

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Euphorbia rockii* (‘akoko)

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 *Euphorbia rockii* (USFWS 2011). 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 review for *Euphorbia rockii* published in the Federal Register on August 2, 2011 (available at https://ecos.fws.gov/docs/five_year_review/doc3807.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 *E. rockii*.

This short-lived perennial compact shrub or small tree in the Euphorbiaceae (spurge) family is endangered and endemic to O‘ahu. The current status and trends for *Euphorbia rockii* are provided in the tables below.

New Status Information:

- There are fewer than 100 individuals in 10 populations ranging from Waialele south to Waimano in the Ko‘olau mountains of O‘ahu (PEPP 2019).
- During a rare plant survey conducted in the O‘ahu Forest National Wildlife Refuge in 2010, a single healthy immature plant was found downslope of the campsite. A mature hybrid specimen between *Euphorbia rockii* and *E. chusiifolia* was found on the margin of the helicopter landing zone (Imada *et al.* 2011). In another survey in 2017, two individuals were discovered along a fenceline at Kawai Iki (PEPP 2017).
- In 2012, 11 critical habitat units in the lowland wet ecosystem were designated for *Euphorbia rockii* in the Ko‘olau mountains of O‘ahu (25,114 ac, 10,162 ha) (77 FR 57648, September 18, USFWS 2012).
- As reported in the previous 5-year review, phylogenetic analysis of nuclear and chloroplast DNA sequence data for species in the tribe Euphorbiaceae indicated that the genus *Euphorbia* was paraphyletic with *Chamaesyce* and other genera nested within it (Steinmann and Porter 2002; Yang and Berry 2011). The recommendation that expanding *Euphorbia* to include *Chamaesyce* was accepted in the update to the Manual of Flowering Plants of Hawaii (Wagner *et al.* 2012), consequently, the scientific name of *Chamaesyce rockii* is changed to *Euphorbia rockii*. This taxonomic change does not affect the range or endangered status of this species. We recognized this taxonomic change in a technical correction published in 2015 that amended the list of endangered and threatened species in the Federal Regulations at section 17.12 (USFWS 2015).

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 *Euphorbia rockii* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.973 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, the assessment classified *E. rockii* as a “wink-out” species. “Wink-out” species are those with no future climate envelope. No projected suitable climate areas exist for the species to persist into the future. Therefore, additional management actions are 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 outside of its known range.

New Management Actions:

- Ungulate monitoring and control—The Army Natural Resources Program-O‘ahu (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 O‘ahu training areas (U.S. Army Garrison Hawai‘i

2010). Some individuals of *Euphorbia rockii* occur within some of the ANRP management units; and actions including fencing, fence maintenance, and ungulate control in these management units may benefit the occurrences of this taxon (Helemano-‘Ōpae‘ula, Kōloa, and Kaipapa‘u) (U.S. Army Garrison Hawai‘i 2010; U.S. Army 2018). This species occurs in other fenced areas including North Kaukonahua and Waimano and may benefit from ungulate exclusion in those areas (U.S. Army 2018).

Synthesis:

Currently there are fewer than 100 individuals of *Euphorbia rockii* in the Ko‘olau mountains, though some populations have not been visited in over twenty years. 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 *E. rockii* is extremely vulnerable to the effects of climate change. There are currently no known *ex situ* collections of this species.

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.

Euphorbia rockii is a short-lived perennial compact shrub or small tree. 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. Only one population may total more than 50 individuals, though most sites have not been monitored within the last five years and sites are isolated from one another (Table 1). Genetic representation is incomplete and not all threats are managed (Table 1, Table 2). Therefore, *Euphorbia rockii* 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 or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019.

