

Asplenium fragile var. *insulare*
(No common name)

**5-Year Review
Summary and Evaluation**

**U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii**

5-YEAR REVIEW

Species reviewed: *Asplenium fragile* var. *insulare* (No common name)

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5-YEAR REVIEW
***Asplenium fragile* var. *insulare* (No common name)**

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia, (503) 231-2071

Lead Field Office:

Pacific Islands Fish and Wildlife Office, Loyal Mehrhoff, Field Supervisor, (808) 792-9400

Cooperating Field Office(s):

N/A

Cooperating Regional Office(s):

N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on April 8, 2010. The review was based on the recovery plan for four species of Hawaiian ferns (USFWS 1998), the final critical habitat designation for *Asplenium fragile* var. *insulare* and other species from the islands of Maui and Hawaii (USFWS 2003a, b), as well as a review of current, available information. The Bernice Pauahi Bishop Museum provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Samuel Aruch, biological consultant, was reviewed by a recovery biologist and the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; 5-year review status of 69 species

in Idaho, Washington, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75(67):17947-17950.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 1994. Endangered and threatened wildlife and plants; endangered status for four ferns from the Hawaiian Islands; final rule. Federal Register 59(185):49025-49032.

Date listed: September 26, 1994

Entity listed: Variety

Classification: Endangered

Revised Listing, if applicable

FR notice: N/A

Date listed: N/A

Entity listed: N/A

Classification: N/A

1.3.3 Associated rulemakings:

USFWS. 2003a. Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the islands of Maui and Kahoolawe, Hawaii; final rule. Federal Register 68(93):25934-26165.

USFWS. 2003b. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii, Hawaii; final rule. Federal Register 68(127):39624-39761.

Critical habitat was designated for *Asplenium fragile* var. *insulare*, a multi-island species; on Maui in a single unit totaling 362 hectares (894 acres) on Federal land (USFWS 2003a) and on Hawaii Island in a single unit of 907 hectares (2,241 acres) on State land (USFWS 2003b).

USFWS. 2012. Endangered and threatened wildlife and plants; listing 38 species on Molokai, Lanai, and Maui as endangered and designating critical habitat on Molokai, Lanai, Maui and Kahoolawe for 135 species. Federal Register 77(112):34464-34775.

Critical habitat revisions are currently being proposed for *Asplenium fragile* var. *insulare* (USFWS 2012).

1.3.4 Review History:

Species status review [FY 2010 Recovery Data Call (August 2010)]:
Increasing

Recovery achieved:

1 (0-25%) (FY 2007 Recovery Data Call)

1.3.5 Species' Recovery Priority Number at start of this 5-year review:

6C

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: USFWS. 1998. Recovery plan for four species of Hawaiian ferns. U.S. Fish and Wildlife Service, Portland, Oregon. 78 pages. Available online at <http://www.fws.gov/pacificislands/recoveryplans.html>.

Date issued: April 10, 1998

Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes
 No

2.1.2 Is the species under review listed as a DPS?

Yes
 No

2.1.3 Was the DPS listed prior to 1996?

Yes
 No

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

Yes
 No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

Yes

No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

Yes

No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

Yes

No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

Yes

No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

A synthesis of the threats (Listing Factors A, B, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for four species of Hawaiian ferns (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Asplenium fragile* var. *insulare* is a short-lived perennial. To be considered stabilized, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (off-site)

collection. In addition, a minimum of three populations should be documented on islands where they now occur or occurred historically. For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population.

This recovery objective has been met.

For downlisting, a total of five to seven populations of *Asplenium fragile* var. *insulare* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

This recovery objective has not been met.

For delisting, a total of eight to ten populations of *Asplenium fragile* var. *insulare* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered.

This recovery objective has not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Little life history information is available for *Asplenium fragile* var. *insulare*. Reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown. Researchers studied six subpopulations in Pohakuloa Training Area and found no gametophytes (gamete-producing generation of the plant reproductive cycle), and the age-class structure of the subpopulations sampled were determined to be 100 percent reproductive adults because all the sporophytes (spore-producing generation of the plant reproductive cycle) had sori

(plural for sorus; a cluster of sporangia [a spore-producing case or sac] on the surface of a fern leaf) on some fronds (USFWS 1998, 2002, 2003a; Center for the Environmental Management of Military Lands [CEMML] 2003).

