5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Adenophorus periens* (palai laʻāu)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Lead Region/Field Office:

Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaiʻi

Name of Reviewer:

Cheryl Phillipson Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation & Restoration Team Manager, PIFWO

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 (Service) beginning in October 2020. The review was based on a review of current, available information since the last 5-year review for *Adenophorus periens* (USFWS 2015). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

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 reviews for *Adenophorus periens* published in the Federal Register on August 27, 2010 and June 30, 2015 (available at *https://ecos.fws.gov/docs/five_year_review/doc3289.pdf* and *https://ecos.fws.gov/docs/five_year_review/doc4546.pdf*) for a complete review of the species' status, threats, management efforts, and references cited. We are not aware of any significant new information regarding the species' biological status since listing to warrant a change in the Federal listing status of *A. periens*.

This short-lived perennial fern in the Polypodiaceae family is endangered and endemic to the islands of Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Maui, and Hawaiʻi. The status and trends for *Adenophorus periens* are provided in the tables below.

New Status Information:

- In 2003, Palmer recognized three Hawaiian genera of Grammitidaceae: *Adenophorus*, *Grammitis*, and *Lellingeria*; however, *Adenophorus periens* along with three other *Adenophorus* species were separated into the subgenus *Oligadenus* as these species were not as glandular as those in the subgenus *Adenophorus*. In addition, *A. periens* was also the most distinctive of those in the subgenus *Oligadenus* (Palmer 2003, pp. 38–39). In 2019, Ranker et al. published taxonomic and nomenclatural updates to the fern and lycophyte flora of the Hawaiian Islands. *Adenophorus periens* was moved from the Grammitidaceae family to the Polypodiaceae family, also recognized in the Smithsonian's Flora of the Hawaiian Islands checklist (Ranker et al. 2019, p. 69; Smithsonian National Museum of Natural History 2021).
- In 2012, 11 critical habitat units (10,162 hectares [ha]; 25,114 acres [ac]) were designated in the lowland wet ecosystem, and three critical habitat units (2,000 ha; 4,944 ac) were designated in the wet cliff ecosystem for *Adenophorus periens* on O‘ahu (77 FR 57648, September 18, 2012). In 2016, three critical habitat units (2,068 ha, 5,110 ac) in the montane wet ecosystem were designated on Moloka‘i; five critical habitat units in the montane wet ecosystem were designated on Maui (8,556 ha, 21,142 ac), and one critical habitat unit (101 ha, 248 ac) in the montane wet ecosystem was proposed on Lāna‘i but excluded in the final rule (81 FR 17790, March 30, 2016). Critical habitat as designated on the islands of Kaua‘i and Hawai‘i in 2003 remains the same (68 FR 9116, February 27, 2003; 68 FR 39624, July 2, 2003).
- In 2021, an individual of *A. periens* was discovered at Wai‘oli, Kaua‘i, growing epiphytically on *Psychotria mariniana* (Heintzman 2021, in litt.). Spore capsules were mostly dehisced (empty), but some samples were sent to Lyon Arboretum's Micropropagation Laboratory for possible storage and propagation. Botanists plan to return soon to the area to collect fresh, mature spores. A second individual was discovered growing epiphytically on a native tree (*Polyscias oahuensis*, ‘ohe mauka) in the upper gulch of ‘Ili‘ili‘ula (Heintzman 2021, in litt.; Heintzman 2021, pers. comm.).

New Threats:

- Climate change loss or degradation of habitat—Climate change may pose a threat to this species. Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini *et al.* (2013) concluded that *Adenophorus periens* is vulnerable to the impacts of climate change, with a vulnerability score of 0.174 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

New Management Actions:

- Surveys and inventories—In 2014, Wood reported that a survey of the headwater drainage at ʻIliʻiliʻula, Kauaʻi, where *Adenophorus periens* was last observed in 1994, was conducted but did not discover any plants (Wood 2014, p. 9, and Appendix, p. 2; Plant Extinction Prevention Program [PEPP] 2015). Also, in 2014, on the island of Hawaiʻi, one plant with one living frond was found at Kahaualeʻa, and a survey was conducted at Kānenuiohamo-Nāpau (Chain of Craters) but no plants were found (PEPP 2015). In 2015 and 2018, surveys were conducted again at Kahaualeʻa, but only two dead plants were found (PEPP 2015, 2018). In a 2019 publication by Wood et al., *A. periens* was considered possibly extinct in the wild (Wood et al. 2019, p. 4); however, two plants were discovered in 2021, one at Waiʻoli, Kauaʻi, and a second individual was discovered growing epiphytically on a native tree (*Polyscias oahuensis*, ʻohe mauka) in the upper gulch of ʻIliʻiliʻula (Heintzman 2021, in litt.; Heintzman 2021, pers. comm.).
- Captive propagation for genetic storage and reintroduction—In 2014, spores were collected from the remaining live frond of the only known plant at Kahaualeʻa on the island of Hawaiʻi (PEPP 2015). Currently, there are no viable propagative materials reported in storage (Lyon Arboretum 2020; National Tropical Botanical Garden [NTBG] 2020). Botanists plan to conduct more collections when possible from the recently discovered plants on Kauaʻi (Heintzman 2021, in litt.).
- Population biology research—A statewide team comprised of members of the Hawaiʻi Rare Plant Restoration Group (i.e., IUCN Hawaiian Plant Specialist Group, Species Survival Commission) is working with local and international fern horticulturists to develop propagation methods for common *Adenophorus* species and apply the methodology for propagation of *A. periens* (PEPP 2016).

