Plantago hawaiensis
(Laukahi kuahiwi)

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: *Plantago hawaiensis* (Laukahi kuahiwi)

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5-YEAR REVIEW
Plantago hawaiensis (Laukahi kuahiwi)

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 designation of critical habitat for *Plantago hawaiensis* and the Big Island plant cluster recovery plan (USFWS 2003, 1996), 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 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; determination of endangered or threatened status for 21 plants from the island of Hawaii, State of Hawaii; final rule. Federal Register 59(43):10305-10325.
Date listed: March 4, 1994
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:

USFWS. 2003. 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 *Plantago hawaiensis* in three units totaling 4,089 hectares (10,103 acres) on Hawaii Island. These designations include habitat on State and Federal lands (USFWS 2003).

1.3.4 Review History:

Species status review [FY 2011 Recovery Data Call (August 2011)]:
Declining

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

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

5

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: USFWS. 1996. Recovery plan for the Big Island plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 202 pages + appendices. Available online at <http://www.fws.gov/pacificislands/recoveryplans.html>.
Date issued: September 26, 1996
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***
__X_ ***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***
__X_ ***No***

2.2 Recovery Criteria

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

__X_ ***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?

__X_ ***Yes***
____ ***No***

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

__X_ ***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 the Big Island plant cluster (USFWS 1996), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Plantago hawaiensis* is a short-lived perennial, and 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 the Big Island (Hawaii Island). 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. There are three populations containing more than 50 mature individuals.

For downlisting, a total of five to seven populations of *Plantago hawaiensis* should be documented on the island of Hawaii. 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 *Plantago hawaiensis* should be documented on the island of Hawaii. 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:

Plantago hawaiensis is a short-lived, herbaceous perennial species that grows as a rosette (Belfield and Pratt 2002; Wagner *et al*. 1999). Longevity studies of the population at Kipuka Maunaiu suggested that 90 percent or more of the individuals survived 3 years or longer (Belfield and Pratt 2002).

Little is known about its life history cycle apart from observations that it closely resembles *Plantago pachyphylla* overall morphologically and that it occupies a drier habitat than *P. pachyphylla* (Wagner *et al*. 1999). Members of the genus have very small, inconspicuous flowers with widely exserted stamens, which is associated with wind pollination. Dunbar-Co *et al*. (2009) studied a number of leaf traits among species of *Plantago* in Hawaii, including *P. hawaiensis*. Little was reported in particular for *P. hawaiensis*, although the authors indicated it has two layers of palisade parenchyma in the leaves and that approximately 40 percent of its stomata occur on the upper leaf surface. Dunbar (2005) reported that, in general, seed viability, for members of Hawaiian *Plantago* is good, based on an observation that approximately 25 percent of the seeds of *P. princeps* var. *longibracteata* germinated after being stored for 14 years at National Tropical Botanic Garden.

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:

Plantago hawaiensis occurs only on the Island of Hawaii (USFWS 1994, 2002). At the time of listing this species was known from four populations with a total of less than 10 wild individuals (USFWS 1994).

When the recovery plan was issued there were eight known populations with a total of over 5,000 individuals (USFWS 1996).

Belfield and Pratt (2002) carried out a detailed 3.5-year demographic study of *Plantago hawaiensis* at two sites, which included analyses of trends in population size, recruitment, phenology, and size class distribution. The species was known from two subalpine populations in the Special Ecological Area of Hawaii Volcanoes National Park in 1994 (Belfield and Pratt 2002; USFWS 2002). The population at Kipuka Kulalio included 357 individuals, but that figure declined to 51 individuals by March 1996, probably in part due to scouring from intermittent stream

channels and debris torrents (Belfield and Pratt 2002). The individuals at Kipuka Maunaiu numbered 277 individuals, which increased to 291 individuals by 2000 (Belfield and Pratt 2002). Smaller seedlings may have been undercounted due to the difficulty of distinguishing them from other germinants.

When critical habitat was proposed, a total of eight populations with more than 5,000 individuals were thought to exist (USFWS 2002). When critical habitat was designated, eight populations were revised to six populations (USFWS 2003).

Giffin (2009) reported a single individual of *Plantago hawaiensis* from Puu Waawaa near the upper boundary of the Forest Bird Sanctuary.