Belfield and Pratt (2002) noted that individuals may be long-lived or able to persist at sites with appropriate habitat and little disturbance. The affinity of this taxon for isolating habitats such as lava tubes and deep cracks may reproductively isolate populations, and defining discrete population units for this taxon requires further study of the taxon's reproductive biology (CEMML 2003a).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

On Maui, *Asplenium fragile* var. *insulare* was historically known from the northern slope of Haleakala and on Kanahau Hill, East Maui. Hank Oppenheimer, Maui Nui Plant Extinction Prevention Program Coordinator (pers. comm. 2008) has reported an unsuccessful attempt to relocate the taxon in the vicinity of Kanahau Hill along Skyline Drive on the west side of Haleakala, and also reported a subsequent wildfire in the area, which he opined extant populations could have survived if they had been growing in a protected hole or cave.

At the time the taxon was federally listed in 1994, it was assumed extinct on Maui (USFWS 1994). In the final recovery plan (USFWS 1998), it was recorded that the taxon had been rediscovered on Maui at the Hanawi Natural Area Reserve, where Rick Warshauer (Botanist, Biological Resources Division U.S. Geological Survey) anecdotally reported *Asplenium fragile* var. *insulare* from a rocky gulch growing at the interface between younger aa lava flows and much older pahoehoe lava or ash deposits in montane wet *Metrosideros* (ohia) forest with other species of ferns (USFWS 1998); Oppenheimer (pers. comm. 2008) was unsuccessful in contacting Warshauer for more specific locality data to revisit the site.

In recent times, East Maui populations have been recorded within Kalialinui ahupuaa on East Maui Watershed Partnership lands, in Waikamoi on private and Federal (Haleakala National

Park) lands (two populations with 18 individuals) (USFWS 2003a), and in the Hanawi Natural Area Reserve (USFWS 1998, 2010a). The Waikamoi populations were discovered by J. Lau in 2000 (H. Oppenheimer pers. comm. 2008; Hawaii Biodiversity and Mapping Program 2010), one in the Waikamoi drainage, 2,127 meters (6,980 feet) elevation; the other in Honomanu drainage, 1,996 meters (6,550 feet) elevation. In 2008, Oppenheimer located a single individual in Waikamoi in the East Wailuaiki drainage basin at 1,887 meters (6,190 feet) elevation (H. Oppenheimer pers. comm. 2008; Bishop Museum 2011). In 2008, Oppenheimer located a small population of four individuals (two of reproductive age) in Hanawi Stream at 2,018 meters (6,620 feet) elevation (H. Oppenheimer pers. comm. 2008; Bishop Museum 2011). Thus, there now appears to be four extant populations on Maui: three in Waikamoi and one in Hanawi. An additional collection at Bishop Museum (2011) was made by B. Gagne in 1973 (*Gagne BH238*) in the Koolau Forest Reserve, in the stream gorge on Base Camp Ridge at 2,040 meters (6,690 feet) elevation; it is unknown whether this site has been monitored or perhaps correlates with already reported localities for the taxon. In 2010, *Asplenium fragile* var. *insulare* was estimated to contain approximately 17 individuals from Hanawi Natural Area Reserve and Waikamoi Preserve on Maui (USFWS 2010a).

On Hawaii Island, *Asplenium fragile* var. *insulare* was historically found below Kalaieha, Laumaia, Keanakolu, and Umikoa on Mauna Kea; Puuwaawaa on Hualalai; west of Keawewai; above Kipuka Ahiu on Mauna Loa; and near Hilo (USFWS 1998, 2002, 2010b; CEMML 2003a). At the time the taxon was federally listed in 1994, eight populations with approximately 295 individuals were found on Hawaii Island (USFWS 1994). In the final recovery plan (USFWS 1998), numbers had fallen slightly to 278 statewide, the majority (nine subpopulations totaling 200 individuals) were found in the U.S. Army's Pohakuloa Training Area; extant populations at that time were located at Puu Huluhulu, Pohakuloa Training Area, Kulani Correctional Facility, Keauhou, the Mauna Loa Strip Road in Hawaii Volcanoes National Park, Kapapala Forest Reserve, Kau Forest Reserve, and the summit area of Hualalai. At the time critical habitat designations were being made in 2002 and 2003, there were a total of 17 populations with more than 300 individuals on Hawaii Island, consisting of 13 populations in the Pohakuloa Training Area, 1 population in

