

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Schiedea adamantis* (Diamond Head schiedea)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 58 species in Washington, Oregon, California, and Hawaii. Federal Register 75(226):71726-71729.

Lead Region/Field Office:

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

Name of Reviewer(s):

Michelle Clark, Plant Biologist, PIFWO

Daniel Clark, Oahu, Kauai, Northwest Hawaiian and American Samoa Islands Team
Manager, PIFWO

Marie Brueggemann, Plant Recovery Coordinator, PIFWO

Recovery Program Lead, PIFWO

Kristi Young, Programmatic Deputy Field Supervisor, PIFWO

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 January 31, 2012. The review was based on a review of current, available information since the last five-year review for *Schiedea adamantis* (USFWS 2008). The National Tropical Botanical Garden provided an initial draft of portions of the five-year review and recommendations for conservation actions needed prior to the next five-year review. The document was reviewed by the Plant Biologist, Islands Team Manager, and Plant Recovery Coordinator, followed by the Recovery Program Lead. It was subsequently reviewed and approved by the Programmatic Deputy Field Supervisor.

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 review for *Schiedea adamantis* published on January 18, 2008 (available at http://ecos.fws.gov/docs/five_year_review/doc1802.pdf) for a complete review of the species' status, threats, and management efforts. No new significant information regarding the species' biological status has come to light since listing to warrant a change in the Federal listing status of *S. adamantis*.

This short-lived shrub is endangered and occurs on Oahu in Diamond Head (Leahi) Crater. The current status and trends for *Schiedea adamantis* are provided in the tables below.

New status information:

- Only one wild population exists, on the rim of Diamond Head (Leahi) Crater. In the summer of 2012, it contained four mature and nine immature individuals. Oahu Plant Extinction Prevention Program (PEPP) staff considers this to be positive, since there have been drought conditions at this site for several years, and PEPP staff had not observed immature individuals or seedlings in the several years previously. In 2011, good summer rains resulted in seedlings germinating in December 2011. They are all still alive at this time, and all look stressed (S. Ching, PEPP, pers. comm. 2012a).
- Severe decline in the number of wild individuals and lack of substantial survivorship of reintroduced individuals is potentially mitigated by the extensive banking of seeds in at least two places, which together offers a broad representation of existing genetic variation in the species. Propagation and reintroduction from these seeds will be necessary to the survival of the species (S. Weller, University of California, Irvine, pers. comm. 2012).

New threats:

- Climate change – Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013.
- Drought – Some observers believe that droughts have increased in severity in this area (S. Ching, pers. comm. 2012a).

New management actions:

- Captive propagation for genetic storage and reintroduction:
 - Drs. Stephen Weller and Ann Sakai, of the University of California, Irvine, carried out two captive propagation plant crossing programs in 2011 with *S. adamantis*. From the first crossing program they produced about 163,900 seeds. They gave 14,400 of these seeds to Susan Ching of the Oahu PEPP and Greg Mansker of Hawaii State Department of Forestry and Wildlife for a preliminary outplanting study. They also have additional seeds in storage to use in a full scale outplanting effort in 2012 to 2013. Weller and Sakai conducted a test planting of 40 seeds from each cross at University of California Irvine and had 77 percent germination. Of these seedlings, they transplanted five individuals per cross (360 seedlings) to check for potential hybridization with other *Schiedea* species in their greenhouse. Progeny are now large and flowering and show no evidence of hybridization. Weller and Sakai also produced seeds from a second crossing program in 2011, but have not yet

- sorted and counted these seeds, nor tested for hybridization (S. Weller, pers. comm. 2012; University of California Irvine 2010, 2011).
- Harold L. Lyon Arboretum (2011) had 77 accessions of *Schiedea adamantis* from the PEPP program totaling over 43,000 seeds in storage as of 2011.
 - Thirty plants were in Greg Mansker's Hawaii Department of Forestry and Wildlife (2011) greenhouse in Leahi Crater in 2011.
 - Weller and Sakai are planning to propagate and outplant hundreds of genetically diverse individuals at Leahi Crater (S. Weller, pers. comm. 2012).
 - Reintroduction / translocation
 - Previous reintroductions outside the Crater thrived while the site was actively managed by the National Guard - but as soon as they pulled out, irrigation ended, and weed control stopped, the plants did not survive (S. Weller, pers. comm. 2012; S. Ching, pers. comm. 2012b).
 - In 2011, Weller and Sakai observed nine individuals surviving at Koko Crater from their 1997 outplanting. These had been planted in an irrigated area, and initially did spectacularly well, with growth to maturity of hundreds of plants. Over the years, most of them died. This may not be surprising if the natural lifespan of this species is not long (S. Weller, pers. comm. 2012). The thick mulch at Koko Crater prevented most regeneration of both *S. adamantis* and weeds (S. Weller, pers. comm. 2012).
 - Surveys/Inventories - Oahu PEPP is monitoring this species (PEPP 2012).
 - Genetic research – As recommended in the 1994 recovery plan for *Schiedea adamantis* (USFWS 1994), research has illuminated the dimorphic gynodioecious breeding systems of this and related species. Quantitative genetic analyses of this species show adequate variation for a number of traits related to reproduction. Lack of genetic variation is not the limiting factor for this species (Campbell *et al.* 2011; Sakai *et al.* 2006, 2008; Weller *et al.* 2007; S. Weller, pers. comm. 2012). Most crosses used female plants as seed parents because this guaranteed that the progeny were highly outcrossed, and would be less likely to suffer from the effects of inbreeding depression, which experimentation has shown is very high in this species (Sakai and Weller 1999).