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

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	ca 63 (Kauaʻi) 3 (Molokaʻi) 1,215 (Hawaiʻi); 1,280 total	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No

1999 (recovery plan)	79–84 (Kauaʻi) 6 (Molokaʻi) 1,215–1,241 (Hawaiʻi); 1,295–1,330 total	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	0 (Lānaʻi) 59 (Kauaʻi) 7 (Molokaʻi) 0 (Maui) 0 (Oʻahu) Unknown (Hawaiʻi); 1,000+ est total	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2010 (5-year review)	20–93 (Kauaʻi) ca 30 (Hawaiʻi); 50–123 total	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2012 (critical habitat, Oʻahu)	0 (Oʻahu)	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No

2015 (5-year review)	ca 31 (Kauaʻi) Unknown (Hawaiʻi)	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2016 (critical habitat, Maui Nui)	0 (Maui, Molokaʻi, Lānaʻi)	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
Date	**No. wild individuals**	**No. outplanted**	***Preventing Extinction Criteria identified by HPPRCC**	***Preventing Extinction Criteria Completed?**
2021 (5-year review)	2 (Kauaʻi) 0 (Oʻahu, Molokaʻi, Maui, Lānaʻi, Hawaiʻi)	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			Reproduction (*i.e.* viable seeds, seedlings) at all 3 populations	No
			3 populations with 50 mature individuals each	No

* The Preventing Extinction Stage was established in 2011. Prior to 2011, the Interim Stabilization Stage was the first stage towards recovery (now it is the second stage after Preventing Extinction).

Table 2. Threats to *Adenophorus periens* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate destruction and degradation of habitat	A	Ongoing	None
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	None
Fire destruction and degradation of habitat	A	Ongoing	None
Volcanic activity (at Kahauale‘a)	E	Ongoing	None
Climate change degradation or loss of habitat	E	Ongoing	None
Reduced viability due to low numbers	E	Ongoing	Partial, spore collection if possible

Synthesis:
Currently there are two wild individuals of *Adenophorus periens* on Kaua‘i. No other extant individuals are known from O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i at this time. There has been a drastic decline in the range and number of population and individuals of this species (Table 1). A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *A. periens* is vulnerable to the effects of climate change. Spores were collected in 2014 and from an older (dehisced) frond from a recently discovered plant in 2021. Botanists plan to return to the two known plants on Kaua‘i to collect fresh spores if possible.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Multi-Island Plants (USFWS 1999) and have been updated according to the draft revised recovery objective guidelines developed by the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC 2011). The HPPRCC identifies an additional initial objective, the Preventing Extinction Stage, in addition to the Interim Stabilization, Delisting, and Downlisting objectives. Furthermore, life history traits such as breeding system, population size fluctuation or decline, and reproduction type (sexual or vegetative), have been included in the calculation of goals for the number of populations and reproducing individuals for each stage. The goals for each stage remain grouped by life span defined as annual, short-lived perennial (fewer than 10 years), or long-lived perennial.

Adenophorus periens is a short-lived perennial fern. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three

populations total should be documented on one or more islands where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable spores, gametophytes, sporophytes), with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. Two wild individuals were recently discovered on Kaua‘i, and botanists plan to collect propagative materials when available; however, none are currently in storage and no other individuals are currently known (Table 1). Not all threats are being managed (Table 2). Therefore, *Adenophorus periens* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021.

