5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Euphorbia halemanui* (‘Akoko)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2015a. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 133 species in Hawaii, Oregon, Idaho, and Washington. Federal Register 80(30): 8100–8103.

Lead Region/Field Office:

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

Name of Reviewer(s):

Cheryl Phillipson, Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Gregory Koob, 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 (USFWS) beginning in January 2016. The review was based on a review of current, available information since the last 5-year review for *Euphorbia halemanui* (USFWS 2010). The evaluation by Cheryl Phillipson, Biologist, was reviewed by the Plant Recovery Coordinator and the 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 halemanui* (*Chamaesyce halemanui*) published in the Federal Register on August 27, 2010 (USFWS 2010, available at *https://ecos.fws.gov/docs/five_year_review/doc3325.pdf*) for a complete review of the species’ status, threats, and management efforts. No significant new information regarding the species biological status have come to light since listing to warrant a change in the Federal listing status of *E. halemanui*.

This climbing, short-lived perennial shrub in the Euphorbiaceae family is endangered and endemic to the island of Kauai. The current status and trends for *Euphorbia halemanui* are provided in the tables below.

New Status Information:

In addition to those populations cited in the previous 5-year review, new observations include the following:

- In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Chamaesyce halemanui* to *Euphorbia halemanui* (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species. Although no common name was provided for *C. halemanui* when it was listed, it was determined in the technical correction that the common name of akoko is appropriate for this species.
- New research about this species' life history and biology is in progress. A preprint of Yang *et al.* 2016 is available online (*https://doi.org/10.1101/056580*, June 2, 2016). This work describes the biogeographic movement (radiation) of the Hawaiian *Euphorbia* along the Hawaiian Islands chain.
- In 2010, there were estimated to be 300 to 400 individuals in four populations. Currently, there are four populations totaling between 85 and 195 individuals, based on survey information from 2012 to 2016 (NTBG 2012a-b, 2015a-k, 2016).
- The Plant Extinction Prevention Program (PEPP) reevaluated this species' status in 2016, as numbers of individuals are decreasing over time, and placed *Euphorbia halemanui* in the "POP" category, a potential PEPP species. PEPP species are those plants with fewer than 50 individuals in the wild.

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 Hawaii 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 halemanui* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.703 (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.
- Hurricanes—Loss and degradation of habitat—Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are endemic to the island. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel *et al.* 2008; Yu *et al.* 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013).

New Management Actions:

- Captive propagation for genetic storage and reintroduction—Cuttings were collected in 2013, but there are no other records of collected materials (NTBG 2017) and this material does not currently exist in *ex situ* collections nor was outplanted.
- Surveys and inventories—Surveys for occurrences of this species are ongoing (PEPP 2016).

Synthesis:
Surveys conducted since completion of the last 5-year review for this species confirm four populations, and estimated numbers of individuals are about half of what they were in 2010 (NTBG 2012a-b, 2015a-k, 2016). Cuttings were collected in 2013; however, there are no other records of collected materials. A landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *Euphorbia halemanui* is highly vulnerable to the effects of climate change, in that there will be a smaller area of suitable habitat available for the species in the near future.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Kauai Plant Cluster (USFWS 1995), and have been updated according to the draft revised recovery objective guidelines developed by the Hawaii 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 determination 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 halemanui is a short-lived climbing perennial shrub with no specific characteristics known. 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 from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or seed bank) collection. In addition, a minimum of three populations should be documented on Kauai where they now occur or occurred historically and each of these populations must be naturally reproducing (*i.e.* viable seeds, seedlings), with a minimum of 50 mature individuals per population.

The preventing extinction goals for this species have not been met, as currently no single population of 50 mature individuals exists, no genetic representation exists (Table 1), and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Euphorbia halemanui* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
No new threats and no significant new information regarding the species biological status have come to light since the last 5-year review in 2010. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2017.

- Surveys and inventories—Survey areas where *Euphorbia halemanui* has been observed in the past to obtain a more accurate assessment of populations and numbers.
- Ungulate monitoring and control—Fence wild populations to prevent further damage by ungulates. Protect all occurrences against browsing, trampling, and disturbances from feral ungulates.
- Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of urban development such as road clearing or realignment.
- Invasive plant monitoring and control—
    - Control established ecosystem-altering nonnative invasive plant species around all populations.
    - Control invasive nonnative species that compete with the species around all populations.
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction.
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Predator and herbivore monitoring and control—
    - Implement effective control methods for rodents around all known populations.
    - Study *Euphorbia halemanui* populations to determine the level of threat from invertebrate herbivory and the need for additional recovery actions.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from drought.
- Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations.

