related wildfire. Existing plants produce many flowers and immature seed capsules, but few mature capsules are found on the plants and germination of seedlings in the wild is poor (U.S. Army Garrison 2005b). Thus, available survey data would indicate that *C. herbstii* has been declining in numbers of individuals present in the range, with only one existing population unit with at least 25 mature, reproducing individuals. However, efforts to reverse this decline have been employed through habitat protection and augmentation pursuant the Makua Implentation Plan Addendum (U.S. Army Garrison 2006d, 2005a, Makua Implementation Team 2003)

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

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

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

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

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

reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

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

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

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

Critical Habitat Description A total of 497 ha (1,227 ac) in three separate units on the island of Oahu was designated for *Chamaesyce herbstii*. Critical habitat was designated on State lands (Mokuleia Forest Reserve and Pahole Natural Area Reserve) and private land (Honouliuli Preserve). Two of the units provide habitat for one population and one unit provides habitat for

five populations of 300 mature, reproducing individuals each (68 FR 35950). To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *C. herbstii* (68 FR 35950).

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

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 exclosures. All individuals of *C. squamigera* in the action area are located in areas of low risk from training-related wildfire.

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

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

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

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

Species Description *Cyanea grimesiana* ssp. *obatae* is a short-lived perennial in the Campanulaceae (bellflower family). It is a single-stemmed or sparingly branched shrub 1 to 3.2 m (3.3 to 10.5 ft) tall, with leaves clustered at the stem tips. The wide, deeply lobed, pinnate leaves are 27 to 58 cm (10.6 to 22.8 in) long and 14 to 32-cm (5.5 to 12.6 in) wide. The tubular flowers are purple or green to yellow-white and 5.5 to 8.0-cm (2.2 to 3.1 in) long. The elliptical orange berries are 1.8 to 3.0-cm (0.7 to 1.2 in) long. *Cyanea grimesiana* ssp. *obatae* can be

distinguished from the two other subspecies of *C. grimesiana* by its short, narrow calyx lobes that are not fused and do not overlap (Wagner et al 1999; Makua Implementation Team 2003).

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

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

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

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

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

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

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

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

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

Threats *Cyanea grimesiana* ssp. *obatae* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. This subspecies is particularly vulnerable to predation by rats and slugs. Major rat damage has occurred to five mature plants in West Makaleha population unit, and slugs prey on

plants of all size/age classes. Slugs likely attack all members of this genus, as suggested by investigations of the related *Cyanea superba* ssp. *superba*. Slug predation killed half of 14 outplants at the North Branch of South Ekahanui population unit, and the remaining plants are in poor condition most likely due to the stress of predation (U.S. Army Garrison 2005b).

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

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 exclosures. Reintroductions within the North Branch of South Ekahanui population unit are within the management unit fence, although the naturally occuring

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

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

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 waianaeensis*, *Diplazium sandwichianum*, *Dryopteris unidentata*, *Dubautia* sp., *Freycinetia arborea*, *Hedyotis acuminata*, *H. terminalis*, *Metrosideros polymorpha*, *Myrsine lessertiana*, *Nothocestrum* sp., *Perrottetia sandwicensis*, *Pipturus albidus*, *Pisonia umbellifera*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Rumex* sp., *Selaginella arbuscula*, or *Streblus pendulinus*. The plant community, associated species, and elevations are indicative of important features such as soil

moisture, nutrient cycling and availability, temperature ranges, and light levels that are primary constituent elements of the habitat required for the subspecies' conservation.

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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 Pupukea-Paumalu Forest Reserves, and Pahole Kaala Natural Area Reserve) and private land. One of the critical habitat units provides habitat for four populations of 300 mature, reproducing individuals each, one unit provides habitat for three populations, and one unit provides habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *C. longiflora* (68 FR 35950).

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

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

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

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

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

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 exclosure (naturally occurring individuals in this population unit are on steep cliffs inaccessible to pigs). A total of about 196.5 ha (485.5 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Manuwai, Pahole, Upper Kapuna, West Makaleha). About 153.0 ha (378.1 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). In 2005, genetic storage goals were about 21 percent complete, with 31 plants from the three existing population units combined meeting the goals outlined in the Makua Implementation Plan. In addition, there were five plants growing in the Army nursery (U.S. Army Garrison 2005b).

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

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 stablization (defined as 50 mature, reproducing individuals per population unit). The Kahanahaiki and Pahole to Kapuna population units are located within the low and very low fire risk zones for training-related wildfire (U.S. Army Garrison 2005b). The Central and East Makaleha, and Makaha, population units are designated as future reintroduction sites for this subspecies.

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

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

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

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

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

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

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

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

Occurrences of *Cyanea superba* ssp. *superba* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). This subspecies has a history of precipitous decline and extremely low genetic variability; any catastrophic disturbance during a major low point could extirpate one or more population units or result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal

species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. superba* ssp. *superba* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. superba* ssp. *superba* have been almost totally extirpated from the Waianae Mountains. Although this subspecies is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003). Low genetic variability and small population size usually result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor. Although *C. superba* ssp. *superba*, outplants seem to be vigorous and produce viable seed, reduced genetic variability could result in potentially deleterious consequences for long-term persistence of the subspecies. Thus, *C. superba* ssp. *superba* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

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

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

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
Opaeula (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 Opaeula. Stabilization actions as outlined in the Makua Implementation Plan will be implemented to stabilize this taxon. To be considered stable, *C. dentata* must meet the criteria required for stability of a short-lived perennial species. The stabilization measures will include surveys for additional occurrences, collection and propagation of this taxon for genetic storage and reintroduction into the wild, monitoring and management of known population units as identified in the Makua Implementation Plan, ungulate control, development and implementation of slug control at reintroduction sites and elsewhere where deemed necessary, and rat control around the reintroduced individuals and other population units, if necessary (Service 2003b).

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

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

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

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

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

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

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

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

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

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 on or more population units and may result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *D. subcordata* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *D. subcordata* have been almost totally extirpated from the Waianae

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

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

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

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

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

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

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 a there is a history of local declines, *D. subcordata* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

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

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

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

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

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

Historic and Current Distribution Historically, *Diellia falcata* was known from almost the entire length of the Waianae Mountains, from Manini Gulch to Palehua Iki, as well as from the Koolau Mountains of Oahu, from Kaipapau Valley to Aiea Gulch. Currently, *D. falcata* is locally

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

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

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

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

Ecology *Diellia falcata* is a terrestrial fern that typically grows in deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest between 224 and 953 m (735 and 3,126 ft) elevation. Typically, *Diella* sp. is restricted to spatially fragmented habitat type on the steep sides of gulches. Plants gow on soil that is rocky, granular and usually dry, with some leaf litter and mosses (Aguraiuja 2001). *Diellia falcata*, currently the most successful *Diellia* species, is known from almost the entire length of the Waianae Mountains on Oahu, with 14 larger occurrences (40 to 2,000) and eight occurrences

smaller than 10 individuals (Service 1999a). Fronds bearing sori (spores) have been observed year-round (Service 1998b). Aguraiuja observed the Kahanahaiki population of *D. falcata* had significantly fewer sporelings and premature individuals and more mature individuals than expected and that the peak of gametophyte establishment and vegetative growth was in April. On the South-Palawai drainage, *D. falcata* occurred in small groups and various life stages, however, premature stages formed about 60 percent of the population (Aguraiuja 2001, Aguraiuja et. al. 2004). *Diellia falcata* hybridizes with *D. unisora* to form an endemic hybrid *D. lauii* which was described as locally common when found by J. Lau in 1991.

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

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

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

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

The primary constituent elements for these units include deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* sp., *Asplenium kaulfussii*, *Carex meyenii*, *Charpentiera* sp., *Claoxylon sandwicense*, *Coprosma foliosa*, *Diospyros hillebrandii*, *D. sandwicensis*, *Diplazium sandwichianum*, *Doodia kunthiana*, *Dryopteris unidentata*, *Elaeocarpus bifidus*, *Freycinetia arborea*, *Hedyotis terminalis*, *Hibiscus* sp., *Melicope* sp., *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Nephrolepis exaltata*, *Nestegis*

sandwicensis, *Nothocestrum* sp., *Pipturus* sp., *Pisonia sandwicensis*, *Pouteria sandwicensis*, *Psychotria* sp., *Psydrax odorata*, *Sapindus oahuensis*, *Selaginella arbuscula*, *Sophora chrysophylla*, or *Xylosma* sp. and elevations between 394 and 932 m (1,292 and 3,057 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Critical Habitat Description Critical habitat was designated for this species on Kauai on February 27, 2003, and on Oahu on June 17, 2003. A total of 1,020 ha (2,522 ac) in five separate

units has been designated for *Euphorbia haeleeleana*. Three units located on Kauai include 659 ha (1,630 ac), and two on Oahu total 370 ha (919 ac). Each unit on Kauai will provide habitat for two populations, one unit on Oahu provides habitat for one population, and the other Oahu unit provides habitat for three populations of *E. haeleeleana*. Each population will have a minimum of 300 mature, reproducing individuals (68 FR 9116; 68 FR 35950).

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

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 exclosure. Elsewhere in the action area, there is one mature individual in the Keawaula population unit and 34 reintroduced individuals in the Kahanahaiki Management Unit; neither management unit is fenced. *Euphorbia haeleeleana* plants in the action area are located in areas at risk from training-related wildfire. About 199 individuals occur in the high fire risk zone and 35 occur in the low fire risk zone. The individuals in high fire risk zones represent about 25 percent of the species' total range-wide number of mature individuals. Thus, *E. haeleeleana* in the action area is characterized by one occurrence that harbors more than 25 mature reproducing individuals that comprises 25 percent of all remaining individuals, all of which are located within the high to low risk fire zones, and by two occurrences with low numbers and unknown trends.

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 haeleeleana* in the action area. However, this species benefits from ecosystem-level management in the fenced Kaluakauila Management Unit where non-native ungulates and weeds are controlled.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 exclosure. The Army recently planted large *F. neowawraea* saplings in deep soil along a gulch bottom in the Kahanahaiki to Kapuna population unit. It is hoped the outplants will respond to this favorable environment with growth and vigor, and that hand-pruning of branches damaged by the black twig borer will allow the trees to mature and flower. The Army has submitted a research application to U.S. Geological Survey, Biological Resources Division for black twig borer research and is working with the University of Hawaii and the Hawaii Department of Agriculture to support research funding (U.S. Army Garrison 2005b). Genetic storage goals for *F. neowawraea* are less than one percent complete, with only four plants from three population units combined meeting the goals outlined in the Makua Implementation Plan. In addition, there are 11 plants growing in the Army nursery (U.S. Army Garrison 2005b).

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

Species Description *Gouania vitifolia* is a perennial vine in the Rhamnaceae (buckthorn family). It is a climbing shrub or woody vine with tendrils and elliptic, papery leaves that have

toothed or lobed margins. The leaves are 3 to 8 cm (1.2 to 3.2 in) long, with a moderate to dense covering of short soft hairs on both surfaces. Small white flowers are arranged in axillary spikes 0.8 to 7 cm (0.3 to 2.8 in) long. The winged fruits are 9 to 10 mm (0.4 in) long and contain small, dark, glossy seeds (Wagner et al 1999).

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

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

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

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

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

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

*Stabilization Population Units

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

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

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

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

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for 27 other plant target taxa in the Makua action area, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Army and the Service are developing a full stabilization plan for *Gouania vitifolia*, which will be

reviewed and approved by the Makua Implementation Team. In 2005, State-wide *ex situ* collections for this species included five cuttings in a nursery (Harold L. Lyon Arboretum), nine apical stems in micropropagation (Harold L. Lyon Arboretum), one plant in a botanical garden (Waimea Valley Audubon Center), 18 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and six seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

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

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

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

Environmental Baseline of the Species and Critical Habitat

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

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

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

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

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

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

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

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

Historic and Current Distribution *Hedyotis degeneri* var. *degeneri* is endemic to the northern Waianae Mountains of Oahu. Records indicate this taxon historically was known from Mt. Kaala in the northern Waianae Mountains, and was found primarily on the windward side of the range. *Hedyotis degeneri* var. *degeneri* in the Kahanahaiki area of Makua are the only ones recorded on the leeward side of the Waianae Mountains. It is estimated only one occurrence of six individuals of *H. degeneri* var. *degeneri* was known when the species was listed in 1991 (56 FR 55770). All except one of the known *H. degeneri* var. *degeneri* population units were discovered in the last eight years, so population trends are not yet evident (Makua Implementation Team 2003). More individuals were discovered in 2003, when there were five occurrences totaling 131-146 individuals. Since 2003 additional individuals have been discovered. Currently, there are 322 known individuals in two population units located on Federal, State, and private lands (Table SB 19) (U.S. Army Garrison 2005b). Two of these population units exceed minimum numerical criteria for stabilization population units (defined as 100 mature, reproducing individuals per population unit).

Trends in reproduction indicate that only about seven percent of all individuals are immature plants. Recruitment has been observed in good habitat of the Kahanahaiki to Pahole population unit, as seedlings become juvenile and then mature plants (U.S. Army Garrison 2005b). Thus, *Hedyotis degeneri* var. *degeneri* is characterized by four population units, one of which exceed minimum numerical criteria for stabilization population unit, and an overall increase in numbers due to discovery of new individuals. Even with the discovery of new individuals this species has a high risk of extinction due to the overall low population numbers and limited range.

Table SB 19. Range-wide Distribution of *Hedyotis degeneri* var. *degeneri*

Population Unit (PU)	**1991 (1)**	**1995-1998 (2)**	**2003 (3)**	**2004 (4)**	**2005 (5)**	**2006 (6)**
*Kahanahaiki	Unk	Unk	11	40/0	279/16	492/16

*Pahole	Unk	25	150			
*Alaiheihe and Manuwai	Unk	Unk	60	60/0	61/2	34/2
*Central Makaleha & W Branch of E Makaleha	Unk	1	47	47	33/10	33/10
E Branch of E Makaleha	Unk	Unk	10	10	13/9	10/0
Kamaileunu	6	6	0	0	0	0
Total PU's	1	3	5	4	386/37	561/44
Total Individuals	6	32	278	157	**= 423**	**= 615**

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

(1) Listing rule (61 FR 53098)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 Status update (U.S. Army Garrison 2005b)
(6) 2006 Status update (U.S. Army Garrison 2006c)

Ecology *Hedyotis degeneri* var. *degeneri* typically grows on upper gulch slopes and on ridge tops between elevations of 570 and 720 m (1,870 to 2,360 ft). It usually occurs in the understory of mesic forests dominated by *Diospyros sandwicensis* and/or *Metrosideros* species. *Hedyotis degeneri* var. *degeneri* also occurs where scrubby forests of the upper gulch slopes grade into shrubland on ridge crests. Flowering and fruiting has been recorded at various times of the year. The flowers are likely to be insect-pollinated, but dispersal agents for the fruits are unknown. The longevity of *H. degeneri* var. *degeneri* individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for *H. degeneri* var. *degeneri* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Hedyotis degeneri* var. *degeneri* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. At relatively high numbers, this taxon still needs protection from non-native ungulates and weeds to attain stabilization. Thus, *H. degeneri* var. *degeneri* has a high background risk of species extinction, and intensive management is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hedyotis degeneri* var. *degeneri* are described in the introduction to the "Status and

Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 100 mature, reproducing individuals are needed per population unit to exceed minimum numerical criteria for stabilization for short-lived perennials (Makua Implementation Team 2003). The Kahanahaiki subunit II portion of the Kahanahaiki to Pahole population unit is not fenced. The East Makaleha and Manuwai Management Units are not fenced; fence construction for these management units is scheduled for 2008 and 2012, respectively. Fencing these management units is needed to benefit East Branch of East Makaleha and part of the Alaiheihe and Manuwai population units, respectively. In addition, surveys to locate *H. degeneri* var. *coprosmifolia* should be conducted. Genetic material should be collected and any remaining individuals protected to determine whether this taxon represents a genetically distinct variety (Service 1998a).

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 schlechtendahliana*, and potentially could hybridize with these species. No outplantings of *H.s degeneri* var. *degeneri* have yet been attempted for this taxon. *Hedyotis degeneri* var. *degeneri* is represented in *ex situ* collections that include 10 cuttings in a nursery (Army Environmental Division, Oahu), 73 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 11,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and five seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b; U.S. Army Garrison 2005d).

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 need extensive research in order to understand why the species is declining and to reverse this alarming trend. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

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 Kawaiu population unit) is shorter (2 to 6 m (6.5 to 20ft) tall), branches near the ground to form a multi-trunked tree, and has moderately spiny to spineless stems. The recently discovered Makua type morphologically resembles *H. brackenridgei* ssp. *molokaiana*, which previously had been recorded only from West Molokai. The Makua type is a rambling shrub with branches that spread outward, not upwards as in the other two types, and has smaller leaves and no spines. For the purposes of the Makua Implementation Plan and this Biological Opinion, the target taxon consists of the various Oahu and Molokai occurrences of typical *H. brackenridgei* ssp. *mokuleianus* and typical *H. brackenridgei* ssp. *molokaiana*, and occurrences falling between these two morphological extremes (Makua Implementation Team 2003).

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 Kawaiu*	--	--	3/1	1/22	3/10	5/6
Kaimuhole and Palikea Gulch*	--	--	3/5	7/230	7/238	7/238
Kaumoku Nui	--	--	0/2	2/750	2/750	14/0
Kihakapu	--	--	1/2	6/316	6/373	6/373
Total Individuals	**6-8**	**153-203**	**62** (49/13)†	**1398** (72/1326)	**1472** (82/1390)	**669** (48/621)

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

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

Ecology *Hibiscus brackenridgei* ssp. *mokuleianus* on Oahu occurs on slopes, cliffs, and arid ledges in lowland dry forest and shrubland at elevations of 24 to 490 m (79 to 1,607 ft) (68 FR 35950). The Waialua type occurs in dry gulches, gulch bottoms, and lower to middle gulch slopes in mixed and native dry forest, and the Kealia type occurs on open ledges and bluffs in mixed native and alien grasses, shrubs, and trees (Makua Implementation Team 2003). The Makua type occurs in sites similar to the West Molokai site, on rocky slopes in areas that are drier and more open than any of the other Oahu sites, and in vegetation consisting of mixed native and alien shrubs and grasses. Wild plants of all types lose their leaves at the beginning of the summer dry season, usually by June, and remain dormant until new growth appears with the wet season, usually by October. The three Oahu types vary in growth rates and age at which cultivated plants begin to flower. Most of the cultivated Makua stock flowers at younger than 6 months; cultivated stock of the other types begin to flower at ages ranging from 6 months to 4 years. Flowering occurs from December through June. Flowers open in the afternoon and early evening and remain open until early the next morning, and are pollinated by sphinx or hawk months. Mature seed capsules are present from February through June, and seeds of cultivated plants may remain viable in garden soil for up to 15 years. In the wild, seedlings are often found at locations where no mature plants have been seen for many years. The longevity of *H. brackenridgei* ssp. *mokuleianus* plants in the wild is undocumented, but it is considered a short-lived species because wild populations appear to undergo large fluctuations in numbers (Makua Implementation Team 2003). Other demographic information for *H. brackenridgei* ssp. *mokuleianus* in the wild is unknown, including longevity, number of seeds produced, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Hibiscus brackenridgei* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. The Makua type of *H. brackenridgei* ssp. *mokuleianus* is particularly threatened by fire, weeds, and predation by the Chinese rose beetle and other insects (Makua Implementation Team 2003; U.S. Army Garrison 2005b). In addition, *H. brackenridgei* ssp. *mokuleianus* in areas near human habitation is threatened by hybridization and genetic contamination from the related, cultivated taxon *H. brackenridgei* ssp. *brackenridgei*, which is sold in commercial nurseries and does not occur naturally on Oahu or Molokai (Makua Implementation Team 2003). This taxon experiences large population fluctuations related to drought and its natural recruitment is severely reduced by feral ungulates and invasive weeds. Occurrences also are vulnerable to extirpation from naturally occurring events such as windstorms and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *H. brackenridgei* ssp. *mokuleianus* in the wild already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *H. brackenridgei* ssp. *mokuleianus* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hibiscus brackenridgei* ssp. *mokuleianus* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). At least 50 mature, reproducing individuals typically are needed in each of at least three population units to attain stabilization for short-lived perennials. However, species subject to common, large fluctuations in numbers may require a stabilization target of at least 100 mature individuals for each population unit. Due to the persistence of *H. brackenridgei* ssp. *mokuleianus* seeds in the soil seed bank, increasing the numerical criterion for stabilization is not warranted for this species. However, locations of historical occurrences should be surveyed for new regeneration from seed (Makua Implementation Team 2003). The Haiwi to Kawaiu population unit, and Kaimuhole and Palikea Gulch population unit, are stabilization population units located on private lands in remote, steep, invasive weed-dominated areas. The Army does not plan to manage these sites because they are not considered viable in the long-term. Instead of managing wild individuals in these population units, the Army proposes to establish reintroductions with stock from these population units in more manageable areas on Dillingham Military Reservation. In addition, the Army recently determined that the private landowner of land designated as the Kaimuhole Management Unit is unwilling to give permission for fence construction (U.S. Army Garrison 2006c). Therefore, the Army is seeking a replacement management unit and stabilization population unit for the Kaimuhole and Palikea Gulch population unit.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Hibiscus brackenridgei* ssp. *mokuleianus*, which are incorporated in

the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). One population unit for each of the three morphological types is being managed for stabilization (U.S. Army Garrison 2005b). In addition, this subspecies occurs in two management units where it will benefit from population unit and/or ecosystem-level protection. The management units are Haili to Kealia (subunits I and II), which is not fenced, and Lower Ohikilolo, which is fenced. Stock from three of the five wild population units has been established in *inter situ* and *ex situ* sites around Oahu. *Hibiscus brackenridgei* ssp. *mokuleianus* grows easily from cuttings, produces many flowers and seeds in a season, and there is good recruitment at *inter situ* sites. Much of the seed collected, however, is unviable (U.S. Army Garrison 2005b).

In 2005, additional current State-wide *ex situ* collections for the species *Hibiscus brackenridgei* included 10 vegetative buds in micropropagation (Harold L. Lyon Arboretum), 23 cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 83 plants in nurseries (Harold L. Lyon Arboretum and Volcano Rare Plant Facility), 229 plants in botanical gardens (Amy Greenwell Ethnobotanical Garden, Maui Nui Botanical Garden, and Waimea Valley Audubon Center), two ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 17,895 seeds in seed storage (Lyon Arboretum Seed Storage Facility and Maui Nui Botanical Garden), and three seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

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 amplectens*, *Chamaesyce* sp., *Diospyros hillebrandii*, *Dodonaea viscosa*, *Doryopteris* sp., *Erythrina sandwicensis*, *Heteropogon contortus*, *Lepidium bidentatum*, *Melanthera remyi*, *Pleomele halapepe*, *Psydrax odorata*, *Reynoldsia sandwicensis*, *Sida fallax*, or *Waltheria indica*. The primary constituent elements for the other unit on Oahu, for the Makua type, include dry shrublands at elevations of 32 to 490 m (105 to 1,607 ft) and containing one or more of the following associated native plant species: *Doryopteris* sp., *Dodonaea viscosa*, *Heteropogon contortus*, *Sida fallax*, or *Waltheria indica*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

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 – *Isodendrion laurifolium* (Aupaka)

Critical Habitat Description A total of 1,757 ha (4,342 ac) of critical habitat was designated for *Isodendrion laurifolium* in five separate units on Kauai and Oahu. Approximately 800 ha (1,979 ac) were designated on Kauai and 955 ha (2,362 ac) were designated on Oahu. Critical habitat has been designated on State (Kuia Natural Area Reserve and Alakai Wilderness Preserve on Kauai; Mokuleia, Waianae Kai, and Honolulu Watershed Forest Reserves, and Pahole and Kaala Natural Area Reserves on Oahu) and private lands. On Kauai, two units provide habitat for two populations each, and on Oahu, one unit provides habitat for four populations and two units provide habitat for one population of *I. laurifolium*. The recovery goal is that each population will be represented by a minimum of 300 mature, reproducing individuals (68 FR 9116, 68 FR 35950).