Hawaii Volcanoes National Park, 2 populations just south of the Upper Waiakea Forest Reserve and the Mauna Loa Forest Reserve, and 1 population in the Keokea section of the South Kona District, on State, Federal, and private lands (USFWS 2002; CEMML 2003a). In Pohakuloa Training Area, *A. fragile* var. *insulare* is found in Kipuka Alala, near Kipuka Kalawamauna and Puu Koli, on the 1843 lava flow, and in the Palila Critical Habitat area (Shaw 1997; CEMML 2003a). There, the census at the end of 2005 was 500 to 849 individuals at nine sites, all naturally occurring, with protective fencing present at four sites (protecting 238 to 529 individuals) (CEMML 2006); at the end of 2007, the Pohakuloa Training Area census was 626 to 1,071 individuals in 11 Areas of Species Recovery, with four units 100 percent fenced (protecting 306 to 591 individuals) (CEMML 2008). Four Areas of Species Recovery recorded over 50 individuals, including two within the fenced Kipuka Alala (Areas of Species Recovery 33 [147 to 247 individuals] and Areas of Species Recovery 34 [122 to 302 individuals]), one just outside of Kipuka Alala (Areas of Species Recovery 36 [148 individuals]), and one in the East Range (Areas of Species Recovery 38 [70 to 119 individuals]) (CEMML 2008).

In Hawaii Volcanoes National Park, 11 sites have been recently reported (Belfield and Pratt 2002; Benitez *et al.* 2008). Seven sites have been documented in the Mauna Loa Special Ecological Area (Belfield and Pratt 2002): four sites are represented by a series of openings in a lava tube between Kipuka Kulalio and Kipuka Maunaiu above 2,195 meters (7,200 feet) elevation, each supporting 10 to 30 clumps of *Asplenium fragile* var. *insulare*; an adjacent lava tube system just northwest of upper Kipuka Kulalio supported five individuals near the base of a dark and damp wall of the tube at 2,590 meters (8,500 feet) elevation, the highest elevational sighting of the taxon in Hawaii Volcanoes National Park; a sixth site near Hawaii Volcanoes National Park's western boundary with Kapapala Ranch at 1,680 meter (5,500 feet) elevation, the number of individuals was not specified; and a seventh site at "Three Trees Kipuka" within the Central Lava Flow near 1,890 meters (6,200 feet) elevation (Belfield and Pratt 2002). The latter site was first vouchered in 1943, so the taxon has persisted at this site for over 65 years; at least 200 individuals were counted on the interior walls of a large lava tube in 1999, and Linda Pratt (Botanist, U.S. Geological Survey, Pacific Island Ecosystems Research Center,

pers. comm. 2011) confirms that the population was still vigorous when visited in 2010, and too plentiful to count.

Benitez *et al.* (2008) conducted surveys of the Kahuku addition to Hawaii Volcanoes National Park between 2004 and 2006, and discovered four new lava tube sites with an unspecified count of *Asplenium fragile* var. *insulare* individuals. These individuals are protected from feral ungulate damage by natural topography and the fern's epilithic growth habit on the inner walls of lava tubes. Numerous unsurveyed lava tubes remain in the high-elevation subalpine habitat at Kahuku, and may provide additional suitable habitat for this fern (Benitez *et al.* 2008). A report of 300 mature individuals located in the Kapapala Forest Reserve in 2003 (USFWS 2010b) is incorrect; the report misinterprets a statement in the critical habitat designation (USFWS 2003b) that Kapapala would provide habitat for a single population of 300 mature individuals, at the time inhabited by 11 individuals. In 2010, the estimated statewide total of *Asplenium fragile* var. *insulare* was 14 populations containing 603 to 948 individuals (USFWS 2010a).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Palmer (2002, 2003) proposed that morphological and habitat differences within the taxon suggested that *Asplenium fragile* var. *insulare* might represent a complex between two or more taxa. One form is delicate, nonproliferous (not bearing plantlets), longer, narrower, and light green in color, and is often found in lava tubes openings. In contrast, a coarser, proliferous (bearing plantlets), shorter, wider, darker green form is usually found in more open areas. Dan Palmer (pers. comm. 2011) relates that he has not since followed up with a closer study of the situation.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Asplenium fragile var. *insulare* is a delicate, small to medium-sized, short-lived perennial fern in the spleenwort family (Aspleniaceae). The species is indigenous to the Hawaiian Islands, as it also occurs in the Andes of South America (Palmer 2003), but the variety is endemic to the islands of Maui and Hawaii. Hillebrand (1888) treated the taxon as *Asplenium*