The Plant Extinction Prevention Program (2007) reported finding a new wild population of *Plantago hawaiensis* containing an estimated 73 mature individuals at Kahuku, growing on an old pahoehoe lava flow near 1,800 meters (5,906 feet) elevation in six sites. This population was observed by staff of Hawaii Volcanoes National Park between 2004 and 2006, where 73 individuals were observed (Benitez *et al*. 2008).

The most current information reports, five populations of *Plantago hawaiensis* containing several hundred individuals (USFWS 2010).

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

Preliminary morphological and molecular data based on the nitrate reductase gene suggested that the population of *Plantago hawaiensis* from Kulani may be a form of *P. pachyphylla* (Dunbar 2005, 2006). However, further studies (Dunbar-Co *et al*. 2008) placed the two accessions of *P. hawaiensis* together as a sister taxa in a molecular phylogeny of Hawaiian *Plantago*, based on the rDNA internal (ITS) and external (ETS) transcribed spacers and the spacers associated with the chloroplast genes *ndhF–rpl32* and *rpl32–trnL* (Dunbar-Co *et al*. 2008). Unpublished microsatellite data indicate significant genetic variation between the two sampled populations of *P. hawaiensis*, suggesting the possibility that the two may be deserving recognition as distinct taxa (Dunbar-Co, pers. comm. 2011).

2.3.1.4 Taxonomic classification or changes in nomenclature:

Plantago hawaiensis (A. Gray) Pilg., a member of the plantain family (Plantaginaceae), was first described in 1862 by Asa Gray as a variety of *P. pachyphylla* (USFWS 1994). Other synonyms for this species include

P. gaudichaudiana H. Lév., *P. hawaiensis* var. *laxa* Pilg., and *P. pachyphylla* var. *hawaiensis* subvar. *gracilis* A. Gray (Wagner *et al*. 1999). The species was collected as early as 1840 by the U.S. Exploring Expedition and in 1854 by the French botanist E. J. Rémy.

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):

Plantago hawaiensis is typically found in dry shrubland habitats on the leeward side of Hawaii Island, often in cracks in lava (Rock 1920; Wagner *et al*. 1999), between 1,584 and 2,513 meters (5,198 to 8,243 feet) elevation (USFWS 2003). However, Belfield and Pratt (2002) determined that periodic water-flow channels are evidently required by the species, and indicated that the report for dry lava fields by Rock (1920) was probably incorrect. However, Dunbar-Co *et al*. (2008) reported the species as occurring in bogs and alpine shrublands. Associated native plant species include *Acacia koa* (koa), *Coprosma ernodeioides* (aiakanene), *C. montana* (pilo), *Dryopteris wallichiana* (laukahi), *Dodonea viscosa* (aalii), *Metrosideros polymorpha* (ohia), and *Vaccinium reticulatum* (ohelo) (USFWS 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 (USFWS 2002)
    - Feral pigs (*Sus scrofa*)
    - Goats (*Capra hircus*)
    - Mouflon sheep (*Ovis gmelini musimon*)

- Ecosystem-altering invasive plant species degradation of habitat (USFWS 2002)
    - *Passiflora tarminiana* (banana poka)

Current conservation efforts:

- Ungulate exclosure – Hawaii Volcanoes National Park constructed a fenced exclosure for *Plantago hawaiensis* at Kipuka Maunaiu and Kipuka Kulalio of the Mauna Loa Strip (Plant Extinction Prevention Program 2007).

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

None reported.

2.3.2.3 Disease or predation:

Threats:

- Ungulate predation or herbivory – The sharp decline in the population at Kipuka Kulalio was feared, at one point, to be caused by grazing by feral mouflon sheep or feral goats (Dunbar 2005). However, Belfield and Pratt (2002) had stated earlier that a decline due to mouflon sheep was less likely after finding evident signs of feral sheep (*Ovis aries*) instead, including droppings, around relatively healthy individuals of *P. hawaiensis*.
- Nonnative bird predation – Evidence of Kalij pheasants (*Lophura leucomelanos*) (such as footprints and egg shells, indicating possible nest sites) were found in association with the population from Kipuka Kulalio (Belfield and Pratt 2002). Although pheasants are known to eat tender leaves, the authors felt it was unlikely that the pheasants would be uprooting larger individuals (Belfield and Pratt 2002).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Threats:

- Lack of adequate hunting regulation in areas with ungulates – The lack of adequate ungulate control and the existence of established hunting programs in areas where *Plantago hawaiensis* occurs outside of Hawaii Volcanoes National Park continue to threaten this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Threats:

