Astelia waialealae
(Pa‘iniu)

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: ***Astelia waialealae (Pa'iniu)***

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5-YEAR REVIEW
Astelia waialealae (Pa‘iniu)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional Office:
Region 1, Endangered Species Program, Division of Recovery, Sarah Hall, (503) 231-6868

Lead Field Office:
Pacific Islands Fish and Wildlife Office, Mary M. Abrams, 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 in March, 2016. The review was based on final rule listing and designating critical habitat for this species; the recovery outline; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawaii, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Gregory Koob, Conservation and Restoration Team Manager.

1.3 Background:

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

[USFWS] U.S. Fish and Wildlife Service. 2015. Endangered and threatened wildlife and plants; 5-year status reviews of 133 species in Hawaii, Oregon, Idaho, and Washington. Federal Register 80(30): 8100–8103.

1.3.2 Listing history:

Original Listing
FR notice: USFWS. 2010. Endangered and threatened wildlife and plants; determination of endangered status for 48 species on Kauai and designation of critical habitat, final rule. Federal Register 70(75): 18960–19165.
Date listed: April 13, 2010
Entity listed: Species
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:
N/A

1.3.4 Review History:
This is the first 5-year review for this species. *Astelia waialealae* is a perennial herb that was listed as endangered, with designation of critical habitat, on April 13, 2010 (USFWS 2010a). The recovery outline for *A. waialealae* is included in the recovery outline for the Kauai Ecosystem, published in 2010 (USFWS 2010b). The final recovery plan is in preparation.

1.3.5 Species' Recovery Priority Number at start of this 5-year review: At the start of the 5-year review, the Recovery Priority Number proposed for *Astelia waialealae* is 5, based on the high degree of threat, a moderate potential for recovery with some threats that are well understood and easily alleviated and other that are currently difficult to alleviate, and its status as a full species (USFWS 2010b).

1.3.6 Current Recovery Plan or Outline:
Name of plan or outline: USFWS. 2010b. Recovery outline for the Kauai ecosystem. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pages.
Date issued: June 17, 2010
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***
__X__ ***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***

_X_ ***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 (Factors A, B, C, D, and E) affecting this species is presented in section 2.3.2.

The recovery plan is currently being drafted. However, the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (HPPRCC 2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so USFWS also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, USFWS has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. A species with a narrow extant range is one currently known from one or two adjacent gulches or ridges within the same mountain range. Some species have historically been known from only one population. For these species, given the limited information known of their habitat requirements, the number of mature individuals needed to prevent extinction was doubled within the known population rather than expanding the known range of the species for preventing extinction and the interim stage. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

To prevent extinction of *Astelia waialealae* (a dioecious obligate outcrosser with a narrow extant range and with a short life span), the species needs a minimum of three populations consisting of 100 mature individuals per population. In addition to achieving the numbers of reproducing individuals, all major threats must be controlled in the immediate vicinity of the populations, each population must show evidence of some stage of natural reproduction (*i.e.*, viable seeds or seedlings), and 50 mature individuals from each of three populations, or less if fewer than 50 remain, must be represented in an *ex situ* collection that is secure and well managed.

This recovery objective has not been met (see Table 1).

Interim Stage

To meet the interim stage of recovery of *Astelia waialealae*, 600 mature individuals are needed in each of three populations and all major threats must be controlled around each population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and documented replacement regeneration within each of the target populations. Each population must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant *et al.* 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats. Species-specific management actions must no longer be

necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

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 is known about the life history of *Astelia waialealae*, other than that the flowers are dioecious (with male and female flowers on separate plants). Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS 2010a, 2010b).

Astelia waialealae is a short, rhizomatous perennial herb in the Asteliaceae family (Wagner *et al.* 1999; Wagner and Herbst 2003). It has silvery leaves that are 12 to 20 centimeters (cm) (4.7 to 7.9 inches (in)) long and 1.3 to 2.2 cm (0.5 to 0.9 in) wide, with scales present on both surfaces. The staminate flowers are in racemes 3 to 7 cm (1.2 to 2.8 in) long and the tepals (outer part of a flower, which includes the petals or sepals) are dark purple. The pistillate flowers are also in racemes, which are 2.5 to 3 cm (1 to 1.2 in) long and have dark purple tepals. Berries are orange, ovoid, 8 millimeters (mm) (0.3 in) long and 4 mm (0.2 in) in diameter (Wagner *et. al*. 1999).