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

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1992 (listing)	50	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No

1995 (recovery plan)	96–151	0	All threats managed in all three populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	85–135	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
2010 (5-year review)	300–400	11	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
Date	**No. wild individuals**	**No. outplanted**	***Preventing Extinction Criteria identified by HPPRCC**	***Preventing Extinction Criteria Completed?**
2016 (5-year Review)	85–195	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Reproduction (*i.e.* viable seeds, seedlings) at all three populations	Unknown
			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 halemanui* and conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	None
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	None
Drought loss or degradation of habitat	A	Ongoing	None
Fire destruction or degradation of habitat	A	Ongoing	None
Hurricane destruction and degradation of habitat	A	Ongoing	None
Climate change loss or degradation of habitat	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	None
Rodent predation or herbivory	C	Ongoing	None
Invertebrate predation or herbivory	C	Ongoing	None
Human disturbance—Development and roads	E	Ongoing	None
Stochastic events–Reduced viability due to low numbers	E	Ongoing	Partial, cuttings taken for propagation

References:

See previous 5-year review in 2010 for a full list of references. Only references for new information are provided below.

Businger, S. 1998. Hurricanes in Hawaii. University of Hawaii, Honolulu. 6 pp.

Emanuel, K., R. Sundararajan, and J. Williams. 2008. Hurricanes and global warming. American Meteorological Society: March. Pp. 347–367.

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] Hawaii and Pacific Plants Recovery Coordinating Committee. 2011. Revised recovery objective guidelines. 12 pp.

Kitayama, K. and D. Mueller-Dombois. 1995. Biological invasion on an oceanic island mountain: do alien species have wider ecological ranges than native species? Journal of Vegetation Science 6: 667–674.

Murakami, H., B. Wang, T. Li, and A. Kitoh. 2013. Projected increase in tropical cyclones near Hawaii. Nature Climate Change, 5 MAY 2013, DOI: 10.1038/NCLIMATE1890.

[NTBG] National Tropical Botanical Garden. 2012a. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 062527, 25 APR 2012.

[NTBG] 2012b. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 065087, 2 OCT 2012.

[NTBG] 2015a. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 035590, 1 AUG 2015.

[NTBG] 2015b. NTBG database herbarium specimen detail for *Euphorbia halemanui*. no number, 30 AUG 2015.

[NTBG] 2015c. NTBG database herbarium specimen detail for *Euphorbia halemanui*. no number, 18 SEP 2015.

[NTBG] 2015d. NTBG database herbarium specimen detail for *Euphorbia halemanui*. no number, 18 SEP 2015.

[NTBG] 2015e. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070835, 22 SEP 2015.

[NTBG] 2015f. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070830, 22 SEP 2015.

[NTBG] 2015g. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070846, 22 SEP 2015.

[NTBG] 2015h. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070845, 22 SEP 2015.

[NTBG] 2015i. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070832, 22 SEP 2015.

[NTBG] 2015j. NTBG database herbarium specimen detail for *Euphorbia halemanui*. 070834, 22 SEP 2015.

[NTBG] 2015k. NTBG database herbarium specimen detail for *Euphorbia halemanui*. no number, 22 SEP 2015.

[NTBG] 2016. NTBG database herbarium specimen detail for *Euphorbia halemanui*. no number, 24 FEB 2016.

[NTBG] 2017. National Tropical Botanical Garden. Controlled Propagation Database Report.

Perlman, S. 1992. After Iniki: a survey of some of Kauai's rarest plants. Unpublished report. 9 pp.

[PEPP] Plant Extinction Prevention Program. 2016. Hawaii Department of Land & Natural Resources, DOFAW rare plant program, section 6 interim performance report, F15AF00595, Plant Extinction Prevention Program annual report Fiscal Year 2016 (July 1, 2015-June 30, 2016). 53 pp.

[USFWS] U. S. Fish and Wildlife Service. 2010. *Chamaesyce halemanui* 5-year review summary and evaluation. *https://ecos.fws.gov/docs/five_year_review/doc3325.pdf.*

[USFWS] 2015a. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 133 species in Hawaii, Oregon, Idaho, and Washington. 80 FR 8100, February 13, 2015.

[USFWS] 2015b. Endangered and threatened wildlife and plants; technical corrections for 54 wildlife and plant species on the list of endangered and threatened wildlife and plants. 80 FR 35860, June 23, 2015.

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Yu, J., Y. Wang, and K. Hamilton. 2010. Response to tropical cyclone potential intensity to a global warming scenario in the IPCC AR4 CGCMs. Journal of Climate 23: 1354–1373.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Euphorbia halemanui* (‘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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