5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Diplazium molokaiense* (no common name)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 70 species in Idaho, Montana, Oregon, Washington, and the Pacific Islands. Federal Register 73(83):23264-23266.

Lead Region/Field Office:

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

Name of Reviewer(s):

Marie Bruegmann, Pacific Islands Fish and Wildlife Office, Plant Recovery Coordinator
Marilet A. Zablan, Pacific Islands Fish and Wildlife Office, Assistant Field Supervisor for Endangered Species
Jeff Newman, Pacific Islands Fish and Wildlife Office, Acting 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 of the U.S. Fish and Wildlife Service (USFWS), beginning on April 29, 2008. The review was based on the final critical habitat designations for *Diplazium molokaiense* and other species from the islands of Kauai, Oahu, Maui, and Molokai, as well as a review of current, available information (USFWS 2003a, 2003b, 2003c, 2003d, and 2003e). 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 Assistant Field Supervisor for Endangered Species and Acting 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 designations for *Diplazium molokaiense* published in the Federal Register on January 9, 2003 (Lanai), February 27, 2003 (Kauai), March 18, 2003 (Molokai), May 14, 2003 (Maui), and June 17, 2003 (Oahu) (USFWS 2003a, 2003b, 2003c, 2003d, and 2003e) 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. molokaiense*.

Diplazium molokaiense was known historically on five of the main Hawaiian Islands. At the time of listing, four populations of *D. molokaiense* were known from two islands, one population on Oahu at Schofield Barracks in the Waianae Mountains and three populations on Maui on the slopes of Haleakala. The Maui populations were found on the north slope at Ainahou and Maliko Gulch and on the south slope at Waiopai Gulch (USFWS 1994). *Diplazium molokaiense* currently exists in only three populations on the island of Maui, and may no longer be extant in any of the previously observed locations (Wood 2006).

One population, discovered in 2006 by Ken R. Wood of the National Tropical Botanical Garden, is on West Maui at Puehuehu Nui, in the first drainage north of Luakoi Ridge, and has five individuals (Wood 2007). In addition, there are two populations containing less than 60 individuals on the slopes of Haleakala, East Maui. The first, in East Honomanu, was successfully relocated in April 2006, during surveys within The Nature Conservancy's Waikamoi Preserve near East Honomanu Stream. This population, which was originally discovered in 1997, has less than 20 individuals and seems to be relatively stable (Wood 2006). A second East Maui population was discovered in 1998 by Hank Oppenheimer (Wood 2006) in the Kula Forest Reserve (erroneously referred to as the Polipoli State Park population, but located just outside the park), at elevations between 1,700 and 1,737 meters (5,600 and 5,700 feet). There are 41 individuals in that population and it is currently monitored by Hank Oppenheimer, Maui and Lanai coordinator for the Plant Extinction Prevention program. This population estimate includes smaller plants that were probably overlooked in previous counts due to the lush and diverse fern overgrowth. Since much of the fern cover has died off from a recent fire, it is easier now to count plants (H. Oppenheimer, Plant Extinction Prevention Program, pers. comm. 2008; Wood 2006). This Kula Forest Reserve population is recovering well post-fire. The individuals did not burn, but were scorched from the heat and lost all their fronds, and have since produced new fronds and appear healthy (H. Oppenheimer, pers. comm. 2008). Within the last 25 years, only one other occurrence of *D. molokaiense* has been recorded; an individual from Waiopai Gulch, East Maui on Department of Hawaiian Home Lands property (USFWS 1998), which may no longer be extant (Wood 2006). There is no new information regarding genetics, genetic variation, or trends in genetic variation for this species.

Diplazium molokaiense was listed as endangered and has been recognized as a member of the Aspleniaceae (spleenwort) family (USFWS 1994, 1998, 2003 a-e). Palmer (2003) placed the genus *Diplazium* in the family Athyriaceae. *Diplazium*, *Cystopteris*, *Deparia*, and *Athyrium* compose four Hawaiian genera in the Athyriaceae, totaling 11 Hawaiian endemic species (Wood 2006).