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:

Astelia waialealae was known historically from five populations in the Alakai Swamp and the Halemanu plateau areas of Kauai (Wagner *et al.* 1999; HBMP 2010). In 1994, botanists from National Tropical Botanical Garden (NTBG) and USFWS undertook a systematic survey of bogs on

Kauai, revisiting all of the historically known locations of *A. waialealae* as well as 16 additional bogs. At that time, *A. waialealae* was confirmed to exist in three bogs. Sincock Bog 1 contained three *Astelia* clumps with three individuals in one clump (individuals within the same clump are presumed to be genetically identical (Bruegmann 2006, pers. comm.)) five in another, and possibly 10 in the third, for a total of 18 individuals. Sincock Bog 2 contained two clumps, with one individual in each, and Waiakoali Bog (Circle Bog), contained two clumps of plants with one individual in each (Perlman and Wood 1995). In 1996 and 1997, in a joint venture project with Hawaii Division of Forestry and Wildlife (DOFAW) and USFWS, both Sincock Bog 1 and Sincock Bog 2 were fenced, followed by Circle Bog in 1998. Regular monitoring of these bogs commenced, and with protection from the fences, there was an increase in the numbers of clumps and individuals of *A. waialealae* found in all three bogs. By 2001, the number of *A. waialealae* reached a peak of 13 clumps and 52 individuals. By 2005, the number of individuals began dropping dramatically, with visible signs of poor health for those remaining. Three offsets were collected for propagation at DOFAW's Rare Plant Facility at Volcano (VRPF 2015). Individuals survived in the greenhouse for a few years but died before additional plants could be propagated (Moriyasu 2005, in litt.). Also in 2005, three sterile individuals were discovered at the Waialeale Summit outside the fenced exclosure, possibly all connected by a single rhizome (NTBG 2005). In 2005, there were 16 individuals, possibly representing six genetically distinct plants. Currently, there are populations at three locations (Circle Bog, the Sincock Bog area, and Waialeale summit) totaling 10 individuals (PEPP 2015; Bruegmann *et al.* 2016).

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

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Astelia waialealae was described by Wawra (1875). This species is recognized as a distinct taxon in Wagner *et al.* (1999). Wagner and Herbst (2003) maintained this species but moved the genus from the Liliaceae to the Asteliaceae family.

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.):

See section 2.3.1.2 above for spatial distribution of the species.

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

Astelia waialealae occurs only in bogs and on bog hummocks (low mounds or ridges of vegetation) at the summit of Mount Waialeale and within Alakai Swamp (Alakai WP and Wainiha Preserve) on the island of Kauai. Habitat associated with *A. waialealae* is dominated by *Metrosideros polymorpha* (ohia) at 1,220 to 1,585 meters (4,000 to 5,000 feet) elevation on Kauai (Wagner *et al.* 1999), with the following associated native species: *Alyxia stellata* (maile), *Astelia menziesiana* (painiu), *Broussaisia arguta* (kanawao), *Carex alligata* (no common name (NCN)), *C. montis-eeka* (Molokai sedge), *Cheirodendron* spp. (olapa), *Coprosma elliptica* (pilo), *Deschampsia nubigena* (hairgrass), *Dianella sandwicensis* (uki uki), *Dichanthelium* spp. (NCN), *Dicranopteris* spp. (uluhe), *Drosera anglica* (English sundew), *Dubautia* spp. (naenae), *Gahnia* spp. (uki), *Ilex anomala* (kawau), *Keysseria erici* (NCN), *Korthalsella* spp. (hulumoa), *Leptecophylla tameiameiae* (pukiawe), *Lobelia kauaensis* (pue), *Lycopodiella cernua* (wawaeiole), *Machaerina* spp. (uki), *Melicope clusiifolia* (kukaemoa), *M. feddei* (alani), *Myrsine denticulata* (kolea), *Oreobolus furcatus* (NCN), *Plantago* spp. (*kuahiwi laukahi*), *Psychotria mariniana* (kopiko), *Rhynchospora chinensis* ssp. *spiciformis* (kuolohia), *Sadleria* spp. (amau), *Scaevola glabra* (ohe naupaka), *Smilax melastomifolia* (hoi kuahiwi), *Stenogyne* spp. (NCN), *Vaccinium* spp. (ohelo), *Viola kauaensis* (pohe hiwa), and *Wikstroemia* spp. (akia) (Wagner *et al.* 1999; HBMP 2010).

