

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Phlegmariurus* (= *Huperzia*) *nutans* (wawae`iole)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 58 species in Washington, Oregon, California, and Hawaii. Federal Register 75(226):71726-71729.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

Name of Reviewer(s):

Vickie Caraway, Plant Biologist, PIFWO

Daniel Clark, Oahu, Kauai, Northwest Hawaiian and American Samoa Islands Team
Manager, PIFWO

Marie Brueggemann, Plant Recovery Coordinator, PIFWO
Recovery Program Lead, PIFWO

Kristi Young, Programmatic Deputy Field Supervisor, PIFWO

Methodology used to complete this 5-year 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 January 31, 2012. The review was based on a review of current, available information since the last five-year review for *Phlegmariurus* (= *Huperzia*) *nutans* (USFWS 2009). The National Tropical Botanical Garden provided an initial draft of portions of the five-year review and recommendations for conservation actions needed prior to the next five-year review. The document was reviewed by the Plant Biologist, Islands Team Manager, and Plant Recovery Coordinator, followed by the Recovery Program Lead. It was subsequently reviewed and approved by the Programmatic Deputy Field Supervisor.

Background:

For information regarding the species' listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (http://ecos.fws.gov/tess_public).

Review Analysis:

Please refer to the previous 5-year review for *Phlegmariurus* (= *Huperzia*) *nutans* published on July 21, 2009 (available at http://ecos.fws.gov/docs/five_year_review/doc2444.pdf) for a complete review of the species' status, threats, and management efforts. No significant new information regarding the species' biological status has come to light since listing to warrant a change in the Federal listing status of *Phlegmariurus* (= *Huperzia*) *nutans*.

This short-lived club moss is endangered and occurs only in the Koolau Mountains on Oahu. Historically, *Phlegmariurus* (= *Huperzia*) *nutans* was also found in the Wahiawa Mountains of Kauai (Palmer 2003). The current status and trends for the species are provided in the tables below.

New taxonomic information:

No new taxonomic information has been received since the last 5-year review (USFWS 2009). However, the 2012 supplement to the *Manual of the Flowering Plants of Hawaii* (Wagner *et al.* 2012) reiterates the change from the genus *Phlegmariurus* to the currently accepted *Huperzia*. In 2012, USFWS revised the taxonomic status for this species when it revised critical habitat on Oahu, with no change in range or distribution (USFWS 2012). This species is now listed as *Huperzia nutans* and addressed as such for the remainder of this review.

New status information:

- The most recent surveys report five small, fragmented populations containing a combined total of 11 individuals on Oahu: five mature individuals at North Kahana and North Kaukonahua, three mature and two immature individuals in Koloa Gulch and Kaipapau; one mature individual in South Kaukonahua (Oahu Army Natural Resources Program [OANRP] 2012).
- There are no known extant individuals on Kauai.

New threats:

- Climate change - 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) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013.

New management actions:

- Ungulate exclosures – OANRP staff had plans to fence populations of *Huperzia nutans* within the Kawailoa Training Area and Schofield Barracks East Range in Koloa and North and South Kaukonahua (U.S. Army 2007), but this hasn't been possible through 2011 (U.S. Army Garrison 2011).
- Captive propagation for genetic storage and reintroduction
 - Due to the low number of extant individuals and the risk of removing material from the known plants, propagation tests were conducted on the more common species, *Huperzia phyllanthus* (U.S. Army Garrison 2009).
 - Cuttings of *Huperzia phyllanthus* were successfully established in the greenhouse in 2009 (U.S. Army Garrison 2009).
 - Strobili (spore-bearing cones) collections of *Huperzia phyllanthus* were made for Harold L. Lyon Arboretum to test micropropagation; no germination has occurred to date (U.S. Army Garrison 2008, 2010).
- Population viability monitoring – OANRP staff has not detected any clear trends in population sizes due to the difficulty of detecting individual plants, sparse distribution

of individuals over rough terrain with thick vegetation, and one or two individual plants found per location. Also, all known plants have been found within the last 15 years (U.S. Army Garrison 2009).

Synthesis

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for plants from the island of Oahu (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Huperzia nutans* 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 island of Oahu and, if possible, at least one other island (Kauai) 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.

The stabilization goals for this species have not been met (see Table 1). No wild population contains 50 mature individuals and the majority of populations contain only one or two individuals, and none of the threats have been sufficiently managed (Table 2). Therefore, *Huperzia nutans* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Captive propagation for genetic storage and reintroduction
 - Continue to collect spores and track maternal sources for use in *ex situ* propagation.
 - Continue developing propagation techniques. Send spores to different facilities to assist in development of these techniques.
- Reintroduction / translocation– Reintroduce the species into its known historical range once propagation methods are developed.
- Ungulate exclosures
 - Implement planned construction of fenced exclosures to provide protection from feral ungulates.
 - Monitor fenced exclosures for evidence of breaching by feral ungulates.
- Surveys / inventories – Continue to conduct thorough surveys of all suitable historical habitat.
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species.
- Population viability research - Study *Huperzia nutans* populations with regard to population size and structure, geographical distribution, reproductive cycles, longevity, specific environmental requirements, mycorrhizal (fungal) associations, limiting factors, and threats.

Table 1. Status and trends of *Huperzia nutans* from listing through current 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	<50	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1996 (recovery plan)	4	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1998 (recovery plan)	4	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Partially
2003 (critical habitat)	7	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2009 (5-yr review)	11	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2013 (5-yr review)	11	0	All threats managed in all 3 populations	No (Table 2)
			Complete genetic storage	No

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
			3 populations with 50 mature individuals each	No

Table 2. Status of threats to *Huperzia nutans* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – pigs habitat modification and herbivory	A, C, D	Ongoing	None
Military activity – possibility of fire and habitat modification	A, E	Ongoing	Unknown
Invasive introduced plants	A, E	Ongoing	Unknown
Stochastic events	A, E	Ongoing	None
Climate change	A, E	Increasing	None

References:

See previous 5-year review for a full list of references (USFWS 2009). Only references for new information are provided below.

[OANRP] Oahu Army Environmental Program. 2012. Oahu implementation plan - population unit status. 1 page. Unpublished.

Palmer, D. 2003. Hawaii’s ferns and fern allies. University of Hawaii Press, Honolulu. 323 pages.

U.S. Army Garrison. 2007. 2007 Status reports for the Makua implementation plan and the draft Oahu implementation plan. U.S. Army Garrison, Hawaii and Pacific Cooperative Park Studies Unit. Schofield Barracks, Hawaii. 719 pages. Available online at http://manoa.hawaii.edu/hpicesu/DPW/2007_YER/YER_2007_edited.pdf.

U.S. Army Garrison. 2008. Final implementation plan for Oahu training areas: Schofield Barracks Military Reservation, Schofield Barracks East Range, Kawaihoa Training Area, Kahuku Training Area, and Dillingham Military Reservation. Hawaii. 624 pages. Available online at http://manoa.hawaii.edu/hpicesu/DPW/2008_OIP/2008_OIP_edited.pdf.

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- [USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; endangered status for 23 species on Oahu and designation of critical habitat for 124 species; final rule. Federal Register 77:57648-57862.
- Wagner, W.L., D.H. Herbst, N. Khan, and T. Flynn. 2012. Hawaiian vascular plant updates: a supplement to the manual of the flowering plants of Hawaii and Hawaii's ferns and fern allies, version 1.3. Available online at
<http://botany.si.edu/pacificislandbiodiversity/hawaiianflora/Hawaiian_vascular_plant_updates_1.3.pdf>. Accessed August 21, 2012.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Huperzia nutans* (wawaeiole)

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

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