fragile, with a native range including Maui and the Andes from Mexico to Peru. Later, Robinson (1913) incorrectly chose to recognize the Hawaiian material as an endemic species, *A. rhomboideum*; Morton (1947) pointed out that *A. rhomboideum* was described by Brackenridge in 1854 solely from type material collected in Peru, and that material collected by Brackenridge from Hawaii during the same voyage was placed under another name, possibly *A. menziesii* [synonym *A. monanthes*].

Noting that Hawaiian material matched Andean voucher material enough, such that there would be little justification for describing Hawaiian plants as a new species, Morton (1947) chose to describe a new Hawaiian endemic variety, *Asplenium fragile* var. *insulare*, which differed from the typical variety in being a larger, coarser plant with thicker rachises and larger fronds, and almost all the pinnae with a superior basal lobe.

Palmer (2002) noted that the name *Asplenium peruvianum* was published prior to *A. fragile* for the same taxonomic entity, and he published a new combination for the taxon being reviewed here as *A. peruvianum* var. *insulare*. The USFWS published a proposed rule to incorporate this taxonomic change in the official list of species protected under the Federal Endangered Species Act (USFWS 2012). For purposes of this review, the name *Asplenium peruvianum* var. *insulare* will henceforth be used for what previously was called *A. fragile* var. *insulare*.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

No new information.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Hank Oppenheimer discovered two new populations of *Asplenium peruvianum* var. *insulare* on Maui in 2008, increasing the number of known extant populations on the island to four (H. Oppenheimer pers. comm. 2008; Plant Extinction Prevention Program 2009). The single individual from The

Nature Conservancy's Waikamoi Preserve was found in the East Wailuaiki drainage basin on a bare cindery wall under an overhang in dense shade on bare ground along a well-established trail from Camp 1. Associated native plant species included *Metrosideros polymorpha* (*ohia*), species of *Rubus*, *Peperomia*, *Uncinia*, *Carex*, *Grammitis*, *Dryopteris*, *Asplenium*, and *Pteris*; the elevation was 1,887 meters (6,190 feet) (H. Oppenheimer pers. comm. 2008; Bishop Museum 2011). The Hanawi population of four individuals was found in Hanawi Stream on a small ledge on a mossy, dark, vertical wall near a small waterfall along a narrow stream. Associated native plant genera included *Metrosideros*, *Cheirodendron*, *Dubautia*, *Melicope*, *Rubus*, *Coprosma*, *Cyanea*, *Peperomia*, *Carex*, *Uncinia*, *Deschampsia*, *Sadleria*, *Dryopteris*, *Asplenium*, *Athyrium*, and *Grammitis*; the elevation was 2,018 meters (6,620 feet) (H. Oppenheimer pers. comm. 2008; Bishop Museum 2011).

Belfield and Pratt (2002) described the habitat of *Asplenium peruvianum* var. *insulare* in Hawaii Volcanoes National Park as consistently moist, in dark entrances of deep, large-diameter lava tubes, where it appeared to be maintaining itself and likely needed no human intervention to persist; with complete fencing of the alpine unit of the National Park completed.

Otherwise, there is nothing new to report on the habitat or associated species of *Asplenium peruvianum* var. *insulare*. Existing information is available in USFWS (1998, 2002, 2003a, 2003b, 2010b), Shaw (1997), and CEMML (2003).

2.3.1.7 Other:

No new information.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Threats:

- Ungulate degradation of habitat:
 - On Hawaii Island (USFWS 1998, 2002, 2010b; Belfield and Pratt 2002; CEMML 2003a)

- Feral sheep (*Ovis aries*)
 - Goats (*Capra hircus*)
 - Pigs (*Sus scrofa*)
 - Cattle (*Bos taurus*)
- Established ecosystem-altering invasive plant species degradation of habitat:
 - *Verbascum thapsus* (common mullein) at Mauna Loa Special Ecological Area (Belfield and Pratt 2002)
 - *Pennisetum setaceum* (fountain grass), at Pohakuloa Training Area, which also increases the fire threat (USFWS 1998, 2002; CEMML 2003a)
- Lava flow degradation of habitat (USFWS 1998, 2002, 2010b; CEMML 2003a)
- Landslides and flooding – On Maui at Waikamoi Preserve and Hanawi Natural Area Reserve (Plant Extinction Prevention Program 2009)