The primary constituent elements of the units on Oahu include gulch slopes, ravines, or ridges in diverse mesic or dry forest dominated by *Metrosideros polymorpha*, *Acacia koa*, *Eugenia reinwardtiana*, or *Diospyros sandwicensis* and containing one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *A. pulvinatum*, *Carex wahuensis*, *Charpentiera tomentosa*, *Doodia* sp., *Dryopteris unidentata*, *Hedyotis terminalis*, *Hibiscus arnottianus*, *Nestegis sandwicensis*, *Pisonia* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Sapindus oahuensis*, *Smilax melastomifolia*, or *Xylosma hawaiiense*, at elevations between 180 and 959 m (590 and 3,146 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral goats and pigs, competition with non-native plant species, and potential threats from military activities (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Four percent or 62 ha (153 ac) of the designated critical habitat for *Isodendrion laurifolium* is found in one unit within the Makua action area. The critical habitat unit is located in the northeastern portion of the action area and is in the area of low fire risk. This portion of the critical habitat in the action area, together with 554 ha (1,371 ac) outside the Makua action area, provides habitat for the conservation of four populations of *I. laurifolium*. It is estimated that more than one-half of the critical habitat is located in an area with 50 to 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area Threats to the critical habitat include military training; habitat degradation and/or destruction by feral goats and pigs; competition from non-

native plant species such as *Aleurites moluccana*, *Cordyline fruticosa*, *Grevillea robusta*, *Psidium cattleianum*, *Schinus terebinthifolius*, and *Toona ciliata*. In addition, rats, slugs, the black twig borer and the Chinese rose beetle impact native habitat (68 FR 35950).

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 exclosures are planned for the West Makaleha and Upper Kapuna Management Units. Non-native plants and ungulates are controlled within the West Makaleha and Upper Kapuna Management Units (K. Kawelo, pers. comm. 2004).

Status of the Critical Habitat – *Isodendrion longifolium* (Aupaka)

Critical Habitat Description A total of 2,127 ha (5,255 ac) of critical habitat has been designated for *Isodendrion longifolium* in seven separate units on Kauai and Oahu. Approximately 1,414 ha (3,488 ac) were designated in five units on Kauai and 714 ha (1,762 ac) in two units on Oahu. Critical habitat has been designated on State (Halelea Forest Reserve, Hono o Na Pali Natural Area Reserve, and, Kokee and Na Pali Coast State Parks) and private lands on Kauai and on private and State (Mokuleia Forest Reserve and Mt. Kaala Natural Area Reserve) lands on Oahu. On Kauai, one unit provides habitat for two populations and four units provide habitat for one population each, and, on Oahu, one unit provides habitat for three populations and one unit provides habitat for one population of *I. longifolium*. Each population is to be comprised of a minimum of 300 mature, reproducing individuals (68 FR 9116; 68 FR 35950).

The primary constituent elements of the units on Oahu include steep slopes or stream banks in mixed mesic or lowland wet *Metrosideros polymorpha-Dicranopteris linearis* forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* sp., *Bobea brevipes*, *Carex* sp., *Cyanea* sp., *Cyrtandra* sp., *Hedyotis terminalis*, *Isachne pallens*, *Melicope* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pittosporum* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Psychotria* sp., *Selaginella arbuscula*, or *Syzygium sandwicensis*, and elevations between 316 and 880 m (1,036 and 2,886 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

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 *Isodendrion longifolium* is located in one unit in the northeastern portion of the Makua action area in the low fire risk area. This portion of the critical habitat in

the action area, together with 551 ha (1,362 ac) outside the action area, provides habitat for the conservation of three populations of *I. longifolium.* It is estimated that the majority of the critical habitat is located in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area The primary threats to the critical habitat include habitat degradation or destruction by feral goats and pigs, a risk of habitat degradation from naturally occurring stochastic events, and fire caused by military training activities. Non-native plants such as *Ageratina riparia*, *Clidemia hirta*, *Oplismenus hirtellus*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Christella parasticia* outcompete the vegetative primary constituent elements to further degrade habitat quality and plant vigor (68 FR 35950).

Ongoing Conservation Actions for Critical Habitat Within the Action Area One hundred percent, 0.5 ha (1 ac), of the critical habitat is located within the West Makaleha Management Unit. Construction of a fence is planned for the West Makaleha Management Unit (K. Kawelo, pers. comm. 2004).

Status of the Critical Habitat – *Isodendrion pyrifolium* (Aupaka)

Critical Habitat Description A total of 535 ha (1,322 ac) of critical habitat was designated for *Isodendrion pyrifolium* in five separate units on three islands. Critical habitat was designated on State (e.g., West Maui Forest Reserve and West Maui Natural Area Reserve on Maui, and Nanakuli Forest Reserve on Oahu) and private lands. Each unit provides habitat for one or more populations, each with a minimum of 300 mature, reproducing individuals of *I. pyrifolium*. On Maui, 224 ha (555 ac) in one unit was designated to provide habitat for two populations; one unit of 107 ha (246 ac) was designated on Molokai to provide habitat for one population; and 233 ha (573 ac) in three units was designated to provide habitat, for one population each, on Oahu (68 FR 12982; 68 FR 25934; 68 FR 35950).

The primary constituent elements of the units on Oahu include bare rocky hills or wooded ravines in dry shrublands, and elevations from 37 to 692 m (121 to 2,270 ft). The plant community and elevation are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat on Oahu for this species are unknown as this species is no longer extant on this island (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Less than one percent, or 1 ha (3 ac), of the designated critical habitat for *Isodendrion pyrifolium* occurs within the Makua action area. This critical habitat unit provides habitat for the conservation of one population of *I. pyrifolium*. Located in the southwestern portion of the action area, the critical habitat is in both the high fire risk zone and low fire risk zones.

Threats to the Critical Habitat in the Action Area The primary threats to critical habitat in the action area are unknown; however, based on current information regarding general threats to plant critical habitat, feral ungulates, non-native plant species, and fire are all likely to be significant (K. Kawelo, pers. comm. 2004).

Ongoing Conservation Actions Within the Action Area Only two percent, or 0.03 ha (0.08 ac), of the critical habitat in the action area is in the Lower Ohikilolo Management Unit. This management unit is fenced and the Army is working to control non-native plants to reduce the risk of fire (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Lepidium arbuscula* (Anaunau)

Species Description *Lepidium arbuscula* is a short-lived perennial in the Brassicaceae (mustard) family. This species is a gnarled shrub, 0.6 to 1.2 m (2 to 4 ft) tall, with leaves crowded at the ends of the branches. The leaves are 2.6 to 6.0 cm (1.0 to 2.4 in) long and 0.8 to 1.8-cm (0.3 to 0.7 in) wide. The small white flowers form one to three erect simple racemes, 7 to 15 cm (2.8 to 5.9 in) long. The fruit is short and ovate to suborbicular in shape, and 3.5 to 4 mm (0.1 to 0.2 in) long and wide. The reddish brown seeds are 1.5 to 2.0 mm (0.1 in) long. *Lepidium arbuscula* is the only native *Lepidium* in the Waianae Mountains and is distinguished from others in the genus by its height (Wagner et al 1999).

Listing Status *Lepidium arbuscula* was federally listed as endangered on October 10, 1996, and State listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in 1998 (61 FR 53108; Service 1998a). Critical habitat was designated for this species on Oahu in 2003 (68 FR 35950).

Historic and Current Distribution Historically, *Lepidium arbuscula* was known from scattered localities throughout the Waianae Mountains. Currently, approximately 900 individuals in 10 small, widely dispersed occurrences are distributed from Kuaokala in the northern Waianae Mountains to Lualualei-Nanakuli Ridge in the southern Waianae Mountains. These occurrences include Ohikilolo, Makua-Keaau Ridge, Kapuhi Gulch, and Manini Gulch, Pahoa and Halona, northwest of Puu Kaua, Halona, Lualualei-Nanakuli Ridge, Kamaileunu Ridge, and Mohiakea Gulch (Table SB 23).

Table SB 23. Range-wide Distribution of *Lepidium arbuscula.*

Occurrences	**Number of Known Individuals**				
	1996 (1)	**1998-1999** (2)	**2003** (3)	**2003** (4)	**2005** (5)
Ohikilolo	--	--	--	1	10/0‡
Keeau	--	--	--	60	30/6
Lower Makua	--	--	--	--	1/0
Manini Gulch	<10	<10	--	1	--
Kuaokala	--	--	--	--	5/0

Mohiakea (SBW)	<10	<10	--	10	10/0
South of Pohakea Pass	--	--	--	--	50+
Pohakea Pass to Kolekole Pass	--	--	--	--	50+
Kamaileunu	--	--	--	--	50+
Total Individuals	**<900**	**<900**	**1000**	**906**	**900**

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

(1) Listing rule (61 FR 53089)
(2) Recovery plan (Service 1998a), Makua Endangered Species Mitigation Plan (U.S. Army Garrison 1999a)
(3) Critical habitat rule (68 FR 35950)
(4) Oahu Biological Opinion (Service 2003a)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Lepidium arbuscula* generally grows on exposed ridge tops and cliff faces in mesic and dry vegetation communities between 131 and 978 m (430 and 3,208 ft) in elevation. This species is typically associated with native plant species such as *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *C. wahuensis*, *Chamaesyce multiformis*, *Dodonaea viscosa*, *Dryopteris unidentata*, *Dubautia* sp., *Eragrostis variabilis*, *Leptecophylla tameiameiae*, *Lysimachia hillebrandii*, *Metrosideros polymorpha*, *Peperomia* sp., *Psydrax odorata*, *Rumex albescens*, *Schiedea ligustrina*, *Sida fallax*, or *Sophora chrysophylla*. *Lepidium arbuscula* has been observed in flower in February but little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Threats to the species *Lepidium arbuscula* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threats to *L. arbuscula* include loss of habitat and degradation of the remaining habitat by non-native plants and animals. Non-native plants compete with *L. arbuscula* for nutrients, light, and space. Feral goats threaten *L. arbuscula* by browsing on plants, trampling individuals, and causing general habitat destruction. The occurrences located on military land are threatened by fire caused by military training actions. The occurrence at the head of Kapuhi Gulch is also threatened by its proximity to a road (68 FR 35950).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Lepidium arbuscula* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *L.*

arbuscula is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Oahu action areas (Service 2003a).

The recovery plan for this species identifies several important conservation actions that should be implemented for the conservation *Lepidium arbuscula*. To reduce impacts from feral goats, exclosures or strategic barrier fences should be constructed around all the known occurrences of *L. arbuscula,* where feasible. Control or removal of goats from these areas and the broader landscape will alleviate their impact on native ecosystems. Non-native plants should be controlled or removed from the vicinity of all known occurrences of *L. arbuscula*. Occurrences that have only a few remaining individuals should be given priority to conserve genetic representation (Service 1998a).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Lepidium arbuscula*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Hawaii and Pacific Plant Recovery Coordinating Committee 2007). The National Tropical Botanical Garden has seeds of this species in storage. The Service is currently not aware of any other conservation efforts for this species (Service 2003a).

Environmental Baseline of the Species

Status of the Species in the Action Area Currently, approximately 10 percent, or approximately 125 individuals, of the known *Lepidium arbuscula* plants are found in the Makua action area. None of the occurrences in the action area have reached the minimum number (50) of mature, reproducing individuals threshold, as required for stabilization populations. However, the Holona occurrence, within the action area, is nearing this threshold with 45 mature individuals and 31 immature individuals. Four occurrences in the action area are within a fenced unit. These occurrences harbor approximately 110 individuals. The other four action area occurrences are not fenced and none of the action area occurrences are actively managed by the Army. *Lepidium arbuscula* plants in the action area are located in areas at risk from training-related wildfire; however all individuals occur in the low fire risk zone. Thus, *L. arbuscula* in the action area is characterized by seven population units, with the total number of individuals per population unit ranging from 3 to 76 (all with fewer than 50 mature, reproducing individuals) and all of which are located within low fire risk zones.

Threats to the Species The primary threats to *Lepidium arbuscula* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The major threats to *L. arbuscula* are fire from military training activities, competition with non-native plants, and habitat degradation and/or destruction by feral goats (Service 1999b).

Conservation Needs of the Species Pursuant to the guidelines established in the Makua Implementation Plan, *Lepidium arbuscula* will not be stabilized because there are at least three stabilization population units known to exceed minimum numeric criteria outside of the Makua action area. However, the Oahu Implementation Team will review the status of this species to

determine if any species-specific conservation actions are needed, such as collection for genetic storage. *Lepidium arbuscula* would benefit from additional conservation actions such as fencing, ungulate removal, reduction of non-native plant species, and control of wildfires (Service 2003a and 1999b). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

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 exclosures for the West Makaleha and Upper Kapuna Management Units is planned. The Army currently controls non-native plants and ungulates within the Pahole, West Makaleha, and Kahanahaiki management units (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Melanthera tenuifolia* (Nehe)

Species Description *Melanthera tenuifolia* is a short-lived perennial herbaceous plant in the Asteraceae (sunflower) family. The main stems can grow several meters long and may rest on the ground or on other plants, and roots sprout along the undersides of the stems. The leaves are oppositely arranged in pairs but appear whorled owing to the three-parted, palmately compound, finely dissected leaflets. Each leaflet is 3 to 8.5 cm (1.2 to 3.3 in) long. The yellow flower heads are borne at the branch tips singly or in clusters of two, and consist of 8 to 10 ray florets and 20 to 30 disk florets per head. The winged achenes (a type of dry, closed fruit) are 1.8 to 2.6 mm (0.07 to 0.1 in) long (Wagner et al 1999; 56 FR 55770).

Listing Status *Melanthera tenuifolia* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). This species was formerly classified and listed as *Lipochaeta tenuifolia*. The taxonomic change to *Melanthera tenuifolia* is cited in the "Supplement to the *Manual of the Flowering Plants of Hawaii*" (Wagner and Herbst 2003). The status of *Melanthera tenuifolia* is identical to that of *Lipochaeta tenuifolia*, the federally listed taxon.

These population units are found on Federal and State lands (68 FR 35950). Five of the six existing population units are exceeding minimum numerical criteria for a stabilization population unit (defined as at least 50 mature, reproducing individuals for short-lived perennials).

Survey data of *Melanthera tenuifolia* since it was listed in 1991 indicate significant increases in the total range-wide number of individuals, due in large part to enhanced reproduction and recruitment in managed sites. However, a 25 to 31 percent decrease in overall numbers seems to have occurred since 2003. *Melanthera tenuifolia* reproduces both vegetatively and sexually, and both vegetative clones and seedlings are commonly observed. Vegetative reproduction creates identical adjacent plants, so monitoring results are based on individuals identified as plant material at least 2 m (6.6 ft) apart (U.S. Army 2005b). Plants in the Kahanahaiki, Kaluakauila, Keawaula, and the three Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *M. tenuifolia* is characterized by six population units, of which five are exceeding minimum numerical criteria for stabilization population, overall increasing trends in numbers since listing and decreasing trends over the short-term since 2003.

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 stabilitzation. The eastern part of the Kamaileunu and Waianae Kai population unit is located in an area that will be protected by the Makaha Management Unit fence scheduled for construction in 2007 thru 2009. The Mt. Kaala Natural Area Reserve population unit is not fenced but is regularly controlled for goats (U.S. Army Garrison 2005b). In addition, about 1,367 individuals (42 percent of all remaining individuals) of this species occur in five management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Kaluakauila, Lower Ohikilolo, and Ohikilolo, which are fenced; and Makaha (subunit I) and Manuwai, which are not fenced.

Cuttings of *Melanthera tenuifolia* root easily with moderate success (50 to 75 percent success rate). Vegetative clones of plants from fire-threatened sites are prioritized for greenhouse genetic storage (U.S. Army Garrison 2005b). Seed is difficult to collect because of unpredictable fruiting seasons and site inaccessibility. Although seed from clones appears viable, it does not germinate; research is needed to determine how to overcome seed dormancy for feasible outplanting techniques. Current *ex situ* collections for this species include apical and lateral buds in micropropagation (Harold L. Lyon Arboretum), 13 cuttings in a nursery (Harold L. Lyon Arboretum), three plants in a botanical garden (Waimea Valley Audubon Center), one ungerminated seed in a nursery (Harold L. Lyon Arboretum), and 5,700 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 209 ha (516 ac) of critical habitat, in three separate units, was designated for *Melanthera tenuifolia* on State lands (Makua-Keaau and Waianae Kai Forest Reserves, and Kaala Natural Area Reserve) on Oahu. Overall, these units provide habitat to support four populations. To meet recovery goals, a population should be represented by at least 50 mature, reproducing individuals of *M. tenuifolia* (68 FR 35950).

The primary constituent elements of critical habitat include ridge tops or bluffs in open areas or protected pockets of dry to mesic forests or shrublands or forests dominated by *Diospyros sandwicensis*, at elevations between 110 and 978 m (361 and 3,208 ft). In addition, all units

contain one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *Diospyros* sp., *Dodonaea viscosa*, *Doryopteris* sp., *Dubautia* sp., *Eragrostis* sp., *Myoporum sandwicense*, *Osteomeles anthyllidifolia*, *Psydrax odorata*, *Reynoldsia sandwicensis*, *Rumex* sp., *Sapindus oahuensis*, *Santalum* sp., or *Schiedea* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Fire has severely degraded habitat in population units on Makua where critical habitat has not been designated; critical habitat within the action area but outside the installation is also threatened by fire.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 47 percent of all known individuals of *Melanthera tenuifolia* are located within the action area, in the Ohikilolo, Kahanahaiki, Kaluakauila, and Keawaula population units (see Table SB 25). All but the Keawaula population units have exceeded minimum numerical criterion for stabilization population units, of at least 50 mature, reproducing individuals for short-lived perennials. However, threats are not controlled and genetic storage goals are not complete, so these population units are not considered fully stabilized (U.S. Army Garrison 2005b). Overall numbers in the Ohikilolo and Kahanahaiki population units have decreased from 2,016 individuals in 2003 to 1,243 in 2005 (Ohikilolo), and from 300 in 2003 to 81 in 2005 (Kahanahaiki). Overall numbers in the Kaluakauila and Keawaula population units have increased from 113 to 124 and from 40 to 60, respectively, during that same time period. Plants in the Kahanahaiki, Kaluakauila, Keawaula, and Ohikilolo population units are located in fire risk zones. Approximately 223 individuals occur in the high fire risk zone, 1,285 individuals in the low fire risk zone. These individuals at risk from fire in the action area represent about 53 percent of the species' total range-wide numbers. The Ohikilolo population unit is located within the Lower Ohikilolo and Ohikilolo management units on Makua, along the steep south wall of Makua valley. The Army has not systematically monitored this population unit, but incidental observations indicate *M. tenuifolia* is returning to habitat where it had been extirpated by goats (U.S. Army Garrison 2005b). The Ohikilolo Makai site contains plants in an extremely dry, low elevation (122 m; 400 ft) that may represent a distinct ecotype (U.S. Army Garrison 2005b). The Kaluakauila population unit is located within the Kaluakauila Management Unit on the north side of Makua Valley on Makua. The Kahanahaiki population unit is located in the C-ridge vicinity of Makua, and the Keawaula population unit is located within the action area north of the installation boundary; these population units are not located within management units. Thus, *M. tenuifolia* in the action area comprises 53 percent of all remaining individuals and is characterized by three population units exceeding minimum numerical criteria for stabilization population units and one population unit near minimum numerical criteria for a stabilization population unit, located within high through the low to very low fire risk zones.

Status of the Critical Habitat in the Action Area The action area contains a total of 67 ha (166 ac), or 32 percent, of the total critical habitat for *Melanthera tenuifolia*. Part of one critical habitat unit is located on State land in the south-central part of the action area. This area is part

of a critical habitat unit totaling 67 ha (166 ac) that extends beyond the action area and provides potential habitat to support one population of 300 mature, reproducing individuals, that is currently occupied. Approximately 8 ha (19 ac) of designated critical habitat is in the low fire risk zone and 60 ha (147 ac) are in the very low fire risk zone. About 32 percent of the total critical habitat designated for this species is located in an area at risk from training-related wildfire in the action area. It is estimated that almost all the critical habitat is in areas of less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

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 exclosure fence and by grass control within forest patches to minimize the spread of fire. About 42 percent of the critical habitat in the action area is within fenced management units. Genetic storage goals for *M. tenuifolia* are seven percent complete, with 21 plants from all six population units combined meeting the goals of the Makua Implementation Plan. There are currently 73 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Critical Habitat – *Melicope pallida* (Alani)

Critical Habitat Description A total of 1,774 ha (4,385 ac) of critical habitat was designated for *Melicope pallida* in seven separate units on Kauai and Oahu. Five critical habitat units were designated on Oahu encompassing 1,321 ha (3,265 ac). Each unit provides habitat for one or more populations, each comprised of at least 100 mature, reproducing individuals of *M. pallida*. One unit on Oahu provides habitat for three populations, one unit provides habitat for one population, and two units combined will provide habitat for one population of *M. pallida*. Critical habitat has been designated on Federal (Lualualei Naval Reservation on Oahu), State (Alakai Wilderness Preserve and Na Pali Coast State Park on Kauai; Mokuleia Forest Reserve, Kaala and Pahole Natural Area Reserves on Oahu) and private (Honouliuli Preserve) lands (68 FR 9116; 68 FR 35950).

The primary constituent elements of these units include steep rock faces in lowland dry or mesic forests and containing one or more of the following associated native plant species: *Abutilon sandwicense*, *Acacia koa*, *Alyxia oliviformis*, *Bobea elatior*, *Cibotium* sp., *Dryopteris* sp., *Metrosideros polymorpha*, *Pipturus albidus*, *Psychotria mariniana*, *Sapindus oahuensis*, *Syzygium sandwicensis*, *Tetraplasandra* sp., *Wikstroemia oahuensis*, or *Xylosma hawaiiense*, and elevations between 234 to 841 m (768 to 2,758 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat include the black twig borer, the Chinese rose beetle, wildfire, habitat degradation by feral pigs and non-native plants, and stochastic events (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Two percent (28 ha; 69 ac) of the designated critical habitat for *Melicope pallida* is located in one unit within the northeastern portion of the Makua action area in an area of low fire risk. This portion of the critical critical habitat unit within the action area along with 826 ha (2,042 ac) outside of the action area provides habitat for

the conservation of three populations of *M. pallida*. It is estimated that more than one-half of the critical habitat is in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area The major threats to the primary constituent elements of the critical habitat include the black twig borer, fire from military training activities, habitat degradation by feral pigs, and stochastic events. Non-native plants, especially *Andropogon virginicus*, *Clidemia hirta*, *Psidium cattleianum*, *Pterolepis glomerata*, and *Toona ciliata*, compete with associated native plants for light, space, and nutrients. In addition, predation of associated native plants by rats, slugs and the Chinese rose beetle threaten critical habitat (68 FR 35950).

Ongoing Conservation Actions for the Critical Habitat Within the Action Area Sixty-eight percent (19 ha; 47 ac) of the critical habitat in the action area is in Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha Management Units. The Army currently controls non-native plant species in the West Makaleha Management Unit. Construction of additional fence exclosures is planned for the Upper Kapuna and West Makaleha Management Units (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Neraudia angulata* (No Common Name)

Species Description *Neraudia angulata* is a short-lived shrub in the Urticaceae (nettle family). It is an upright shrub up to 3 m (9.8 ft) tall with alternately arranged leaves 7 to 15 cm (2.7 to 5.9 in) long. The undersides of the leaves are usually covered with hairs, and the leaf margins are sometimes toothed. The flowers are borne in axillary clusters, and the species is dioecious (with male and female flowers on separate plants). Many cultivated plants, however, have both male and female flowers (Makua Implementation Team 2003). The mature fruit is small and seed-like, and is enclosed in a red, fleshy calyx (Wagner et al 1999).

The taxonomy of *Neraudia angulata* is in need of further study. There are two recognized varieties of *N. angulata*: var. *angulata* and var. *dentata*. Variety *angulata* is characterized by leaf undersides with hairs lying close to the leaf surface in a silvery sheen, and by leaf margins that are not toothed. Variety *dentata* has leaf undersides with hairs projecting out from the leaf surface, and some plants have some leaves with toothed leaf margins. The two varieties reportedly can be found growing near one another, yet remain distinct entities. Occurrences also have been found that apparently do not represent either strict var. *dentata* or strict var. *angulata* (Makua Implementation Team 2003).

Listing Status *Neraudia angulata* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Both varieties of *N. angulata* are included in the listed taxon.