2.3.1.7 Other:

N/A

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 (Factor A):

Ungulate degradation of habitat—Feral pigs (*Sus scrofa*), goats (*Capra hircus*) (NTBG 1994, 2005, 2007; HBMP 2010; PEPP 2010, 2011, 2012, 2014, 2015; Bruegmann *et al.* 2016), and black-tailed deer (*Odocoileus hemionus columbianus*) (PEPP 2010, 2011, 2012, 2014, 2015) modify and degrade habitat by disturbing and destroying vegetative cover, trampling

plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil.

Established ecosystem-altering invasive plant degradation of habitat—Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Astelia waialealae* include *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Juncus planifolius* (rush), *Rubus rosifolius* (thimbleberry), and *Xyris camplanata* (yellow-eyed grass) (HBMP 2010; Bruegmann and Caraway 2010; Bruegmann *et al.* 2011; Bruegmann *et al.* 2016).

Hurricanes—Loss and degradation of habitat—In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel *et al.* 2008; Yu *et al.* 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013).

Climate change loss or degradation of habitat—Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *A. waialealae* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.896 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). The analysis determined that *A. waialealae* is a species with no overlap between current and future climate envelopes and is unlikely to easily tolerate expected changes in climate within its current climate envelope. This limitation means this

species must either endure in suitable microrefugia within its current envelope or move to newly available climate-compatible areas to avoid extinction. Species that were estimated to overlap less than 1 percent of their current climate envelope with their projected future climate envelope were classified as "no-overlap" species. For these species, habitat quality within the toleration zone was switched to an unsuitable state in the model as there is effectively no area within that zone for the species to utilize. Therefore, additional management actions are needed to conserve this taxon into the future.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):

Not a threat.

2.3.2.3 Disease or predation (Factor C):

Ungulate predation or herbivory—Predation or herbivory by goats and black-tailed deer has been noted as a threat to this species (HBMP 2010; NTBG 2005; PEPP 2010, 2011, 2012, 2014, 2015). The basal rosette of the plant is starchy and may provide a food source for feral pigs (NTBG 2005; Perlman and Wood 1995).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

Lack of adequate hunting regulations—The Hawaii Department of Land and Natural Resources Regulation (Administrative Rule No. 1, Chapter 3) established the 4,022 hectare (9,939 acre) Alakai Wilderness Preserve (WP) in 1964, recognizing the pristine forest values of this area and the need to control potential degrading factors. However, no funding was obligated along with this law to allow the Hawaii DLNR to adequately manage the area.

Feral pig and goat hunting is allowed in the habitat of *Astelia waialealae*, with a bag limit of one pig per hunter per day and goat hunting limited to eight weekends and one goat per rifle or muzzleloader. Black-tailed deer hunting is allowed year-round but is limited to two animals per hunter per day in *Astelia* habitat (DLNR 2010). However, because of the remote and rugged topography, little public hunting is conducted in this area. Game mammals have unrestricted access to most areas across the landscape of Kauai, regardless of underlying land use designation; therefore, any unfenced populations are at risk. In addition, the fenced populations are still at risk. The Natural Conservancy of Hawaii (TNC) has constructed exclosure fences for pigs in the *Astelia* habitat (Clark 2009, in litt.), but pigs, goats, and recently black-tailed deer, have repeatedly breached the fence (PEPP 2010, 2011, 2012, 2014, 2015).

Lack of adequate biosecurity legislation—Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Astelia waialealae*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma *et al.* 2002).

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):

Invasive species—Established invasive plant species competition—Threats from introduced invasive plants previously described in section 2.3.2.1 above, in addition to degrading habitat, directly complete with *Astelia waialealae* for water, light, and nutrients (Bruegmann and Caraway 2010; Bruegmann *et al.* 2011).

Fire destruction or degradation of habitat—Fire can destroy dormant seeds as well as plants. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat by altering microclimate conditions favorable to nonnative plants. Nonnative plants can spread as a consequence of fire, produce a high fuel load, and many are adapted to survive and regenerate after fire, establishing rapidly in newly burned areas, continuing and compounding the fire cycle (D'Antonio *et al.* 1992). When a bog catches fire, it may be more severe, with combustion spreading deeper into the peat (HWMO 2017, in litt.). In 2008, a lost hiker set Circle Bog on fire as a signal for potential rescuers. The fire destroyed 5 acres of bog habitat (HWMO 2014, *gis.ctahr.hawaii.edu/WildfireHistory*; Wysong 2008, in litt.).

