5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Chamaesyce kuwaleana* (‘akoko)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2009. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 103 species in Hawaii. Federal Register 74(49):11130-11133.

Lead Region/Field Office:

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

Name of Reviewer(s):

Marie Bruegmann, Plant Recovery Coordinator, PIFWO
Jess Newton, Recovery Program Lead, PIFWO
Assistant Field Supervisor for Endangered Species, 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 March 16, 2009. The review was based on final critical habitat designation for *Chamaesyce kuwaleana* and other species from the island of Oahu (USFWS 2003), as well as a review of current, available information. The National Tropical Botanical Garden provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Tamara Sherrill, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Lead and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

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).

Application of the 1996 Distinct Population Segment (DPS) Policy:

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designation for *Chamaesyce kuwaleana* published in the Federal Register on June 17, 2003 (USFWS 2003) for a complete review of the species’ status (including biology and habitat), threats, and management efforts. No new threats and 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 *C. kuwaleana*.

Chamaesyce kuwaleana was listed as endangered in 1991. At that time, two populations containing several hundred individuals were known (USFWS 1991). It was also listed as endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species in 2003 (Bruegmann and Caraway 2003). When the recovery plan was written, three populations containing approximately 2,000 individuals were known (USFWS 1998). In 2003, when critical habitat was designated, five populations of 2,000 individuals were reported (USFWS 2003).

Fruits in Euphorbieae subfamily are generally dry capsules, exploding their seed only a few meters from their source. However, there are a few cases of long-distance dispersal within Euphorbieae, which include the genus *Chamaesyce.* Molecular evidence supports that this group probably originated in the New World. Because many *Chamaesyce* species possess mucilaginous seeds, their long-distance dispersal may have been accomplished by adhering to animals. This helps to explain why *Chamaesyce* is one of the few taxa within Euphorbieae that has transoceanic distribution (Steinmann and Porter 2002).

There are approximately 30 taxa of *Chamaesyce* in Hawaii that have radiated from a single colonizer. A graduate student at the University of Hawaii at Manoa, Maggie Sporck, has been focusing her research on the relationship between leaf structure and habitat in the Hawaiian *Chamaesyce*. In 2007, a population of *Chamaesyce kuwaleana* accessible from the Kauaopuu Ridge of the Waianae Mountains, Oahu, at 330 meters (1,083 feet) elevation, was characterized for habitat and leaf functional traits. Small leaf area, high leaf mass per area, and low nitrogen concentration indicated that this species has adapted to dry, mostly open habitat. These traits also indicate that this species exhibits slow respiration and growth, and the production of long-lived leaves that function even under harsh xeric conditions (Maggie Sporck, University of Hawaii, pers. comm. 2010). Hawaiian *Chamaesyce* species are uniquely classified as C4 photosynthetic. C4 plants usually have a leaf anatomy that allows the plant to grow in high light conditions with low moisture availability, and are usually characterized as grasses. The taxa within the Hawaiian *Chamaesyce* are the only trees with C4 photosynthetic leaves known to science (M. Sporck pers. comm. 2010; University of Hawaii 2010).

While this species was identified from Moku Manu, an offshore islet of Oahu, and Waianae locations other than Lualualei in the past (USFWS 1991, 1998, 2003), at present it appears to be growing only in the Lualualei area in the Waianae mountains of Oahu.

Several hundred individuals of *Chamaesyce kuwaleana* were observed from 1987 to 1994. On Oahu at Kauaopuu Peak (on the border of Wahiawa and Waianae Districts, on a ridge separating Lualualei from Waianae Kai), approximately 500 individuals were seen at 274 meters (900 feet) elevation and another 50 individuals at 280 meters (920 feet) elevation (Hawaii Biodiversity and Mapping Program 2010; Perlman 2009; Wood 2009). Approximately 200 mature individuals with additional seedlings located at Waianae Kai-Lualualei Ridge were reported in 2004 by Joel Lau of the Hawaii Biodiversity and Mapping Program (Hawaii Biodiversity and Mapping Program 2010).