Historic and Current Distribution The genus *Neraudia* is endemic to the Hawaiian Islands. Historic data indicate *Neraudia angulata* occurred throughout the Waianae Mountains of Oahu

(56 FR 55770). Assessment of long-term population trends is difficult because of the tendency of *N. angulata* occurrences to fluctuate in size and it has only been monitored with any diligence since 2003. When the species was listed in 1991, only five occurrences totaling 15 individuals were known. Since then, more occurrences have been discovered, but the number of sites was still thought to be diminishing in 2003 (Makua Implementation Team 2003). With the initiation of intensive population unit and habitat management in 2003, numbers of individuals have increased. Currently, *N. angulata* occurs in nine population units totaling approximately 380 individuals (Table SB 26). These population units are found on Federal, State, city/county, and private lands (68 FR 35950). None of the existing population units has met minimum numerical criteria for stabilization (defined for this species as at least 100 mature, reproducing individuals). Occurrences of *N. angulata* var. *dentata* are found in the Kapuna population unit, and were formerly found in the Manuwai population unit (all individuals within the Manuwai population unit are now dead; U.S. Army Garrison 2006c). In addition, a new occurrence of one var. *dentata* plant was discovered at Punapohaku on Makua, and is the only known leeward Waianae plant of this variety (U.S. Army Garrison 2005b).

Since consistent monitoring efforts began in 2003, three population units have increased in numbers, five have decreased or remained nearly the same, and one has disappeared. The most robust population units of *Neraudia angulata* are at Waianae Kai Makai and Waianane Kai Mauka, on State land. However, the apparent increases in these population units are due to discovery of plants in new areas htrough more diligent survey efforts (U.S. Army Garrison 2005b). The Makua population unit has increased due to habitat protection and population augmentation. The Halona and Makaha population units have decreased substantially. These decreases have occurred in the number of both mature and immature plants. In general, *N. angulata* tends to experience large declines or fluctuations in population size. Plants in the Kaluakauila, Makua, and Punapohaku population units are located in high and low risk fire zones for training-related wildfire. Thus, *N. angulata* is characterized by low numbers in nine population units not meeting minimum numerical criterion for stabilization, an overall increase in abundance due primarily to discovery of new individuals and augmentation, and population unit individual numbers that range from increasing to decreasing to little change.

Table SB 26. Range-wide Distribution of *Neraudia angulata*.

Population Units	Numbers of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kalauakauila*	--	--	--	--	0/0 [13/0]	0/0 [27/0]
Kapuna	--	--	1/0‡	1/0	1/0	2/0
Makua*	--	--	29/2	12/61 [0/20]§	14/67 [15/19]	40/6 [4/0]
Punapohaku	--	--	--	--	1/0	1/0
Halona	--	--	15/0	15/0	8/0	30/4
Leeward Puu Kaua	--	--	3/0	2/0	3/0	4/0
Makaha	--	--	56/14	7/4	16/1	16/1
Manuwai*	--	--	12/0	0/2	1/0	0/0

Waianae Kai Makai	--	--	4/0	46/35	46/35	46/60
Waianae Kai Mauka*	--	--	21/25	49/4	49/54	57/82
Total Individuals	**15**	**110**	**182** (141/41)[†]	**258** (132/106) [0/20]	**343** (139/157) [28/19]	**380** (196/153) [31/0]

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Neraudia angulata* is found in dry forests and shrublands, and occasionally in mesic forests and shrublands, at elevations of 189 to 978 m (620 to 3,208 ft) (Makua Implementation Team 2003; 68 FR 35950). Plants occur on gulch slopes, on steep to nearly vertical cliffs and cliff ledges, in the forest understory, and among shrubs and grasses in exposed areas (Makua Implementation Team 2003). Plants may lose all their leaves during the dry summer months (U.S. Army Garrison 2005b). *Neraudia* species are wind-pollinated (Wagner *et al* 1999), and flowering and fruiting occur throughout the year. The red, fleshy calyx surrounding the mature fruit suggests that fruit-eating birds may disperse the seeds. The longevity of *N. angulata* is probably similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). This dioecious species is subject to large declines or fluctuations in population size. Other demographic information for *N. angulata* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Neraudia angulata* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. This species is particularly threatened by fire. In addition, occurrences of *N. angulata* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a). *Neraudia angulata* tends to fluctuate widely in population size, and any catastrophic disturbance during a major low point could extirpate one or more population units or result in the extinction of the species in the wild (Makua Implementation Team 2003). Thus, *N. angulata* has a very high background risk of species extinction and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Neraudia angulata* are described in the introduction to the "Status and

Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. However, species subject to common, large fluctuations in numbers may require a stabilization target of at least 100 mature individuals for each population unit. The minimum population size was increased for this species also because fertilization and seed set of dioecious plants require more reproducing individuals of both male and female plants within pollination range that are flowering at the same time (Makua Implementation Team 2003).

All varieties of *Neraudia angulata* should be, and are being, conserved in the wild. The Kapuna and Punapohaku (and formerly the Manuwai) population units contain plants of var. *dentata* (U.S. Army Garrison 2005b). Because the habitat at these sites is degraded by ungulates and invasive weeds, this stock will be used to reintroduce plants in appropriate habitat in the Kaluakauila Management Unit on Makua. The Makaha and Waianae Kai population units contain stock that is intermediate between var. *angulata* and var. *dentata*. If pure var. *angulata* plants are found, the Army recommends that a fourth population unit be managed for stabilization to conserve that variety (U.S. Army Garrison 2005b). However, because the taxonomy of *N. angulata* is still not well understood, outplanting must proceed with caution to avoid compromising the genetic integrity of the varieties, populations, and potential ecotypes currently included within *N. angulata* (Makua Implementation Team 2003).

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
Kalauakauila*	--	--	200-400	200/0	198/35	198/35
Keaau	--	--	21/31‡	21/31	21/31	21/31
Keawaula	--	--	200/30	200/30	138/5	138/5
Makua (east rim)	--	--	1	1/0	0/0	0/0
Makua* (south side)	--	--	120-140	56/1	56/19	56/1 [16/0]§
Punapohaku	--	--	--	152/14	302/21	302/21
Kaimuhole & Palikea Gulch (Kihakapu)*	--	--	48/6	8/3	58/7	58/7
Kealia	--	--	3	3/0	3/0	0/0
Keawapilau	--	--	9/1	5/0	5/0	5/0
Kolekole (east side)	--	--	13	13/0	12/0	12/0
Makaha*	--	--	159	159/0	16/3	16/3
Nanakuli	--	--	5	5/0	5/0	5/0
Puu Kaua (leeward)	--	--	12	12/0	12/0	12/0
Waianae Kai*	--	--	200-320	200/0	224/5	224/5
Lualailua, Maui	--	--	--	--	--	--
Other Surveyed Locations						6/45
Total Individuals	**1500-3000**	**1489-1610**	**1199-1539**	**1148** (1067/81)†	**1210** (1084/126)	**1256** (1087/153) [16/0]

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c), Army 2006 database (U.S. Army Garrison 2006d)

Ecology *Nototrichium humile* is found on gulch slopes and gulch bottoms in the understory of dry forests dominated by *Diospyros sandwicensis* or *Sapindus oahuensis*, dry shrublands near ridge tops, and open dry cliffs and cliff ledges sparsely vegetated with shrubs and grasses. Small groups or isolated plants sometimes occur in mesic habitats. On cliffs, *N. humile* is somewhat protected from feral ungulates, invasive alien weeds, and fire. This species usually is found on north-facing slopes at elevations of 60 to 700 m (197 to 2,298 ft) (Makua Implementation Team 2003). Flowering in *N. humile* is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering. Pollination vectors for this species are not known, nor is it known if the plants are self-compatible. Based on observations of particular individuals, the plants live for at least one or two decades (Makua Implementation Team 2003). Other demographic information for *N. humile* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Nototrichium humile* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. This species is one of the more fire-endangered species at Makua because of its occurrence in the lower, drier reaches of the Waianae Mountains (Makua Implementation Team 2003). Thus, although almost half of its 16 population units have exceeded minimum numerical criteria for stabilization population units, *N. humile* has a high background risk of species extinction, and ongoing stabilization management is needed to protect it from existing and additional threats and ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Nototrichium humile* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Nototrichium humile*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Four population units of *N. humile* are being managed for stabilization. In addition, about 693 individuals (approximately 53 percent of all remaining individuals) of this species occur in six management units where they will benefit from population unit and/or ecosystem-level protection. The management units include the Kahanahaiki, Kaluakauila, and Ohikilolo, which are fenced; and the Kaimuhole, Makaha, and Waianae Kai Management Units, which are not fenced.

Seed collection from *Nototrichium humile* is difficult and germination rates are very low; most fruit tested have no seeds. A major part of genetic storage is maintained in the greenhouse from cuttings, which have a 70 percent success rate (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 384 cuttings in a nursery (Army Environmental Division, Oahu), 10 plants in botanical gardens (Amy Greenwell Ethnobotanical Garden and Waimea

Valley Audubon Center), and 3,700 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 900 ha (2,224 ac) of critical habitat, in five separate units, was designated for *Nototrichium humile* on Oahu and Maui. On Oahu, 502 ha (1,241 ac) of critical habitat was designated in four units on State lands (Kaena State Park, Pahole Natural Area Reserve, and Kuaokala, Mokuleia, and Waianae Kai Forest Reserves), and on private lands. Overall, the four units on Oahu provide habitat to support six populations. On Maui, one unit on State and private lands was designated to provide habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *N. humile* (68 FR 35950).

The primary constituent elements of critical units on Oahu include cliff faces, gulches, stream banks, or steep slopes in dry or mesic forests often dominated by *Diospyros sandwicensis* or *Sapindus oahuensis*, at elevations between 185 and 806 m (607 and 2,644 ft). In addition, all Oahu units contain one or more of the following associated native plant species: *Abutilon sandwicense*, *Alyxia oliviformis*, *Antidesma pulvinatum*, *Artemisia australis*, *Bidens cervicata*, *Canavalia* sp., *Carex wahuensis*, *Charpentiera* sp., *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Erythrina sandwicensis*, *Eugenia reinwardtiana*, *Hibiscus* sp., *Melanthera tenuis*, *Metrosideros polymorpha*, *Myoporum sandwicense*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Peperomia* sp., *Pisonia umbellifera*, *Pleomele* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Reynoldsia sandwicensis*, *Sicyos* sp., *Stenogyne* sp., *Streblus pendulinus*, or *Syzygium sandwicensis*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 858 individuals, or 68 percent of all known individuals of *Nototrichium humile*, are located within the action area in seven population units (see Table SB 27). Five of these action area population units have exceeded minimum numerical criteria for a stabilization population (at least 25 mature, reproducing individuals). Four population units (including three that have exceeded minimum numerical criteria for a stabilization population) have declined in numbers since 2003, and two population units have more or less maintained their numbers. Only the Punapohaku population unit has increased in numbers since 2004, since it was first discovered. The Kaluakauila population unit is located within the Kaluakauila Management Unit, the Makua population units are located within the Ohikilolo Management Unit, and the Kahanahaiki population unit is located within the Kahanahaiki Management Unit; these three management units are fenced. Survivorship of 18 augmented plants in the Makua population unit is about 83 percent so far (U.S. Army Garrison 2005b). The Kahanahaiki, Keaau, Keawaula, and Punapohaku population units are not located within management units or fences. All action area individuals are located in fire risk zones. About 566 individuals occur in the high fire risk zone, 193 individuals occur in the low fire risk

zone and 139 in the very low risk zone. Thus, *N. humile* in the action area consists of approximately 70 percent of the total remaining individuals of this species and occurs in seven population units, five of which have exceeded minimum numerical criteria for a stabilization population and four (including three of the stabilization population units) of which are declining in numbers, with the majority (44 percent) within the high fire risk zone.

Status of the Critical Habitat in the Action Area The action area contains a total of about 6 ha (16 ac) or slightly more than one percent of the total critical habitat for *Nototrichium humile* on Oahu, or slightly less than one percent of the State-wide total. Critical habitat is located within one unit in the northwestern part of the action area (within the Kaluakauila Management Unit) in an area of high fire risk. This area is part of a critical habitat unit totaling 5 ha (13 ac) that extends beyond the action area and provides habitat for one population of 300 mature, reproducing individuals. There is less than one percent of another 1 ha (3 ac) critical habitat unit that all falls within the action area. This unit is in the very low fire risk zone.

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Nototrichium humile* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Nototrichium humile* in the action area is especially vulnerable to wildfire resulting from military training activities. Fires have already destroyed or damaged portions of *N. humile* habitat within the action area. The July 2003 prescribed fire, for example, burned about 2.4 ha (6 ac) of *N. humile* critical habitat on State land in the Kaluakauila population unit, and about five plants were destroyed in the Punapohaku population unit. The fire also burned to within 40 m (131 ft) of *N. humile* plants on C-Ridge (U.S. Army Garrison 2003b). About two percent of the total State-wide critical habitat for this species is located in fire risk zones in the action area. Thus, because about 80 percent of all known individuals occur within the action area in zones of high to low fire risk, *N. humile* in the action area has a high background risk of species extinction, and major effort is needed to protect it from existing and any additional threats to its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Nototrichium humile* because more than 50 percent of the total remaining individuals are located within the action area. Four population units have been identified for stabilization of *N. humile*: Kaluakauila and Makua (south side) in the action area, and Kaimuhole and Palikea Gulch and Waianae Kai outside the action area. Although there are five stabilization populations which exceed minimum numerical criteria within the action area and two outside the action area, stabilization is not achieved because threats are not controlled and genetic storage goals are not complete. The Army does not expect to augment stabilization population units because of relatively high existing numbers of mature individuals (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed where this species is located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. In the action area, approximately 205 individuals of *N. humile* are in fenced units and 600 individuals are not in fenced units. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The seven population units in the action area contain approximately 70 percent of the total remaining individuals of *Nototrichium humile*. The Kaluakauila and Makua (south side) population units within the action area are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, population units are located within the fenced Kahanahaiki, Kaluakauila, and Ohikilolo Management Units (the Makua south-side population unit is located within the Ohikilolo Management Unit). Goats have been virtually eradicated from Makua in general (U.S. Army Garrison 2005b). The Kaluakauila population unit also is protected by a management unit pig exclosure fence and by grass control within forest patches to minimize the spread of fire. In addition, fuels are controlled along the ridgeline between the management unit and the installation boundary to form a fuelbreak (Service 2004). Genetic storage goals for *N. humile* are under one percent complete, with 48 plants from all 16 population units combined not yet meeting the goals of the Makua Implementation Plan. There are also currently 65 plants growing in the Army nursery (U.S. Army Garrison 2005b). Priority Army greenhouse space for this species is for plants from fire-threatened population units.

Status of the Species – *Peucedanum sandwicense* (Makou)

Species Description *Peucedanum sandwicense*, a short-lived perennial and member of the Apiaceae (parsley) family, is a parsley-scented, sprawling herb. Hollow stems arise from a short, vertical, perennial stem with several fleshy roots. The compound leaves are generally three-parted with stalkless leaflets, each egg- or lance-shaped and toothed. The larger terminal leaflet is usually one- to three-lobed and 7 to 13 cm (2.8 to 5.1 inches) long. The other leaflets have leaf stalks 10 to 50-cm (4 to 20 inches) long or are stalkless. Flowers are clustered in a compound umbel of 10 to 20 flowers. The round petals are white and bent inward at the tips. The flat, dry, oval fruits are 10 to 13 mm (0.4 to 0.5 inches) long and 5 to 8-mm (0.2 to 0.3 inches) wide, splitting in half to release a single flat seed. This species differs from the other Kauai members of the parsley family in having larger fruit and pinnately compound leaves with broad leaflets. This species is the only member of the genus on the Hawaiian Islands (Wagner et al 1999).

Listing Status *Peucedanum sandwicense* was federally listed as threatened on February 25, 1994, and State listed as threatened in Hawaii at the same time. A recovery plan was prepared for this species in September 1995 (Service 1995b). Critical habitat was designated in 2003 on Kauai, Molokai, Maui, and Oahu (68 FR 9115; 68 FR 12982; 68 FR 25934; 68 FR 35950).

Historic and Current Distribution Historically, *Peucedanum sandwicense* is known from Molokai, Maui, and Kauai, and discoveries in 1990 extended the known distribution of this species to Oahu. Currently there are a total of 1,000 to 5,000 individuals in 18 occurrences. On Oahu, there are roughly 100 individuals in four occurrences on State, city, and county lands in Keaau Valley, Puu Kawiwi, Waianae Kai, and Kamaileunu Ridge. One occurrence of 20 to 30 individuals is known from State-owned Keopuka Rock, an islet off the coast of Maui. On Molokai, three occurrences totaling fewer than 30 individuals are found on private and State-owned land in Pelekunu Preserve, Kalaupapa National Historical Park, and Huelo, an islet off the

coast of Molokai. The 10 Kauai occurrences are distributed in Waimea Canyon and along the Na Pali Coast within 2.4 km (1.5 mi) of the ocean (Service 1999b; 68 FR 35950). It is also difficult to assess changes in the abundance *P. sandwicense*. However, the total number of individuals on Oahu appears to be relatively stable from the time the species range-wide abundance was first estimated in 1991. Similarly, the overall number of individuals of this species appears to relatively stable on the other islands where it occurs (Maui, Molokia and Kauai) (Table SB 28).

Table SB 28. Range-wide Distribution *Peucedanum sandwicense.*

Occurrences	**Number of Known Individuals**					
	1991 (1)	**1995** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Keaau	--	--	20	--	24	--
Waianae Kai	85	85	79	51	79	16/5‡
Total Population Units on Oahu	1	2	2	4	2	1
Total Individuals on Oahu	**85**	**85**	**99**	**51**	**103**	**21** (16/5)†
Total Population Units State-wide	21	16	16	--	21	--
Total Individuals State-wide	**265-355**	**1000-5000**	**1000-5000**	--	**1153-5163**	--

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

(1) Listing rule (56 FR 55770)
(2) Waianae and Kauai Recovery Plan (Service 1995a, 1995b)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR 35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Peucedanum sandwicense* grows in cliff habitats from sea level to above 900 m (3,000 ft) and is associated with native species such as *Artemisia australis, Chamaesyce* sp., *Diospyros sandwicensis, Eragrostis variabilis*, and *Metrosideros polymorpha*. Little is known about the life history of *P. sandwicense*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1999b).

Threats to the species *Peucedanum sandwicense* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threats to *P. sandwicense* are habitat degradation and browsing by feral ungulates, trampling by hikers and landslides. Non-native plants compete with *P. sandwicense* for light, space, and nutrients (U.S. Army Garrison 2005c). Based on the fact

there are only a very few individuals remaining on the island of Oahu, *P. sandwicense* has a high background risk of extirpation from the island of Oahu and any additional threats could reduce expectation of its long-term persistence on the island. However, there is only a moderate risk of background extinction for this species State-wide as there are several thousand individuals on Kauai.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Peucedanum sandwicense* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *P. sandwicense* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Schofield Barracks action areas (Service 2003a). The recovery plan for this species identifies several important conservation actions including fencing, weed control, maintenance of adequate genetic material and outplanting of local genetic material (Service 1995b).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Peucedanum sandwicense*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Hawaii and Pacific Plants Recovery Coordinating Committee 2007). Plants and seeds of *P. sandwicense* are currently held at the following institutions: Harold L. Lyon Arboretum, Pahole Mid-Elevation Rare Plant Facility, and the Waimea Arboretum. The Service is unaware of any other specific conservation actions for this species (Service 1999b; L. Durand, pers. comm. 2004).

Environmental Baseline of the Species

Status of the Species in the Action Area There are approximately 25 individuals *Peucedanum sandwicense* within the Makua action area. However, the exact number is not known because the Army does not actively monitor this species. *Peucedanum sandwicense* is a short-lived perennial herb and fluctuations in abundance are normal. Variation in rainfall along with other abiotic and biotic factors may account for these fluctuations. Furthermore, seeds of *P. sandwicense* may persist in the seed bank and there may be a reoccurrences of this species within the action area when there are more suitable environmental conditions.

Threats to the Species The primary threats to *Peucedanum sandwicense* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E.

Conservation Needs of the Species and Critical Habitat in the Action Area Pursuant to the guidelines established in the Makua Implementation Plan, *Peucedanum sandwicense* will not be stabilized. There are thousands of individuals outside of the action area. There most robust populations are located on the island of Kauai where there are thought to be between 1,000 and 5,000 individuals of this species. This species will benefit from additional conservation actions

such as fencing, ungulate removal, reduction of non-native plant species, and control of wildfires (Service 1999b).

Ongoing Conservation Actions for the Species There is no species specific conservation action for this species in the action area.

Status of the Species and Critical Habitat – *Phyllostegia kaalaensis* (No Common Name)

Species Description *Phyllostegia kaalaensis* is a short-lived perennial herbaceous plant in the Lamiaceae (mint family). It has long stems extending from the base of the plant with oppositely arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. Inflorescences are borne at the stem tips on stalks with nodes of 3 to 6 white, tubular, slightly fragrant flowers. Each segment of the black, four-segmented fruits contains a single seed surrounded by fleshy pulp (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Phyllostegia kaalaensis* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species was included in recovery plans for Oahu plants (Service 1998a). Critical habitat was designated for *P. kaalaensis* on Oahu on June 17, 2003 (68 FR 35950). *Phyllostegia kaalaensis* was accepted as a species distinct from the more common, closely related *P. glabra* in the 1990s (Wagner et al 1999).

Historic and Current Distribution *Phyllostegia kaalaensis* is endemic to the Waianae Mountains of Oahu, where it has been known only since the 1970s. When the species was listed in 1996, five occurrences totaling less than 50 individuals were known (61 FR 53089). Available survey data indicate that *P. kaalaensis* has been extirpated in the wild since the late 1990s. The causes for its extirpation are unknown. The Waianae Kai population unit, for example, was first discovered in 1993 at about 30 plants, all of which had disappeared by 2004. Currently, there is one existing population unit with only two augmented immature plants located on State land in the Keawapilau to Pahole population unit (Table SB 29) (U.S. Army Garrison 2006c). This population unit is being established at two reintroduction sites using greenhouse-propagated stock, and is far from reaching minimum numerical stabilization criterion (defined as 50 mature, reproducing individuals per population unit). Moreover, these reintroductions have not been very successful, with very low survival rates. Demographic data for this species indicate reproduction in this species is probably primarily through vegetative cloning, as most of the previously known, naturally occurring plants occurred in dense patches far away from any other plants of the species. In addition, cuttings were salvaged from the Keawapilau to Pahole, Palikea Gulch, and Waianae Kai population units and are now being maintained as *ex situ* living collections. The Keawapilau to Pahole population unit and Palikea Gulch population unit are located within the Makua action area and the Schofield Barracks Military Reservation action area, respectively, where they are at zones of very low risk to training-related wildfire. Thus, *P. kaalaensis* is characterized by one reintroduced population unit containing only two augmented immature individuals.

Table SB 29. Range-wide Distribution of *Phyllostegia kaalaensis.*

Population Units	Numbers of Known individuals

	1996 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kapuna*	--	--	2	0/0[‡] [0/20][§]	0/0 [0/19]	0/0 [0/2]
Keawapilau*	--	--	2			
Pahole*	--	--	10-15			
Ekahanui	--	3	0	0	0	0
Makaha*	0	0	0	0	0	0
Manuwai*	0	0	0	0	0	0
Palikea Gulch	--	1	10	0	0	0
Waianae Kai	--	30	8	0	0	0
Total Individuals	**<50**	**40**	**32-37**	**20** (0/0)[†] [0/20]	**19** (0/0) [0/19]	**2** (0/0) [0/2]

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

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

Ecology *Phyllostegia kaalaensis* typically was found in mesic to dry-mesic areas in gulch bottoms and upper gulch slopes at elevations of 490 to 760 m (1,610 to 2,500 ft). It occurred most commonly in forests dominated by the native trees *Diospyros sandwicensis* and/or *Sapindus oahuensis*, or in forests containing a mix of several tree species, under forest canopy and in sunny openings. Flowering and fruiting occur from January to June. The flowers are presumably pollinated by moths, and the fleshy black fruits are characteristic of seed dispersal by fruit-eating birds (Makua Implementation Team 2003). The branches of *Phyllostegia kaalaensis* often touch ground and take root to produce a separate plant, and reproduction in this species may be primarily through vegetative means. The longevity of *Phyllostegia kaalaensis* individuals is unknown but is probably less than 10 years as with other perennial herbaceous plants; however, vegetative clones have the potential to live indefinitely (Makua Implementation Team 2003). Other demographic information for *Phyllostegia kaalaensis* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, and specific environmental requirements.

Threats *Phyllostegia kaalaensis* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. Outplants of *P. kaalaensis* in rocky gulch slopes and bottoms are vulnerable to trampling damage because of its extensive underground rhizome growth.

