

Huperzia mannii
(wawae‘iole)

**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: *Huperzia mannii* / wawae‘iole

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5-YEAR REVIEW
***Huperzia mannii* (wawae'iole)**

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 March 16, 2009. The review was based on final critical habitat designations for *Huperzia mannii* and other species from the islands of Maui, Hawaii, and Kauai (USFWS 2003a, 2003b, 2003c) as well as a review of current, available information. The National Tropical Botanical Garden 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 Tamara Sherrill, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Lead 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. 2009. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 103 species in Hawaii. Federal Register 74(49):11130-11133.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 1992. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 15 plants from the island of Maui, Hawaii. Federal Register 57(95):20772-20788.

Date listed: May 15, 1992

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. 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.

USFWS. 2003c. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 95 plant species from the islands of Kauai and Niihau, Hawaii; final rule. Federal Register 68(39):9116-9479.

Critical habitat was designated for *Huperzia mannii* in five units totaling 1,172 hectares (2,899 acres) on Maui (USFWS 2003a). These designations include habitat on State, Federal, and private lands. The species no longer occurs on the island of Hawaii and Kauai, and critical habitat was not designated on Hawaii Island and Kauai because habitat essential to the species' conservation on these islands was not determined (USFWS 2003b,c).

1.3.4 Review History:

Species status review [FY 2010 Recovery Data Call (September 2010)]: Stable

Recovery achieved:

1 (0-25%) (FY 2007 Recovery Data Call – most recent year reported)

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

2

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: Recovery plan for the Maui plant cluster.

Date issued: July 27, 1997.

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, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Maui plant cluster (USFWS 1997), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Huperzia mannii* 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, weeding, etc.) 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. 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 not been met.

For downlisting, a total of five to seven populations of *Huperzia mannii* 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 *Huperzia mannii* 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 for short-lived perennials. 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:

In his book, *Hawaii Ferns and Fern Allies*, Dan Palmer states that this species is probably related to a group of similar tropical American species (Palmer 2003).

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:

The epiphytic (not rooted in the ground and not a parasite), hanging firmoss, *Huperzia mannii*, was known from 670 to 1,600 meters (2,200 to 5,249 feet) elevation on Kauai, East and West Maui, and the island of Hawaii, but it has not been seen for many years except on East Maui (Haleakala National Park Resource Management 2004; Palmer 2003). A population at Laupahoehoe at 920 meters (3,018 feet) elevation on the island

of Hawaii has not been reported since 1991, and in 1996 was described as a new species, *Huperzia stemmermanniae* (Medeiros *et al.* 1996; S. Perlman, National Tropical Botanical Garden, pers. comm. 2009). On West Maui 14 to 17 individuals of *H. mannii* were seen in 1991 in Lihau Natural Area Reserve summit area at 1,262 meters (4,140 feet) elevation, on a south facing slope; all but one individual was growing epiphytically on trees (Medeiros *et al.* 1996; National Tropical Botanical Garden 2009b; Perlman 2009).

A population in East Maui at Healani Region (USFWS 1997) has not been reported since 1982. On East Maui at Waikamoi, north of Puu o Kaka'e, Opana Gulch, *Huperzia mannii* was observed in 1997 at 1,311 meters (4,300 feet) elevation (Wood 2009). One large plant was also observed in 1997 on East Maui, at Kahikinui Forest Reserve's Manawainui Gulch, at 1,698 meters (5,570 feet) elevation, in a fenced enclosure (Perlman 2009). An unnamed gulch west of the Manawainui Gulch, also within the Reserve at 1,630 meters (4,880 feet) elevation had a population of seven individuals growing on the trunks of *Acacia koa* (koa) trees in 1997 (USFWS 1997).

Haleakala National Park Resource management staff reported in 2004 that there were ten individuals in Kipahulu, at elevations between 710 and 815 meters (2,330 and 2,675 feet), and 14 individuals at Kaapahu between 732 and 792 meters (2,400 and 2,600 feet) elevation (Haleakala National Park Resource Management 2004). Park staff found another 16 individuals of *Huperzia mannii* in December 2006 between 792 and 945 meters (2,600 and 3,100 feet) elevation in the Kipahulu area (Haleakala National Park Resource Management 2006). Twenty-three individuals were observed again in 2009 in East Maui's Kipahulu Valley, on Cable Ridge at 670 meters (2,220 feet) elevation, and another five plants at 701 meters (2,300 feet) elevation (Perlman 2009). Two populations were reported in 2010 on Cable Ridge containing between 61 and 71 individuals, with an additional unreported number of individuals in a third population. One of these populations may have as many as 50 individuals (F. Jacob, Kipahulu Ohana, pers. comm. 2010).