- Surveys and inventories—The historical range of *Adenophorus periens* should be surveyed intensively for new individuals, especially on Kaua‘i and Hawai‘i.
- Ungulate monitoring and control—Construct and maintain fenced exclosures to protect suitable habitat and individuals from the negative impacts of browsing by ungulates.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species at the known occurrence and at sites capable of supporting reintroductions of *A. periens*.
- Fire monitoring and control—Continue to develop and implement fire prevention management plans for the known occurrence and at sites capable of supporting reintroductions of *A. periens*.
- Captive propagation for genetic storage and reintroduction—
    - Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction.
    - Conduct research to determine protocols for *ex situ* propagation and maintenance of genetic stock.
- Reintroduction and translocation—
    - Determine sites that have the highest likelihood of maintaining reintroductions.
    - Begin reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Population biology research—Continue to support local and international fern horticulturists in development of propagation methods for common *Adenophorus* species that can be applied to *A. periens*.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species.
- Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species.

References:

Fortini, L., J. Price, J. Jacobi, A. Vorsino, J. Burgett, K. Brinck, F. Amidon, S. Miller, S. Gon II, G. Koob, and E. Paxton. 2013. A landscape-based assessment of climate change vulnerability for all native Hawaiian plants. Technical report HCSU-044. Hawai‘i Cooperative Studies Unit, University of Hawaii at Hilo, Hawai‘i. 134 pp.

Heintzman, S. 2021, in litt., Email with collection form for *Adenophorus periens* on Kaua‘i. 8 JUN 2021.

Heintzman, S. 2021, pers. comm., Plant Extinction Prevention Program species update for *Adenophorus periens* on Kaua‘i. 2 AUG 2021.

Lyon Arboretum. 2020. Report on controlled propagation of listed species, as designated under the U.S. Endangered Species Act. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

[NTBG] National Tropical Botanical Garden. 2020. Report on controlled propagation of listed species, as designated under the U.S. Endangered Species Act. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

Palmer, D.D. 2003. Hawai‘i’s ferns and fern allies. University of Hawai‘i Press, Honolulu. 324 pp.

[PEPP] Plant Extinction Prevention Program. 2015. PEPP annual report fiscal year 2015 (July 1, 2014-June 30, 2015). 179 pp.

[PEPP] 2016. Plant Extinction Prevention Program FY 2016 Annual Report (Oct 1, 2015-Sep 30, 2016), US FWS CFDA Program #15.657; Endangered Species Conservation-Recovery Implementation Funds, Coop Agreement F14AC00174, December 24, 2016, UH Manoa, PCSU, PEPP. 237 pp.

[PEPP] 2018. Plant Extinction Prevention Program, annual recovery subpermit FWSPIFWO-26 report (January 1st, 2018–December 31st 2018), as designated under the U.S. Endangered Species Act. Unpublished report submitted to U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 49 pp.

Ranker, T.A., C.T. Imada, K. Lynch, D.D. Palmer, A.L. Vernon, and M.K. Thomas. 2019. Taxonomic and nomenclatural updates to the fern and lycophyte flora of the Hawaiian Islands. American Fern Journal 109(1): 54–72.

Smithsonian National Museum of Natural History. 2021. *Adenophorus periens*. *In* Flora of the Hawaiian Islands, checklist. *http://naturalhistory2.si.edu/botany/hawaiianflora/,* accessed 8 JUN 2021.

[USFWS] U.S. Fish and Wildlife Service. 2010. *Adenophorus periens* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc3289.pdf.*

[USFWS] 2012. Endangered and threatened wildlife and plants; Endangered status for 23 species on Oahu and designation of critical habitat for 124 species; final rule. Department of the Interior, Federal Register 77 (181): 57648–57862, September 18, 2012.

[USFWS] 2015. *Adenophorus periens* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc4546.pdf.*

[USFWS] 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 species; final rule. Department of the Interior, Federal Register 81 (61): 17790–18110, March 30, 2016.

[USFWS] 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Wood, K.R. 2014. Botanical survey report for the windward slopes south of Kawaikini including ʻIliʻiliʻula, ʻIole & Waiʻahi headwaters, Kauaʻi, Hawaiʻi. Prepared for the U.S. Fish and Wildlife Service, FWS Agreement No. 12200-B-G010, National Tropical Botanical Garden, Kalaheo. 48 pp. + Appendix, 163 pp.

Wood, K.R, H. Oppenheimer, and M. Keir. 2019. A checklist of endemic Hawaiian vascular plant taxa that are considered possibly extinct in the wild. Technical Report National Tropical Botanical Garden, *https://www.researchgate.net/publications/332916448*. 16 pp.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Adenophorus periens* (palai laʻāu)

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 Reclassify from Endangered to Threatened status
_____ No Change in listing status

For **Field Supervisor, Pacific Islands Fish and Wildlife Office**

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2021.08.31 12:46:09 -10'00'

_____ Date_____