Occurrences of *Phyllostegia kaalaensis* are also particularly vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770, 68 FR 35950, Service 1998a). Because the plants known in 2003 represent a small number of genetically unique clones, inbreeding depression could potentially occur in *P. kaalaensis* populations. Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *P. kaalaensis* in the wild already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *P. kaalaensis* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Phyllostegia kaalaensis* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. The Keawapilau to Pahole population unit is only partially fenced. This population unit needs augmentation and reintroduction, and reintroductions are needed in the Makaha and Manuwai population units that represent all available genetic stock. Research is needed to test a variety of outplanting techniques and site characteristics. If indications of inbreeding depression are observed, controlled experiments should be conducted by mixing different stocks. Extirpated sites also should be monitored periodically for regeneration. Reintroductions for establishment of this and other population units cannot proceed until fences are built for the Upper Kapuna, Manuwai, and Makaha Management Units. The Makaha Management Unit and part of the Upper Kapuna Management Unit are scheduled for fence construction in 2007 or shortly thereafter.

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Phyllostegia kaalaensis*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Only the Pahole portion of the Keawapilau to Pahole population unit is fenced and partially weeded. *Phyllostegia kaalaensis* can be successfully propagated from cuttings. However, this species has the lowest survival rate for any taxon the Army has outplanted so far (maximum 32 percent) (U.S. Army Garrison 2005b). In 2005, *P. kaalaensis* was represented in *ex situ* collections that included 723 apical and lateral vegetative buds in micropropagation (Harold L. Lyon Arboretum), 104 cuttings in a nursery (Harold L. Lyon Arboretum), and three seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Very little seed was ever collected and no seed has ever been tested for storage and most storage is with cuttings from now-extinct occurrences in the Keawapilau to Pahole, Palikea Gulch, and Wiaiane Kai population units (U.S. Army Garrison 2005b).

Critical Habitat Description A total of 843 ha (2,082 ac) of critical habitat in six separate units was designated for *Phyllostegia kaalaensis* on Oahu. Critical habitat was designated on State lands (Mokuleia and Waianae Kai Forest Reserves, and Pahole and Mt. Kaala Natural Area Reserves) and private land (Honouliuli Preserve). Three units each provide habitat for one population, two units combined provide habitat for one population, and one unit provides habitat for six populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *P. kaalaensis* (68 FR 35950).

The primary constituent elements of critical habitat include gulch slopes or bottoms or almost vertical rock faces in mesic forest or *Sapindus oahuensis* forest at elevations between 248 and 878 m (813 and 2,880 ft). In addition, all units contain one or more of the following associated native plant species: *Antidesma platyphyllum*, *Claoxylon sandwicense*, *Diplazium sandwichianum*, *Freycinetia arborea*, *Hibiscus* sp., *Myrsine lanaiensis*, *M. lessertiana*, *Neraudia melastomifolia, Pipturus albida*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Streblus pendulinus*, or *Urera glabra*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Only two immature individuals of *Phyllostegia kaalaensis*, representing all of the known individuals of this species, are located within the action area, on State land in the Keawapilau to Pahole population unit (see Table SB 29). Plants in the Pahole portion of the population unit were last observed in 2000, in a fenced area protected from pigs. These last plants may have been extirpated due to drought-induced invasion of non-native invasive weeds. Survivorship rates in the Pahole and Keawapilau portions of the population unit have been very low. Immature individuals were outplanted in a wide variety of sites, from deeply shaded to sunny exposed areas; so far, the healthiest plants are those in sunny openings. *Phyllostegia kaalaensis* plants in the action area are located in areas at risk of training-related wildfire. Both remaining individuals occur in the very low fire risk zone. Thus, *P. kaalaensis* in the action area is characterized by one population unit of two reintroduced immature plants that comprise 100 percent of all remaining individuals, and are located in a zone at very low risk of training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 107 ha (263 ac), or 13 percent of the total critical habitat for *Phyllostegia kaalaensis*. Designated critical habitat is located within two units in the northeastern portion of the action area. These critical habitat areas are portions of two larger critical habitat units that combined form 646 ha (1,596 ac) and extend outside the action area boundary to provide habitat for 6 populations of *P. kaalaensis*. Critical habitat for this species in the action area occurs in areas at risk of training-related wildfire, with 8.1 ha (19.9 ac) located in the low fire risk zone and 98.4 ha (243.1 ac) in the very low fire risk zone. It is estimated that more than half of the critical habitat occurs in areas with predominantly non-native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Phyllostegia kaalaensis* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. About 13 percent of critical habitat for this species is located in areas at low and very low risks of training-related wildfire. Thus, because there are only two known remaining individuals within the action area, *Phyllostegia kaalaensis* in the action area area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Phyllostegia kaalaensis* because no population units meeting numerical criteria for stabilization exist outside the action area. Three population units have been identified for stabilization of *P. kaalaensis*: Keawapilau to Pahole in the action area, and Makaha and Manuwai outside the action area. The Kapuna and Keawapilau portions of the Keawapilau to Pahole population unit are not fenced. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Keawapilau to Pahole population unit, which contains all *in situ* individuals of *Phyllostegia kaalaensis*, is being managed as specified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located in the action area within the fenced Pahole Management Unit. A total of about 237.7 ha (587.0 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaimuhole, Makaha, Manuwai, Pahole, Upper Kapuna, West Makaleha). About 98.0 ha (242.0 ac) of the total critical habitat that is within management units is located inside the action area (Kahanahaiki, Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were about four percent complete, with six plants towards the goals outlined in the Makua Implementation Plan. In addition, there were six plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Plantago princeps* var. *princeps* (Ale, Laukahi kuahiwi)

Species Description *Plantago princeps* is a short-lived woody perennial of the Plantaginaceae (plantain) family. It is a shrub at least 1 m (3.3 ft) tall that is single-stemmed or sparingly branched at the base. The leathery, oblong leaves are up to 20 cm (7.8 in) long and clustered at the branch tips. The stem tips usually bear several erect inflorescences, each of which consists of a single stem of small, densely arranged flowers on the upper portion. The small capsules contain three to four black seeds that are 1.5 to 2.1 mm (0.06 to 0.08 in) long. Seed surfaces are covered by a sticky mucilaginous membrane (Wagner et al 1999; Makua Implementation Team 2003).

There are four varieties of *Plantago princeps*: var. *anomala* (Kauai), var. *laxiflora* (Molokai, Maui, and Hawaii), var. *longibracteata* (Kauai and Koolau Mountains of Oahu), and var. *princeps* (Waianae and Koolau Mountains of Oahu). All are woody shrubs except *P. princeps* var. *longibracteata*, which is herbaceous. In addition to geographic distribution, these varieties are distinguished by the amount of pubescence on stems, leaves, and flowers; size and venation of leaves; and orientation of flowers.

Listing Status *Plantago princeps* was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. This species is included in the recovery plan for multi-island plants (Service 1999a). Critical habitat was designated for *P. princeps* on Oahu on June 17, 2003 (68 FR 35950); on Kauai on February 27, 2003 (68 FR 9116); on Molokai on March 18, 2003 (68 FR 12982); and on Maui on May 14, 2003 (68 FR 25934). All varieties are included in the listed taxon.

Historic and Current Distribution *Plantago princeps* is a species endemic to the Hawaiian Islands. Historically, *Plantago princeps* was found on Kauai, Oahu, Molokai, Maui, and Hawaii (where it no longer exists). The two varieties that historically occurred on Oahu are var. *princeps* and var. *longibracteata*. Survey data indicate *P. princeps* var. *princeps*, a woody variety, is currently the only variety extant on Oahu. *Plantago princeps* var. *princeps* has been recorded from three general areas on Oahu, including the leeward Waianae Mountains, windward Waianae Mountains, and southeastern Koolau Mountains (Kalihi, Nuuanu, and Manoa valleys). *Plantago princeps* var. *princeps* was rediscovered in 1987 in the North Branch of North Palawai Gulch; before then, the species had not been seen in the Waianae Mountains since the 1800s. Similarly, the species had not been seen in the Koolau Mountains for over 50 years until this variety was rediscovered in 2001 at Waiawa, near the Koolau summit ridge. Currently, most of the known *P. princeps* var. *princeps* population units are scattered throughout the leeward and windward sides of the Waianae Mountains. *Plantago princeps* var. *longibracteata*, the herbaceous variety, historically was known from Kauai and the Koolau Mountains of Oahu. This variety still occurs on Kauai but is now extirpated from Oahu.

Since listing, available survey data indicate the State-wide total number of individuals of *Plantago princeps* (including all four varieties) appears to be stable or possibly increasing, though this increase could be due to more diligent survey efforts (Table SB 30). When the species was listed in 1994, all four varieties totaled 300 to 1,200 individuals State-wide (59 FR 56333); currently, there are 354 individuals on Oahu and an unknown number State-wide (Hawaii Biodiversity and Mapping Program 2005). When the species was listed, there were five occurrences totaling about 20 individuals on Oahu. *Plantago princeps* var. *princeps* is currently known from nine population units totaling 354 individuals on Oahu, located on Federal, State, and private lands (68 FR 35950). Because all currently known population units of this species were discovered relatively recently, trends in abundance and distribution are difficult to determine. A rapid decline from 20 to 5 individuals of *P. princeps* var. *princeps* was documented in the North Palawai population unit over 1987 to 2003, attributed to competition with daisy fleabane (*Erigeron karvinskianus*), a highly invasive non-native plant (Makua Implementation Team 2003). Trends in abundance and distribution on Oahu indicate that *P. princeps* var. *princeps* has increased since 2003, from eight population units totaling up to 253 individuals to nine population units totaling 354 individuals. None of the currently known population units contains more than fifty mature, reproducing individuals (the minimum number

required for stabilized populations as defined in the Makua Implementation Plan) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). *Plantago princeps* var. *princeps* is present in both the Makua and Schofield Barracks action areas in the Ohikilolo, Pahole, and North Mokiakea population units, in areas at risk from training-related wildfire (Service 2003a).

Demographic data for this species indicates most of the population units of wild *Plantago princeps* var. *princeps* are recruiting successfully (U.S. Army Garrison 2005b). Three Oahu population units have increased in numbers since 2003, three have decreased, and three have remained more or less the same. However, increases in two of the population units are due to refinement of age classes and discovery of additional individuals as a result of more consistent monitoring efforts, not a significant change in numbers or distribution (U.S. Army Garrison 2005b). Thus, *P. princeps* var. *princeps* is characterized by nine population units, each of which contain fewer than fifty mature, reproducing individuals and an overall trend in abundance on Oahu that appears to be increasing but is due in part to increased monitoring efforts.

Table SB 30. Range-wide Distribution of *Plantago princeps* var. *princeps.*

Population Units	**Number of Known Individuals**					
	1994 (1)	**1999** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Ohikilolo*	--	--	14	22/0	22/12	12/14
Pahole	--	--	12	2/2	3/13	2/14
Ekahanui*	--	--	16/7‡	33/50	34/88	34/86
Halona	--	--	50-100	50-100	10/28	10/28
Konahuanui/ Kaneohe (Koolau)*	--	--	--	40/5	40/5	40/5
North Mohiakea/Puu Kalena (SBWR)	--	--	70	20/3	15/5	10/13
North Palawai (north branch)	--	--	7	2/2	1/1	--
North Palawai (south branch)	--	--	25	0	--	1/1
Nuuanu	--	--	--	1/0	1/0	1/0
Waiawa (Koolau)*	--	--	40/2	16/17	16/67	16/67
Total Population Units Oahu (2 varieties)	5	7	8	9	10	9
Total Individuals Oahu (2 varieties)	**20+**	**150-250**	**253-303** (234-284/19)†	**265-315** (186-236/79)	**361** (142/219)	**354** (126/228)
Total Population Units State-wide (all 4 varieties)	18	29	27	--	20	490-1962(7)
Total Individuals State-wide (all 4 varieties)	**300-1200**	**640-1750**	**795-973**	--	**844-2316**	**844-2316**

Shaded population units are inside the action area.

* Stabilization population units
SBMR = Schofield Barracks Military Reservation, West Range.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (59 FR 56333)
(2) Recovery plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003) and critical habitat rules (68 FR 9116; 68 FR 12982; 68 FR 25934; 68 FR 35950)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b); Hawaii Biodiversity and Mapping Program 2005; M. Bruegmann, USFWS, pers. comm. (2006)
(6) 2006 status update (U.S. Army Garrison 2006c)
(7) S. Ching, pers. comm. (2007)

Ecology *Plantago princeps* var. *princeps* occurs in two different habitat types, at elevations of 480 to 1,100 m (1,580 to 3,600 ft) (Service 1999a). In the Waianae Mountains, this variety is found on cliff faces, ledges, and bases, in mesic vegetation consisting predominantly of native grasses, sedges, herbs, and shrubs. Historical occurrences in the southeastern Koolau Mountains also were found in mesic cliff habitats. In contrast, the Waiawa population unit occurs on a streamside embankment in wet, rainforest habitat close to the Koolau summit ridge, an area with the highest precipitation on Oahu (Service 2003a). *Plantago princeps* var. *princeps* appears to produce flowers and fruits throughout the year (Wagner et al 1999), with increased fruiting in the spring (U.S. Army Garrison 2005b). The sticky seeds may have once been dispersed by now-extinct species of flightless birds (Carlquist 1980; Makua Implementation Team 2003). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *P. princeps* var. *princeps* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Plantago princeps* var. *princeps* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Because this species prefers cliff habitat, ungulate and weed threats are relatively low (U.S. Army Garrison 2005b). Rat predation on fleshy stems and leaves is a problem in the North Palawai and Ekahanui population units (in Honouliuli Preserve), and may have caused the near disappearance of the North Palawai population units (U.S. Army Garrison 2005b). Fire is a threat to population units in Army action areas (Ohikilolo, Pahole, and North Mohiakea) and to areas vulnerable to non-military related fire. For example, fire burned native vegetation in parts of the Ekahanui Management Unit and near the Halona population unit during summer 2005 (U.S. Army Garrison 2005b). In addition, occurrences of *P. princeps* var. *princeps* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999a). Thus, *P. princeps* var. *princeps* has a high background risk of species extinction, and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Plantago princeps* var. *princeps* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). The Army has noted that a re-evaluation of stabilization population units may be needed to account for the recently discovered population unit on the Kaneohe side of Puu Konahuanui (currently the largest population unit at 45 total individuals) (U.S. Army Garrison 2005b). A pig-proof fence is needed for the Ekahanui population unit and is planned for 2007. A fence is also needed for the Waiawa population unit and is planned as part of the Army's Oahu Implementation Plan (U.S. Army Garrison 2005b).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Plantago princeps* var. *princeps*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo, Pahole, and Ehakanui population units are fenced and protected by cliffs and steep terrain. In addition, about 271 individuals (77 percent of all remaining individuals on Oahu) of this species occur in five management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Palikea and Waiawa, which are not fenced; and Ekahanui, Ohikilolo, and Pahole, which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit *P. princeps* in the Ekahanui and Palawai population units within the preserve. This species is also included in the Army's stabilization plan for species impacted by military training at other areas on Oahu associated with Schofield Barracks Military Reservation (Service 2003a).

Seed collection from this taxon is difficult because it inhabits inaccessible cliffs. Plants fruit year-round, with peak production in the spring, and germination rate of fresh seed is about 60 percent. Cuttings can be successfully propagated, but the plants do not survive well in the greenhouse (U.S. Army Garrison 2005b). *Plantago princeps* is represented in *ex situ* collections, including four cuttings in a nursery (Army Environmental Division, Oahu), 81 plants in a nursery (Haleakala National Park), 39 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and 5,900 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 2,632 ha (6,504 ac) in 12 separate units on four islands was designated as critical habitat for *Plantago princeps*, including 1,418 ha (3,504 ac) in five units on Oahu (68 FR 35950). Critical habitat on Oahu was designated on Federal (Oahu Forest National Wildlife Refuge), State (Ewa, Mokuleia, and Waiahole Forest Reserves and Pahole Natural Area Reserve), and private lands (including Honouliuli Preserve). The 12 critical habitat units State-wide provide habitat to support nine populations, and the five critical habitat units on Oahu provide habitat for three populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *P. princeps* (68 FR 35950).

On Oahu, the primary constituent elements for three critical habitat units in the Waianae Mountains include slopes or ledges in *Metrosideros polymorpha* lowland mesic forests or shrublands at elevations between 110 and 1,064 m (361 and 3,490 ft). In addition, all units

contain one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Chamaesyce* sp., *Dubautia plantaginea*, *Eragrostis* sp., *Lysimachia* sp., *Pilea peploides*, or *Viola* sp. The primary constituent elements for the two critical habitat units in the Koolau Mountains include sides of waterfalls or wet rock faces at elevations between 211 and 885 m (692 and 2,903 ft) that contain one or more of the following associated native plant species: *Bidens* sp., *Coprosma granadensis*, *Eugenia* sp., *Lobelia gaudichaudii*, *Metrosideros rugosa*, or *Scaevola glabra*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 42 individuals, or 12 percent of all known individuals of Plantago princeps var. princeps on Oahu, are located within the action area in the Ohikilolo and Pahole population units (see table above) (U.S. Army Garrison 2005b). These action area individuals represent 12 percent of the total State-wide population. None of the population units exceeds 50 mature reproducing individuals (the minimum number required for a stabilized population). Overall, the total known number of individuals of this taxon in the action area has increased from 26 in 2003 to 42 individuals in 2006, but most of that increase is due to discovery of additional plants in the Ohikilolo population unit (U.S. Army Garrison 2005b). Currently, about 67 percent of the action area individuals are immature plants, compared to less than eight percent immature individuals in 2004. The Ohikilolo and Pahole population units within the action area are located in fire risk zones; however, all known individuals occur in the low fire risk zone. These individuals at risk of fire in the action area represent about 12 percent of the taxon's total known number of individuals on Oahu and about one percent of the species' State-wide total. Thus, *P. princeps* var. *princeps* in the action area is characterized by two population units which do not meet the numerical criteria for a stabilization population unit and represent about 12 percent of the taxon's total number of individuals on Oahu. The total number of known individuals has increased primarily due to new discoveries from refined monitoring efforts.

Status of the Critical Habitat in the Action Area The action area contains a total of 62 ha (153 ac), or two percent, of the total State-wide critical habitat for *Plantago princeps*. Critical habitat is located on State land in the northeastern portion of the action area, in two critical habitat units. These units total 15 ha (37 ac) and 53 ha (130 ac), respectively, and together extend beyond the action area to provide habitat to support one population of 300 mature, reproducing individuals. The entire acreage for both of these critical habitat units occurs in the low fire risk zones of the action area. State-wide, slightly more than one percent of critical habitat for this species on Oahu, Kauai, Maui, and Hawaii is located in an area at risk from training-related wildfire, with none located in the high fire risk zone. It is estimated that almost all critical habitat is in areas of greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Plantago princeps* var. *princeps* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Although only 12 percent or less of all known individuals of this taxon on Oahu occurs within the action area, *P. princeps* var. *princeps* in the action area has a high background risk of species extinction and requires ongoing stabilization management to ensure its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Plantago princeps* var. *princeps* because the no population units meeting minimum numerical criteria for a stabilization population exist outside the action area. Stabilization goals to improve the status of *P. princeps* var. *princeps* include management to attain three population units, each with a minimum of 300 mature, reproducing individuals. Three population units have been identified for stabilization of *P. princeps var. princeps*: Ohikilolo, Ekahanui, and Waiawa. Augmentation of the Ohikilolo and Pahole population units is needed as soon as propagation and outplanting techiques are refined; the Army has not outplanted this taxon yet because of difficult access at field sites (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed for the Ohikilolo, Pahole, Upper Kapuna, and West Makaleha Management Units, which either contain individuals or portions of critical habitat. The 42 individuals of this species occurring in the action area are in fenced management units and this species will thus benefit from ungulate exclusion. There are no plans to fence the small portion of the Upper Kapuna Management Unit that coincides with critical habitat. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Ohikilolo population unit is being managed as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Within the action area, the Ohikilolo and Pahole Management Units are proposed to be fenced starting in 2007 and completed by 2015 thus controlling ungulates. Weed management will be an ongoing strategy to control invasive species. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua (U.S. Army Garrison 2005b). Genetic storage goals are nine percent complete, with 41 plants from all nine population units combined meeting the goals outlined in the Makua Implementation Plan, and there are 10 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species – *Pritchardia kaalae* (Loulu)

Species Description *Pritchardia kaalae* is a long-lived palm of the Arecaceae (palm) family. The tree grows to 5 m (16.4 ft) tall, with a single erect trunk surmounted by a cluster of fan-shaped fronds. The inflorescences are as long as the frond tips and often extend well beyond them, and consist of flowers in one or more clusters. *Pritchardia* species usually, if not always, have perfect flowers (with both male and female reproductive parts), and *P. kaalae* is probably self-compatible. The round, fleshy fruits are about 2 cm (0.8 in) in diameter and much smaller than fruits of other *Pritchardia* species (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Pritchardia kaalae* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species is included in the recovery plan for Oahu plants (Service 1998a). Critical habitat has not been designated for this species.

Historic and Current Distribution *Pritchardia kaalae* is a species endemic to the Hawaiian Islands and to the island of Oahu. Trends in distribution indicate that *P. kaalae* historically was found only in the northern Waianae Mountains of Oahu. In contrast to other *Pritchardia* species in Hawaii, no evidence indicates that the distribution of *P. kaalae* has been influenced by the actions of native Hawaiians (Makua Implementation Team 2003). When the species was listed in 1996, there were five occurrences totaling approximately 130 individuals. Since listing, the total number of individuals has increased to about 911 plants (see table below). However, 85 percent of these are immature plants and 15 percent are mature plants; there are only 137 mature trees range-wide (U.S. Army Garrison 2005b). Two of the five currently known population units have exceeded minimum thresholds for a stabilization population (defined as at least 25 mature, reproducing individuals per population unit for long-lived perennials) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). Population units of *P. kaalae* are located on Federal and State lands (U.S. Army Garrison 2005b) (Table SB 31).

Demographic data indicate the number of mature trees has been slowly decreasing as older trees die and few immature plants are available to take their place (Makua Implementation Team 2003). Since consistent monitoring for this species began at Makua about 10 years ago, little or no recruitment has been observed in wild population units due to goat and rat predation and uprooting by pigs (U.S. Army Garrison 2005b). The Ohikilolo population unit is the only one with documented seedlings (410 immature individuals including seedlings). With protection and management, many seedlings are appearing, and rat control should result in significant increases in recruitment rates (Makua Implementation Team 2003). In addition, *Pritchardia kaalae* is easy to grow from seed and outplantings have been extremely successful (U.S. Army Garrison 2005b). Nonetheless, both augmented and naturally occurring seedlings and immature plants grow very slowly and do not become reproductive for decades. Plants in the Ohikilolo population units are located in zones at low risk from training-related wildfire. Thus, *P. kaalae* is characterized by five population units, two of which exceed minimum numeric criteria for stabilization, low numbers of mature trees and an overall abundance that is increasing through augmentation and enhanced survival of seedlings and immature plants associated with habitat management.

