

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Diellia erecta* (Asplenium-leaved diellia)

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):

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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 Bernice P. Bishop Museum provided most of the updated information on the current status of *Diellia erecta*. They also provided recommendations for conservation actions needed prior to the next five-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 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 *Diellia erecta* published in the Federal Register on January 9, February 27, March 18, May 14, June 17, and July 2 of 2003 (USFWS 2003a, b, c, d, e, f) 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 *D. erecta*.

Historically, *Diellia erecta* was known from the Kokee area on Kauai; the Koolau Mountains on Oahu; Pukoo, Pelekunu Valley, and Kaunakakai Gulch on Molokai; Mahana Valley and Hauola Gulch on Lanai; scattered locations on Maui; and various locations on the island of Hawaii. At the time of Federal listing, however, *D. erecta* was known only from 13 populations totaling about 63 individuals on Molokai, Maui, and Hawaii (USFWS 1994).

In 2005, *Diellia erecta* was reported from Hawaii Loa, Oahu (55 individuals), Puu Kolekole, Molokai (25 individuals), Hanaulaiki, Maui (six), and Manuka, Hawaii (155 individuals) (Aguraiuja 2005; Wood 2005). *Diellia erecta* form (f.) *alexandri* is known from Kawai Iki, Kauai (43 individuals), and Polipoli, Maui (one mature healthy individual prior to a fire in 2007) (Aguraiuja 2005; Perlman 2006). The Kawai Iki population was noted to be over-represented by mature individuals, with an under-representation of immature and sporeling (young plants produced from spores) individuals (Aguraiuja 2005). Population numbers are declining with time, and in the case of *D. erecta* f. *alexandri*, are probably near extinction (Aguraiuja *et al.* 2004). The Molokai population is now considered *D. erecta* f. *alexandri* (Plant Extinction Prevention Program 2007). The taxon has not been seen on Lanai since 1929 (USFWS 2003a).

In 2008, fewer than 100 wild individuals were known (USFWS 2008). The following are the only recent monitoring surveys. Hawaii Loa, the remaining Oahu population, consists of only four mature and 10 immature individuals (Plant Extinction Prevention Program 2008). The Puu Kolekole, Molokai population has not been relocated (H. Oppenheimer, Maui Nui Coordinator, Plant Extinction Prevention Program, pers. comm. 2008). *Diellia erecta* f. *erecta* at Hanaula Iki, Maui has declined to five individuals (Plant Extinction Prevention Program 2007, 2008; H. Oppenheimer, pers. comm. 2008), and *D. erecta* f. *alexandri* at Kawai Iki, Kauai totals 39 individuals (USFWS 2008). The one plant at Polipoli, Maui (Kula Forest Reserve) is struggling to recover after a large fire in early 2007 (H. Oppenheimer, pers. comm. 2008). The exact number of plants in the Manuka population on the island of Hawaii is not currently known, but has declined since 2005 (USFWS 2008).

Populations are localized and small, mostly remotely located, and are within highly fragmented native communities. The single individual of *D. erecta* f. *alexandri* in Polipoli occurs within a very small and isolated patch of native vegetation (Aguraiuja 2005).

At the time of Federal listing, *Diellia erecta* was considered to be a species with no subspecific taxa (USFWS 1994). The species has since been divided into three forms (f.): f. *alexandri*, from Kauai, Molokai, and Maui; f. *erecta*, found on all the major Hawaiian Islands; and f. *pumila* formerly recorded from Kauai, Oahu, Lanai, Maui and Hawaii, but now known only from a single population on Hawaii (Palmer 2003). *Diellia erecta* is the most variable species of the genus, and the separation of individual specimens into forms is still somewhat arbitrary (Aguraujuja *et al.* 2004). *Diellia erecta* f. *alexandri* is morphologically the easiest of the three forms to distinguish (Aguraujuja *et al.* 2004), and a molecular analysis approach is needed to better understand the taxonomy of the species.

Diellia species have short, creeping non-branching rhizomes and a clump of two to five fronds (six to seven for *D. erecta* f. *alexandri*) (Aguraujuja 2005). Active growth occurs during the rainy season, from November to May. Frond longevity is up to 18 months, and the number of fronds is dependent on habitat conditions. Spore producing fronds are found year-round with optimal growing conditions, with maximal spore release occurring after the wet season. The germination of gametophytes and sporelings occurs from December to April. Limiting factors for sporeling survival are erosion, the blanketing effect of litter or rain wash during the wet season, and reduced soil moisture during the dry season. Gametophyte ecology needs further study (Aguraujuja 2005).

