

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Euphorbia herbstii* ('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 herbstii* (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 herbstii* published in the Federal Register on August 2, 2007 (available at https://ecos.fws.gov/docs/five_year_review/doc1125.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. herbstii*.

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

New Status Information:

- Currently there are seven mature and six immature wild individuals remaining from Pahole to Kapuna in the Wai‘anae mountains of O‘ahu. This marks a drastic decline from the previous year's estimates of 97 individuals, and indicates a steep declining trend from the 2003 estimates of 170 individuals (Army Natural Resources Program-O‘ahu (ANRP) 2018).
- 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 herbstii* is changed to *Euphorbia herbstii*. 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 17.12 (USFWS 2015) and will now refer to this variety by its current name.
- In 2012, 11 critical habitat units in two ecosystems (lowland mesic and dry cliff) were designated for *Euphorbia herbstii* in the Wai‘anae mountains of O‘ahu (7,313 ac, 2,960 ha) (77 FR 57648, September 18, USFWS 2012).
- In 2013, the Plant Extinction Prevention Program (PEPP) reevaluated the status of this species, and noted that, as there was estimated to be fewer than 50 individuals of *Euphorbia herbstii* remaining in the wild, this species had reached the criteria level for “PEP” designation (PEPP 2013). PEPP focuses its conservation efforts on these most critically rare plant species by threat management, propagule collection and storage, and outplanting.

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 herbstii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.837 (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:

- 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). *Euphorbia herbstii* is a species targeted for stabilization and management; and actions including fencing and ungulate control in management units may benefit the occurrences of this taxon (Pahole, Kapuna, Mākaha, and Kaluaa-Wai‘eli) (U.S. Army Garrison Hawai‘i 2010).
- Invasive plant monitoring and control—The ANRP controls nonnative invasive plants in management units in which support wild and outplanted individuals of *Euphorbia herbstii* (U.S. Army Garrison Hawai‘i 2010; ANRP 2018).
 - Rodent predation or 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 Mākaha management unit (ANRP 2018).
 - Slug herbivory—Testing showed that Ferroxx® is a more effective slug control than Sluggo®, and this toxicant is currently used to protect individuals of *Euphorbia herbstii* from herbivory by slugs at the Kapuna and Pahole management units (ANRP 2018).
 - Captive propagation for genetic storage and reintroduction—
 - The ANRP reports that 21 wild individuals have met genetic storage goals with either 50 seeds in storage or three plants in the nursery (ANRP 2018).
 - The Plant Extinction Prevention Program (PEPP) reports that collections were made from 66 founders, representing three populations (‘Ēkahanui, Kapuna, and Pahole) of both wild and reintroduced individuals (PEPP 2017). However no propagules were secured in *ex situ* storage from ‘Ēkahanui before it was extirpated around 2002.
 - Lyon Arboretum Seed Conservation Laboratory reports storage of 211 seeds representing seven individuals from Kapuna (Lyon Arboretum 2018).
 - The Pahole Rare Plant Facility [PRPF] reports one plant in storage representing one wild individual at Kapuna (Pahole Nursery 2018).
 - Reintroduction—
 - The ANRP reports reintroduction and survival of 30 mature and 134 immature plants at Kapuna to Pahole, Kaluaa, and Mākaha (ANRP 2018).

Synthesis:

Currently there are seven mature and six immature wild individuals (from Pahole to Kapuna) of *Euphorbia herbstii* in the Wai‘anae mountains. 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. herbstii* is highly vulnerable to the effects of climate change. Approximately 1,800 seeds are in storage and more than 160 individuals are outplanted in three populations.

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 herbstii is a short-lived perennial 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. There are no wild populations totaling more than 50 individuals (Table 1). Genetic representation is incomplete and not all threats are managed (Table 1, Table 2). The species has dramatically declined in total population size despite these threat control efforts. Therefore, *Euphorbia herbstii* 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 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.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with *Euphorbia deppeana* if areas are accessible.
- Fire monitoring and control—Develop and implement fire management plans.
- 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—Continue to augment and establish new populations within historical habitat to increase numbers of individuals.

- 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 herbstii* 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 | 0 | All threats managed in all three populations | No |
| | | | Complete genetic storage | No |
| | | | Three populations with 50 mature individuals each | No |
| 1998 (recovery plan) | <200 | 0 | All threats managed in all three populations | No |
| | | | Complete genetic storage | No |
| | | | Three populations with 50 mature individuals each | No |
| 2003 (critical habitat) | 162–164 | 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) | 56 | 2 | All threats managed in all three populations | No |
| | | | Complete genetic storage | Partially |
| | | | Three populations with 50 mature individuals each | No |

| 2012 (critical habitat) | <60 | 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) | 13 | >160 | All threats managed in all three populations | No |
| | | | Complete genetic storage | Partially |
| | | | Reproduction (<i>i.e.</i> 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 herbstii* 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 |
| Rat predation and herbivory | C | Ongoing | Partial, control at one management unit |

| | | | |
|---|---|---------|--|
| Slug predation and herbivory | C | Ongoing | Partial, control at one management unit |
| Competition with established invasive plant species | E | Ongoing | None |
| Stochastic events and small populations | E | Ongoing | Partial, seed, propagule storage, and reintroduction are ongoing |

References:

See previous 5-year review for a full list of references (USFWS 2007). 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.
- 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.
- 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.
- [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. 2013. PEPP annual report fiscal year 2013 (July 1, 2012-June 30, 2013). 207 pp.
- [PEPP] 2017. Plant Extinction Prevention Program annual report fiscal year 2017 (October 1, 2016 – September 30, 2017). 235 pp.
- [PEPP] 2019. Plant Extinction Prevention Program interim report fiscal year 2019 (October 1, 2018 – September 30, 2019).
- 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 Garrison Hawai‘i. 2010. Integrated natural resources management plan 2010-2014, Island of O‘ahu. 375 pp.
- [USFWS] U.S. Fish and Wildlife Service. 2007. *Chamaesyce herbstii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. https://ecos.fws.gov/docs/five_year_review/doc1125.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 herbstii* ('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 _____