Current conservation efforts:

- Ungulate control – The eastern fenced unit at Pohakuloa Training Area will be ungulate free by 2015 (U.S. Army Garrison 2009).
- Ecosystem-altering invasive plant species control – At Pohakuloa Training Area staff controls *Pennisetum setaceum* and *Senecio madagascariensis* as their highest priority of invasive plant control (U.S. Army Garrison 2009).
- Ungulate exclosure – In 2008, the U.S. Army agreed to fence the entirety of Training Area 21, located on the east side of Pohakuloa Training Area, which would encompass 607 hectares (1,500 acres) and a majority of the 300 caves with potential habitat for *A. peruvianum* var. *insulare* (U.S. Army Garrison 2009). The fence is to be completed by the end of 2013 and ungulates removed by the end of 2015 (USFWS 2008). This Eastern Fence Unit would protect more lava tubes, meet the minimum requirement of the Biological Opinion (USFWS 2003c) to provide protected habitat for *A. peruvianum* var. *insulare*, and exclude feral ungulates from a significantly

larger area (U.S. Army Garrison 2009). This fence unit complements other fenced units protecting *A. peruvianum* var. *insulare* habitat at Pohakuloa Training Area, including the Kipuka Kalawamauna Fence Unit, which includes about 24 percent of the Kipuka Kalawamauna Endangered Plant Habitat; Kipuka Alala Fence Units; and the Large Fence Units on the west and southwest side of Pohakuloa Training Area, comprising six contiguous fence units enclosing approximately 7,921 hectares (19,572 acres) and consisting of 101 kilometers (63 miles) of fencing (U.S. Army Garrison 2009).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

No identified threats.

2.3.2.3 Disease or predation:

Threats:

- Ungulate predation or herbivory – On Hawaii Island (USFWS 2002, 2010b; Belfield and Pratt 2002; CEMML 2003a). It was observed that no colonies appeared to be completely decimated by goats, suggesting that they may not actively seek out this fern (USFWS 1998). Predation by feral goats was considered a potential threat to the sizable populations of *A. peruvianum* var. *insulare* at Keauhou and Kulani because they could feed on the ferns at the entrances to lava tubes (USFWS 1998).
 - Feral sheep
 - Goats
 - Pigs
 - Cattle
- Slugs– Oppenheimer noted that slugs might be a potential threat (H. Oppenheimer pers. comm. 2008).

Current conservation efforts:

- Predator/herbivore control – In 2008, slugs were not observed at either the Hanawi or Waikamoi sites (H. Oppenheimer pers. comm. 2008).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

No new information.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Threats:

- Military activities – At Pohakuloa Training Area, this species is threatened by military operations and construction activities (USFWS 1998, 2002, 2010b; CEMML 2003a).
- Fire – Resulting from military operations (USFWS 1998, 2002, 2010b; CEMML 2003a)
- Human disturbance:
 - To potential habitat in high-elevation lava tube entrances (Belfield and Pratt 2002)
 - Filling of lava tubes entrances and vents (USFWS 1998, 2002, 2010b; CEMML 2003a)
- Ungulate trampling – Ungulates generally cannot access individuals growing in caves with skylights; but individuals growing terrestrially at cave entrances can be trampled or browsed (CEMML 2003a)
- Low numbers – increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (USFWS 2003a; Plant Extinction Prevention Program 2009)
- Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

Current conservation efforts:

- Compliance and enforcement – The U.S. Army's Pohakuloa Training Areas land stewardship is governed by the Sikes Act of 1997, which statutorily requires all military installations with land or water suitable for the conservation and management of natural resources to

complete an Integrated Natural Resources Management Plan (INRMP), to be updated every five years, which integrates implementation of the installation's mission with stewardship of the natural resources found there (USFWS 2003b). At Pohakuloa, the USFWS is a major cooperorator in the implementation of this INRMP.