The main threats to *Diellia erecta* remain habitat degradation by feral ungulates which vary by island [pigs (*Sus scrofa*), goats (*Capra hircus*), mouflon sheep (*Ovis* spp.), cattle (*Bos taurus*), and axis deer (*Axis axis*)] (Factors A and D); competition with invasive introduced plant species (Factor E); stochastic extinction due to the small number of existing individuals (Factor E); reduced reproductive vigor (Factor E); and drought conditions (Factor E) (USFWS 1994, 1999, 2002, 2003a, b, c, d, e, f, 2008; Aguraujuja *et al.* 2004; Aguraujuja 2005; Wood 2005; Plant Extinction Prevention Program 2007, 2008).

On Kauai, *Diellia erecta* f. *alexandri* is threatened with habitat degradation by feral pigs and goats (Factors A and D) and competition with introduced invasive plant species such as *Blechnum occidentale* (hammock fern), *Cyperus meyenianus* (Meyen's flatsedge), *Gravillea robusta* (silk oak), *Lantana camara* (lantana), *Morella faya* (firetree), *Passiflora tarminiana* (banana poka), *Rubus argutus* (blackberry) and/or *Setaria palmifolia* (palmgrass) (Factor E) (USFWS 2003b). Habitat disturbance by feral pigs has been noted to affect the population at Kawai Iki (Aguraujuja 2005). On Oahu, the main threats are habitat degradation by feral pigs (Factors A and D), competition with invasive introduced species such as *Blechnum appendiculatum*, *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Oplismenus hirtellus* (basketgrass), *Phymatosorus grossus* (maile scented fern), *Psidium cattleianum* (strawberry guava), *Schinus terebinthifolius* (Christmas berry) and *Schefflera actinophylla* (octopous tree) (Factor E) (USFWS 2003e). On Molokai, threats include habitat degradation by feral pigs, goats, and axis deer; and competition with invasive introduced plant species such as *Blechnum occidentale*, *Fraxinus uhdei* (tropical ash), *Lantana camara*, *Melinis minutiflora* (Molasses grass), *Psidium cattleianum*, and *Ricinus communis* (castorbean) (Factor E)

(USFWS 1994, 1999, 2003c). Habitat at Puu Kolekole, Molokai has been reduced due to trampling and browsing by goats (Factors A, C, and D) (Agurauja 2005).

On Lanai, the taxon was last seen in 1929, but its habitat remains threatened by axis deer, mouflon sheep (Factors A and D), and invasive introduced plant species (Factor E) (USFWS 2003a). On Maui, the taxon is threatened by habitat degradation caused by feral pigs, goats and cattle (Factors A and D); and competition with introduced invasive plant species *Blechnum occidentale*, *Lantana camara*, *Erigeron karvinskianus* (daisy fleabane), *Adiantum hispidulum* (Australian maidenhair), *Ageratina adenophora* (Maui pamakani), *A. riparia* (Hamakua pamakani), *Oplismenus hirtellus*, and *Rubus niveus* (Hill raspberry), and *R. rosifolius* (thimbleberry) (Factor E) (USFWS 1994, 1999, 2003d; Plant Extinction Prevention Program 2008). On Hawaii, the main threats include habitat degradation by pigs, goats, and cattle (Factors A and D); and competition with invasive introduced species *Blechnum occidentale* (Factor E) (USFWS 1994, 1999, 2002).

The life-span of fronds is reduced by the activities of introduced insects (*Heliothrips haemorrhoidalis*) (Factor C) (Agurauja 2005). Drought and erosion impacts the growth and survival of the mature *Diellia erecta* individuals (Factor E). Competition of gametophytes and sporelings of *D. erecta* f. *alexandri* with other fern species may be reducing the survival of the taxon (Factor E) (Agurauja 2005). We now consider fire to be a threat (Factor E) for this taxon as the one plant at Polipoli (Kula Forest Reserve) was adversely affected by a large fire in early 2007. The fire did not directly affect the plant, but it had been singed from the intense heat of the adjacent introduced trees burning (Plant Extinction Prevention Program 2007; H. Oppenheimer, pers. comm. 2008).

Diellia erecta is poorly represented in *ex situ* (off-site) collections. The National Tropical Botanical Garden (2008) has spores in storage, but the representation of different populations is unclear. The Harold L. Lyon Arboretum (2007) on Oahu has 16 individuals in micropropagation. Fertile fronds have been collected by the Plant Extinction Prevention Program field botanist and stored at Harold L. Lyon Arboretum (Plant Extinction Prevention Program 2007). The Pahole Rare Plant Facility on Oahu also has four seedlings in genetic storage (Plant Extinction Prevention Program 2007). The Hawaii Division of Forest and Wildlife recently installed fencing to prevent pig, goat, and axis deer ingress at the Polipoli, Maui site. The invasive introduced plant species *Rubus niveus* invaded the burned area after the fire, and is currently being controlled by the Hawaii Division of Forestry and Wildlife (H. Oppenheimer, pers. comm. 2008).

