5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Euphorbia deppeana* (‘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 deppeana* (USFWS 2007). 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 deppeana* published in the Federal Register on August 2, 2007 (available at *https://ecos.fws.gov/docs/five_year_review/doc1124.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. deppeana*.

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

New Status Information:

- In 2016, the only known population of *Euphorbia deppeana* on the Nu‘uanu Pali cliffs was estimated to total 65 mature individuals (PEPP 2019). On February 18, 2019, two large landslides affected this area (Hawaii News Now 2019, in litt.). Initial surveys after the landslides were conducted; however, access was difficult or not allowed due to the instability of the terrain. The larger landslide is adjacent to the larger patch of plants and has impacted them. Below that landslide area about a dozen plants were observed. There are plants known further to the south and on rocky areas to the north, but these areas were not surveyed. It is possible that there are more plants than those directly observed, but only 26 mature individuals were observed (Ching 2019, in litt.).
- 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 deppeana* is changed to *Euphorbia deppeana*. 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, amending the list of endangered and threatened species in the Federal Regulations at section 17.l2 (USFWS 2015) and will now refer to this variety by its current name.
- In 2012, three critical habitat units in the wet cliff ecosystem were designated for *Euphorbia deppeana* in the Ko‘olau mountains of O‘ahu (4,944 ac, 2,000 ha) (77 FR 57648, September 18, USFWS 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 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 deppeana* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.84 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are 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:

- Captive propagation for genetic storage and reintroduction—
    - The Plant Extinction Prevention Program (PEPP) reports that cuttings were taken from five individuals before a planned State Parks rock fall mitigation project was to begin in 2015 (PEPP 2015).

- Lyon Arboretum Seed Conservation Laboratory reports storage of five seeds representing one individual (Lyon Arboretum 2018).
- The National Tropical Botanical Garden (NTBG) reports two individuals in a living collection and storage of at least 19 seeds (NTBG 2018).
- The Pahole Nursery reports two plants in storage representing two wild individuals (Pahole Nursery 2018).

Synthesis:
Currently there are at least 26 mature individuals in one population of *Euphorbia deppeana* in the Koʻolau mountains; however, more surveys may be conducted to reassess this population once the landslide area is stabilized. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *E. deppeana* is highly vulnerable to the effects of climate change. Fewer than 50 seeds are in storage and a few plants are in living collections.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Oʻahu Plants (USFWS 1998), and have been updated according to the draft revised recovery objective guidelines developed by the Hawaiʻi 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 deppeana is a short-lived perennial subshrub. 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 Oʻahu 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 mature individuals (Table 1). Genetic representation is incomplete and threats are not managed at the only known population (Table 1, Table 2). Therefore, *Euphorbia deppeana* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
Other than 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 2007. 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. Reassess the population when the landslide area is accessible.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with *Euphorbia deppeana* if areas are accessible.
- 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.
- Captive propagation for genetic storage and reintroduction—
    - Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction.
    - Continue to assess genetic variability within the extant populations and implement a plan for conserving the species' genetic diversity in *ex situ* and reintroduced populations.
- Reintroduction and translocation—
    - Augment current natural populations to increase numbers of individuals.
    - Establish new reintroduction sites within historical habitat.
- Hybridization—Research intergradation between *Euphorbia deppeana* and *E. multiformis* var. *microphylla* to determine the level of threat and if actions should be taken.
- Alliance and partnership development— Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon.

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

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	50–100	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No

1998 (recovery plan)	<50	3	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
2003 (critical habitat)	50	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
2007 (5-year review)	possibly >100	0	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2012 (critical habitat)	ca 100	0	All threats managed in all three populations	No
			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)	26	0	All threats managed in all three populations	No
			Complete genetic storage	Partially

			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 *Euphorbia deppeana* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	None
Fire destruction and degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Competition with established invasive plant species	E	Ongoing	None
Hybridization	E	Ongoing	None
Human impacts	E	Ongoing	None
Stochastic events and small populations	E	Ongoing	Partial, seed and propagule storage ongoing

References:

See previous 5-year review for a full list of references (USFWS 2007). Only references for new information are provided below.

Ching, S. 2019, in litt. Email regarding current status of *Euphorbia deppeana*, 24 JUN 2019.

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Lyon Arboretum. 2018. 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.

[NTBG] National Tropical Botanical Garden. 2018. 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.

[PRPF] Pahole Rare Plant Facility. 2018. 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. 2015. PEPP annual report fiscal year 2015 (July 1, 2014-June 30, 2015). 179 pp.

[PEPP] 2017. PEPP annual report fiscal year 2017 (October 1, 2016 – September 30, 2017). 235 pp.

[PEPP]. 2019. PEPP 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.

[USFWS] U.S. Fish and Wildlife Service. 2007. *Chamaesyce deppeana* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc1124.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 C_4 lineage. American Journal of Botany 98(9): 1486–1503.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Euphorbia deppeana* (‘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
_X____ No Change in listing status

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

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