- Also guiding natural resources management at Pohakuloa is the 2003 Biological Opinion for Routine Military Training and Transformation of the 2nd Brigade 25th Infantry Division (Light), decreed by the USFWS (USFWS 2003c 2009). In 2003, the USFWS published such a Biological Opinion for the Pohakuloa Training Area (USFWS 2003a); among their requirements were construction of large-scale fence units to protect endangered species habitat, ungulate control within the fence units, and annual monitoring, weed control, threat management, and outplanting guidelines (U.S. Army Garrison 2009). At Pohakuloa, the requirements of the Biological Opinion have been woven into the INRMP. In implementing the INRMP, the USFWS provides oversight to ensure that the conservation management strategies are achievable, will benefit the species, are effectively implemented and monitored for effectiveness, and are revised as necessary. Among their tasks are the following: identify action areas for species management; estimate the minimum viable population for rare taxa at Pohakuloa Training Area; determine definitions of success for population viability of rare taxa; develop reintroduction and augmentation protocols for rare plant taxa; determine how to achieve the greatest possible genetic representation for each plant taxon; determine and execute habitat improvements (e.g., control of invasive introduced plants, feral ungulates, rodents, invertebrates, dust, etc.); and develop an invasive plant management plan to reduce and control the threats of incipient weeds and enhance habitat quality (U.S. Army Garrison 2009).
- Alliance and partnership development – Also guiding Pohakuloa natural resources activities is the Pohakuloa Implementation Plan, another requirement of the 2003 USFWS Biological Opinion (U.S. Army Garrison 2009). Involved in the development and execution of this plan are 20 biologists from 11 organizations/agencies

representing the U.S. Army; USFWS; U.S. Forest Service; National Park Service; U.S. Geological Service; Research Corporation, University of Hawaii; Center for Environmental Management of Military Lands, Colorado State University; Volcano Rare Plant Facility; State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife; and Rana Productions (U.S. Army Garrison 2009)

- Captive propagation for genetic storage and reintroduction:
 - Pohakuloa Training Area houses a climate-controlled greenhouse and a plant holding compound to acclimate individuals scheduled for outplanting to conditions more similar to those they will encounter in the wild (USFWS 2003). Seeds are collected for storage at the National Seed Storage Laboratory at Colorado State University, and occasionally used for seed germination tests.
 - Pohakuloa Training Area reported that fertile fronds from 17 individuals were collected from two sites for seedbanking, and that spore storage studies were being conducted at the Center for the Conservation and Research of Endangered Wildlife at the Cincinnati Zoo and Botanical Garden (CEMML 2006). In 2007, 17 locations were visited for spore collection, all in western Pohakuloa Training Area (CEMML 2008). Collections were made at three locations from 12 individuals, while three other locations contained *Asplenium peruvianum* var. *insulare* but could not be accessed safely. Outplanting activities for this taxon is not planned to occur at Pohakuloa Training Area until 2013, pending propagation and site selection (CEMML 2008).
 - The Lyon Arboretum Micropropagation Facility had 200 sporophytes ready for delivery, representing at least four Pohakuloa Training Area locations (CEMML 2006). The nursery at Pohakuloa Training Area (2010) reported 30 individuals in controlled propagation, representing 10 wild individuals from the Training Area.

- The Volcano Rare Plant Facility (2011) reported material in refugia and controlled propagation collected from five separate populations: Keauhou Ranch, Kulani trench lava tube, Piha, Puuwaawaa, and the Kona Forest Unit of Hakalau Forest National Wildlife Refuge. A total of 39 individuals were stored in refugia, while 65 individuals were in controlled propagation, representing 16 wild individuals.
- Harold L. Lyon Arboretum's micropropagation facility (2010) had eight active accessions, seven from Pohakuloa Training Area and a single accession from Keauhou Ranch, for a total of 128 spore and apical explants, and 28 explants were sent back to Pohakuloa Training Area.
- Reintroduction / translocation implementation:
 - Twenty-one individuals were reintroduced at Puu Makaala (Volcano Rare Plant Facility 2010).
 - In 2008, six individuals, representing two wild individuals from the Kona Forest Unit of Hakalau Forest National Wildlife Refuge, were reintroduced at the Kipahoe Natural Area Reserve (Volcano Rare Plant Facility 2008).
- Reintroduction / translocation site identification – At Pohakuloa Training Area, rare plant management takes place within Areas of Species Recovery (ASR)—ecosystem-based rare plant management units meant to facilitate short and long-term planning goals (U.S. Army Garrison 2009).
- Fire protection – In 2003, the Pohakuloa Training Area completed an Integrated Wildland Fire Management Plan to reduce the threat of wildfires (CEMML 2003b). In June 2012, Pohakuloa Training Area drafted a revision of their 2003 Integrated Wildland Fire Management Plan (CEMML 2012).
- Surveys / inventories:
 - At Pohakuloa Training Area field surveys were conducted to identify new populations of threatened and endangered plant species in previously unsurveyed areas and areas of suitable habitat (U.S. Army Garrison 2009).