In 2007, a new population was established as part of a USFWS Landowners Incentive Program grant in Kupaua Valley, Oahu (Plant Extinction Prevention Program 2008). Four mature individuals were outplanted, and most recent observations indicate two individuals are in good health, producing fertile fronds, and the other two remain in moderate condition.

Stabilizing, downlisting, and delisting objectives are provided in the Recovery Plan for Multi-Island Plants (USFWS 1999), based on whether the species is an annual, a short-

lived perennial (fewer than ten years), or a long-lived perennial. *Diellia erecta* 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 stabilization goals for this species have not been met as only one population may have more than 50 mature wild individuals and not all threats have been managed (see Table 1). Therefore, *Diellia erecta* 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. This should include all known forms.
- Construct enclosure fences to protect individuals from the negative impacts of feral pigs, goats, axis deer, mouflon sheep, and cattle; and eradicate introduced invasive plant species within the enclosures.
- Enhance current natural populations to increase numbers of individuals.
- Establish populations in protected habitat within historical range.
- Survey the geographical and historical range of *Diellia erecta* for additional populations.
- Research into breeding system of species and determination of genetic diversity within and between taxonomic forms.
- Genetic study to determine taxonomic status of the three forms.

References:

- Agurauja, R. 2005. Hawaiian endemic fern lineage *Diellia* (Aspleniaceae): distribution, population structure and ecology. *Dissertationes Biologicae Universitatis Tartuensis* 112, Tartu University Press, Estonia. 106 pages.
- Agurauja, R., M. Moora, and M. Zobel. 2004. Population stage structure of Hawaiian endemic fern taxa of *Diellia* (Aspleniaceae): implications for monitoring and regional dynamics. *Canadian Journal of Botany* 82:1438-1445.

- Harold L. Lyon Arboretum Micropropagation Laboratory. 2007. Micropropagation database. University of Hawaii at Manoa. Unpublished.
- National Tropical Botanical Garden. 2007. 2007 Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. Unpublished.
- National Tropical Botanical Garden. 2008. 2008 Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. Unpublished.
- Palmer, D.D. 2003. Hawaii's fern and fern allies. University of Hawaii Press, Honolulu, Hawaii. 324 pages.
- Perlman, S. 2006. Plant Extinction Prevention status of Kauai species. August 28, 2006. Unpublished.
- Plant Extinction Prevention Program. 2007. Annual performance report (July 1, 2006 to June 30, 2007), Plant Extinction Prevention (PEP) program for Oahu, Maui Nui, Hawaii. Unpublished.
- Plant Extinction Prevention Program. 2008. Section 6 annual performance report for endangered plant restoration and enhancement - Plant Extinction Prevention (formerly Genetic Safety Net), Fiscal Year 2008 (July 1, 2007 – June 30, 2008). Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife. 113 pages. Unpublished.
- [USFWS] U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants endangered status for 12 plants from the Hawaiian Islands; final rule. Federal Register **59**(217):56333-56351.
- [USFWS] U.S. Fish and Wildlife Service. 1999. Recovery plan for the multi-island plants. U.S. Fish and Wildlife Service, Portland. 206 pages + appendices.
- [USFWS] U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; designation of critical habitat for plant species from the island of Hawaii, Hawaii; proposed rule. Federal Register 67(102):36968-37106.
- [USFWS] U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; final designation of critical habitat for three plant species from the island of Lanai, Hawaii; final rule. Federal Register 68(6):1220-1274.
- [USFWS] U.S. Fish and Wildlife Service. 2003b. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 95 plant species from the islands of Kauai and Niihau, HI; final rule. Federal Register 68(39):9116-9479.

[USFWS] U.S. Fish and Wildlife Service. 2003c. Endangered and threatened wildlife and plants; final designations and nondesignations of critical habitat for 42 plant species from the island of Molokai, Hawaii; final rule. Federal Register 68(52):12982-13141.

[USFWS] U.S. Fish and Wildlife Service. 2003d. Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the Islands of Maui and Kahoolawe, HI; final rule. Federal Register 68(93):25934-26165.

[USFWS] U.S. Fish and Wildlife Service. 2003e. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 101 plant species from the island of Oahu, HI; final rule. Federal Register 68(116):35949-35998.

[USFWS] U.S. Fish and Wildlife Service. 2003f. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii, HI; final rule. Federal Register 68(127):39624-39761.

[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.

Wood, K.R. 2005. Phytogeographical data and personal observations, Genetic Safety Net taxa (GSN), Maui Nui, Hawaiian Islands. Unpublished.

Personal communication:

Oppenheimer, Hank. 2008. Maui Nui Coordinator, Plant Extinction Prevention Program. Email communication to Bernice P. Bishop Museum in June 2008.

Table 1. Status of *Diellia erecta* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	63	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1999 (recovery plan)	34-36	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	119	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2008 (5-year review)	~ 100	4	All threats managed	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No


U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Diellia erecta*

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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Date 4/2/09