Huperzia mannii has not been seen on Kauai since 1900 (USFWS 2003c). In total, since 1991 the estimated census of *H. mannii* is reported at no more than 118 individuals in 9

populations only on Maui. Since 2003, only 61 to 71 individuals of *H. mannii* have been observed in three populations on Maui.

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:

A population formally known as *Huperzia mannii* on the island of Hawaii at Laupahoehoe is now considered to be *Huperzia stemmermanniae* (Medeiros *et al.* 1996). However, a historical population collected by Degener and Murashige in Kona remains to be described as *H. mannii*. At least one collection from East Maui is also identified as *Huperzia stemmermanniae* (Medeiros *et al.* 1996). This species was identified by a synonym, *Phlegmariurus mannii*, in the Federal Register documents designating critical habitat for the species (USFWS 2003a, 2003b, 2003c), but has since been verified as a separate species.

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.

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

On East Maui, *Huperzia mannii* was observed growing as an epiphyte on aerial (above ground) roots of *Metrosideros polymorpha* (ohia) in *Acacia koa* (koa) – *Metrosideros polymorpha* – *Dicranopteris linearis* (uluhe) mesic forest with associated native species such as *Alyxia stellata* (maile), *Antidesma platyphyllum* (hame), *Asplenium acuminatum* (lola), *Bobea elatior* (ahakea lau nui), *Carex wahuensis* (no common name [NCN]), *Cheirodendron trigynum* (olapa), *Cibotium glaucum* (hapuu), *Coprosma foliosa* (pilo), *Cyanea asplenifolia*

(haha), *Cyrtandra hashimotoi* (keokeo haiwale), *C. platyphylla* (ilihia), *C. spathulata* (kanawao keokeo), *Deschampsia nubigena* (hairgrass), *Dodonaea viscosa* (aalii), *Dryopteris wallichiana* (io nui), *Dubautia menziesii* (naenae), *Elaphoglossum paleaceum* (makue), *Labordia hirtella* (kamakahala), *L. tinifolia* (kamakahala), *Leptecophylla tameiameiae* (pukiawe), *Lobelia grayana* (NCN), *Melicope molokaiensis* (alani), *Myrsine lessertiana* (kolea lau nui), *Peperomia* sp. (ala ala wai nui), *Phyllostegia ambigua* (NCN), *Platydesma spathulata* (pilo kea), *Psychotria* sp. (kopiko), *Pteris cretica* (oali), *Rubus hawaiiensis* (akala), *Streblus pendulinus* (aiai), *Syzygium sandwicense* (ohia ha), and *Wikstroemia oahuensis* (akia) (Perlman 2009; Wood 2009).

At Lihau, West Maui, the habitat is *Metrosideros polymorpha* montane wet forest with associated native species including *Athyrium microphyllum* (akolea), *Broussaisia arguta* (kanawao), *Clermontia arborescens* (oha wai nui), *C. micrantha* (oha wai), *Coprosma* sp. (pilo), *Cyrtandra grayi* (keokeo haiwale), *Diplazium sandwichianum* (pohole), *Ilex anomala* (kawau), *Myrsine lessertiana*, *Peperomia* sp., *Phyllostegia stachyoides* (NCN), *Psychotria* sp., and *Vaccinium* sp. (ohelo) (National Tropical Botanical Garden 2009b; Perlman 2009).

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:

On East Maui, threats include feral pigs (*Sus scrofa*), Axis deer (*Axis axis*), and goats (*Capra hircus*), which degrade the habitat (Perlman 2009; Wood 2009). Invasive introduced plants such as *Clidemia hirta* (Koster's curse), *Holcus lanatus* (common velvet grass), *Miconia calvescens* (miconia), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (blackberry), *Rubus rosifolius* (thimbleberry), and *Sphaeropteris cooperi* (Australian tree fern) degrade the habitat and invade openings created by disturbance, thus crowding out areas which might otherwise recruit and support native species

like *Huperzia mannii* (Medeiros *et al.* 1996; Perlman 2009; USFWS 1997). Invasive introduced plants are also a threat on West Maui (Perlman 2009).

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

Not a threat.

2.3.2.3 Disease or predation:

Rats (*Rattus* spp.), deer, goats, and slugs (unidentified species) are reported to consume the leaves and seeds of *Huperzia mannii* (Perlman 2009; Wood 2009).

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 from invasive introduced plant species previously described in Section 2.3.2.1, in addition to degrading habitat, directly compete with *Huperzia mannii* for light, nutrients, and water.

Climate change may also 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.

In 2004, Haleakala National Park nursery reported having nine individuals from a single Cable Ridge founder plant (Haleakala National Park 2008). A detailed methodology for the recovery of critically endangered plant species at Haleakala National Park has been developed, and includes a model for working with *Huperzia mannii* both within and outside the National Park (Haleakala National Park Resource Management 2006).