The known spatial distribution of *Diplazium molokaiense* has changed in the last five years. There are historical records of the species on Kauai, Oahu, Lanai, and Molokai,

but it has not been noted on those islands for almost 100 years (Wood 2006). On West Maui, this species was recorded in Iao Valley in the 1800s at 427 meters (1,400 feet) and at the same elevation in 1910 around Waikapu. *Diplazium molokaiense* has been observed more recently on the slopes of Haleakala, East Maui (Palmer 2003) where W. H. Wagner, Jr., noted it in Maliko Gulch in 1947 at around 792 meters (2,600 feet). Wagner also documented it around the Ainahou region of Koolau Gap in 1965 at 1,707 meters (5,600 feet), where about 20 individuals grew under overhanging rocks and at the base of cliffs. Thereafter, *D. molokaiense* was not recorded for 20 years, until Robert Hobdy made an observation of a single plant in 1985 around the Waiopai Gulch of Kahikinui, East Maui at 1,494 meters (4,900 feet) elevation. Unfortunately, this individual and all the other previous sightings were never relocated (Wood 2006). The discovery of a new population in the last few years indicates this species may still exist at other locations. It typically grows on the walls of drainages and does not usually occur in dense undergrowth. Currently, there are three populations, totaling no more than 65 individuals.

The recent botanical surveys have also updated the descriptions of ecosystems or habitats in which *Diplazium molokaiense* occurs. The drainages of Honomanu Stream lie just to the east of Waikamoi and flow around 13 kilometers (8 miles) from its upper headwaters at 2,500 meters (8,200 feet) in north central Haleakala down to the sea. The upper regions of its eastern branch, where *D. molokaiense* occurs, are deeply carved and meandering. Botanically, the region represents one of the richer riparian habitats of northern Haleakala. In 2006, within an area of 7 hectares (17.3 acres) Wood observed 135 species of vascular plants from 49 families. Of these species, 61 were native ferns or fern allies, 51 were native dicotyledons, and 8 were native monocotyledons. Thirteen of these taxa are Maui island endemics, with only 15 introduced plant species. Wood compared this area to seven other predominantly native riparian regions of equal size on the slopes of Haleakala, and found this Honomanu site to have the highest fern diversity (Wood 2006). In the regions between 1,400 and 1,600 meters (4,600 and 5,300 feet), the walls of the East Honomanu Stream can exceed 60 meters (197 feet) in height and can be extremely difficult to traverse. The drainages are between 7 and 20 meters (23 and 66 feet) wide and have large basalt boulders strewn along the smooth river-worn basalt bottom, with some areas covered thickly in lichens. Some sections of the stream have impassably high waterfalls from 5 to 15 meters (16 to 50 feet) that plunge into deep pools surrounded by amphitheatres of fern-dominated seeping walls.

The forests above the riparian zone are *Metrosideros polymorpha* (ohia) montane wet forest with a 50 to 70 percent closed canopy of 15 meters (50 feet) height, with an understory dominated by *Cheirodendron trigynum* (olapa), *Broussaisia arguta* (kanawao), *Ilex anomala* (kawau), *Myrsine lessertiana* (kolea lau nui), *Melicope clusiifolia* (alani), *Kadua affinis* (manono), *Kadua axillaris* (no common name [NCN]), *Coprosma ochracea* (pilo), *C. montana* (pilo), and *C. foliosa* (pilo). Dominant native shrubs include *Vaccinium calycinum* (ohelo), *V. dentatum* (ohelo), *Styphelia tameiameiae* (pukiawe), and *Rubus hawaiensis* (akala). Common native herbs are *Astelia menziesiana* (kaluaha), *Nertera granadensis* (makole), several *Peperomia* (ala ala wai nui) species including *P. cookiana*, *P. membranacea*, *P. macraeana*, and the small terrestrial *Pilea*

