

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. 2007. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 71 species in Oregon, Hawaii, Commonwealth of the Northern Mariana Islands, and Territory of Guam. Federal Register 72(45):10547-10550.

Lead Region/Field Office:

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

Name of Reviewer(s):

Christian Torres-Santana, Student Trainee Biologist

Marie Brueggemann, Plant Recovery Coordinator

Marilet A. Zablan, Recovery Program Leader and acting Assistant Field Supervisor for Endangered Species

Gina Shultz, Deputy Field Supervisor

Methodology used to complete this 5-year review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office (PIFWO) of the U.S. Fish and Wildlife Service (USFWS) beginning on March 8, 2007. The review was based on the final critical habitat designation for *Phlegmariurus* (= *Huperzia*) *nutans* or *Lycopodium nutans* [see taxonomy discussion below] and other species from the island of Kauai and Oahu (USFWS 2003a, b), as well as a review of current, available information. The Bernice P. Bishop Museum provided an initial draft of portions of the 5-year review. The evaluation of the status of the species was prepared by our lead PIFWO biologist and reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and acting Assistant Field Supervisor for Endangered Species, and Deputy Field Supervisor, before submission to the Field Supervisor for approval.

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).

Application of the 1996 Distinct Population Segment (DPS) Policy:

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designation for *Lycopodium nutans* published in the Federal Register on February 27, and June 17, 2003 (USFWS 2003a, b) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats and no significant new information regarding the species biological status have come to light since listing to warrant a change in the Federal listing status of *L. nutans* or *Huperzia nutans*.

Lycopodium nutans or *Huperzia nutans* is an erect or pendulous herbaceous epiphytic or terrestrial fern ally historically known from Kauai and scattered locations in the Koolau Mountains of Oahu, bounded by Kaluanui Valley to the north, Paalaa to the west, and Mount Tantalus to the south. The most recent voucher at Bernice P. Bishop Museum from Kauai was collected in August 1909 by C.N. Forbes from the Wahiawa Bog region, and the species is now presumed extirpated on Kauai. On Oahu, at the time the species was federally listed as endangered, only two populations were reported as extant, one at Kaluanui Valley, the other along the Schofield-Waikane Trail on the boundary of State (Ewa Forest Reserve) and Federal lands (Schofield Barracks Military Reservation) (USFWS 1994). At that time fewer than 50 individuals were known to exist. USFWS (1998) recorded three remaining locations totaling perhaps only four plants at Kaukonahua Ridge, Kaukonahua Gulch, and along the Schofield-Waikane Trail. The USFWS (2003b) critical habitat designation also recorded three locations but noted seven plants on Federal and State lands in Kaukonahua Gulch, Kahana, and Kaipapau Gulch following the discovery of new plants in the late 1990s (Hawaii Biodiversity and Mapping Program 2007). The most recent surveys report five small, fragmented populations totaling 11 individuals on Oahu: five at north Kaukonahua Gulch, one in Kaukonahua Gulch, two in Kahana, two in Kaipapau, and one in Koloa Gulch (USFWS 2003c, 2008). At least eight plants are on lands owned and managed by the U.S. Army in the Kawailoa Training Area and Schofield Barracks East Range (USFWS 2003c; U.S. Army 2006, 2007). There are no known extant individuals on Kauai (USFWS 2003a).

Little is known about the life history and biology of *Lycopodium nutans* or *Huperzia nutans*. Although the species has been observed fertile in May and December, the herbarium database at the National Tropical Botanical Garden (2008) and data from Hawaii Biodiversity and Mapping Program (2007) reveal that the plant was observed fertile in January, March, August, and October as well.

In 1999, W.H. Wagner described a new hybrid, *Phlegmariurus x koolauensis* W.H. Wagner, intermediate between *P. nutans* (= *Huperzia nutans*) and the common *P. phyllanthus* (= *Huperzia phyllantha*). The hybrid subtly combines the characters of the two parent species (Wagner *et al.* 1999), and requires careful consideration by field botanists in distinguishing the endangered taxon. *Lycopodium nutans* has undergone several name changes. Originally described as *Lycopodium nutans* in 1854, this species name was used when the species was federally listed as endangered (USFWS 1994). More recently, the species was transferred to *Phlegmariurus nutans*, as used in the USFWS recovery plan and critical habitat designations (USFWS 1996, 1998, 2003a, b).

Palmer (2003) uses the currently accepted name, *Huperzia nutans*, which will be used throughout the remainder of this review.

