5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Schiedea kaalae* (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 *Schiedea kaalae* (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 *Schiedea kaalae* published in the Federal Register on January 18, 2008 and August 13, 2013 (available at *https://ecos.fws.gov/docs/five_year_review/doc1804.pdf* and *https://ecos.fws.gov/docs/five_year_review/doc4236.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 *S. kaalae*.

This short-lived perennial shrub in the Caryophyllaceae (carnation) family is endangered and endemic to O‘ahu. The current status and trends for *Schiedea kaalae* are provided in the tables below.

New Status Information:

- Currently there are seven mature and one immature wild individuals of *Schiedea kaalae* in two populations in the Waiʻanae mountains and five individuals in one population in the Koʻolau mountains of Oʻahu (Army Natural Resources Program-Oʻahu (ANRP) 2018; Plant Extinction Prevention Program 2019, in litt.). A second population of one individual in the Koʻolau mountains has not been observed since 2013.
- In 2012, 20 critical habitat units were designated in three ecosystems (lowland mesic, lowland wet, and wet cliff) in the Waiʻanae and Koʻolau mountains on Oʻahu (13,772 ac, 5,573 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 *Schiedea kaalae* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.797 (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:

- Ungulate 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). Ungulate fencing protects wild and reintroduced plants at Pahole-Kapuna, Kaluaa-Waiʻeli, ʻĒkahanui, and Makaua (ANRP 2018). These areas are currently ungulate-free.
- Nonnative plant control—Nonnative plants are controlled by the ANRP in the Pahole-Kapuna area (ANRP 2018).
- Rodent predation and herbivory—The ANRP has found that Goodnature™ A24 rat traps are more effective than the Victor® snap traps, and these traps are deployed in a large-scale grid at the ʻĒkahanui management unit. Traps are checked at 4-month intervals (U.S. Army Garrison 2010; ANRP 2018).
- Slug predation and herbivory—Testing showed that Ferroxx® is a more effective slug control than Sluggo®, and this toxicant is currently used to protect individuals of *Schiedea kaalae* from herbivory by slugs at the Pahole-Kapuna and ʻĒkahanui management areas (U.S. Army Garrison 2010; ANRP 2018).
- Captive propagation for genetic storage and reintroduction—

  - The ANRP reports collection and storage of more than 14,000 seeds from eight populations representing 39 founders. The nursery at ANRP has 392 plants representing 36 founders from eight populations (U.S. Army 2018).
  - Lyon Arboretum Micropropagation Laboratory reports propagation of more than 1,600 explants held at three facilities. These explants represent 36 individuals from eight populations (Lyon Arboretum 2018). The Lyon Seed Conservation Laboratory reports 144 seeds in storage representing seven individuals from three populations (Lyon Arboretum 2018).
  - The National Tropical Botanical Garden (NTBG) reports four plants in a living collection at McBryde Garden (NTBG 2018).
  - Waimea Arboretum reports four plants in refugia representing one wild individual (Waimea Arboreum 2017).
  - Pahole Rare Plant Facility (PRPF) reports 23 plants in refugia representing six populations (PRPF 2018).
  - There are a total of 36 founders representing eight populations that are largely extirpated. With the exception of Ma‘akua, all wild, extant individuals are represented (ANRP 2018). This includes two founders from Pahole, one from Kaluaa, nine from Kahana, one from Makaua,one from North Pālāwai, seventeen from ‘Ēkahanui, one founder from Huliwai, six founders from Maakua, , and one founder from Schofield Barracks West (ANRP 2018).
- Reintroduction—ANRP, the Division of Forestry and Wildlife (DOFAW), and PEPP reintroduced thousands of individuals of *Schiedea kaalae* at several sites including ‘Ēkahanui, Kaluaa, Pahole, Kahana, including 1,009 plants at Kaluanui (ANRP 2018, Ching 2019, in litt.; PEPP 2019). There are currently 478 outplants in the Wai‘anae mountains, and over 1,000 outplants in the Ko‘olau mountains.
- Population biology research—As discussed in the previous 5-year review, plants at reintroduction sites were observed to have some seedling recruitment, but no observations of recruiting immature or mature plants (replacement). Researchers established two common gardens of *Schiedea kaalae* to investigate whether low success was caused by inbreeding depression, and whether outbreeding depression or heterosis (greater vigor in hybrids) were observed as a result of outcrossing among populations. Controlled pollinations were conducted between plants from nine nearby and widely separated populations of *S. kaalae*. Progeny fitness was determined to be greater in plants from interpopulation crosses. and greatest when the populations were the furthest apart (between the Wai‘anae and Ko‘olau mountain ranges). Results of the study led to the researchers recommendations that (1) plants used for reintroductions should be those resulting from crosses within and between the O‘ahu mountain ranges where microlepidopteran pollinators are present; (2) *ex situ* propagules represent all parental combinations; (3) there be assessment of fitness of progeny at the common garden sites, and; (4) there be an assessment of interactions between ecological and genetic factors that may limit population size (Weisenberger *et al.* 2014).
- Pollinator research—During a study of the population biology of *Schiedea kaalae*, a previously undescribed microlepidopteran was observed visiting the flowers and collecting nectar (Weisenberger *et al.* 2014). In 2015, Medeiros described this