- Between 2004 and 2006, surveys were conducted at the Kahuku addition to Hawaii Volcanoes National Park. Four new lava tube sites with an unspecified count of individuals were discovered (Benitez *et al.* 2008).
- In August 2008, while surveying for *Cyanea horrida* Hank Oppenheimer discovered a single individual of *Asplenium peruvianum* var. *insulare* at Waikamoi Preserve on Maui (Plant Extinction Prevention Program 2009). Within the same year, Oppenheimer discovered another four individuals of *A. peruvianum* var. *insulare* during a survey at Hanawi Natural Area Reserve on Maui (Plant Extinction Prevention Program 2009).
- Threats research – Four zones (East Range, 3 locations of *Asplenium peruvianum* var. *insulare*; North Range, a single population in the Palila Critical Habitat; West Range, 8 locations; and Southwest Range, 12 fenced and 5 unfenced locations, 3 with more than 50 individuals each) containing *A. peruvianum* var. *insulare* populations, at the time estimated at 20 to 25 populations containing 205 to 300 individuals, were evaluated for potential detrimental effects from construction, military activities, fire, dust, and alien species introductions (CEMML 2003a). Construction activities were to pose no direct or indirect effects (CEMML 2003a). Threats from military activities in all zones, ranging from dismounted and mounted vehicle maneuvers and bivouacking, were rated very low to discountable; as a preventative measure, troops were to be provided with soldier field cards instructing that caves, lava tubes, and sinkholes were off-limits, and rocky outcroppings or rock structures were not to be disturbed (CEMML 2003a). Fire vulnerability was rated none to low, lessened by adherence to an existing Wildland Fire Management Plan, and in the event of a fire, all training in the area would cease immediately, with full focus on suppressing the fire; in case of fire damage to *A. peruvianum* var. *insulare* locations, the Army would reinitiate Section 7 consultation with the USFWS (CEMML 2003a). In the Southwest Range, fire management corridors would help contain and compartmentalize a fire; in the East Range,

discontinuous vegetation would limit its ability to carry a fire. Dust problems attendant to close proximity to roads were rated very low to discountable, with no minimization measures required (CEMML 2003a). Spread of introduced plant species threats to populations of *A. peruvianum* var. *insulare* were rated very low to discountable, even though the spread of introduced species was likely to occur because of military foot and vehicular traffic (CEMML 2003a). As a preventative measure, troops were to be instructed on the need to maintain clean clothing and vehicles to avoid transporting seeds or vegetation from one part of the training area to another; and they were to be provided with soldier field cards instructing that caves, lava tubes, and sinkholes were off-limits, and rocky outcroppings or rock structures were not to be disturbed (CEMML 2003a).

- Threats management planning – An Area of Species Recovery is created by drawing polygons around areas with high natural resource value, quality habitat, and/or listed species, excluding areas without sensitive species. A listed plant survey is conducted in each established unit, threats to species are assessed, and the area prioritized for various management actions, including weed, rodent, and ungulate control. In an Area of Species Recovery, listed plants are provided with 100 meter (328 feet) buffers to optimize habitat condition and minimize threats to listed species (U.S. Army Garrison 2009). At the end of 2007, *Asplenium peruvianum* var. *insulare* was found in at least seven Areas of Species Recovery (CEMML 2008).

2.4 Synthesis

The stabilization goals for this species have been met. There are several sites containing 50 or more mature individuals of *Asplenium peruvianum* var. *insulare* located within Hawaii Volcanoes National Park and Pohakuloa Training Area on Hawaii Island (CEMML 2008; Benitez *et al.* 2008; L. Pratt pers. comm. 2011). In addition, all threats are only being partially managed by both institutions. On Maui, there is no population containing 50 or more individuals as of 2010, but there were approximately 17 individuals located at Waikamoi Preserve and Hanawi Natural Area Reserve (USFWS 2010a).

The downlisting goals for this species has been partially met, as threats are being partially managed (Table 2) and this species is in genetic storage.