Table SB 31. Range-wide Distribution of *Pritchardia kaalae.*

Population Units	Number of Known Individuals					
	1996 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Ohikilolo*	--	--	65/100‡	72/3 [0/308]§	75/221 [0/274]	75/410 [0/284]
Ohikilolo East & West Makaleha*	--	--	--	0 [0/75]	0 [0/32]	0/0 [0/72]
Makaha	--	--	1/0	1/0	4/0	4/0
Makaleha to Manuwai*	--	--	138/3	39/3	50/2	54/3
Waianae Kai	--	--	7/2	7/2	4/5	4/5
Total Individuals	**130**	**130**	**316** (211/105)†	**510** (119/8) [0/383]	**667** (133/228) [0/306]	**911** (137/418) [0/356]

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

(1) Listing rule (61 FR 53089)
(2) Recovery plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Pritchardia kaalae* occurs in the mesic zone on moderately steep slopes to very steep cliffs at elevations of 450 to 980 m (1,476 to 3,215 ft) (Wagner et al 1999; Makua Implementation Team 2003). Many *P. kaalae* plants at lower elevations are found in forests dominated by *Diospyros sandwicensis* or *Metrosideros* species; at higher elevations, they are found in the upper, wetter zone of mesic forest dominated by *Metrosideros tremuloides*. The common habitat of *P. kaalae* is steep, open cliffs vegetated with grasses and sedges, shrubs, and small trees (Makua Implementation Team 2003). Recent studies of fossil pollen and charcoal deposits on Oahu indicate that *Pritchardia* constituted a major element of lowland vegetation when Polynesians first settled in Hawaii. Fruit predation by the Polynesian rat brought by early Polynesian settlers appears to have caused a collapse of these *Pritchardia* populations. The *Pritchardia* species of this largely vanished lowland vegetation have not been identified, but *P. kaalae* possibly may have extended from the Waianae Mountains into the lowland populations that were decimated by rats (Makua Implementation Team 2003). Seeds of the related species *P. remota* can survive in the soil for "a significant period of time" (U.S. Army Garrison 2005b). The longevity of *P. kaalae* has not been documented but is presumed to be many decades (Makua Implementation Team 2003). Other demographic information for *P. kaalae* in the wild is unknown, including growth rate, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats to the Species *Pritchardia kaalae* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Pritchardia kaalae* is particularly vulnerable to seedling predation by goats and fruit predation by rats (Makua Implementation Team 2003; U.S. Army Garrison 2005b). This species may also be vulnerable to lethal yellowing, a palm disease prevalent in many tropical and subtropical zones worldwide. Hawaiian *Pritchardia* species planted in Florida as ornamentals are extremely susceptible to this fatal, incurable disease. Lethal yellowing is caused by a "mycoplasma-like organism" transmitted by a sap-sucking plant hopper, *Myndus crudus*, which has not yet been found in Hawaii (Murakami 1999). Nonetheless, lethal yellowing disease remains a potential serious threat to *P. kaalae* on Oahu. Thus, *P. kaalae* has a high background risk of species extinction due to low numbers and serious threats from non-native predators and disease, and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Pritchardia kaalae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Pritchardia kaalae*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo and Makaleha to Manuwai population units have met minimum numerical criteria for a stabilization population, but threats are not fully controlled and genetic storage is not complete. The Ohikilolo East and West Makaleha population unit within the action area is being established by reintroduction. In addition, about 898 individuals (98 percent of all remaining individuals) of this species occur in four management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Manuwai, East Makaleha, and West Makaleha, which are not fenced; and Ohikilolo, which is fenced.

Germination from seed is a reliable propagation technique for *Pritchardia kaalae*, particularly using excised embryos (50 percent germination). Reintroductions in the wild have been successful, but seedlings grow very slowly; survival of two-year-old outplants is about 89 percent (U.S. Army Garrison 2005b). *Pritchardia kaalae* is represented in *ex situ* collections including 172 embryos in micropropagation (Harold L. Lyon Arboretum), 193 mature fruit in storage or awaiting processing at a nursery (Army Environmental Division, Oahu), seven plants in a botanical garden (Waimea Valley Audubon Center), and 12 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area About 841 individuals, or 92 percent of all known individuals of *Pritchardia kaalae*, are located within the action area in the Ohikilolo, and Ohikilolo East and West Makaleha population units (see table above). However, only 75 of

these individuals in the action area are mature trees, which represent about 55 percent of the total 137 mature trees that exist range-wide. The Ohikilolo population unit has currently exceeded the minimum numerical criteria for a stabilization population (defined as 25 mature individuals per population unit) and includes both naturally occurring and reintroduced plants. The Ohikilolo East and West Makaleha population unit consists entirely of 72 augmented immature plants that have been outplanted in fenced areas since 2002. Currently, about 91 percent of the action area individuals are immature plants. Overall, action area numbers of *P. kaalae* have increased since 2003, from 165 (including 65 mature trees) to 841 (including 75 mature trees) (U.S. Army Garrison 2005b; Army database 2006). All *P. kaalae* plants in the action area are at risk from training-related wildfire; however, all individuals of this species found in the action area are located in the low or very low fire risk zones. These individuals at risk of fire in the action area represent about 92 percent of the species' total range-wide numbers.

The Ohikilolo population unit is located within the Ohikilolo Management Unit, where vegetation consists of native dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Ohikilolo East and West Makaleha population unit is located in parts of the Ohikilolo, East Makaleha, and West Makaleha Management Units. Vegetation in the East Makaleha Management Unit consists of dry-mesic to wet native forest and shrubland, and alien-dominated dry-mesic to wet-mesic shrubland and forest (U.S. Army Garrison 2005a). Vegetation in the West Makaleha Management Unit consists primarily of mixed alien-dominated mesic forest and native-dominated forest and shrubland, with areas of Oahu diverse lowland mesic forest, a rare natural community. At lower elevations, vegetation in the West Makaleha Management Unit consists of seasonally dry, alien-dominated forest and shrubland (U.S. Army Garrison 2005a). Two hundred seventy five (30 percent of the individuals range-wide) both mature and immature individuals of *P. kaalae* are within fenced management units in the action and will therefore benefit from ungulate exclosure. Thus, *P. kaalae* in the action area is characterized by one population unit containing 92 percent of all remaining individuals and 55 percent of all mature individuals, which is increasing due to habitat management and augmentation, and another population unit that is being established through reintroduction.

Threats to the Species in the Action Area The primary threats to *Pritchardia kaalae* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Thus, because 92 percent of all known individuals and 55 percent of all mature trees occur within the action area, *P. kaalae* in the action area has a high background risk of species extinction; any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Pritchardia kaalae* because there are only two population units exceeding minimum numerical criteria for a stabilization population, including only one outside the action area. Three population units are identified for stabilization of *P. kaalae*: Ohikilolo and Ohikilolo East and West Makaleha in the action area, and Makaleha to Manuwai outside the action area. The Ohikilolo population unit within the action area has exceeded minimum numerical criteria for a stabilization population, although threats are not fully controlled and genetic storage is not complete. The Ohikilolo East and West Makaleha

population unit is being established by reintroduction and will be managed for stabilization, but will not contain mature trees for many years. The East Makaleha and West Makaleha Management Units are not fenced, and ungulates and weeds are minimally controlled; fence construction is planned for 2008 and 2009, respectively (U.S. Army Garrison 2005b). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The Ohikilolo, and Ohikilolo East and West Makaleha, population units within the action area are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, this species occurs in the East Makaleha, Ohikilolo, and West Makaleha Management Units within the action area. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, goats have been virtually eradicated from Makua, and weeds and rats are controlled in some *P. kaalae* occurrences (U.S. Army Garrison 2005b). The other management units are not fenced. Genetic storage goals are about 13 percent complete, with 27 plants from all four population units combined meeting the goals outlined in the Makua Implementation Plan, and there are also 30 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Sanicula mariversa* (No Common Name)

Species Description *Sanicula mariversa* is a perennial herbaceous plant in the Apiaceae (parsley family). Basal leaves arise from a thick underground storage root, and are up to 23-cm (9 in) wide with three to five lobes. The yellow flowers are borne in masses on stems up to 0.7 m (2.3 ft) tall. Some of the flowers are perfect (with both male and female reproductive parts) and others have only staminoid (male) parts. The egg-shaped fruits are 4 to 6 mm (about 0.2 in) long and covered with hooked bristles (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Sanicula mariversa* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for this species was designated on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Sanicula* is a genus endemic to the Hawaiian Islands. Historic data indicate *Sanicula mariversa* occurred in the central Waianae Mountains of Oahu (68 FR 35950). This species was first discovered in the 1970s, on Ohikilolo Ridge, and nothing is known of its past distribution and abundance (Makua Implementation Team 2003). When the species was listed, only two occurrences totaling less than 200 individuals were known. Currently, *S. mariversa* occurs in four population units totaling approximately 224 individuals, none of which is stable (Table SB 32). These population units are found on Federal, State, and city/county lands (68 FR 35950).

Currently demographic data is insufficient to detect trends in *Sanicula mariversa*. Since listing, consistent surveys have been conducted for only two locations. These surveys have shown that annual counts do not necessarily reflect numerical individual trends or the number of mature and

immature individuals persisting. *Sanicula mariversa* is a perennial herb that is dormant during the summer. In addition, individual plants do not emerge each year and take many years to mature making detection in the field challenging. Mature plants flower inconsistently and appear to die after flowering once. Environmental conditions, such as large seed production years or favorable germination conditions may influence age at maturity and the length of dormancy periods. All these characteristics result in unpredictable population fluctuations from year to year (U.S. Army Garrison 2005b). Plants in the Keaau and Ohikilolo population units are located in low and very low risk zones for training-related wildfire. Thus, due to low numbers, lack of population units meeting stabilization numeric criteria, and insufficient knowledge of ecological influences on population dynamics, demographic data for *S. mariversa* are insufficient to determine whether the species is sustaining its numbers or declining.

Table SB 32. Range-wide distribution of *Sanicula mariversa.*

Population Units	Numbers of known individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Keaau*	--	--	16/125‡	7/100	14/69	14/114
Ohikilolo*	--	--	34/109	1/62 [0/19]§	0/51	0/52
Kamaileunu*	--	--	26	13/22	3/16	4/36
Puu Kawiwi	--	--	2	0/32	0/36	0/4
Total Individuals	**< 200**	**75**	**312** (78/234)†	**256** (21/216) [0/19]	**189** (17/172)	**224** (18/206)

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Sanicula mariversa* occurs on dry, well-drained slopes at elevations of about 750 m (2,461 ft), usually on north-facing slopes just below the ridgeline or on exposed ridge crests. Most of the known plants grow in deep soil, although two plants were found at Puu Kawiwi in the cracks of a nearly vertical rock face (Makua Implementation Team 2003). Leaves and stems die back to the storage root usually in May, and the plants are dormant during the dry summer months until new growth emerges usually in October or November. Flowering occurs from February through May, with fruits maturing a few months later. The massed inflorescences suggest pollination by insects, and bristles on the fruit suggest dispersal by birds. Because *S. mariversa* is an herbaceous species, its longevity probably is similar to that of other small plants that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003).

Other demographic information for *S. mariversa* in the wild is unknown, including longevity, dormancy cycles, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Sanicula mariversa* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Sanicula mariversa* also is threatened by trampling by hunters and hikers on Keaau Ridge, and potentially by fence maintenance activities on Ohikilolo Ridge (Makua Implementation Team 2003). Population units of *S. mariversa* are especially vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. mariversa* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. mariversa* has a very high background risk of species extinction and additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Sanicula mariversa* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The numerical criterion for stabilization of short-lived perennials is generally defined as three population units each consisting of 50 mature, reproducing individuals. Owing to infrequent, inconsistent flowering and significant population fluctuations from year to year, this standard was increased for *S. mariversa* to 100 mature, reproducing individuals per population unit. Other particular needs for the conservation of *S. mariversa* include research on seasonal life cycle, dormancy, and seed bank influences, and development of an effective monitoring program to determine whether stabilization criteria should be revised. For example, a five-year average of plants at various stages of maturation may be a more suitable goal for this species than annual counts of observed individuals. In addition, refinement of genetic storage goals require better data on seed dormancy, and propagation techniques must be developed (U.S. Army Garrison 2005b).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Sanicula mariversa*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, individuals of this species occur in three management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Kamaileunu, and Keaau and Makaha, which are not fenced; and Ohikilolo, which is fenced.

Germination trials with fresh *Sanicula mariversa* seed have been unsuccessful, and research is needed to determine dormancy constraints and appropriate propagation and outplanting

techniques. In the wild, plants reintroduced in the Ohikilolo population unit have not been seen since 2003, and seed-sowing trials in 1999 resulted in only one germinated plant (U.S. Army Garrison 2005b). In 2005, *ex situ* collections for this species included 11 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) and 11,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 93 ha (230 ac) of critical habitat in six separate units was designated for *Sanicula mariversa* on State lands (Makua, Keaau, and Waianae Kai Forest Reserves and Mt. Kaala Natural Area Reserve) and on private lands (Honouliuli Preserve) on Oahu. One unit provides habitat for two populations and five units together provide habitat for four populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. mariversa* (68 FR 35950).

The primary constituent elements of critical habitat include dry, well-drained, slopes or rock faces in mesic shrublands or open grassy areas at elevations between 475 and 1,025 m (1,558 and 3,362 ft). In addition, all units contain one or more of the following associated native plant species: *Bidens torta*, *Carex meyenii*, *Doryopteris* sp., *Eragrostis* sp., *Metrosideros polymorpha*, or *Metrosideros tremuloides*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Habitat degradation by goats and trampling by humans on or near trails are particular threats in some *S. mariversa* critical habitat units (68 FR 35950).

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 80 percent of all known individuals of *Sanicula mariversa* are located within the action area, in the Ohikilolo and Keaau population units (see Table SB 32). These population units have been monitored since 1995 and 1999, respectively. Neither population unit is currently meeting stabilization numerical criteria (defined as 100 mature individuals). The number of individuals in both population units varies significantly from year to year, ranging from 12 individuals in 1998 to 138 in 2002 in Ohikilolo, and from 11 in 2001 to 107 in 2004 in Keaau. In addition, 19 immature plants were reintroduced to the Ohikilolo population unit in 2001 but have since disappeared (U.S. Army Garrison 2005b). The Army does not plan any future reintroductions or augmentations of *S. mariversa* until more is known about its dormancy cycle. All individuals in the Ohikilolo and Keaau population units are at low and very low risk of training-related wildfire. About 52 individuals occur in the low fire risk zone and 128 individuals in the very low fire risk zone. These population units are located within an extremely dry part of the action area that is buffered somewhat from fire by a strip of thick forest and by sparsely vegetated cliffs (U.S. Army Garrison 2005a). The Ohikilolo population unit is located within the Ohikilolo Management Unit on Makua, which occurs along the steep wall of Makua valley. The Keaau population unit is located within the Keaau and Makaha Management Unit on the saddle ridge between the Keaau and Makaha valleys. Thus, the species is characterized by low numbers of individuals, lack of population units meeting

minimum numerical criteria for stabilization, location of 80 percent of the individuals within fire risk zones.

Status of the Critical Habitat in the Action Area A total of 10.0 ha (24.8 ac), or 11 percent, of the total critical habitat for *Sanicula mariversa* is found within two critical habitat units in the action area. These two critical habitat units are located on State land in the south-central part of the action area, and together provide potential habitat to support one population of 300 mature, reproducing individuals. Critical habitat for this species in the action area is located in an area at risk of training-related wildfire, with 0.3 ha (0.8 ac) in the low fire risk zone and 9.7 ha (24.0 ac) in the very low fire risk zone. It is estimated that slightly more than half of the critical habitat within the action area is found in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Sanicula mariversa* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Sanicula mariversa* in the action area is especially vulnerable to wildfire from military training activities. Feral goats have been substantially reduced in the Ohikilolo population unit, but not in the Keaau population unit. In addition to browsing and trampling, goat activity also has resulted in substantial erosion in parts of the Keaau population unit. About 11 percent of the total critical habitat designated for this species is located in the low and very low fire risk zones. Thus, because about 80 percent of all known individuals occur within the action area in zones of low to very low fire risk, *S. mariversa* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Sanicula mariversa* because more than 50 percent of all known individuals occur within the action area, and no population units meeting minimum numerical criteria for stabilization exist outside the action area. Three population units have been identified for stabilization of *S. mariversa*, only one of which is located outside of the action area: Keaau-and-Ohikilolo within the action area and Kamaileunu outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Management designations may need to be revised to ensure that two population units are stabilized outside the action area. In addition, post-fire revegetation plans and site-specific fuel modification are needed where this species is located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. The critical habitat adjacent to the Ohikilolo Management Unit will not be fenced, but it is located in very steep terrain that limits ungulate and human access (Service 2004a). The Keaau and Makaha Management Unit will be fenced in 2009, and is in need of goat and invasive weed control; there are no plans to fence the Kamaileunu Management Unit. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area Two population units containing 80 percent of the total remaining individuals are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, this species occurs in two management units in the action area, Ohikilolo, which is fenced, and Keaau-and-Makaha, which is not fenced. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, goats have been virtually eradicated from Makua, and invasive weeds are controlled around *S. mariversa* sites. A total of about 19.6 ha (48.4 ac) of critical habitat for this species is located within management units both within and outside of the action area (Ekahanui, Kamaileunu, Keaau and Makaha, Manuwai, Ohikilolo). About 2.4 ha (6.0 ac) of the total critical habitat that is within management units is located inside the action area (Keaau and Makaha, Ohikilolo). In 2005, genetic storage goals were 42 percent complete, with 84 plants from all four population units combined towards meeting the goals of the Makua Implementation Plan; there were no plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea hookeri* (No Common Name)

Species Description *Schiedea hookeri* is a relatively long-lived perennial of the Caryophyllaceae (pink) family. It is a sprawling or clumped sub-shrub (stems woody at the base) with stems 0.3 to 0.5 m (1 to 1.6 ft) long that curve slightly upward or lie close to the ground in matted clumps. The narrow, oppositely arranged leaves are 3 to 8 cm (1.2 to 3.2 in) long and 0.4 to 1.5-cm (0.2 to 0.6 in) wide. The small, perfect flowers (with both male and female reproductive parts) have no petals and are borne in open, branched clusters that are hairy and somewhat sticky. The fruit is a capsule about 3 mm (0.1 in) long (Wagner et al 1999).

Listing Status *Schiedea hookeri* was federally listed as endangered on October 10, 1996 (61 FR 53108), and was State listed as endangered at the same time. A recovery plan for multi-island plants included this species (Service 1999a), and critical habitat was designated on June 17, 2003 (68 FR 35950). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Trends in distribution indicate range restriction in *Schiedea hookeri*, which historically occurred in the Waianae Mountains of Oahu and perhaps occurred on Maui (although the single fragmentary collection from East Maui may represent another species) (61 FR 53108). Currently, this species occurs only in the Waianae Mountains. When the species was listed in 1996, 11 occurrences totaling 220 to 330 individuals were known. Currently, 18 occurrences totaling about 420 individuals are known on Federal, State, city/county, and private lands (Table SB 33) (68 FR 35950). Current numbers include 128 individuals within the Makua action area and 5 individuals within the Schofield Barracks Military Reservation action area (Service 2003a; U.S. Army Garrison 2006c). Trends in numbers and distribution are difficult to discern, however, owing to inconsistent identification of occurrences and monitoring efforts. No range-wide surveys have been conducted for this species. According to the most recent information available, four of the 18 population units have reached stabilization population minimum numerical criteria (defined as at least 50 mature, reproducing individuals); three of these

stabilization populations are located outside the action area (Service 1999a; U.S. Army Garrison 2006c). No recent information is available on trends in reproduction in the wild, and there is no evidence of reproduction from seed under field conditions (Service 1999a). Plants in the Kahanahaiki, Kaluakauila, Keaau, Ohikilolo, and North Mohiakea occurrences are located in zones at risk from training-related wildfire. Thus, *S. hookeri* is characterized by apparently increasing trends in numbers and reaching minimal numeric criteria for a stabilization population in four of the 18 existing occurrences.

Table SB 33. Range-wide Distsribution of *Schiedea hookeri*.

Population Units	**Number of Known Individuals**			
	1996 (1)	**2003** (2)	**2005** (3)	**2006** (4)
Kahanahaiki	--	--	20	20
Kaluakauila	--	6-10	52	52/0/40‡
Keaau	--	--	12	12
Ohikilolo	--	--	4	4
Lower Kaala Natural Area Reserve	--	--	37	50
Kalena-Kaala Ridge	--	--	--	--
Kaluaa to Ekahanui	--	60	110	2
Kamaileunu Ridge	--	11	--	--
Kolekole/Puu Hapapa	--	10	--	--
Makaha/Makaha-Waianae Kai Ridge	--	40	--	--
Makua/Makaha Ridge	--	4	5	17
North Mohiakea (SBWR)	--	5	--	--
North Waieli	--	--	3	3
Palikea Gulch	--	10	--	20
Puu Kaua	--	55	50	50
Waianae Kai/ Waianae Kai Ridge	--	63	94-144	150
Total Individuals	**220-330**	**333-383**	**387-437**	**420**^
Other Locations				82

Shaded occurrences are inside the action area; numbers include total individuals.
SBWR = Schofield Barracks West Range.
‡Total mature/immature/seedling individuals
^Totals from Army database

(1) Listing rule (61 FR 53108), recovery plan (Service 1999a)
(2) Critical habitat rule (68 FR 35950), Oahu Biological Opinion (Service 2003a)
(3) Army re-initiation request (U.S. Army Garrison 2005c)
(4) Army database (U.S. Army Garrison 2006d)

Ecology *Schiedea hookeri* occurs in the understory of diverse mesic or dry lowland forests typically dominated by *Metrosideros polymorpha* or *Diospyros* species, at elevations ranging between 350 and 900 m (1,148 and 2,953 ft) (61 FR 53108; 68 FR 35950; Wagner et al 1999). It usually grows on slopes, cliffs and cliff bases, rock walls, and ledges. *Schiedea hookeri* is an

outcrossing species probably pollinated by insects. Mature fruits have been observed in June and August, but seed dispersal mechanisms are unknown. This species varies considerably throughout its range in potential for vegetative (clonal) growth and spread. Upright plants at one site, for example, show little clonal potential, whereas decumbent plants at another site exhibit clonal growth by nodal rooting (68 FR 35950; Service 1999a). Plant longevity is probably similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials). Other demographic information for *S. hookeri* in the wild is unknown, including phenology, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Schiedea hookeri* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Schiedea hookeri* is particularly vulnerable to predation by non-native slugs and snails (61 FR 53108). Seedlings from other *Schiedea* species that occur in mesic or wet sites are apparently consumed by these alien invertebrates. One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). *Schiedea* species that occur in dry areas, however, produce abundant seedlings following winter rains, perhaps because drier sites have fewer non-native invertebrate herbivores (Service 1999a). *Schiedea hookeri* also may suffer from a lack of pollinators (Service 1999a). Wildfire ignited by military training activities is a threat to this species in the Makua and Schofield Barracks action areas.

Occurrences of *Schiedea hookeri* are probably not as vulnerable as other endangered *Schiedea* species to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution. Nonetheless, a series of self-pollination experiments that included within-occurrence crosses and crosses among occurrences demonstrated that *S. hookeri* shows moderately strong inbreeding depression. Reductions in population size could result in expression of inbreeding depression among progeny, such as reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species (68 FR 35950). Thus, owing to minimum numeric criteria being reached in four occurrences, *S. hookeri* has a moderate background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

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

Ongoing Conservation Actions No information is available on conservation management for *Schiedea hookeri* since it was listed as endangered. However, about 128 individuals (30 percent of all remaining individuals) of this species occur action area in management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Keaau and Kahanahaiki, which are not fenced; and Kaluakauila and Ohikilolo, which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *S. hookeri* within the preserve. This species is represented in *ex situ* collections that include nine cuttings in a nursery (Harold L. Lyon Arboretum) and 30 plants in a botanical garden (Waimea Valley Audubon Center) (Service 2005b).

Critical Habitat Description A total of 1,102 ha (2,724 ac) of critical habitat was designated in seven separate units for *Schiedea hookeri* on Oahu. Critical habitat was designated on State lands (Kaena Point State Park, Kuaokala, Mokuleia, and Waianae Kai Forest Reserves; and Pahole and Kaala Natural Area Reserves), Federal lands (Lualualei Naval Reservation), and private lands (Honouliuli Preserve). These seven critical habitat units provide habitat for eight populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. hookeri* (68 FR 35950).

The primary constituent elements of critical habitat include slopes, cliffs or cliff bases, rock walls, or ledges in diverse mesic or dry lowland forest often dominated by *Metrosideros polymorpha*, *Diospyros sandwicensis*, or *D. hillebrandii*; at elevations between 238 and 978 m (781 and 3,208 ft). In addition, all units contain one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma pulvinatum*, *Artemisia australis*, *Bidens torta*, *Carex meyenii*, *Carex wahuensis*, *Charpentiera tomentosa*, *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Eragrostis grandis*, *Hibiscus* sp., *Leptecophylla tameiameiae*, *Melanthera tenuis*, *Pisonia sandwicensis*, *Pouteria sandwicensis*, *Psydrax odorata*, *Sida fallax*, or *Stenogyne* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area The four occurrences of *Schiedea hookeri* in the action area total about 128 individuals or about 30 percent of the species' range-wide distribution (U.S. Army Garrison 2006c) (see Table SB 33). Only the Kaluakauila occurrence is exceeding minimum numerical criteria for a stabilization population at 52 mature individuals. This occurrence is within a fenced ungulate exclosure; the other three action area occurrences are not fenced, and none of the action area occurrences are actively managed by the Army. *Schiedea hookeri* plants in the action area are located in areas at risk from training-related wildfire. About 92 individuals occur in the high fire risk zone, 20 individuals in the low fire risk zone and 6 in the very low fire risk zone. These individuals in fire risk zones represent about 31 percent of the

species' total range-wide numbers; about 25 percent of the species' total range-wide numbers are located in the high fire risk zone. The Kaluakauila occurrence (52 individuals) is located within a zone of high fire risk, in an extremely dry area (U.S. Army Garrison 2005a). Thus, *S. hookeri* in the action area is characterized by one occurrence at minimum numeric levels to be categorized as a stabilization population unit that comprises 30 percent of all remaining individuals, most of which are located within high to very low fire risk zones, and by three occurrences with low numbers not reaching minimum numerical stabilization criteria and unknown trend.

