5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Phyllostegia kaalaensis* (no common name)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2017. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 138 species in Hawaii, Oregon, Washington, and California. Federal Register 82(75): 18665–18668, April 20, 2017.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

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 2018. The review was based on a review of current, available information since the last 5-year review for *Phyllostegia kaalaensis* (USFWS 2013). The evaluation completed 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 *Phyllostegia kaalaensis* published in the Federal Register on January 18, 2008 and August 7, 2013 (available at *https://ecos.fws.gov/docs/five_year_review/doc1852.pdf* and *https://ecos.fws.gov/docs/five_year_review/doc4231.pdf*) for a complete review of the species' status, threats, and management efforts. 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 *P. kaalaensis*.

This short-lived perennial erect to decumbent herb in the Lamiaceae (mint) family is endangered and endemic to O‘ahu. The current status and trends for *Phyllostegia kaalaensis* are provided in the tables below.

New Status Information:

- There are no known wild populations of *Phyllostegia kaalaensis*.
- In 2012, 11 critical habitat units in two ecosystems (lowland mesic and dry cliff) were designated for *Phyllostegia kaalaensis* in the Waiʻanae mountains of Oʻahu (13,652 ac, 5,525 ha) (77 FR 57648, September 18, 2012).

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 Hawaiʻi 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 *Phyllostegia kaalaensis* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.946 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions may be needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat in areas outside of its known range

New Management Actions:

- Ungulate and nonnative plant control—The Army Natural Resources Program-Oʻahu (ANRP) undertakes stabilization and management of endangered species to fulfill the requirements of the 2003 and 2008 Biological Opinions for U.S. Army activities in the Mākua and Oʻahu training areas (U.S. Army Garrison Hawaiʻi 2010; USFWS 2003). Reintroductions of *Phyllostegia kaalaensis* occur in fenced and managed areas (Pahole, Mākaha, and Manuwai) (ANRP 2018).
- Nonnative plant control—Nonnative plants are controlled by the ANRP in the fenced areas (ANRP 2018).
- Propagation and reintroduction—
    - The ANRP along with the Plant Extinction Prevention Program (PEPP) reintroduced more than 200 individuals at four sites; however, none of the outplantings has survived (ANRP 2018; PEPP 2013).
    - This species is infested and killed by powdery mildew (*Neoerysiphe galeopsidis*) at reintroduction sites. University of Hawaii and Utah Valley University researchers conducted a study testing the effects of inoculation of propagules with a mycorrhizal fungi and an endophytic mycoparasite (a yeast, *Pseudozyma aphidis*) and effects on disease severity in *Phyllostegia kaalaensis* (Koko *et al*. 2018). They found that the endophyte alone performed well in protecting plants from powdery mildew, and that the best time to treat plants would be while they were grown in the greenhouse.

- The Lyon Arboretum Micropropagation Laboratory reports propagation of more than 600 explants from four populations prior to their extirpation, representing eight wild individuals. Some collections have been maintained for twenty years (Lyon Arboretum 2018, in litt.).
- Waimea Arboretum reports five plants propagated representing one wild individual, with two surviving (Waimea Arboretum 2014, 2015, 2017).

Synthesis:
Currently there are no wild individuals of *Phyllostegia kaalaensis* in the Wai‘anae mountains of O‘ahu. Over 200 individuals have been reintroduced but due to disease, none have survived. 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 *P. kaalaensis* is extremely vulnerable to the effects of climate change. All reintroductions of *P. kaalaensis* occur within fenced and managed areas. Research into methods for protection from disease has shown some success. Eight wild individuals have been secured prior to their extirpation and maintained in *ex situ* collections for many years.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the O‘ahu Plants (USFWS 1998), 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.

Phyllostegia kaalaensis is a short-lived perennial erect to decumbent herb. To prevent extinction, which is the first step 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. In addition, a minimum of three populations should be documented on O‘ahu where they now occur or occurred historically and each of these populations must be naturally reproducing (*i.e.,* viable seeds, seedlings, saplings) and increasing in number, with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There are no populations totaling more than 50 individuals. The main threat of powdery mildew, observed to be fatal likely in combination with other threats, has not been controlled, and research suggests that at most survival in the field can be prolonged by only a few years with the treatment described above; however, research is ongoing. Genetic representation

is complete (Table 1, Table 2). Therefore, *P. kaalaensis* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
Other than the new data on this taxon's vulnerability to climate change, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019.