peploides. Native sedges and grasses densely cover the understory with *Carex alligata* (NCN), *Deschampsia nubigena* (hairgrass), *Uncinia uncinata* (NCN), and *Machaerina angustifolia* (uki). Common woody climbers and vines are *Freycinetia arborea* (ie ie) and *Smilax melastomifolia* (hoi kuahiwi). Common native ferns, which can dominate the understory, include *Diplazium sandwichianum* (hoio), *Athyrium microphyllum* (akolea), *Adenophorus tripinnatifidus* (NCN), *Cibotium glaucum* (hapuu), *Cibotium menziesii* (hapuu), *Elaphoglossum wawrae* (hoe a Maui), *Elaphoglossum paleaceum* (makue), *Pneumatopteris sandwicensis* (hoio kula), *Asplenium hobdyi* (NCN), *Sadleria pallida* (amau), *S. cyatheoides* (amau), *S. souleyetiana* (amau), and *Marattia douglasii* (pala, mule's foot fern), with many of the species epiphytic on trees or living on rocks in association with a rich bryophyte layer over ground, trees, boulders, and basaltic walls. Below these forests and within the riparian zone where *Diplazium molokaiense* occurs, the forest canopy is around 70 percent open with occasional emergent 15 meter (50 feet) tall *Metrosideros polymorpha* trees, in addition to 8 to 10 meters (25 to 33 feet) tall *Cheirodendron trigynum*. Common shrubs and tree species along the banks of the drainage include *Rubus hawaiensis* (akala), *Coprosma ochracea*, *C. foliosa* (pilo), *Broussaisia arguta*, and a well dispersed population of *Gunnera petaloidea* (ape ape). In Honomanu, the ferns occur along the stream on a concave wall vertically carpeted in a fine light-green species of moss. This site stretches around 10 to 12 meters (33 to 39 feet) along the eastern bank of the stream. Approximately 12 healthy *D. molokaiense* individuals can be seen sparsely distributed along this cool, moist, shaded wall and growing up as high as 5 meters (16 feet) above the stream bed. In addition, three individuals are precariously situated near the high water line and are barely attached. Associated pteridophytes at this site include *Pteris cretica* (oali), *P. excelsa* (waimakanui), *Polystichum haleakalense* (kaupu), *Pneumatopteris sandwicensis* (hoio kula), *Selaginella arbuscula* (lepe lepe a moa), *Diplazium sandwichianum*, *Coniogramme pilosa* (loulu), *Dryopteris fusco-atra*, *Asplenium hobdyi*, *A. excisum* (pamoho), and *A. normale* (NCN) (Wood 2006).

Recent botanical research around Puehuehu Nui, West Maui, documented five individuals of *Diplazium molokaiense* in the first drainage north of Luakoi ridge. This region represents a mesic to wet forest and shrubland with an 80 percent forest cover associated with *Cheirodendron trigynum, Metrosideros polymorpha, Dodonaea viscosa* (aalii), *Nestegis sandwicensis* (olopua), *Coprosma foliosa, Kadua acuminata* (manono), *Cyrtandra grayi* (haiwale), rich in ferns with *Pneumatopteris sandwicensis, Selaginella, Tectaria* sp., and *Pteris excelsa*. There are two clusters, one rhizome creeping and branching with four separate plants, each plant about two by ten centimeters with about five fronds. Another plant is 10 meters (39 feet) up stream on a concave wall of three meters wide drainage about 35 to 50 centimeters (14 to 20 inches) above the gulch bottom, at a 320-degree aspect, just below a small water fall, at 1,070 meters (3,510 feet) elevation. It has a single plant on the rhizome, which is mostly fertile (Wood 2007).

Threats to the rich natural ecosystem of East Honomanu include habitat degradation and destruction by feral pigs (*Sus scrofa*) (Factor A); catastrophic extinction through environmental events, especially flash floods (Factor E); and competition with invasive introduced plant species (Factor E), including *Acacia melanoxylon* (Australian

blackwood) , *Ageratina adenophora* (sticky snakeroot), *Anthoxanthum odoratum* (sweet vernal grass), *Cerastium fontanum* subsp. *triviale* (common mouse chickweed), *Epilobium ciliatum* (willow herb), *Epilobium billardierianum* subsp. *cinereum* (willow herb), *Holcus lanatus* (common velvet grass), *Hypochoeris radicata* (hairy cat's ear), *Juncus planifolius* (bog rush), *Lapsana communis* (nipplewort), *Prunella vulgaris* (self heal), *Rubus argutus* (blackberry), and *Youngia japonica* (hawksbeard). *Cortaderia jubata* (NCN), which can be highly invasive, was first reported in the general region at 1,540 meters (5,050 feet) (Wood and Perlman 1997). Since then, in spite of removal efforts, it has spread into several adjacent regions of Haleakala's northern slopes. Invasive species do not, however, dominate the area (Wood 2006).