Status of the Critical Habitat in the Action Area The action area contains a total of 30 ha (75ac) or three percent of the total critical habitat for *Schiedea hookeri*. Designated critical habitat is located within one unit in the northeastern portion of the action area. About three percent of critical habitat for this subspecies is located in an area at risk of training-related wildfire, with 6 ha (14 ac) located in the high fire risk zone and approximately 25 ha (61 ac) are in the very low fire risk zone. It is estimated that the critical habitat is located in an area with up to 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea hookeri* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. This species is particularly threatened by competition with non-native weeds and by fire. The July 2003 prescribed fire at Makua burned within 20 m (66 ft) of *S. hookeri* plants in the Kaluakauila Management Unit, and burned approximately 2.4 ha (6 ac) of *S. hookeri* critical habitat (U.S. Army Garrison 2003b). About two percent of the total critical habitat designated for this species is at risk from training-related wildfire in the action area, with less than one percent located in the high fire risk zone. In addition, only 31 percent of all known individuals occur within the action area. Thus, *S. hookeri* in the action area has a moderate background risk of species extinction, and any additional threats are unlikely to eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area *Schiedea hookeri* non stabilization species by the Army because less than 50 percent of all remaining individuals are located within the action area, and there are three stabilization population units outside the action area. A post-fire revegetation plan and site-specific fuels modification plan are needed where *S. hookeri* is present in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

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

Status of the Species – *Schiedea kaalae* (No Common Name)

Species Description *Schiedea kaalae* is a short-lived perennial of the Caryophyllaceae (pink) family. It has a short woody caudex (perennial stem at the ground surface) less than 20 cm (8 in) tall, with short branches that trail along the ground and end in rosettes of thick, oppositely arranged leaves. The small, perfect flowers (with both male and female reproductive parts) are borne in open, branched clusters up to 40 cm (15.6 in) long. The fruit is a small capsule filled with tiny, dark seeds (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Schiedea kaalae* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for *S. kaalae* was designated on June 17, 2003 (68 FR 35950). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate *Schiedea kaalae* was known from the north-central and south-central Waianae Mountains and the northern Koolau Mountains of Oahu. When listed in 1991, there were five occurrences in the Waianae Mountains and two occurrences in the Koolau Mountains that together totaled less than 100 individuals (56 FR 55770). In 2003, eight population units totaling 24 to 25 individuals indicated a steady decline for this species (Makua Implementation Team 2003). The latest information available indicates an increasing in detection due to more diligent survey effort and augmentation, with 10 population units totaling 235 individuals located on Federal, State, and private lands (68 FR 35950) (Table SB 34). Of these, 62 individuals are naturally occurring and 173 are augmentations from greenhouse-propagated stock. A new population unit was recently discovered at Kahana, and additional individuals were discovered at the Makua population unit (U.S. Army Garrison 2005b). None of the population units have reached the numeric targets for stabilization (defined as 50 mature individuals for short-lived perennials).

Demographic information in the wild is unknown, as *Schiedea kaalae* seedlings and immature plants are seldom seen, especially in Waianae population units. The apparent lack of recruitment is probably due to seedling predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2004a, 2005b). The Nature Conservancy of Hawaii has propagated and outplanted *S. kaalae* from seed and cuttings, but no seedlings have been observed at those outplanting sites (U.S. Army Garrison 2004a). No information is available on the survival rate of immature outplantings. Individuals of this species are at risk from training-related wildfire in the Makua and Schofield Barracks Military Reservation action areas. Thus, *S. kaalae* is characterized by extremely low numbers that are increasing only by augmentation and occasional discovery of new occurrences.

Table SB 34. Range-wide Distribution of *Schiedea kaalae*.

Population Units	Number of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Pahole*	--	--	3	1/0‡	2/0	0/3 [19/0]
Huliwai	--	--	1-2	0	0	0
Kahana (Koolau)*	--	--	--	11/0	5/2	5/2
Kaluaa and Waieli*	--	--	--	--	0/0 [40/25]	0/0 [72/44]
Kaipapau	--	--	--	2/0	0	0
Maakua (Koolau)*	--	--	4	4/0	16/0	16/0
Makaua (Koolau)	--	--	2	2/0	1/1	1/0 [0/1]
Mohiakea (SBMR)	--	--	1	1/0	1/0	1/0
North Kaluaa	--	--	2	0/0 [0/53]§	0	0
North Palawai	--	--	1	1/0	1/0	1/0
South Ekahanui* (North and South)	--	--	10	5/0 [0/75]	14/0 [0/46]	14/0 [56/0]
Total Individuals	<100	13	24-25	**155** (27/0)† [0/128]	**154** (40/3) [40/71]	**235** (38/5) [147/45]

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b), T. Takahama (Hawaii Division of Forestry and Wildlife, pers. comm. 2006)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Schiedea kaalae* in the Waianae Mountains is consistently found on steep slopes and shaded sites in the understory of diverse mesic forest and wet forest, usually in gulch bottoms or low to mid gulch slopes, at elevations between 210 to 790 m (689-2,592 ft). It often grows on slopes with sparse groundcover and occasionally in cracks in rock embankments. In the Koolau Mountains, *S. kaalae* occurs in gulch bottoms and on lower gulch slopes within mesic to wet habitats, some of which are constantly wet from seeping water. Plants can grow on gentle to moderate slopes, steep rock embankments, and nearly vertical cliffs (56 FR 55770; Makua Implementation Team 2003). Where *S. kaalae* occurs in the same drainages as its relatives *S. hookeri*, *S. nuttallii*, *S. obovata*, and *S. pentandra*, it is usually found in the drier areas. *Schiedea kaalae* flowers from March through June. Cultivated plants are capable of self-pollination, but *S.*

kaalae is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). In the field, biologists have observed a non-native syrphid fly visiting the plants (Makua Implementation Team 2003). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information on *S. kaalae* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Schiedea kaalae* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Schiedea kaalae* is particularly vulnerable to predation by non-native slugs and snails. One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). In addition to the very low risk of training-related wildfire from military activities at Makua, one individual of *S. kaalae* is exposed to the risk of training-related wildfire at Mohiakea Gulch in the Schofield Barracks Military Reservation action area (Service 2003a).

Most importantly, occurrences of *Schiedea kaalae* are vulnerable to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a). In addition, *S. kaalae* and the related species *S. nuttallii* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. However, low levels of genetic diversity in *S. kaalae* populations may not be detrimental to the species as plants from populations that appear to have undergone repeated self-fertilization are vigorous in cultivation (Makua Implementation Team 2003). Nonetheless, the science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. kaalae* already is in a phase of "quasi-extinction," with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. kaalae* has a very high background risk of species extinction, and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Schiedea kaalae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The three population units identified for stabilization of *S. kaalae* are all located on State or private lands. The Army proposes to manage an additional two population units for stabilization at Maakua and Kahana, in the Koolau Mountains (U.S. Army Garrison 2005b). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. kaalae* and associated native plants.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea kaalae*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Population units of *S. kaalae* are fenced in the Pahole, South Ekahanui, Kaluaa and Waieli, Makuaa, Mohiakea, and North Palawai population units; weeds are partially controlled only in the Mohiakea, North Palawai, and Kahana population units (U.S. Army Garrison 2005b). In addition, this species occurs in three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Lower Kahana, which is not fenced; and Ekahanui and Pahole, which are fenced. The South Ekahanui population unit is augmented by The Nature Conservancy of Hawaii. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats, including the South Ekahanui population unit of *S. kaalae*. Seeds and cuttings have been taken from the recently discovered plants in the Kahana population unit for propagation and augmentation (U.S. Army Garrison 2005b).

Obtaining sufficient seed for genetic storage of *Schiedea kaalae* is difficult because plants do not produce much seed at one time. This species can be propagated from both seed and cuttings. Germination rates of fresh seeds vary from less than 15 percent to 75 percent (U.S. Army Garrison 2005b). The Nature Conservancy of Hawaii has propagated this species successfully from seed in the greenhouse, and has reintroduced plants to three sites in Honouliuli Preserve. Survivorship of these outplants appears good, but they have not yet produced any seedlings (U.S. Army Garrison 2005b). This species is represented in several *ex situ* collections, including one apical vegetative bud in micropropagation (Harold L. Lyon Arboretum), 23 cuttings in a nursery (Harold L. Lyon Arboretum), 17 plants in a nursery (Harold L. Lyon Arboretum), nine plants in a botanical garden (Waimea Valley Audubon Center), 598 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 6,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 193 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 1,103 ha (2,726 ac) in six separate units was designated as critical habitat for *Schiedea kaalae* on Oahu. Critical habitat was designated on State lands (Pahole Natural Area Reserve, Mokuleia, Hanuula, and Kaipapau Forest Reserves, and Sacred Falls and Kahana Valley State Parks) and private lands (Honouliuli Preserve and others). These critical habitat units provide habitat for 10 populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. kaalae* (68 FR 35950).

The primary constituent elements of critical habitat include steep slopes, cliffs, stream banks, or deep shade in diverse mesic or wet forests at elevations between 64 and 904 m (210 and 2,965 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Boehmeria grandis*, *Charpentiera* sp., *Claoxylon sandwicense*, *Cyrtandra calpidicarpa*, *Cyrtandra laxiflora*, *Diospyros hillebrandii*, *Diplazium arnottii*, *Diplazium sandwichianum*, *Dryopteris unidentata*, *Freycinetia arborea*, *Hedyotis acuminata*, *Nothocestrum longifolium*, *Pipturus albidus*, *Pisonia sandwicensis*, *Pisonia umbellifera*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Selaginella arbuscula*, or *Xylosma hawaiiense*. The plant community, associated species, and elevations are a barometer for such things as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as

primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area The action area includes 22 (19 mature, 3 immature) *Schiedea kaalae* plants in the Pahole population unit or about nine percent of the species' total range-wide numbers (see Table SB 34). In 2003, there were three individuals in this population unit (Makua Implementation Team 2003; U.S. Army Garrison 2005b). The 22 plants are within the fenced Pahole Management Unit where ungulates, but not invasive weeds, are controlled by the Hawaii Division of Forestry and Wildlife (U.S. Army Garrison 2004a). This part of the Pahole Natural Area Reserve is in a zone of very low fire risk. Thus, *S. kaalae* in the action area is characterized by one population unit that has increased in number to 22 individuals or about nine percent of all remaining individuals of this species.

Status of the Critical Habitat in the Action Area The action area contains a total of 150 ha (372 ac) or 14 percent of the total critical habitat designated for *Schiedea kaalae* on Oahu and in the state. Critical habitat is located on State land (Pahole Natural Area Reserve) in the northeastern part of the action area. This critical habitat is part of a total 425 ha (1,051 ac) critical habitat unit that extends beyond the action area and provides habitat for two populations of 300 mature, reproducing individuals each. About 14 percent of critical habitat for this species is located in an area at risk from training-related wildfire, with almost no critical habitat located in the high fire risk zone. Approximately 0.0 ha (trace <0.1 ac.) are in the high fire risk zone, 7.4 ha (18.2 ac) are in the low fire risk zone and 143.1 ha (353.6 ac) are in the very low fire risk zone. It is estimated that almost half of the critical habitat in the action area contains less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea kaalae* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The greatest limiting factor to the stabilization of *S. kaalae* is slug predation of seedlings (U.S. Army Garrison 2005b). The action area critical habitat represents about 14 percent of total critical habitat at risk from training-related fire, with none in the high fire risk zone. Although the species as a whole is extremely at risk, the 22 plants in the very low fire risk zone of the action area represent only about nine percent of the species' range-wide distribution. Thus, *S. kaalae* in the action area has a relatively low background risk of species extinction, and any additional threats are unlikely to affect the species' long-term persistence outside the action area.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Schiedea kaalae* because no population units exceeding minimum criteria for stabilization exist outside the action area (Makua Implementation Team 2003). Three population units have been identified for stabilization of *S. kaalae*: Pahole within the action area, and North Kaluaa and South Ekahanui

outside the action area. In addition, the Army has proposed two additional, backup population units for stabilization: Kahana and Maakua in the Koolau Mountains outside the action area. Army Natural Resources Staff have not seen the *S. kaalae* plant in the Pahole population unit within the action area and long-term access issues with the Hawaii Division of Forestry and Wildlife are unclear (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. kaalae* in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The Pahole population unit is located within the fenced Pahole Management Unit, and is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). About 10 percent of the mature individuals of this species in the action area are within a fenced portion of the Pahole Management Unit. In general, sufficient collections for genetic storage have been difficult to achieve as plants produce few seeds at a time. Genetic storage goals are two percent complete, with 21 plants from all nine population units combined towards fulfilling the goals outlined in the Makua Implementation Plan. There are also 15 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea nuttallii* (No Common Name)

Species Description *Schiedea nuttallii* is a short-lived perennial of the Caryophyllaceae (pink family). It is an erect subshrub (stems woody at the base) up to 1.5 m (4.9 ft) tall with purple-tinged, oppositely-arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. The small, perfect flowers (with both male and female reproductive parts) are borne in terminal clusters 20 to 25 cm (7.8 to 9.8 in) long. The tiny hard, black seeds are contained within small papery capsules 2.5 to 3.5 mm (0.1 to 0.14 in) long (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Schiedea nuttallii* was federally listed as endangered on October 10, 1996 (61 FR 53108), and was State listed as endangered at the same time. A recovery plan for multi-island plants included the listed taxon, then classified as comprised of plants from Kauai, Oahu, Molokai, and Maui (Service 1999a). Critical habitat for the listed taxon was designated for Oahu on June 17, 2003 (68 FR 35950); for Molokai on March 18, 2003 (68 FR 12982); and for Kauai on February 27, 2003 (68 FR 9115). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Previous Biological Opinions for military training at Makua cover Oahu occurrences of the listed taxon, and the Makua Implementation Plan covers the Waianae "subspecies" (Makua Implementation Team 2003). When listed, *Schiedea nuttallii* was considered to include historical occurrences on Kauai, Oahu, Molokai, and Maui, with occurrences still existing on Kauai and Oahu (61 FR 53108). The Makua Implementation Plan noted the species' taxonomy was under revision, and likely would be reclassified as two subspecies, with the Oahu and Maui

plants as the subspecies *nuttallii* and newly discovered plants on Molokai as a new subspecies (Makua Implementation Team 2003). However, the recently revised taxonomy of the genus *Schiedea* treats *S. nuttallii* as a full species comprised of Oahu, Molokai (recently extirpated), and Maui (historic) occurrences (Wagner et al 2005). The Kauai occurrence formerly considered as *S. nuttallii* is now recognized as two species endemic to Kauai, *S. perlmanii* and *S. kauaiensis*. The recently discovered occurrence on Molokai is recognized as a new species, *S. laui*. This Biological Opinion considers *S. nuttallii* as defined by Wagner et al (2005), i.e., as comprised of currently existing occurrences on Oahu. The status of this newly classified species is identical to that of Oahu occurrences of the federally listed taxon.

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate considerable range restriction in *Schiedea nuttallii*, which was one of the most widely distributed species in the genus with documented occurrences on Oahu, Molokai (recently extirpated), and West Maui (historical) (Wagner et al 2005). On Oahu, *S. nuttallii* was recorded from scattered occurrences throughout the Waianae Mountains and the southeastern Koolau Mountains. The species is now restricted to the northern Waianae Mountains; plants in the southern Waianae Mountains have not been seen since the late 1970s (Makua Implementation Team 2003). Plants are located on Federal and State lands (68 FR 35950). The Ekahanui Gulch occurrence at the privately owned Honouliuli Preserve, which was noted when the species was listed, has not been seen since 1978 (Service 1999a).

Consistent monitoring survey data for this species are available only since 2003, when *Schiedea nuttallii* was characterized as "clearly declining" with 50 total individuals in three population units (Makua Implementation Team 2003). Currently, this species consists of only two known population units totaling 94 individuals (Table SB 35). The Kahanahaiki portion of the Kahanahaiki to Pahole population unit is located on Makua. The Pahole portion of the Kahanahaiki to Pahole population unit and the Kapuna-Keawapilau Ridge population unit are located in Pahole Natural Area Reserve. The Kahanahaiki to Pahole population unit currently contains 80 mature individuals, and may meet the numerical criterion for stability (defined as 50 mature, reproducing individuals for short-lived perennials). This population unit increased from about 48 total individuals in 2003 to 91 total individuals in 2006, primarily owing to Army augmentation efforts (Makua Implementation Team 2003, U.S. Army Garrison 2006d). About 50 percent of all currently existing individuals are augmentations from greenhouse-propagated stock, including about 52 percent of all mature individuals and 36 percent of all immature individuals. The Kahanahaiki to Pahole population unit is located within low to very low zones at risk from training-related wildfire.

Demographic data in the Kahanahaiki to Pahole population unit include limited recruitment. However, both augmented and naturally occurring immature plants are attacked by invertebrates and are not vigorous (U.S. Army Garrison 2004a, 2005b). Although total numbers have increased from 60 to 94 since 2003, the total number of naturally occurring individuals in the Kapuna-Keawapilau Ridge population unit has remained at only three individuals. Thus, *Schiedea nuttallii* is characterized by low numbers of known individuals with only two existing population units, including one that has met minimum numerical criteria for stabilization but is being sustained primarily through augmentation.

Table SB 35. Range-wide distribution of *Schiedea nuttallii.*

Population Units	Numbers of Known Individuals					
	1996 (1)	**1999** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki*	--	28	21/12	31/8‡	23/8	37/7
Pahole*	2	20-50	14-15	[13/5]§	[35/10]	[43/4]
Kapuna-Keawapilau Ridge*	--	--	2/1	3/0	3/0	3/0
Ekahanui Gulch	--	2	--	--	--	--
Makaha*	--	--	--	0	0	0
Total Individuals	**25**	**50-80**	**50-51**	**60** (34/8) [13/5]	**79** (26/8) [35/10]	**94** (40/7) [43/4]

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

(1) Listing rule (61 FR 53115)
(2) Recovery Plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Schiedea nuttallii* occurs in the understory of diverse mesic forest at elevations between 400 and 730 m (1,312 and 2,395 ft). It typically grows on steep rock walls and forested slopes of north-facing gulches in *Acacia koa-Metrosideros polymorpha* lowland mesic forest and *Metrosideros polymorpha-Dodonaea viscosa* forest (68 FR 35950). Flowers and fruits are abundant in the wet season and less so throughout the year. *Schiedea nutttallii* is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *S. nuttallii* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats to the Species *Schiedea nuttallii* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea nuttallii* is particularly vulnerable to predation by non-native slugs and snails. Seedlings have been observed in wild populations, but recruitment is reduced because of these alien invertebrates. Augmented *S. nuttallii* individuals seem to survive the initial outplanting transition but are subsequently weakened by invertebrate injury (Makua Implementation Team 2003). One study noted, for example, that seedling mortality for the

related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). This species also may be threatened by the black twig borer *Xylosandrus compactus*, which causes slight to severe defoliation and reduced plant vigor that may kill branches or the entire plant (68 FR 35950; U.S. Army Garrison 2004a). Black twig borer predation would be of particular concern for *S. nuttallii* because no control methods are available that do not also harm native scolytid beetles. Regarding fire vulnerability, *S. nuttalli* is a small, understory herbaceous plant less than 1.5 m (4.9 ft) tall with stems that are woody only at the base. Whether *S. nuttallii* resprouts or regenerates from buried seeds after fire is unknown, but it is probably similar to most native Hawaiian plants in lack of resistance or tolerance to fire.

Most importantly, occurrences of *Schiedea nuttallii* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; 68 FR 35950; Service 1999a). In addition, *S. nuttallii* and the related species *S. kaalae* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. nuttallii* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. nuttallii* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Schiedea nuttallii* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. nuttallii* and associated native plants.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea nuttallii*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Army has been augmenting occurrences in the Kahanahaiki and Pahole population unit since 2003. In addition, this species is located in occurrences over three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Upper Kapuna, which is not fenced; and Kahanahaiki and Pahole, which are fenced.

Schiedea nuttallii has been successfully propagated by tissue culture from seed, and from cuttings. The germination rate of fresh seed is about 50 percent, and the success rate of cuttings is 10 to 50 percent. Seed can be stored with little or no decrease in viability, but germination trials have not yet been conducted because so few plants are available to provide material (U.S. Army Garrison 2005b). Both remaining population units, Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge, are represented in *ex situ* collections (U.S. Army Garrison 2005b). In 2005,

these *ex situ* collections included 108 cuttings in nurseries (Army Environmental Division,Oahu, and Harold L. Lyon Arboretum), 54 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 1,300 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 20 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 1,256 ha (3,103 ac) of critical habitat, in six separate units on three islands, was designated for *Schiedea nuttallii*, including 709 ha (1,753 ac) in three units on Oahu. Critical habitat on Oahu was designated on State lands (Mokuleia Forest Reserve, and Pahole and Kaala NATURAL AREA RESERVEs) and on private lands (Honouliuli Preserve) (68 FR 35950). The three critical habitat units on Oahu provide habitat to support six populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. nuttallii* (68 FR 35950).

The primary constituent elements of critical habitat on Oahu include rock walls, forested slopes, or steep walls in *Acacia koa-Metrosideros polymorpha* lowland mesic forest or *Metrosideros polymorpha-Dodonaea viscosa* forest at elevations between 408 and 1,072 m (1,338 and 3,516 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *Bidens torta*, *Cibotium chamissoi*, *Coprosma* sp., *Cyanea longiflora*, *Hedyotis terminalis*, *Ilex anomala*, *Machaerina* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pipturus* sp., and *Psydrax odorata*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

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 According to U.S. Army Garrison (2006d), all known individuals of *Schiedea nuttallii* are located within the previously-designated action area, in the Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge population units (see Table SB 35); see the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. However, we have information that indicates the Kapuna-Keawapilau Ridge population unit is actually located outside the current action area (M. Mansker, pers. comm. 2005). The Kahanahaiki to Pahole population unit currently contains about 91 total individuals, or 97 percent of all remaining individuals of this species. This population unit contains 80 mature individuals and could be considered meeting numerical stabilization targets; however, threat control and genetic storage goals are not yet complete. This population unit increased from 48 total individuals in 2003 to 91 total individuals in 2006, owing primarily to Army augmentation efforts. About 52 percent of all individuals in this population unit are augmentations, including many nursery-propagated seedlings and clones (cuttings). The vigor of outplanted individuals ranges from healthy to poor and survivorship ranges from 50 to 75 percent; so far, there is no regeneration at augmented sites (U.S. Army Garrison 2005b). The Kapuna-Keawapilau Ridge population unit has remained static at three individuals since 2003. Plants of this species in action area are located in zones at risk of training-related wildfire. About 84 individuals occur in the low fire risk zone and 10 individuals in the very low fire risk zone. Thus, *S. nuttallii* in the

action area is characterized by one population unit meeting minimum numerical criteria for stabilization but that is increasing primarily by augmentation, with 100 percent of all remaining individuals at low and very low risks of training-related wildfire.