- Surveys and inventories—Survey for wild plants of *Phyllostegia kaalaensis* in suitable habitat within historical range.
- Ungulate monitoring and control—Continue to monitor fencing around all reintroduced populations to provide protection from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with *Phyllostegia kaalaensis* at all reintroduced populations.
- 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.
- Disease control—Continue to research and implement effective control methods for powdery mildew.
- Captive propagation—
    - Continue to collect cuttings or seed from tagged individuals, keeping close track of maternal source for use in *ex situ* propagation.
    - Develop a plan to conserving the extant genetic diversity within the species.
    - Research possible causes of low seed production and lack of embryo development.
- Reintroduction—
    - Continue reintroduction efforts to establish new populations that are managed for current threats.
    - Determine which reintroduction sites are best for success of outplantings and have access for frequent monitoring.
- Alliance and partnership development—Work with the ANRP, the Division of Forestry and Wildlife, and other land managers to contribute to implementation of ecosystem-level restoration and management to benefit this species.

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

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1996 (listing)	<50	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
1998 (recovery plan)	150–200	0	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2003 (critical habitat)	<45	0	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2008 (5-year review)	0	2	All threats managed in all three populations	Partially
			Complete genetic storage	Yes
			Three populations with 50 mature individuals each	No
2012 (critical habitat)	0	14	All threats managed in all three populations	Partially
			Complete genetic storage	Yes

			Three populations with 50 mature individuals each	No
2013 (5-year review)	0	0	All threats managed in all three populations	Partially
			Complete genetic storage	Yes
			Three populations with 50 mature individuals each	No
Date	**No. wild individuals**	**No. outplanted**	***Preventing Extinction Criteria identified by HPPRCC**	***Preventing Extinction Criteria Completed?**
2019 (5-year review)	0	>200, none survive	All threats managed in all three populations	Partially
			Complete genetic storage	Yes
			Reproduction (*i.e.* viable seeds, seedlings) at all three populations	No
			Three 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 after Preventing Extinction).

Table 2. Threats to *Phyllostegia kaalaensis* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate destruction and degradation of habitat	A	Ongoing	Partial, ungulate control at three management areas
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	Partial, nonnative plant control at three management areas
Climate change degradation or loss of habitat	A	Ongoing	None
Ungulate predation and herbivory	C	Ongoing	Partial, ungulate control at three management areas
Disease	C	Ongoing	Partial, initial studies show some success with control
Competition with established invasive plant species	E	Ongoing	Partial, nonnative plant control at three management areas
Low numbers	E	Ongoing	Partial, seed collection and propagation from reintroductions ongoing

References:

See previous 5-year reviews for a full list of references (USFWS 2008, 2013). Only references for new information are provided below.

[ANRP] Army Natural Resource Program-O‘ahu. 2018. 2018 status report for the Makua and Oahu implementation plans. 217 pp.

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. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Hawaii. 134 pp.

[HPPRCC] Hawai‘i and Pacific Plants Recovery Coordinating Committee. 2011. Revised recovery objective guidelines. 8 pp.

Koko, J., C. Egan, and N. Hynson. 2018. Project update. Testing the effects of inoculation with arbuscular mycorrhizal fungi and the foliar endophytic mycoparasitic yeast *Moeziomyces aphidis* on the disease severity from *Neoerysiphe galeopsidis* in infected *Phyllostegia kaalaensis* plants. *In* Appendix ES-6, 2018 Status Report for the Makua and Oahu Implementation Plans, Pacific International Center for High Technology Research, Army Natural Resources Program-Oahu, 4 pp.

Lyon Arboretum 2018, in litt., Report on controlled propagation of listed and candidate 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, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2013. Annual report fiscal year 2013 (July 1, 2012-June 30, 2013). 207 pp.

[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. Department of the Interior, Federal Register 77 (181): 57648–57862, September 18, 2012.

[USFWS] 2013. *Phyllostegia kaalaensis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc4231.pdf.*

[USFWS] 2017. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 138 species in Hawaii, Oregon, Washington, and California. Federal Register 82(75): 18665–18668, April 20, 2017.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Phyllostegia kaalaensis* (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

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

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