In the Kula Forest Reserve, *Rubus niveus* (mysore raspberry) is rampant now, though it was not at the *Diplazium molokaiense* site until after the fire. The Plant Extinction Prevention Program is controlling it both manually and chemically. They are also controlling other weeds such as *Salsola tragus* (Russian thistle), *Cardamine flexuosa* (bittercress) and *Epilobium ciliatum*. The Hawaii Division of Forestry and Wildlife has constructed barriers to deter pigs. It is not a complete exclosure, since there are many large diameter trees lying down and it would disturb the site too much to clear a fence line completely around the ferns. New trees continue to fall as they did before the fire, and will continue to do so after every Kona storm for several years since many of the large forestry trees around the site did burn and die. The downed trees do, however, block more trees from landing on most of the ferns, and may provide some needed shade, since the surrounding area has become sunnier since the fire (H. Oppenheimer, pers. comm. 2008).

Around Puehuehu Nui, West Maui, threats include competition with invasive introduced plant species (Factor E), including *Buddleia asiatica* (butterfly bush), *Psidium guajava* (guava), *Grevillea robusta* (silk oak), *Ageratina adenophora* (pamakani haole), and *Rubus rosifolius* (thimbleberry) (Wood 2007)

There is no new information regarding overutilization for commercial, recreational, scientific, or educational purposes (Factor B). There is no new information regarding disease or predation (Factor C), and no changes in the adequacy of existing regulatory mechanisms (Factor D).

Climate change may also pose a threat to *Diplazium molokaiense* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species.

In addition to all of the other threats, species like *Diplazium molokaiense* that are endemic to 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, landslides, flooding and disease outbreaks (Factor E). The effects of these processes on this single-island endemic are exacerbated by anthropogenic threats, such as

habitat loss for human development or predation by introduced species (Factor E) (USFWS 1998).

A biotic inventory of the Waikamoi Preserve is scheduled to be conducted by The Nature Conservancy of Hawaii, which will help to evaluate potential habitat for *Diplazium molokaiense* (Wood 2006). National Tropical Botanical Garden has a spore collection of *D. molokaiense* from April 2006 and is cultivating a single rhizome recovered from storm damage and flooding in Honomanu in 2006 (Wood 2006). Two individuals were rescued following the Polipoli fire (Perlman 2008). Nine individuals from spores collected at East Honomanu are in the nursery at the National Tropical Botanical Garden (2008).

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for four species of ferns (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Diplazium molokaiense* is a short-lived perennial, and to be considered stable, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on the island of Maui and at least one other island on which it was known historically. 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 (see Table 1), as the three known populations each have less than 50 individuals and all threats are not being managed. Therefore, *Diplazium molokaiense* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Continue collection and propagation of spores from all three wild populations.
- Control pigs and invasive introduced plant species around wild populations.
- Augment wild populations and reintroduce into suitable protected habitat.
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species

References:

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Wood, K. R. 2007. *Diplazium molokaiense* range rediscovery. Records of the Hawaii Biological Survey for 2006; Part 2: Notes. Bishop Museum Occasional Papers(96):14.

Personal Communications

Oppenheimer, Hank. 2008. Maui Nui Coordinator, Plant Extinction Prevention Program. E-mail to Margaret A. Clark, National Tropical Botanical Garden, dated August 18, 2008. Subject: *Diplazium molokaiense*

Table 1. Status of *Diplazium molokaiense* from listing through 5-year review.

Date	No. wild indivs.	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	23	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1998(recovery plan)	1	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	23	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)	~65	0	All threats managed	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Partially

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Diplazium molokaiense*
(no common name)

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

Field Supervisor, Pacific Islands Fish and Wildlife Service

Date AUG 2 7 2010