Status of the Critical Habitat in the Action Area The action area contains a total of 199.7 ha (493.5 ac), or 16 percent of the total critical habitat for *Schiedea nuttallii* on Oahu. Critical habitat was designated for this species on other islands in 2003; however, plants on Kauai and Maui are no longer considered within the taxon *S. nuttallii* (Wagner et al 2005). Designated critical habitat on Oahu is located within one unit in the northeastern portion of the Makua action area. This critical habitat is a portion of a larger 527 ha (1,304 ac) critical habitat unit that extends outside the action area boundary and provides habitat for four populations of *S. nuttallii*. About 16 percent of critical habitat for this species on Oahu is located in an area at risk of training-related wildfire, with 0.2 ha (0.6 ac) located in the high fire risk zone, 17.1 ha (42.3 ac) in the low fire risk zone, and 182.2 ha (450.2 ac) in the very low fire risk zone. It is estimated that nearly one-half of the critical habitat in the Makua action area is found in areas comprised of 50 to 75 percent native plant cover and another one-quarter is found in areas with greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea nuttallii* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea nuttallii* in the action area is particularly vulnerable to predation by non-native slugs and snails, and may be susceptible to predation by the black twig borer (U.S. Army Garrison 2004a). About 16 percent of critical habitat for this species on Oahu is located in an area at high, low, and very low risks of training-related wildfire. Thus, because 100 percent of all known remaining individuals occur within the action area, *S. nuttallii* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Schiedea nuttallii* because more than 50 percent of all known individuals occur within the action area and no population units meeting minimum numeric criteria for stabilization exist outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for expedited stabilization of *S. nuttallii*: Kahanahaiki to Pahole within the action area, and Kapuna-Keawapilau Ridge and Makaha outside the action area. The Makaha population unit will be established through reintroduction after an ungulate-exclosure fence is built in 2007. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. nuttallii* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge population units, which contain all of the

total remaining individuals of *Schiedea nuttallii*, are being managed for stabilization as specified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located in the Kahanahaiki (subunit II) and Pahole Management Units, which are fenced; and in the Upper Kapuna Management Unit, which is not fenced. All but one wild site in the Pahole part contain good-quality habitat within fenced exclosures, are augmented with outplanted individuals, and are partially controlled to reduce cover of non-native weeds. A total of about 332.3 ha (821.1 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaluaa and Waieli, Pahole, Upper Kapuna, West Makaleha). About 170.5 ha (421.1 ac) of the total critical habitat that is within management units is located inside the action area (Kahanahaiki, Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were 11 percent complete, with 11 plants from both remaining population units combined towards meeting the goals outlined in the Makua Implementation Plan, and 23 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea obovata* (No Common Name)

Species Description *Schiedea obovata* is a short-lived perennial of the Caryophyllaceae (pink family). It is an erect subshrub (stems woody at the base) up to 1 m (3.3 ft) tall, with oppositely arranged, elliptic leaves 4 to 11 cm (1.6 to 4.3 in) long. The small, perfect flowers (with both male and female reproductive parts) lack petals and are borne in axillary clusters. The berry-like seed capsules are covered by fleshy purple calyx lobes and contain many tiny black seeds (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Alsinidendron obovatum* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). The recently revised taxonomy of *Schiedea* incorporates species previously classified as *Alsinidendron*, and *Alsinidendron obovatum* has been reclassified as *Schiedea obovata* (Wagner et al 2005). The status of *Schiedea obovata* is identical to that of *Alsinidendron obovatum*, the federally listed taxon. The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate that *Schiedea obovata* has declined significantly in the last 20 years (Makua Implementation Team 2003). Historically, this species was known from the northern and southern parts of the Waianae Mountains. When the species was listed in 1991, two occurrences totaling about 100 individuals were known, in Kapuna Gulch and Pahole Gulch (56 FR 55770). Since then, more occurrences have been discovered, but by 2003 plants were no longer found at some locations (Makua Implementation Team 2003). In late 2003, a new population unit was discovered in North West Makaleha, near a historical Keawapilau population, but surveys to locate other population units in the southern Waianae Mountains were unsuccessful (U.S. Army Garrison 2004a. Currently, two population units, Kahanahaiki to Pahole and Keawapilau to West Makaleha, total 389 individuals located on Federal and State

lands (68 FR 35950) (Table SB 36). The Kahanahaiki to Pahole population unit has met numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit) (Makua Implementation Team 2003). The existing population units also are located within low and very low fire risk zones for training-related wildfire.

Demographic data indicate *Schiedea obovata* is increasing in numbers only due to augmentation efforts and the discovery of a new population unit in North West Makaleha. About 82 percent of all of individuals are augmentations from greenhouse-propagated stock. Recruitment of seedlings and immature plants into the mature population is limited by predation by non-native slugs and snails that feed on and damage leaves and stems (Makua Implementation Team 2003; U.S. Army Garrison 2004a; U.S. Army Garrison 2005b). One study noted, for example, that seedling mortality doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). Furthermore, slugs have the potential to completely halt seedling regeneration in several sites (U.S. Army Garrison 2004a, 2005b). Thus, *S. obovata* is characterized by declining in the current range and two existing population units with low numbers, of which one is exceeding minimum numerical criteria for stabilization and increasing through augmentation and discovery of new individuals.

Table SB 36. Range-wide distribution of *Schiedea obovata.*

Population Units	Number of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki*	--	--	0	0/0‡ [65/25]§	0/0 [58/183]	0/0 [103/190]
Pahole*	--	--	0			
Keawapilau*	--	--	0	21/12	42/34	44/27 [11/14]
North West Makaleha*	--	--	--			
West Makaleha*	--	--	3			
Makaha*	--	--	--	0	0	0
Other Locations	--	--	--	--	--	13
Total Individuals	**100**	**11-12**	**3-10**	**123** (21/12)† [65/25]	**317** (42/34) [58/183]	**389** (44/27) [114/204]

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Schiedea obovata* occurs on ridges and slopes in lowland diverse mesic forests dominated by *Acacia koa* and *Metrosideros polymorpha*, at elevations of 560 to 760 m (1,837 to 2,494 ft). Plants generally flower after two years of growth, and are normally self-fertilizing (Makua Implementation Team 2003). Flowers and fruit are produced year-round, especially in

response to rainfall during winter and spring. Seed dispersal mechanism is unknown, although the plant's "false berry" possibly may attract fruit-eating birds that may disperse the seeds (Makua Implementation Team 2003). Plants survive 3 to 6 years, or less under drought conditions (Service 1995a, Service 1998a). Population units in the wild have been known to disappear for a number of years and then reappear after large rainfall events, apparently owing to persistence of seeds in the soil seed bank (U.S. Army Garrison 2004a). Other demographic information for *S. obovata* in the wild is unknown, including number of seeds produced, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Schiedea obovata* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea obovata* is particularly vulnerable to predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2005b). The decline and possible extirpation of the southern Waianae population units of *S. obovata* are partially attributed to residential development, establishment of military installations, reforestation with non-native trees in the early 1900s, and trampling and illegal collecting by people (Makua Implementation Team 2003). Most importantly, population units of *S. obovata* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a). Because *S. obovata* is thought to be a facultative self-pollinator, inbreeding depression may not be significant (U.S. Army Garrison 2004a). This species experiences large population fluctuations related to drought and its natural recruitment is severely reduced by slug predation (U.S. Army Garrison 2005c). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). Thus, *S. obovata* has a very high background risk of species extinction and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Schiedea obovata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stabilization criteria for short-lived perennials. However, because of the common, large declines or fluctuations in numbers of *S. obovata*, the Makua Implementation Team (2003) identified a stabilization target of at least 100 mature individuals for each population unit of this species. An increased stabilization criterion is needed because any adverse disturbance during a major low point in a population unit's fluctuation could extirpate that unit. In addition to stabilizing the two existing population units, a third population unit must be established by reintroduction and managed for stabilization outside the action area. Research on slug control in forest settings is needed to find ways to reduce this threat to *S. obovata* and associated native plants.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea obovata*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species occurs in the Kahanahaiki, Pahole, and West Makaleha Management Units where it will benefit from population unit and/or ecosystem-level protection. The Army and the Hawaii Division of Forestry and Wildlife have been outplanting this species within fenced exclosures since 1999. The Kahanahaiki to Pahole population unit is located within the fenced Kahanahaiki and Pahole Management Units, and the North West Makaleha site within the Keawapilau to West Makaleha population unit is fenced. Fence construction is planned for the entire West Makaleha Management Unit in 2007. Invasive weeds are controlled at extant *S. obovata* sites, but not at historical sites.

Schiedea obovata seed can be successfully stored and remain viable for several years, and outplantings have been successful (U.S. Army Garrison 2005b). In 2005, this species was represented in the following *ex situ* collections: one cutting in a nursery (Army Environmental Division, Oahu), 14 plants in a botanical garden (Waimea Valley Audubon Center), 161 seeds in micropropagation (Harold L. Lyon Arboretum), 236,814 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 13 seedlings in micropropagation (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 232 ha (574 ac) of critical habitat was designated for *Schiedea obovata* on June 17, 2003, in three separate units. Critical habitat was designated on State lands (Mokuleia, Nanakuli, and Waianae Kai Forest Reserves, and Pahole Natural Area Reserve), to provide habitat for seven populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. obovata* (68 FR 35950).

The primary constituent elements of critical habitat include ridges and slopes in lowland diverse mesic forest dominated by *Acacia koa* and *Metrosideros polymorpha* at elevations between 477 and 943 m (1,565 and 3,093 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *Bidens torta*, *Cibotium chamissoi*, *Coprosma* sp., *Cyanea longiflora*, *Hedyotis terminalis*, *Ilex anomala*, *Machaerina* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pipturus* sp., and *Psydrax odorata*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

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

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area All known individuals of *Schiedea obovata* are located within the action area, in the Kahanahaiki to Pahole and Keawapilau to West Makaleha population units (see Table SB 36). The Kahanahaiki to Pahole population unit, with 103 mature individuals, may be considered exceeding numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit), but threats are not adequately controlled and genetic storage is not complete. All naturally occurring *S. obovata* plants in the

Kahanahaiki, Pahole, and Keawapilau sites had disappeared by 2001 and no seedlings have regenerated from the soil seed bank (U.S. Army Garrison 2004a). All current individuals in the Kahanahaiki to Pahole population unit are augmentations from greenhouse-propagated stock. The Keawapilau to West Makaleha population unit has increased from 3 individuals in 2003 to 96 in 2006, due to augmentation and discovery of new subpopulations within the population unit. About 74 percent of total individuals in this population unit are naturally occurring, not augments. The Army has augmented wild populations at three sites (Kahanahaiki, Pahole, and West Makaleha). High seedling recruitment has resulted from plants reintroduced at Pahole. Plants reintroduced at Kahanahaiki are less vigorous, perhaps reflecting differences in genetic founder material (U.S. Army Garrison 2005b). All plants within the action area are located in areas at risk of training-related wildfire. About 91 individuals occur in the low fire risk zone and 298 individuals in the very low fire risk zone. Thus, *S. obovata* in the action area is characterized by one population unit meeting numerical criteria for stabilization and one population unit not exceeding numerical criteria that contain all remaining individuals in low and very low fire risk zones, and by numbers that are increasing almost entirely by augmentation and discovery of new individuals.

Status of the Critical Habitat in the Action Area The action area contains a total of 164.5 ha (406.4 ac), or 71 percent, of the total critical habitat for *Schiedea obovata*. Most of the critical habitat is located on State land in the northeastern portion of the action area. This critical habitat is part of a total 176 ha (436 ac) critical habitat unit that extends beyond the action area and provides potential habitat to support five populations of 300 mature, reproducing individuals each. Critical habitat for this species in the action area is located in an area at risk of training-related wildfire, with 0.04 ha (0.1 ac) in the high fire risk zone, 14.5 ha (35.9 ac) in the low fire risk zone and 149.9 ha (370.4 ac) in the very low fire risk zone. It is estimated that almost the entire critical habitat is within areas that contain more than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea obovata* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea obovata* in the action area is particularly vulnerable to predation by non-native slugs and snails. The action area critical habitat in the high to low and very low fire risk zones represents about 71 percent of total critical habitat for this species. Thus, because all known individuals occur within the action area and all are within fire risk zones, *S. obovata* in the action area has a very high background risk of species extinction and any additional threats could reduce the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Schiedea obovata* because more than 50 percent of all known individuals occur within the action area, and population units exceeding numerical criteria for stabilization do not exist outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for stabilization of *S. obovata*: Kahanahaiki to Pahole and Keawapilau to West Makaleha within the action area, and Makaha, to be reintroduced outside the action area after fence construction. Fencing and control of feral ungulates is needed for the West Makaleha and Upper Kapuna Management Units, along with additional control of non-

native vegetation. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. obovata* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kahanahaiki to Pahole population unit and Keawapilau to West Makaleha population units are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Within the Kahanahaiki to Pahole population unit, the Army has augmented the Kahanahaiki occurrence and the State has augmented the Pahole occurrence, and both areas are fenced. This species in the action area also occurs at a fenced site within the West Makaleha Management Unit. Weeds are controlled around extant *Schiedea obovata* sites in both population units. A total of about 183.5 ha (453.5 ac) of critical habitat for this species is located within management units both within and outside of the action area (Makaha, Pahole, Palikea, Upper Kapuna, West Makaleha). About 152.4 ha (376.6 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were 31 percent complete, with 31 plants from both population units combined towards meeting the goals outlined in the Makua Implementation Plan, and 12 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species – *Silene lanceolata* (No Common Name)

Species Description *Silene lanceolata*, a member of the Caryophyllaceae (pink) family, is a short-lived perennial. Flowers are white with deeply lobed, clawed petals, and stems are 15 to 50 cm (6 to 20 in) long and woody at the base. Leaves are narrow, smooth and fringed with hairs. This species is distinguished from other Hawaiian members of the genus by its erect stem, terminal inflorescence, and length of the calyx, clawed petals, and carpophore (ovary structure) (Wagner et al 1999).

Listing Status *Silene lanceolata* was federally listed as endangered on October 8, 1992 (57 FR 46325) and state listed as endangered at the same time. A recovery plan was prepared for this species in September 1996 (Service 1996). Critical habitat was designated for *S. lanceolata* on Molokai and Oahu in 2003 (68 FR 12982; 68 FR 35950).

Historic and Current Distribution Historically, *Silene lanceolata* was found on Kauai, in Makua Valley on Oahu, below Puu Kolekole in east Molokai, Maunalei on Lanai, and on Mauna Kea on Hawaii. *Silene lanceolata* is currently known from a total of 2,640 individuals on the islands of Molokai, Oahu, and Hawaii. On Molokai, a single occurrence of approximately 100 individuals was reported in 1987 on private land near Puu Kolekole. On Hawaii, it is found on the Army's Pohakuloa Training Area in Kipuka Kalawamauna, Puu KeeKee, and Kipuka Alala. These three occurrences are distributed over a distance of approximately 15 km (9 mi) and total more than 2,500 individuals. On Oahu, this species has increased from approximately 40 known individuals in five occurrences in mid to late 1990s to 157 known individuals in two occurrences

in 2006 (U.S. Army Garrison 1999a, U.S. Army Garrison 2006c) (Table SB 37). Thus, *S. lanceolata* is characterized by two population units at low numbers, and an overall abundance on Oahu that appears to be increasing but is due in part to increased monitoring efforts.

Table SB 37. Range-wide Distribution of *Silene lanceolata.*

Population Units	Number of Known Individuals					
	1991 (1)	**1996** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Ohikilolo	--	40	40	--	24	11/6
Waianae Kai	--	--	--	12	80/60‡	80/60
Total Population Units on Oahu	--	1	1	4	2	2
Total Individuals on Oahu	--	**40**	**40**	**62**	**164**	**157** (91/66)
Total PopulationUnits State-wide	3	5	5	--	3	--
Total Individuals State-wide	100-130	<1500	>2640	--	**664 -1164** (604-1,104/60)†	--

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

(1) Listing rule (56 FR 55770)
(2) Molokai Recovery plan (Service 1996)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR 35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology On Oahu, *Silene lanceolata* grows on cliff faces and ledges of gullies in dry to mesic shrublands at elevations between 351 and 978 m (1,151 to 3,208 ft). Associated native plant species include *Artemisia australis*, *Bidens* sp., *Carex* sp., *Chamaesyce* sp., *Dodonaea viscosa*, *Lysimachia* sp., *Osteomeles anthyllidifolia*, *Schiedea mannii*, or *Tetramolopium filiforme*. Information on the reproductive cycles, longevity, specific environmental requirements, and limiting factors for this species are unknown (68 FR 35950).

Threats to the Species *Silene lanceolata* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Habitat destruction by feral goats, pigs, and sheep; fire from military activities; and competition with non-native plant species threaten *S. lanceolata* (U.S. Army Garrison 1999a; 68 FR 35950). Thus, although almost half of individuals (98 percent) are located outside the action area, *S. lanceolata* has a moderate background risk of species extinction range wide and high background risk of species extinction (because of low numbers of individuals) on Oahu without protection from existing and additional threats.

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

The recovery plan for *Silene lanceolata* identifies several conservation actions that should be implemented for its recovery. Fenced exclosures should be constructed at all known occurrences to reduce impacts from ungulates. Subsequent control of ungulates and rats from all occupied sites will remove their impact on this species and its habitat. Control measures for non-native plant species that threaten *S. lanceolata* should be implemented. Augmentation of existing occurrences and the establishment of new occurrences should be done by outplanting when adequate propagated materials are available. Control of highly flammable vegetation and maintenance of fuelbreaks is also needed, for plant occurrences found growing in areas of high risk from fire.

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Silene lanceolata* (Hawaii and Pacific Plant Recovery Coordinating Committee 2007). This plan will include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is also being propagated at Pahole Mid-Elevation Rare Plant Facility, Pohakuloa Training Area Plant Facility, and the Volcano Rare Plant Facility (Service 1999a; Service 2005b). In addition occurrences of this species occur in two management units where they may benefit from stabilization management of other species and/or ecosystem-level protection. The management units are Ohikilolo, which is fenced; and Waianae Kai Management Unit, which are not fenced.

Environmental Baseline of the Species

Status of the Species in the Action Area Approximately 17 individuals, or less than two percent of the total known individuals of *Silene lanceolata,* occur within the Makua action area and are located within the Ohikilolo Management Unit in area of low fire risk.

Threats to the Species in the Action Area The primary threats to *Silene lanceolata* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Silene lanceolata* is threatened by competition for light, space, and nutrients from non-native plant species; fires that result from Army training activities; and habitat degradation and destruction by feral goats and pigs (U.S. Army Garrison 1999a).

Conservation Needs of the Species in the Action Area *Silene lanceolata* does not require stabilization pursuant to the guidelines established in the Makua Implementation Plan because only two percent of the known individuals occur within the action area. This species will,

however, benefit from additional conservation actions such as fencing, ungulate and non-native plant control, and control of wildfires that are undertaken for other native plants in the action area (U.S. Army Garrison 1999a). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The Service is unaware of any species-specific management activities occurring in the action area for *Silene lanceolata*.

Status of the Critical Habitat – *Solanum sandwicense* (Popolo aiakeakua)

Critical Habitat Description A total of 2,975 ha (7,352 ac) of critical habitat was designated in five separate units on Kauai and Oahu for *Solanum sandwicense*. Two units were designated on Kauai and three units (328 ha; 811 ac) was designated on Oahu. To meet recovery goals, each unit is intended to provide habitat for one population, each represented by a minimum of 300 mature, reproducing individuals of *S. sandwicense*. Critical habitat has been designated on State lands on both islands (e.g., Kuia Natural Area Reserve, and Kokee and Na Pali Coast State Parks on Kauai, and Mokuleia Forest Reserve and Pahole Natural Area Reserve on Oahu) and private lands (Honouliuli Preserve) on Oahu (68 FR 9116; 68 FR 35950).

The primary constituent elements for the units on Oahu include talus slopes or streambeds at elevations between 471 and 1,006 m (1,545 and 3,300 ft), which occur in open, sunny areas that contain the associated native plant species *Pisonia* sp. and *Psychotria* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral pigs, competition with non-native plant species, fire, and stochastic events such as landslides (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Four percent (105 ha; 258 ac) of the State-wide critical habitat for *Solanum sandwicense* is located in one unit in the Makua action area. The critical habitat unit is located in the northeastern portion of the action area in the low fire risk area. This critical habitat unit provides habitat for the conservation of one population of *S. sandwicense*. It is estimated that nearly one-half of the critical habitat occurs in areas with greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to Critical Habitat in the Action Area Threats to primary constituent elements of the critical habitat in the action area include habitat degradation by feral pigs, competition from non-native plant species, and fire from military training activities (68 FR 35950).

Ongoing Conservation Actions Within the Action Area A total of 102 ha (253 ac), or 98 percent, of the critical habitat in the action area is in the Pahole, Upper Kapuna Sub-Unit and

Upper Kapuna Management Units. The Pahole Management Unit is fenced, and non-native plant species and ungulates within the unit are controlled. A fence for the Upper Kapuna Management Unit is planned for the near future (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Spermolepis hawaiiensis* (No Common Name)

Species Description *Spermolepis hawaiiensis*, a member of the Apiaceae (parsley) family, is a slender annual herb with few branches. Its leaves are dissected into narrow, lance-shaped divisions. *Spermolepis hawaiiensis* is the only member of the genus native to Hawaii. It is distinguished from other members of the family by being a non-succulent annual with an umbrella-shaped inflorescence (68 FR 35950).

Listing Status *Spermolepis hawaiiensis* was federally listed as endangered on November 10, 1994, and state listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in July 1999 (Multi Island Recovery Plan 1999; 59 FR 56333). Critical habitat was designated for this species on February 27, 2003 for the islands of Niihau and Kauai; March 18, 2003 for the island of Molokai; May 14, 2003 for the island of Kahoolawe and Maui; and June 17, 2003 for the island of Oahu (68 FR 9115; 68 FR 12981; 68 FR 25934; 68 FR 35950).

Historic and Current Distribution Historically, *Spermolepis hawaiiensis* was known from (Waimea) Kauai, (Koko Head) Oahu, (Paomai and Kahinahina) Lanai, and (Apua) Hawaii. Currently, a total of 12 occurrences of *S. hawaiiensis* are known on Kauai, Oahu, Molokai, Lanai, West Maui, and Hawaii. The total number of individuals State-wide is estimated between 5,000 and 10,000 individuals. On Kauai, this species has been observed in the Koaie branch and other unspecified locations within Waimea Canyon, Hanapepe at Kapahili Gulch, and Hipalau on State and private land. The total number of plants on Kauai is a few thousand. On Oahu, this species is known from a total of fewer than 60 individuals at Diamond Head and Makua-Keaau ridge on State and Federal lands, respectively. On Molokai, about 600 plants were reported from Kamalo, on private land. On Lanai, two occurrences of *S. hawaiiensis* are known: east of Puu Manu with 50 to 100 individuals and Kaa Gulch with about 300 individuals, both on private lands. On West Maui, *S. hawaiiensis* is known from two occurrences in the Lihau section of the West Maui Natural Area Reserve with 60 to 100 individuals and several hundred to thousands of plants, respectively; and, above Lahainaluna School with about 100 individuals. On the island of Hawaii, three occurrences of about 500 individuals are found on the U.S. Army's Pohakuloa Training Area in Kipuka Alala, Puu Anahulu, and an unnamed kipuka within the 1859 lava flow (Makua Implementation Team 2003) (Table SB 38).

Table SB 38. Range-wide Distribution of *Spermolepis hawaiiensis.*

Population Units	**Number of Known Individuals**					
	1991 (1)	**1999** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Punapohaku	--	--	--	--	--	2/0
Ohikilolo	--	several hundred	<50 -several hundred	--	several hundred	170/184‡

Diamond Head	--	10-thousands	10-thousands	--	thousands	--
Total Population Units on Oahu	--	2	2	6	2	2
Total Individuals on Oahu	--	several hundred	<60– several hundred	110-910	thousands	(172/184)†
Total Population Units State-wide	6	12	12	6	9+	--
Total Individuals State-wide	thou-sands	2000-6000	5000 – 10,000	6,385-12,135*	thousands	--

Shaded occurrences are inside the action area.
*Taken from the USFWS list of Hawaiian Island Plants, August 11, 2003.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR55770)
(2) Recovery plan (Service 1999a)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Spermolepis hawaiiensis* is known from various vegetation types, including *Metrosideros polymorpha* forests, *Dodonaea viscosa* lowland dry shrubland, cultivated fields, and pastures between about 300 and 600 m (1,000 and 2,000 ft) in elevation. Associated plant species include *Doryopteris* sp., *Gouania hillebrandii*, and *Sida fallax*. This species is an annual, and numbers fluctuate greatly from year to year, depending on climatic conditions and other unknown factors. Little else is known about the life history of this taxon. Reproductive cycles, specific environmental requirements, and limiting factors are unknown (Makua Implementation Team 2003).

Threats to the Species *Spermolepis hawaiiensis* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Current threats to *S. hawaiiensis* are habitat degradation by feral goats, axis deer, and mouflon sheep; competition with various non-native plants; wildfire; military activities; and destruction of habitat, as well as direct destruction of individual plants by erosion, landslides, and rockslides (Service 1999a; 68 FR 35950).