- Surveys, inventories, and monitoring—Continue surveys for occurrences in known historical sites and in suitable habitat.
- Ungulate monitoring and control—Continue to fence and monitor all populations to provide protection against the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with *Euphorbia rockii* at all 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.
- Rodent predation and herbivory—Implement rat control methods at all populations.
- Slug herbivory—Implement effective methods for slug control at all populations.
- Captive propagation for genetic storage and reintroduction—Begin collection and propagation efforts for maintenance of genetic stock and for reintroduction.
- Reintroduction and translocation—Augment and establish new populations within historical habitat to increase numbers of individuals and populations.
- Hybridization—Research possible negative effects of hybridization with *Euphorbia clusiifolia* and consider separate reintroduction sites.
- Human interaction monitoring and management—Develop and implement effective measures to reduce the impact of collecting, hiking, and trail maintenance.
- Alliance and partnership development—Work with the U.S. Army, the Hawai'i Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

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

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1996 (listing)	200–400	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	Unknown
1998 (recovery plan)	200–400	0	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	Yes
2003 (critical habitat)	641–773	0	All threats managed in all three populations	No
			Complete genetic storage	Unknown
			Three populations with 50 mature individuals each	Unknown
2011 (5-year review)	141	0	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2012 (critical habitat)	576–710	0	All threats managed in all three populations	Partially
			Complete genetic storage	Partially

			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)	<100	0	All threats managed in all three populations	Partially
			Complete genetic storage	No
			Reproduction (<i>i.e.</i> viable seeds, seedlings) at all three populations	No
			Three populations with 50 mature individuals each	Partially, one population

* 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 *Euphorbia rockii* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate habitat destruction and degradation	A	Ongoing	Partial, three managed fenced areas
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Rat predation and herbivory	C	Ongoing	None
Invertebrate predation and herbivory	C	Ongoing	None
Competition with established invasive plant species	E	Ongoing	Partial, nonnative plant control at some management units
Hybridization	E	Ongoing	None

References:

See previous 5-year review for a full list of references (USFWS 2011). Only references for new information are provided below.

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.

Imada, C., Clifford, P., and J.Q.C. Lau. 2011. 2010 rare plant survey, O'ahu Forest National Wildlife Refuge, Waipi'o, O'ahu. Prepared for U.S. Fish and Wildlife Service, O'ahu Forest National Wildlife Refuge Complex, Hale'iwa, Hawaii Biological Survey, Bishop Museum, Honolulu. 56 pp. + appendices.

Morden, C.W., T. Hiramoto, and M. Yorkston. 2014. Genetic diversity among populations of the endangered Hawaiian endemic *Euphorbia kuwaleana* (Euphorbiaceae). *Pacific Science* 68(1): 75–83.

[PEPP] Plant Extinction Prevention Program. 2017. 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, Cooperative Agreement F14AC00174, December 24, 2016, UH Manoa, PCSU, PEPP. 237 pp.

[PEPP] 2019. Plant Extinction Prevention Program interim report fiscal year 2019 (October 1, 2018 – September 30, 2019). 569 pp.

Steinmann, V.W. and J.M. Porter. 2002. Phylogenetic relationships in Euphorbieae (Euphorbiaceae) based on ITS and ndhF sequence data. *Annals of the Missouri Botanical Garden* 89(4): 453–490.

[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.

U.S. Army Garrison Hawai'i. 2010. Integrated natural resources management plan 2010-2014, Island of O'ahu. 375 pp.

[USFWS] U.S. Fish and Wildlife Service. 2011. *Chamaesyce rockii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. https://ecos.fws.gov/docs/five_year_review/doc3808.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. Endangered and threatened wildlife and plants; technical corrections for 54 wildlife and plant species on the list of endangered and threatened wildlife and plants, direct final rule. Federal Register 80: 35860–35869, June 23, 2015.
- [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.
- Wagner, W.L., D.R. Herbst, N. Khan, and T. Flynn. 2012. Hawaiian vascular plant updates: a supplement to the Manual of the Flowering Plants of Hawai‘i and Hawai‘i’s Ferns and Fern Allies, version 1.1, 19 MAR 2012. 126 pp.
- Yang, Y. and P.E. Berry. 2011. Phylogenetics of the *Chamaesyce* clade (*Euphorbia*, Euphorbiaceae): reticulate evolution and long-distance dispersal in a prominent C₄ lineage. American Journal of Botany 98(9): 1486–1503.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Euphorbia rockii* ('akoko)

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

For Field Supervisor, Pacific Islands Fish and Wildlife Office

_____ Date _____