- Ungulate trampling (USFWS 2002)
    - Feral pigs
    - Goats
    - Mouflon sheep
- Established invasive plant species competition (Belfield and Pratt 2002)
    - *Verbascum thapsus* (common mullein)
- 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:

- Captive propagation for reintroduction and translocation – The Volcano Rare Plant Facility (2011) reported three individuals in controlled propagation.
- Reintroduction / translocation implementation:
    - Successful reintroductions of *Plantago hawaiensis* have been made within the Mauna Loa Special Ecological Area (Belfield and Pratt 2002). The Mauna Loa population appeared to be persisting on its own as of report date (Belfield and Pratt 2002); the current status of this reintroduced population is unknown.
    - In 2004, a total of 279 individuals were reintroduced at Kipuka Kulalio, in the upper and lower fenced exclosures built for silverswords, with no mortality occurring during the first year (Hawaii Volcanoes National Park 2004).
    - Seeds of *Plantago hawaiensis* were germinated in a 50 to 50 mixture of cinder and soil (Hawaii Volcanoes National Park 2004). The Volcanoes Rare Plant Facility refined the propagation techniques for *P. hawaiensis* and reintroduced individuals at Kulani wetlands which are located within the Mauna Loa Boy's School and North Boundary Units (Rubenstein 2007).

- The Plant Extinction Prevention Program (2007) reported 300 mature wild individuals from Kipuka Maunaiu of Hawaii Volcanoes National Park Mauna Loa Strip, last observed in 1997.
- Hawaii Volcanoes National Park reintroduced 796 individuals at Kipuka Kulalio of Hawaii Volcanoes National Park Mauna Loa Strip, however only 301 mature individuals survived (Plant Extinction Prevention Program 2007).
- As of 2010, only two individuals of *P. hawaiensis* in two populations were represented among the *ex situ* collections (USFWS 2010).

2.4 Synthesis

The interim stabilization goals for this species have only been partially met, as there are at least three populations containing more than 50 individuals of *Plantago hawaiensis* (Table 1). The most current information reports, five populations of *P. hawaiensis* containing several hundreds of individuals at Kahuku, Puu Waawaa, Kipuka Maunaiu, Kipuka Kulalio, and Hawaii Volcanoes National Park. However, although there are several hundreds of individuals, not all threats are being managed at all known populations (Table 2). Therefore, *Plantago hawaiensis* meets the definition of endangered as it remains in danger of extinction throughout its range.

Table 1. Status of *Plantago hawaiensis* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	<10	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1996 (recovery plan)	>5,000	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Yes
2003 (critical habitat)	5,705-5,805	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Yes
2012 (5-year review)	Several 100s	303	All threats managed in all 3 populations	Partially (See Table 2)
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Yes

Table 2. Threats to *Plantago hawaiensis* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – Degradation of habitat, trampling, and herbivory	A, C,D, E	Ongoing	Partially: Ungulate exclosures at Kipuka Maunaiu and Kipuka Kulalio
Established ecosystem-altering invasive plant species degradation of habitat	A	Ongoing	No
Established invasive plant species competition	E	Ongoing	No
Nonnative bird predation	C	Ongoing	No
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*
__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

- Captive propagation for genetic storage and reintroduction:
    - Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in *ex situ* propagation.

    - Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation.
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range.
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records.
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions.
- Ungulate exclosures:
    - Monitor the condition of fenced exclosures at Hawaii Volcanoes National Park to prevent breaching by feral ungulates.
    - Continue to construct fenced exclosures for all known populations.
- Ungulate control – Protect all populations against disturbances from feral ungulates.
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations.
- Surveys / inventories – Survey areas of suitable habitat for the species that have not been surveyed, or which have not been surveyed for over ten years.
- Threat monitoring and control:
    - Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods.
    - Monitor the remaining wild populations, taking close notice of factors that may be responsible for senescence among individuals.
- Threats research – Study populations of *Plantago hawaiensis* with regard to nonnative bird predation.
- Population biology research – Study the reproductive biology of the species in the field to determine the pollinators of the species and what factors aid in seed dispersal.
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, Hawaii Volcanoes National Park, 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.

5.0 REFERENCES

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Plantago hawaiensis* (Laukahi kuahiwi)

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:
Chelsie Javar, Fish and Wildlife Biologist
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for

Jess Newton

Date 8/28/2012