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

The recovery plan for this species identifies the following important conservation actions. Fenced exclosures should be constructed around all known occurrences to reduce impacts from feral ungulates. Control of non-native plant species within the exclosures is also needed. Collection, storage, and propagation of representative genetic stock are needed, as well as augmentation of existing occurrences and establishment of additional occurrences (Service 1999a).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Spermolepis hawaiiensis*. This plan will also include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is being propagated at the Pohakuloa Training Area Rare Plant Facility. Currently, no other management actions are known for this species (Service 1999b; Service 2005b; Durand, pers. comm. 2004, Koob1996).

Critical Habitat Description A total of 578.6 ha (1,429.7 ac) in seven separate units on four islands has been designated as critical habitat for *Spermolepis hawaiiensis*. Two units were designated on Kauai (totaling 182 ha; 452 ac), two units were designated on Maui (totaling 114 ha; 280 ac), one unit was designated on Molokai (85 ha; 211 ac), and two units were designated on Oahu (totaling 137 ha; 339 ac). Critical habitat has been designated on State (e.g., Puu Ka Pele Forest Reserve and Waimea Canyon on Kauai; Kanaio and West Maui Natural Area Reserves on Maui; Diamond Head State Park on Oahu) and private lands. Each unit provides habitat for one population of 300, mature, reproductive individuals of *S. hawaiiensis* (68 FR 9116, 68 FR 25934, 68 FR 12982, 68 FR 35950). To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. hawaiiensis* (68 FR 35950).

The primary constituent elements of the units on Oahu include steep or vertical cliffs or the base of cliffs or ridges in coastal dry cliff vegetation containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Dodonaea viscosa*, *Doryopteris* sp., *Heteropogon contortus*, *Santalum ellipticum*, or *Waltheria indica;* and elevations between 25 to 306 m (82 to 1,004 ft). The plant community, associated species, and elevations are a barometer for such things as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral ungulates; non-native plant species; and habitat degradation or destruction from erosion, landslides, and wildland fire (68 FR 35950). See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Currently, fewer than 356 individuals, approximately three to seven percent, of the estimated 5,000 to 10,000 individuals of *Spermolepis hawaiiensis,* are found within the Makua action area (Service 1999a, Makua Implementation Team 2003,U.S. Army Garrison; 2005c, 2006d). Two occurrences of *S. hawaiiensis* are found in the action area in the Punapohaku and Ohikilolo Management Units. Both occurrences are at risk from training-

related wildfire and are within the high fire risk zone, which includes 356 individuals (172 mature plants and 184 seedlings). Thus, *S. hawaiiensis* in the action area is characterized by one stabilization population unit exceeding minimum numerical criteria comprising roughly 10 percent of all remaining individuals on Oahu and three to seven percent of the State-wide individuals, with numbers that have increased slowly due to discovery of new individuals. All individuals are within high risk fire zones (Service 2005b).

Status of the Critical Habitat in the Action Area There is one critical habitat unit within the Makua action area, comprising four percent, 21 ha (53 ac), of the total State-wide critical habitat for *Spermolepis hawaiiensis*. The critical habitat unit is located in the southwestern portion of the action area in the Lower Ohikilolo Management Unit. This habitat unit was designated to provide a portion of the habitat for the conservation of one population with a minimum of 300 mature, reproducing individuals of *S. hawaiiensis* (68 FR 35950). Approximately 1 ha (2 ac) is in the high fire risk zone and the remaining portion in the low fire risk zone. The constituent elements essential for this species include, but are not limited to, steep or vertical cliffs or the base of cliffs or ridges in coastal dry cliff vegetation. The primary constituent elements that may be affected by a training related fire include those associated native plant species found within coastal dry cliff vegetation. It is estimated that the entire critical habitat is within an area of vegetation that is predominantly non-native (K. Kawelo, pers. comm. 2004; Service 2004). This indicates that this critical habitat unit is degraded due to non-native plant encroachment.

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Spermolepis hawaiiensis* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threats to *S. hawaiiensis* and its critical habitat include destruction of habitat and direct destruction of *S. hawaiiensis* plants due to; habitat degradation by feral ungulates; competition for light, space, and nutrients from non-native plant species; and wildfire from military activities. In addition, critical habitat is threatened by predation of associated native plants by rats, slugs, the black twig borer, and the Chinese rose beetle (Makua Implementation Team 2003; 68 FR 35950).

Conservation Needs of the Species and Critical Habitat in the Action Area *Spermolepis hawaiiensis* will not be stabilized pursuant to the guidelines established in the Makua Implementation Plan because the individuals in the Makua action area represent less than one percent of the known individuals of this species. However, this species will benefit from ecosystem-level management within the action area that includes activities such as fencing, ungulate removal, and reduction of non-native plant species and control of wildfires (Makua Implementation Team 2003, U.S. Army Garrison 2004a, 2005b, 2006c). A post-fire revegetation plan and a site-specific fire management plan has been developed for the lower Ohikilolo Management Unit (U.S. Army Garrison2003a). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area At this time, the Service is unaware of any specific species management activities occurring in the action area for *Spermolepis hawaiiensis*. Approximately four percent, 21 ha (53 ac), of the critical habitat occurs within the action area The Army controls non-native plants to reduce

competition with associated plant species and to reduce the risk of fire within the Ohikilolo Management Unit that contains a portion of this critical habitat (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Tetramolopium filiforme* (No Common Name)

Species Description *Tetramolopium filiforme* is a short-lived perennial of the Asteraceae (sunflower) family. It is a dwarf shrub 5 to 15 cm (2 to 6 in) tall, often mounded in shape. The narrow leaves are 1 to 2 cm (0.4 to 0.8 in) long and are clustered at the branch tips. The purple-white flower heads are held above the foliage on long slender stalks. The white to pale lavender ray florets are female, and the maroon or (rarely) yellow disk florets are functionally male. The achenes (a type of dry, closed fruit) are 2 to 2.7 mm (about 0.1 in) long, tipped with bristles almost as long as the achenes, and may have sparse, short glandular hairs (Wagner et al 1999; Makua Implementation Team 2003).

There are two varieties of *Tetramolopium filiforme*, which are differentiated primarily by leaf shape and leaf margin. Variety *filiforme* has extremely narrow, linear leaves with no teeth along the leaf margins; var. *polyphyllum* has leaves that widen towards the leaf apex, with prominent teeth along the leaf margins. These two morphological types are not clearly separated geographically, and their taxonomy needs clarification (Makua Implementation Team 2003). Occurrences along the higher part of Ohikilolo Ridge may contain either of the two varieties, as well as plants with intermediate characteristics. In general, Hawaiian *Tetramolopium* species are highly inter-fertile and appear to be maintained as separate entities through either geographical or ecological separation (Makua Implementation Team 2003).

Listing Status *Tetramolopium filiforme* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Both varieties of *T. filiforme* are included in the listed taxon.

Historic and Current Distribution *Tetramolopium filiforme* is narrowly endemic to the northern leeward Waianae Mountains of Oahu, with its center of abundance on Ohikilolo Ridge in Makua (Makua Implementation Team 2003). Historically, this species was known from Ohikilolo Ridge, Keaau Valley, and Makaha Valley (56 FR 55770). Currently, it is found only in small outlying population units from Kahanahaiki in the north to Kamaileunu Ridge and Puhawai in the south. Only on Ohikilolo Ridge do both varieties occur. Plants on the low, dry, seaward end of the ridge are all typical var. *filiforme*. With ascending elevation into more mesic habitats, plants with var. *polyphyllum* traits begin to appear together with plants of var. *filiforme*. At the highest part of the ridge, most plants show var. *polyphyllum* traits to some degree, and this variety is found only at the higher, wetter part of the ridge. Nowhere along the ridge, however, do all the plants represent var. *polyphyllum*. All known plants occurring outside Ohikilolo Ridge represent var. *filiforme* (Makua Implementation Team 2003). Trends in distribution indicate the number of plants on Ohikilolo Ridge has declined significantly over the last few decades owing to damage by feral goats. In the 1970s, many plants occurred along the crest of the ridge; however, because of a proliferation of goats on the ridge in the 1980s and 1990s, *T. filiforme* is

no longer abundant on the accessible parts of the ridge top. This species still persists in relatively large numbers on cliff faces inaccessible to goats (Makua Implementation Team 2003).

Currently, *Tetramolopium filiforme* occurs in seven population units totaling approximately 3,500 individuals (Table SB 39). These population units are found on Federal and State lands (68 FR 35950). Three of the existing population units have exceeded minimum criteria for stabilization population (at least 50 mature, reproducing individuals for short-lived perennials). Trends in numbers since listing indicate increases until 2003 and decreasing numbers since then in all population units except Keaau and Waianae Kai. In 2003, the last plant in the Waianae Kai population unit was reported as dead (Makua Implementation Team 2003). By 2004, a new population had appeared there, presumably from viable seeds in the soil seed bank (U.S. Army Garrison 2004a). Plants in the Kahanahaiki, Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *T. filiforme* is characterized by seven population units and an overall decreasing trend in numbers since 2003, including three stabilization population units with relatively large numbers that are located in all fire risk zones.

Table SB 39. Range-wide Distribution of *Tetramolopium filiforme.*

Population Units	**Number of Known Individuals**					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki	--	--	50	34/0	45/0	45/0
Keaau	--	--	25	16/4	16/4	30/58
Kaiena*	--	--	--	--	--	9/0
Makaha/ Ohikilolo Ridge*¶	--	--	2500	2500	200/0	200/0
Ohikilolo Mauka*	--	--			2445/552	2442/553
Ohikilolo Makai*	--	--	2500	2500		
Makaha/ Ohikilolo Ridge*¶	--	--	--	--	100/0	100/0
Puhawai*	--	--	6/6‡	2/0	2/11	1/5 [18/0]§
Waianae Kai*	--	--	0	20/2	30/9	30/9
Total Individuals	**500**	**1500-1550**	**5087** (5081/6)†	**5078** (5072/6)	**3414** (2838/576)	**3500** (2857/625) [18/0]§

Shaded population units are inside the action area.
*Stabilization population units
¶ Makaha/Ohikilolo Ridge population unit is partially within the action area.
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53108)
(2) Recovery plan (Service 1998a)
(3) MIP (MIT 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)

(5) Critical habitat rule (68 FR 35950)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Tetramolopium filiforme* occurs in dry habitat at the seaward end of the Ohikilolo population unit and in dry-mesic and mesic habitats at higher, more inland locations. In general, the plants are found on exposed rocky ridges and sparsely vegetated, nearly vertical cliffs, often rooted in cracks in the rock, at elevations of 340 to 900 m (1,116 to 2,953 ft) (Makua Implementation Team 2003). Flowering usually occurs in the late winter and spring. Although capable of self-pollination, *T. filiforme* probably is insect-pollinated, as are most species in the sunflower family with conspicuous flowers. The seeds of *T. filiforme* are presumed to be wind-dispersed, as bristle-bearing achenes also are characteristic of wind-dispersed members of the sunflower family. Birds may also disperse the seeds because the bristles may adhere the achenes to their feathers (Makua Implementation Team 2003). This species is relatively short-lived, usually less than five years. Other demographic information for *T. filiforme* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Tetramolopium filiforme* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In particular, *T. filiforme* is one of the Makua target taxa most threatened by fire. Over the last 20 years, fires have burned into the lower reaches of the Ohikilolo population unit and have almost reached the Kahanahaiki population unit. In addition, infestations of at least two species of non-native scale insects have been observed on *T. filiforme* and need further research (Makua Implementation Plan 2003). Thus, despite its overall relative abundance, *T. filiforme* has a high background risk of species extinction due to its occurrence in high fire risk zones, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Tetramolopium filiforme* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve management of stabilization populations and abatements to threats (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Tetramolopium filiforme*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in two management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Puu Kumakalii, which is not fenced and for which no fence construction is planned, and Ohikilolo, which is fenced.

Tetramolopium filiforme seeds store well for several years, but viability is poor. The Army is focusing on collecting seed from fire-threatened sites in the lower Ohikilolo population unit. Plants can be propagated from both seed and cuttings. Cuttings are more than 90 percent

successful, and The Nature Conservancy of Hawaii has successfully propagated the related *T. lepidotum* from seed. Outplanting has yet been attempted for *T. filiforme* in the wild because this species commonly grows in shallow cracks on exposed rocky ledges and cliffs; transitioning greenhouse plants to such sites may be difficult (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area About 96 percent of all known individuals of *Tetramolopium filiforme* are located within the action area, in the Kahanahaiki, Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units (see Table SB 39). No critical habitat for this species is located within the action area. Two population units within the action area (Makaha/Ohikilolo Ridge and Ohikilolo) have exceeded minimum criteria for a stabilization population (defined as at least 50 mature, reproducing individuals). However, threats are not controlled and genetic storage goals are not complete, so these population units are not met all criteria for a stabilization population. Overall numbers in the action area have declined since 2003, from 5,087 to 3,500 total individuals in 2006.

The Ohikilolo population unit is the center of abundance for *Tetramolopium filiforme* and is the numerically the most significant unit. Army Natural Resources Staff split Ohikilolo occurrences into two population units to demonstrate management differences between the Makua and Makaha sides of the ridge (U.S. Army Garrison 2005b). The Ohikilolo population unit is on the Makua side of the fence along the installation boundary, and the Makaha/Oikikilolo Ridge population unit is outside of it. The Ohikilolo population unit is located within the Ohikilolo Management Unit, along the steep south wall of Makua valley. Vegetation consists of native dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Keaau population unit is located near the Ohikilolo population unit but outside the installation's south boundary. The Kahanahaiki population unit is located in the C ridge vicinity of Makua, outside the Kahanahaiki Management Unit. *Tetramolopium filiforme* plants are located on a small, sparsely vegetated cliff surrounded by *Diospyros sandwicensis* forest. The Kahanahaiki population unit is not fenced, but ungulates are not a threat, as goats have been virtually eliminated from the installation. Approximately 50 percent of the known individuals of *T. filiforme* are protected from ungulates by fencing.

All *Tetramolopium filiforme* plants in action area population units are located in areas at risk from training-related wildfire. About 1,045 individuals (30 percent of known individuals) occur in the high fire risk zone; the remainder occurs in the low and very fire risk zones. However, most of the plants in the Ohikilolo population unit are located on the ridge farther back in the valley in an area that is not continuous with the dense fuels of the lower valley. In the seaward part of this population unit, most of the plants are located on steep cliffs lacking dense fuel vegetation and probably would not be burned (U.S. Army Garrison 2005b). Plants in the Kahanahaiki population unit, however, are extremely vulnerable to fire. The July 2003 prescribed fire burned at least 2 ha (5 ac) of native forest within 20 m (66 ft) of this site, which is now buffered by only a small strip of forest and could be extirpated by future fires (U.S. Army Garrison 2003b, 2005b). Thus, *T. filiforme* in the action area is characterized by four population

units located within high to low to very low fire risk zones, including three population units meeting minimum numerical criteria for stabilization with relatively high but decreasing numbers.

Threats to the Species in the Action Area The primary threats to *Tetramolopium filiforme* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Tetramolopium filiforme* in the action area, and especially within the installation boundary, is extremely vulnerable to wildfire from military training activities. Fire has severely degraded habitat in the Ohikilolo and Kahanahaiki population units (U.S. Army Garrison 2005b). Thus, because 96 percent of all known individuals occur within the action area in zones of high to very low fire risk, *T. filiforme* in the action area has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Tetramolopium filiforme* because there are no stabilization population units outside the action area, threats are not fully controlled, and genetic storage is not complete. Three population units have been identified for stabilization of *T. filiforme*: Ohikilolo within the action area, and Puhawai and Waianae Kai outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals are located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced (fence construction for this area is planned for 2011). The Keaau and Makaha/Ohikilolo Ridge population units are not fenced, and goats are a problem in both areas. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The action area contains 96 percent of the total remaining individuals of *Tetramolopium filiforme*. The Ohikilolo stabilization population unit, which contains 86 percent of the total remaining individuals, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). This population unit is located within the Ohikilolo Management Unit. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua. Genetic storage goals for *T. filiforme* are 25 percent complete, with 75 plants from all six population units combined meeting the goals of the Makua Implementation Plan, and there are currently four plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Viola chamissoniana* ssp. *chammissoniana* (Pamakani)

Species Description *Viola chamissoniana* ssp. *chamissoniana* is a short-lived perennial of the Violaceae (violet) family. It is a basal-branching woody shrub with branches 20 to 60 cm (8 to 23 in) long. Some occurrences, especially on steep cliffs, have plants with reclining or drooping branches; plants in other occurrences have erect branches forming upright shrubs. The triangular leaves are 2 to 4 cm (0.8 to 1.6 in) long and clustered at the ends of the stems. The flowers are

large, white, and held above the leaves. The tiny, dark, egg-shaped seeds are borne in capsules that open as they dry (Wagner et al 1999; Makua Implementation Team 2003).

There are three subspecies of *Viola chamissoniana*: ssp. *chamissoniana* (Oahu), ssp. *tracheliifolia* (Kauai, Oahu, Molokai, and Maui), and ssp. *robusta* (Molokai). The subspecies *tracheliifolia* and *robusta* are not considered rare. The only other native *Viola* occurring in the Waianae Mountains of Oahu is the common *V. chamissoniana* ssp. *tracheliifolia*, which like ssp. *chamissoniana*, occurs throughout that mountain range. Subspecies *tracheliifolia* is generally found growing in the forest understory, whereas ssp. *chamissoniana* is most often in open, exposed habitats. Several sites are known where the two subspecies grow side by side, without natural hybridization.

Listing Status *Viola chamissoniana* ssp. *chamissoniana* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Only the subspecies *chamissoniana* is listed as the endangered taxon.

Historic and Current Distribution *Viola chamissoniana* ssp. *chamissoniana* is a species endemic to the Hawaiian Islands. *Viola chamissoniana* ssp. *chamissoniana* is endemic to the island of Oahu and is known only from the Waianae Mountains. It has been recorded throughout the mountain range on both the windward and leeward sides. Demographic data for this species is deficient, and apparent increases in the number of population units probably reflect more consistent survey efforts since the species was listed, and because all known occurrences were discovered only within the last 20 years. Many *V. chamissoniana* ssp. *chamissoniana* plants grow on steep cliffs inaccessible to feral ungulates, so this taxon may not have declined as much as other taxa that are not cliff-dwelling. *Viola chamissoniana* ssp. *chamissoniana* also may once have been more common on gentler slopes and has persisted only on steep cliffs inaccessible to feral ungulates (Makua Implementation Team 2003).

Currently, *Viola chamissoniana* ssp. *chamissoniana* occurs in eight population units totaling approximately 618 individuals (Table SB 40). These population units are found on Federal and State lands (68 FR 35950). One of these population units has exceeded minimum numerical criteria for a stabilization (defined as at least 50 mature, reproducing individuals for short-lived perennials). Data on numbers of individuals has only been consistent with monitoring since 2003 and indicate an increase from 374 to 618 total known individuals. This increase includes some additional individuals recently discovered in the Puu Kamakalii population unit. The Keaau and Ohikilolo population units are located in the Makua action area, and the Puu Kamakalii population is located in the action area of Schofield Barracks Military Reservation. These occurrences are located in zones at risk from training-related wildfire. Thus, *V. chamissoniana* ssp. *chamissoniana* is characterized by eight population units with low numbers, except for one population unit that exceeds minimum criteria for stabilization.

Table SB 40. Range-wide Distribution of *Viola chamissoniana* ssp. *chammissoniana.*

Population Units	Number of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Keaau	--	--	--	40/10	40/10	40/10
Makaha/Ohikilolo Ridge*	--	--	250/0‡	250/0	12/0	7/0
Ohikilolo*					377/2	433/10
Halona	--	--	3	32/3	32/3	41/3
Kamaileunu	--	--	38	38/0	35/0	35/0
Makaha*	--	--	50	50/0	24/2	24/2
Makaha/Ohikilolo Ridge*	--	--	--	--	20/0	--
Puu Hapapa	--	--	10/3	10/0	10/6	13/0
Puu Kamakalii (SBMR) *	--	--	19/1	53/0	44/0	--
Total Individuals	**14**	**237-257**	**374**	**486** (473/13)†	**617** (594/23)	**618** (593/25)

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

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b), K. Kawelo (pers. comm., 2005)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Viola chamissoniana* ssp. *chamissoniana* occurs in mesic habitats at elevations of 700 to 1,000 m (2,297 to 3,281 ft). It is usually found on north-facing cliffs and cliff ledges that are sparsely to moderately vegetated with native shrubs, grasses, and sedges. Such sites are among the most native and undisturbed mesic habitats of the Waianae Mountains. This taxon also is found on gentle slopes in native shrubland (Makua Implementation Team 2003). Little is known about the breeding system of *V. chamissoniana* ssp. *chamissoniana*. The large, white, fragrant flowers held above the leaves suggest pollination by moths. Plant longevity probably is similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *V. chamissoniana* ssp. *chamissoniana* in the wild is uncertain, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Viola chamissoniana* ssp. *chamissoniana* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat"

section and tabulated in Appendix E. Because of its overall relative abundance and population units in fire risk zones, *V. chamissoniana* ssp. *chamissoniana* has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Viola chamissoniana* ssp. *chamissoniana* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve utilizing stabilization populations to aid in recovery (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization criteria for *Viola chamissoniana* ssp. *chamissoniana*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in four management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Makaha, Palikea, and Puu Kumakalii, which are not fenced, and Ohikilolo, which is fenced.

Viola chamissoniana ssp. *chamissoniana* is easy to propagate from seeds and cuttings. Seeds can be stored at appropriate conditions for several years with 60 percent germination success, and cuttings are also about 60 percent successful. Seed is difficult to collect because wild plants produce very few flowers and seeds at a time. Flowering of some greenhouse plants is more prolific, but most of the fruits are aborted. The Army is conducting nursery pollination experiments to determine limiting factors to seed production (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area Approximately 81 percent of all known individuals of *Viola chamissoniana* ssp. *chamissoniana* are located within the action area, in the Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units (see table above). No critical habitat for this species is located within the action area. One population unit (Ohikilolo) has met minimum criteria for stabilization (at least 50 mature, reproducing individuals). However, threats are not controlled and genetic storage goals are not complete, so this population unit is not considered meeting overall criteria for stabilization (U.S. Army Garrison 2005b). Overall numbers in the action area have increased since 2003, from 250 to approximately 500 total individuals. This increase includes an additional sub-population recently discovered in the Makaha/Ohikilolo Ridge population unit (U.S. Army Garrison 2005b). All plants in the action are located in areas at risk from training-related wildfire; however, all individuals of *V. chamissoniana* ssp. *chamissoniana* are located in the very low fire risk zone. These individuals at risk from fire in the action area represent about 81 percent of the species' total range-wide numbers.

Army Natural Resources Staff split Ohikilolo occurrences into two population units to demonstrate management differences between the Makua and Makaha sides of the ridge (U.S.

Army Garrison 2005b). The Ohikilolo population unit is on the Makua side of the fence along the installation boundary, and the Makaha/Oikikilolo Ridge population unit is outside of it. The Ohikilolo population unit is located within the Ohikilolo Management Unit, along the steep, south wall of Makua valley. Vegetation consists of native, dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Keaau population unit is located near the Ohikilolo population unit but outside the installation's south boundary. Thus, *V. chamissoniana* ssp. *chamissoniana* in the action area is characterized by three population units located within high to very low fire risk zones, including one population unit that exceeds minimum number of individuals suggested in the recovery plans for Waianae plants and Oahu plants for stabilization populations.

Threats to the Species in the Action Area The primary threats to *Viola chamissoniana* ssp. *chamissoniana* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Because about 81 percent of all known individuals occur within the action area in the very low fire risk zones, *V. chamissoniana* ssp. *chamissoniana* in the action area has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Viola chamissoniana* ssp. *chamissoniana* because more than 80 percent of remaining individuals are located within the action area and there is only one population unit that has met criteria for stabilization outside the action area. In addition, threats are not fully controlled and genetic storage is not complete. Three population units are identified for stabilization of *V. chamissoniana* ssp. *chamissoniana*: Ohikilolo within the action area, and Puu Kumakalii and Makaha outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals are located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. Fence construction is planned for the Makaha Management Unit in 2007 thru 2009. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The three population units in the action area contain 81 percent of the total remaining individuals of *Viola chamissoniana* ssp. *chamissoniana*. The population unit inside the action area, which contains 72 percent of the total remaining individuals, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). The Ohikilolo population unit is located within the Ohikilolo Management Unit. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua. Genetic storage goals for *V. chamissoniana* ssp. *chamissoniana* are over two percent complete, with 10 plants from all eight population units combined meeting the goals of the Makua Implementation Plan. There are currently 37 plants growing in the Army nursery (U.S. Army Garrison 2005b).