However, there is no population containing more than 300 individuals (Table 1). Furthermore, no additional populations of *Asplenium peruvianum* var. *insulare* have been reestablished in a secured, managed habitat on Hawaii Island or Maui. Therefore, *A. peruvianum* var. *insulare* meets the definition of endangered as it remains in danger of extinction throughout its range.

Table 1. Status of *Asplenium peruvianum* var. *insulare* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Downlisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
1994 (listing)	8 populations	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 300 mature individuals each	No
1998 (recovery plan)	278	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 300 mature individuals each	No
2003 (critical habitat)	>300	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 300 mature individuals each	No
2012 (5-year review)	603-948	27	All threats managed in all 5-7 populations	Partially (see Table 2)
			Complete genetic storage	Partially
			5-7 populations with 300 mature individuals each	No

Table 2. Threats to *Asplenium peruvianum* var. *insulare* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – Degradation of habitat, herbivory, trampling	A, C, E	Ongoing	Partially: Ungulate exclosures and ungulate control at Pohakuloa Training Area
Established ecosystem-altering invasive plant species degradation of habitat	A	Ongoing	Partially: Ecosystem-altering invasive plant species control at Pohakuloa Training Area
Lava flow degradation of habitat	A	Ongoing	No
Landslides and flooding	A	Ongoing	No
Established invasive plant species competition	E	Ongoing	No
Slug – Herbivory	C	Ongoing	Partially: Surveyed for slugs at Hanawi and Waikamoi, Maui
Hiking and trail maintenance	E	Ongoing	No
Fire	E	Ongoing	Partially: Fire protection and threats research at Pohakuloa Training Area
Military activities	E	Ongoing	Partially: Compliance and enforcement, captive propagation for genetic storage and reintroduction, alliance and partnership development
Human disturbance	E	Ongoing	No
Low numbers	E	Ongoing	Partially: Captive propagation for genetic storage and reintroduction, surveys / inventories on Hawaii Island and Maui, and reintroduction / translocation implementation
Climate change	A, E	Increasing	No

3.0 RESULTS

3.1 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist

Extinction

Recovery

Original data for classification in error

No change is needed

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number: _____

Reclassification (from Endangered to Threatened) Priority Number: _____

Delisting (regardless of current classification) Priority Number:

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Captive propagation for genetic storage and reintroduction :
 - Continue to collect spores from all wild populations on Hawaii Island and Maui, as available, and send to at least two or three different venues for propagation and storage.
 - Tag individuals to track the maternal source for use in *ex situ* propagation to ensure that the greatest possible genetics is represented.
- Reintroduction / translocation site identification – Continue efforts to identify potential suitable reintroduction sites, and monitor current sites for successful establishment and recruitment to better determine optimum reintroduction habitats for the taxon.
- Reintroduction / translocation implementation:
 - Continue to reintroduce the species back into its known historical range on Hawaii Island.

- Attempt to reintroduce the species back into protected habitat within its known historical range on Maui.
- Ungulate enclosure – Complete the East Fence Unit and Large Fence Units at Pohakuloa Training Area.
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates and remove any remaining ungulates inside fenced enclosures.
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations.
- Threats research – Develop and implement control methods for slugs.
- Surveys / inventories:
 - Continue to conduct systematic surveys for populations of *Asplenium peruvianum* var. *insulare* in high elevation lava tubes, especially in Hawaii Volcanoes National Park and Pohakuloa Training Area.
 - Continue to conduct systematic surveys for populations of *Asplenium peruvianum* var. *insulare* on the northern slope of Haleakala and on Kanahau Hill, East Maui.
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of lava flow, military activities, human disturbance, and hiking and trail maintenance.
- Fire protection:
 - Continue to implement the Wildland Fire Management Plan at Pohakuloa Training Area, and revise as new information is received.
 - Develop and implement a fire management plan to protect the species on Maui.
- Population viability monitoring – Conduct annual monitoring of known populations on Hawaii Island and Maui to understand population structure, vigor, demography, and phenology to develop better strategies to recover the taxon.
- Genetic research – Conduct genetic studies to determine if genetically distinct populations exist.
- Federal Register updates – Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, Hawaii Volcanoes National Park, U.S. Army Garrison, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Asplenium fragile* var. *insulare* (No common name)

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-Year Review:

 Delisting
 Reclassify from Endangered to Threatened status
 Reclassify from Threatened to Endangered status
 X No Change in listing status

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:

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