Synthesis:

Downlisting, and delisting objectives are provided in the recovery plan for *Schiedea adamantis* (USFWS 1994). *Schiedea adamantis* is a short-lived perennial, and to be considered for downlisting, the wild population should be increased to at least 500 reproductive plants and two more populations of at least 500 reproductive plants should be established. All populations should be naturally reproducing as indicated by the presence of varied age classes ranging from seedlings to mature, reproducing adults, and should remain at these numbers for a minimum of ten years.

The downlisting goals for this species have not been met, as no population has 500 or more mature individuals (Table 1), and all threats are not being sufficiently managed

throughout the populations (Table 2). Therefore, *Schiedea adamantis* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction.
- Reintroduction / translocation:
 - Install and maintain adequate irrigation at all *S. adamantis* sites.
 - Continue to reintroduce the species back into its known historical range, in and around Diamond Head in at least two new sites as well as augmenting the existing population and reintroduction sites.
 - Consider additional reintroduction sites at higher elevation and somewhat wetter habitat.
- Ecosystem-altering invasive plant species control - Remove invasive introduced plant species within wild and reintroduced populations and maintain those areas free of invasive introduced plants.
- Threats research - Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.
- Fire protection – Continue to implement a fire management plan in cooperation with the landowner.
- Population biology research - Implement genetic studies to assess the viability of remaining individuals.
- Population biology research - Investigate causes of reproductive failure and techniques to improve natural recruitment.
- Population viability monitoring – Continue studies of *Schiedea adamantis* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon.

Table 1. Status of *Schiedea adamantis* from listing through current 5-year review.

Date	No. wild individuals	No. outplanted	Downlisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
1984 (listing)	~78	0	3 populations with 500 mature individuals each	No
			All age classes present	No
			Minimum of 10 years at these levels	No
1994 (recovery plan)	244	0	3 populations with 500 mature individuals each	No
			All age classes present	No
			Minimum of 10 years at these levels	No
2008 (5-yr review)	6	~80	3 populations with 500 mature individuals each	No
			All age classes present	No
			Minimum of 10 years at these levels	No
2013 (5-yr review)	13	15	3 populations with 500 mature individuals each	No (see Table 2)
			All age classes present	No
			Minimum of 10 years at these levels	No

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

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Drought	E	Ongoing	Partially, irrigation is installed at the one reintroduction site.
Fire	A, E	Ongoing	Partially, fire management plan was written but has not been fully implemented
Invasive introduced plants	A, E	Ongoing	Partially
Low population size	E	Ongoing	Partially: Nursery propagation and genetic storage, reintroduction / translocation implementation, and monitoring
Foot traffic from hikers	A, E	Ongoing	None
Climate change	A, E	Increasing	None

References:

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

Campbell, D.R., S.G. Weller, A.K. Sakai, T.M. Culley, P.N. Dang, and A.K. Dunbar-Wallis. 2011. Genetic variation and covariation in floral allocation of two species of *Schiedea* with contrasting levels of sexual dimorphism. *Evolution* 65:757-770.

Harold L. Lyon Arboretum. 2012. Micropropagation and seed storage databases. University of Hawaii at Manoa, Honolulu, Hawaii. Unpublished.

Hawaii Division of Forestry and Wildlife Nursery. 2011. Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. 15 pages. Unpublished.

Plant Extinction Prevention Program. 2012. Plant Extinction Prevention Program annual report, fiscal year 2012 (July 1, 2011-June 30, 2012). 169 pages. Unpublished.

Sakai, A.K. and S.G. Weller. 1999. Final report on the implementation of recovery plan for Diamond Head *schiedea*. Department of Ecology and Evolutionary Biology, University of California, Irvine. 10 pages. Unpublished.

Sakai, A.K., S.G. Weller, W.L. Wagner, M. Nepokroeff, and T.M. Culley. 2006. Adaptive radiation and evolution of breeding systems in *Schiedea*

(Caryophyllaceae), an endemic Hawaiian genus. *Annals of the Missouri Botanical Garden* 93(1):49-63. Available online at <http://www.bioone.org/doi/abs/10.3417/0026-6493%282006%2993%5B49:ARAE0B%5D2.0.CO%3B2>.

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[USFWS] U.S. Fish and Wildlife Service. 1994. Recovery plan for *Schiedea adamantis*. U.S. Fish and Wildlife Service, Portland, Oregon. 55 pages.

[USFWS] U.S. Fish and Wildlife Service. 2008. *Schiedea adamantis* (Diamond Head Schiedea) 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 11 pages. Available online at http://ecos.fws.gov/docs/five_year_review/doc1802.pdf.

Weller, S.G., A.K. Sakai, T.M. Culley, D.R. Campbell, P. Ngo and A.K. Dunbar-Wallis. 2007. Sexually dimorphic inflorescence traits in a wind-pollinated species: heritabilities and genetic correlations in *Schiedea adamantis* (Caryophyllaceae). *American Journal of Botany* 94(10):1716-1725. Available online at <http://www.amjbot.org/content/94/10/1716.full.pdf+html>.

Personal communications:

Ching, Susan. 2012a. Oahu Coordinator, Plant Extinction Prevention Program. E-mail to Margaret Clark, National Tropical Botanical Garden, dated August 22, 2012. Subject: *Lysimachia filifolia*/ substitute *Schiedea adamantis*?

Ching, Susan. 2012b. Oahu Coordinator, Plant Extinction Prevention Program. E-mail to Margaret Clark, National Tropical Botanical Garden, dated August 23, 2012. Subject: *Sch_ada*.

Weller, Stephen G. 2012. Department of Ecology and Evolutionary Biology, University of California, Irvine. E-mail to Margaret Clark, National Tropical Botanical Garden, dated August 30, 2012. Subject: *Schiedea adamantis* 5-year review short form 8-12.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for **5-YEAR REVIEW** of *Schiedea adamantis*
(Diamond Head schiedea)

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 *2013-08-19*