Loss of pollinators—Lack of pollination has been noted as a threat to this species (PEPP 2011, 2014). *Astelia waialealae* is a dioecious plant, producing male and female flowers on separate plants (Wagner *et al.* 1999). Flowering in the wild has rarely been observed, from one female plant, and no seeds were produced (Bruegmann 2006, pers. comm.). The pollinators for this species are unknown. This taxon can reproduce vegetatively (from underground stems), but many individuals have died (Bruegmann 2006, pers. comm.).

Stochastic events—Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to

environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. This is particularly true for dioecious species such as *Astelia waialealae*. Staminate (male) and pistillate (female) flowers occur on separate individuals or for obligate outcrossers (must fertilize from another individual). Isolated individuals have difficulty achieving natural pollen exchange, which can decrease the production of viable seed. No viable seeds or reproduction have been observed in *A. waialealae* (Bruegmann and Caraway 2010).

Current Management actions:

- Ungulate monitoring and control—USFWS and DOFAW have fenced Circle Bog and Sincock 1 and 2 bogs in the Alakai Plateau within the montane wet ecosystem, preventing incursion from feral pigs and goats. These fenced bogs contain all but one population of *Astelia waialealae*; however, pigs, and recently black-tailed deer, have been able to breach the fence, and it must be constantly monitored.
- The Nature Conservancy of Hawaii has completed construction of the perimeter fence encompassing important *Astelia* habitat in the Alakai WP, to protect this and other species from habitat destruction and predation by feral pigs (Clark 2013).
- Predator and herbivore monitoring and control—Monitoring of fenced areas continues at least annually.
- Invasive plant monitoring and control—Monitoring and control of nonnative plants is conducted by USFWS, DOFAW and PEPP staff (USFWS 2010a; Bruegmann and Caraway 2010; Bruegmann *et al.* 2011; PEPP 2014).
- Surveys and inventories—Surveys are ongoing to locate additional individuals of this species (PEPP 2014).
- Captive propagation for genetic storage and reintroduction—In Sept 2013, four individual plants were hand pollinated and protected from feral ungulates with individual wire cages (PEPP 2014). There is no record of seeds being collected.
- Population viability monitoring and analysis—USFWS, DOFAW, and PEPP monitor the populations regularly for flowering and seed set (Bruegmann and Caraway 2010; PEPP 2014).

Table 1. Status and trends of *Astelia waialealae* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2010 (listing and critical habitat)	16	0	All threats managed in all three populations	Partially
			Complete genetic storage	No
			Three populations with 100 mature individuals each	No
2016 (5-year review)	11	0	All threats managed in all three populations	Partially
			Complete genetic storage	No
			Reproduction (*i.e.* viable seeds, seedlings) at all three populations	Unknown
			Three populations with 100 mature individuals each	No

Table 2. Threats to *Astelia waialealae* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partially
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partially
Hurricane destruction and degradation of habitat	A	Increasing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partially
Inadequacy of existing regulatory mechanisms—Lack of adequate hunting regulations	D	Ongoing	None
Invasive species—Established invasive plant species competition	E	Ongoing	Partially

Fire loss or degradation of habitat	E	Ongoing	None
Stochastic events—Reduced viability due to low numbers	E	Ongoing	None
Loss of mutualists—Pollinators	E	Ongoing	None

2.4 Synthesis

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in the HPPRCC's Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and have 50 individuals from each of three populations (or total number of mature individuals if fewer than 50) represented in an *ex situ* (at other than the plant's natural location, such as a nursery or seed bank) collection. In addition, a minimum of three populations should be documented on Kauai where they now occur or occurred historically and each of these populations must be naturally reproducing (demonstrate some reproduction, i.e., viable seeds, seedlings, or saplings), with a minimum of 100 mature individuals per population.

The preventing extinction goals for this species have not been met, as currently no population of 100 mature individuals exists (Table 1), there is no ex situ germplasm collection or propagation, and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Astelia waialealae* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.3 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ 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

- Surveys and inventories—Survey for populations of *Astelia waialealae* in areas of potentially suitable habitat.
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations.
- Invasive plant monitoring and control—
    - Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
    - Continue to control invasive nonnative plant species around all populations that compete with the species.
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Population biology research—Study *Astelia waialealae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
- Based on the recovery criteria above, consider development of a recovery plan.

5.0 REFERENCES

Barrett, S.C.H. and J.R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants—implications for conservation. *In* Genetics and Conservation of Rare Plants, Falk, D.A. and K.E. Holsinger (eds.), Oxford University Press, New York and Oxford. Pp. 3–30.

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Astelia waialealae (Pa'iniu)*

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:_____

For **Field Supervisor, Pacific Islands Fish and Wildlife Office**

GREGORY KOOB

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