new species of Hawaiian microlepidopteran (moth), as *Pseudoschrankia brevipalpis* (kukunahanu‘u) (Medeiros 2015). Observation of the narrowness of the tubular nectary extensions of *S. kaalae* suggest adaptation to a pollinator with an unusually thin proboscis, such as the moth (Weller *et al.* 2017). Moths were further examined for pollen grains on their wings, legs, and proboscis, and flowers were observed for presence of moth scales. Moths were observed transferring pollen between flowers and were determined to be effective pollinators (Weller *et al*. 2017). These studies indicate that this moth may play an important role in the success of reintroductions and recruitment of *S. kaalae*.

Synthesis:
Currently there are approximately 12 mature wild individuals of *Schiedea kaalae* in the Wai‘anae and Ko‘olau mountains of O‘ahu. 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 *S. kaalae* is highly vulnerable to the effects of climate change. Five areas are fenced and ungulate-free. Pahole is managed for removal of nonnative plants and rats are controlled at ‘Ēkahanui. Slugs are controlled at both Pahole and ‘Ēkahanui. Collection, propagation, and reintroductions are ongoing; however, the initial survival rate of reintroductions was low, and may be improved using plants resulting from cross-pollination efforts.

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.

Schiedea kaalae is a short-lived perennial shrub with a nearly stemless woody base. 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. Genetic representation is mostly complete; however, there are only two outplanted populations (with very low recruitment) of 50 mature individuals and not all threats are managed

(Table 1, Table 2). Therefore, *S. kaalae* 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 new threats. There is no 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.

- Ungulate monitoring and control—Continue to fence wild and reintroduced populations and monitor fencing regularly to detect ungulate incursion.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with *Schiedea kaalae* at all wild and 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.
- Continue to implement effective controls for rats at all populations.
- Continue to implement effective slug control at all populations.
- Captive propagation for genetic storage and reintroduction—Continue seed collection from tagged individuals, recording the maternal source for *ex situ* propagation and send seed to at least two separate facilities for propagation and storage.
- Reintroduction—Continue to establish new populations and augment existing populations, keeping close track of maternal source used for *ex situ* propagation.
- Population biology research—
    - Continue to conduct genetic studies to assess the genetic variability and the viability of remaining populations.
    - Continue to investigate the causes of reproductive failure and implement techniques to improve natural recruitment.
- Alliance and partnership development—Continue to 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 *Schiedea kaalae* from listing through current 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization ** Criteria identified in Recovery Plan	Stabilization ** Criteria Completed?
1991 (listing)	<100	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
1998 (recovery plan)	13	Unknown	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2003 (critical habitat)	49	Unknown	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2008 (5-year review)	40	0	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2012 (critical habitat)	40	Unknown	All threats managed in all three populations	Partially
			Complete genetic storage	Partially

			Three populations with 50 mature individuals each	No
2013 (5-year review)	29	402 mature, 42 immature and 2 seedlings total 446	All threats managed in all three populations	Partially
			Complete genetic storage	Partially, one population 64 percent complete
			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)	12	Thousands planted; currently >500 survive	All threats managed in all three populations	Partially, five fenced areas
			Complete genetic storage	Yes
			Reproduction (*i.e.* viable seeds, seedlings) at all three populations	Partially
			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).
** We set the criteria to Stabilization to correct the 2013 5-year review that had used Downlisting Criteria in error.

Table 2. Threats to *Schiedea kaalae* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate destruction and degradation of habitat	A	Ongoing	Yes, five fenced areas ungulate-free
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	Partial, one managed area
Climate change degradation or loss of habitat	A	Ongoing	None
Ungulate predation and herbivory	C	Ongoing	Yes, five fenced areas
Rodent predation and herbivory	C	Ongoing	Partial
Invertebrate predation and herbivory	C	Ongoing	Partial
Competition with established invasive plant species	E	Ongoing	Partial, one managed area
Low numbers	E	Ongoing	Partial, seed collection, propagation, and reintroduction; research on outcrossing

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 Resources Program-O‘ahu. 2018. 2018 status report for the Makua and Oahu implementation plans. 217 pp.

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[NTBG] National Tropical Botanical Garden. 2018. 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, Hawaii.

[PRPF] Pahole Rare Plant Facility. 2018. 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, Hawaii.

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[U.S. Army] U.S. Army, Environmental Division. 2018. Report to the U.S. Fish and Wildlife Service for Oahu Army Natural Resource Program, Permit: TES-043638, Reporting period January 1, 2018-December 31, 2018. 16 pp.

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[USFWS] 2013. *Schiedea kaalae* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc4236.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.

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Weller, S.G., A.K. Sakai, D.R. Campbell, J.M. Powers, S. R. Peña, M.J. Keir, A.K. Loomis, S.M. Heintzman, and L. Weisenberger. 2017. An enigmatic Hawaiian moth is a missing link in the adaptive radiation of *Schiedea*. New Phytologist 213: 1533–1542.

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