The National Tropical Botanical Garden has spores in storage

from collections at Lihau on Maui, and Laupahoehoe Natural Area Reserve on Hawaii Island (most likely *Huperzia stemmermanniae*) in 1991 (National Tropical Botanical Garden 2009a). In 2004, Haleakala National Park made collections of 49 divisions of *H. mannii* and reintroduced 41 individuals in Kipahulu Valley between 975 and 1,158 meters (3,200 and 3,800 feet) elevation (Haleakala National Park Resource Management 2004).

Two other Hawaiian *Huperzia* species have been successfully tissue cultured by Lyon Arboretum on Oahu (Harold L. Lyon Arboretum Micropropagation Laboratory 2009).

A fence measuring 1,340 meters (4,400 feet) by 760 meters (2,500 feet) on the widest side, designed to protect the forest from damage caused by feral pigs and goats, was completed at Cable Ridge on Maui in October of 2010. One-way gates were installed and it is believed that the fenced area is free of feral ungulates (F. Jacob, pers. comm. 2010).

The Manawainui population was fenced in 1990 (USFWS 1997) but it is unknown whether the fence is still effective against feral ungulates.

2.4 Synthesis

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Maui plant cluster (USFWS 1997), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Huperzia mannii* 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 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.

The interim stabilization goals for this species have not been met. Only one of the three populations observed since 2003 has as many as 50 mature individuals (Table 1), and all threats are not being managed (Table 2). Therefore, *Huperzia mannii* meets the definition of endangered as it remains in danger of extinction throughout its range.

Table 1. Status of *Huperzia mannii* from listing through 5-year review.

Date	No. wild indivs	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1992 (listing)	35	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1997 (recovery plan)	<300	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	22	Unknown	All threats managed in all 3 populations	Unknown
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2010 (5-year review)	61-71	41	All threats managed in all 3 populations	Partially (Table 2)
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No: only 1 out of 3 populations with 50 mature individuals

Table 2. Threats to *Huperzia mannii*.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – habitat modification and herbivory	A, C, D	Ongoing	Partially: areas fenced but not all ungulates removed
Rats – herbivory	C	Ongoing	No
Slugs – herbivory	C	Ongoing	No
Invasive introduced plants	A, E	Ongoing	Partially: weed control at Cable Ridge, but not throughout all three populations
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

- Survey historical locations and additional potentially suitable habitat to determine the current status of the species.
- Collect material for genetic storage and propagation for reintroduction.
- Work with Hawaii Division of Forestry and Wildlife, Hawaii State Parks, and National Park Service to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Continue reintroducing individuals into protected suitable habitat within historical range.
- Develop and implement methods to control slugs.
- Control rats in the vicinity of these populations.
- Continue to maintain or construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates.
- Control introduced invasive plant species around all known populations.
- 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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- [USFWS] U.S. Fish and Wildlife Service. 1997. Recovery plan for the Maui plant cluster (Hawaii). U.S. Fish and Wildlife Service, Portland, Oregon. 130 pages. Available online at <http://www.fws.gov/pacificislands/recoveryplans.html>.
- [USFWS] U.S. Fish and Wildlife Service. 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.
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- Wood, K.R. 2009. Notes on *Huperzia mannii*. National Tropical Botanical Garden, Kalaheo, Hawaii. One page. Unpublished.

Personal Communications:

Jacob, Farley. 2010. Kipahulu Ohana, Kahului, Hawaii. E-mail to Tamara Sherrill, Biological consultant, dated October 25, 2010. Subject: *Huperzia mannii* and Cable Ridge fence in Kipahulu.

Perlman, Steve. 2009. Botanist, National Tropical Botanical Garden, Kalaheo, Hawaii. E-mail message to Margaret A. Clark, National Tropical Botanical Garden, dated September 30, 2009. Subject: *Huperzia mannii* at Laupahoehoe

Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Huperzia mannii* (wawae'iole)

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

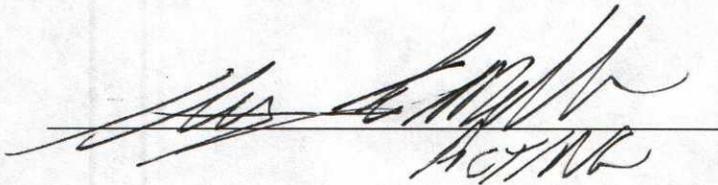
Recommendation resulting from the 5-year review:

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

Review Conducted By:

Chelsie Javar, Fish and Wildlife Biologist
Marie Bruegmann, Plant Recovery Coordinator
Jess Newton, Recovery Program Lead
Assistant Field Supervisor for Endangered Species

Field Supervisor, Pacific Islands Fish and Wildlife Office



Date 5/11