The primary threats to *Huperzia nutans* on Oahu are habitat degradation by feral pigs (*Sus scrofa*) (Factors A and D), and competition from invasive introduced plant species such as *Clidemia hirta* (Koster's curse), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), *Paspalum conjugatum* (buffalo grass), and *Sacciolepis indica* (Glenwood grass) (Factor E) (USFWS 1994, 1996, 1998, 2003a, b, c; Hawaii Biodiversity and Mapping Program 2007). However, habitat for the eight plants on U.S. Army lands is primarily native and invasive introduced plants are not considered a significant threat at this time (U.S. Army 2007). Eight of the extant individuals of *Huperzia nutans* occur on military lands, including six within action areas where active combat training takes place in Kahana/North Kaukonahua, Kawainui-Koloa summit ridge, and South Kaukonahua (Factor E) (U.S. Army 2006, 2007) and are exposed to threats from trampling by foot traffic and fires caused by military activities (Factor E) (USFWS 2003c). Two other plants in Kaipapau are outside the action area and are being managed to collect material for genetic storage. All these populations are currently being managed by the U.S. Army (U.S. Army 2006, 2007).

In addition to all of the other threats, species like *Huperzia nutans* that are currently known from small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, flooding, fire, reduced reproductive vigor, fragmented distribution, and disease outbreaks (Factor E) When considered on their own, the natural processes associated with being now a single island endemic do not affect *H. nutans* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss from human activities or predation by introduced species (Factor E) (USFWS 1998).

Because the species is often epiphytic and has wind-blown spores with limited opportunity for germination and growth, large intact areas of land are required to support a viable population. The U.S. Army has plans to fence, where feasible, populations of *H. nutans* within the Kawaihoa Training Area and Schofield Barracks East Range in Koloa and North and South Kaukonahua (U.S. Army 2007), and to monitor and control feral pigs and invasive introduce invasive plants species within these exclosures (USFWS 2003c).

There are no recent records of propagation success with this species. USFWS (1998) reported that propagation attempts at the National Tropical Botanical Garden were unsuccessful. Because there are so few known wild individuals of *Huperzia nutans*, U.S. Army Natural Resources staff have made it a priority to develop successful propagation techniques for this critically endangered species, and have been experimenting with the closely related but much more common *Huperzia phyllantha* (U.S. Army 2006, 2007). Initial propagation trials using cuttings of the closely related *H. phyllantha* have proven

useful, with those laid flat across a perlite/vermiculite medium or vertically with the cut end inserted into the medium developing roots, new vegetative growth, and immature strobili (spike or cone containing fertile leaves with sporangia) (U.S. Army 2007). Plans are to continue experimenting with propagation techniques using *H. phyllantha*. The experimental techniques include tissue and spore culture, as well as air layering, with assistance from Harold L. Lyon Arboretum and University of Hawaii Department of Horticulture staff. Propagation from spores is made difficult by the fact that the spores are subterranean, non-photosynthetic, and require a mycorrhizal (fungal) association. An attempt by U. S. Army Natural Resources Staff to tissue culture wild-collected material proved unsuccessful (U.S. Army 2006).

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 and recovery goals for this species have not been met as there are only 11 individuals, no spores or plants in collection, and none the threats have been managed (see Table 1). Therefore, *Huperzia nutans* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range.
- Develop adequate propagation techniques.
- Construct enclosure fences to protect individuals from the negative impacts of feral pigs, and eradicate introduced invasive plant species within the enclosures.
- Enhance current natural populations to increase numbers of individuals.
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Survey geographical and historical range for a thorough current assessment of the species.
- Assess genetic variability within extant and *ex situ* populations.

- Study *Huperzia nutans* populations with regard to population size and structure, geographical distribution, reproductive cycles, longevity, specific environmental requirements, limiting factors, and threats.
- Study the reproductive cycle and mycorrhizal (fungal) association for a better understanding of natural recruitment.
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.

References:

Hawaii Biodiversity and Mapping Program. 2007. Program Database. University of Hawaii at Manoa, Honolulu, Hawaii. Unpublished.

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- [USFWS] U.S. Fish and Wildlife Service. 2003c. Biological opinion of the U.S. Fish and Wildlife Service for routine military training and transformation of the 2nd Brigade 25th Infantry Division (Light), U.S. Army installations, island of Oahu. 351 pages. Unpublished.
- [USFWS] U.S. Fish and Wildlife Service. 2008. Rare plant tracking database. Pacific Islands Fish and Wildlife Office, Honolulu, HI. Accessed on April 28, 2008. Unpublished.
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Table 1. Status of *Phlegmariurus* (= *Huperzia*) *nutans* (Wawae`iole) from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	< 50	0	All threats managed in all 3 populations	No
			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	No
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
2008 (5-year review)	11	0	All threats managed	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No

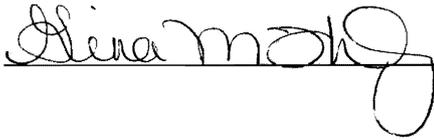
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SIGNATURE PAGE for 5-YEAR REVIEW of *Phlegmariurus* (= *Huperzia*) *nutans*
(Wawae`iole)

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

Acting Field Supervisor, Pacific Islands Fish and Wildlife Office



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