Puu Kailio had approximately 1,000 individuals at 448 meters (1,470 feet) elevation in 1994, and probably still has somewhere between 700 and 1,000 individuals (Wood 2009). Approximately 50 individuals were seen in 2004 on the west side of Kolekole Pass, in Lualualei at 869 meters (2,850 feet) elevation (Ken Wood, Research Biologist, National Tropical Botanical Garden, pers. comm. 2009). Extensive surveys have not been conducted for this species since 1994. Currently, only about 250 individuals are known from two subpopulations, with a third subpopulation estimated to still contain 700 to 1,000 individuals. All three subpopulations are on the same ridge within 2.4 kilometers (1.5 miles) of one another, which suggests a total of one population containing 950 to 1,250 individuals (Hawaii Biodiversity and Mapping Program 2010; Wood pers. comm. 2009).

A population at Kolekole Pass was described in 2004 as most likely a hybrid swarm between *Chamaesyce multiformis* and *C. kuwaleana*. It was a small leafed form, 10 to 25 centimeters (4 to 10 inches) tall, thickly branched, with stems medium brown or red-brown, leaves medium green or tinged red and reflexed (bent backward or downward), and immature fruit green or turning red (Wood 2009).

The members of the genus *Chamaesyce* have been moved to the genus *Euphorbia*. Earlier there was some consensus among taxonomists to remove *Chamaesyce* from *Euphorbia*. However, Steinmann and Porter (2002) disagreed that *Euphorbia* should be divided, and their conclusions were supported by many taxonomists (Bruyns *et al.* 2006). Steinmann and Porter's solution to the problem of Euphorbiinae classification was to expand *Euphorbia* to encompass all members of the subtribe, which includes *Chamaesyce*. They favored this solution as being the least disruptive of current usage, and not requiring the creation of new genera to encompass all the *Euphorbia* species not within the subgenus *Euphorbia*, which would be 90 percent of the species currently in the genus (Steinmann and Porter 2002). This is the treatment supported by Wagner, author of the Flora of the Hawaiian Islands (Warren Wagner, Smithsonian Institution, pers. comm. 2009). Therefore, this species will be referred to as *Euphorbia kuwaleana* in the remainder of this review.

At Puu Kailio, the habitat is degraded lowland shrubland with associated native species including *Artemisia* sp. (ahinahina), *Bidens torta* (kookoolau), *Carex meyenii* (no common name [NCN]), *Dodonaea viscosa* (aalii), *Doryopteris* sp. (NCN), *Eragrostis variabilis* (kawelu), *Heteropogon contortus* (pili), *Lobelia niihauensis* (NCN), *Panicum beecheyi* (NCN), *Schiedea ligustrina* (NCN), *Sida fallax* (ilima), and *Waltheria indica* (uhaloa) (Perlman 2009; Wood 2009). In Kauaopuu, the habitat is also degraded lowland shrubland with *Artemisia* sp., *Bidens* sp., *Carex* sp. (NCN), *Chamaesyce* sp. (akoko), *Dodonaea viscosa*, *Heteropogon contortus*, and *Plectranthus parviflorus* (ala ala wai nui) (USFWS 2003; Wood 2009). On the west side of Kolekole Pass, *Euphorbia kuwaleana* occurs on vertical open basalt cliffs with lichens, shrubs of *Bidens torta*, *Carex wahuensis* (NCN), *Chamaesyce multiformis* (akoko), *Cyperus phleoides* (NCN), *Deschampsia nubigena* (hairgrass), *Leptecophylla tameiameiae* (pukiawe), and *Metrosideros polymorpha* (ohia) (Wood 2009).

Fire is a threat to this species (Perlman 2009; Wood 2009) and has damaged individuals in the Waianae Mountains in the past (Hawaii Biodiversity and Mapping Program 2010). Invasive introduced plant species in this area include *Acacia confusa* (formosa koa), *Acacia farnesiana* (klu), *Ageratina riparia* (spreading mist flower), *Bryophyllum pinnatum* (airplant), *Cenchrus ciliaris* (buffelgrass), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Opuntia ficus-indica* (prickly pear), *Psidium cattleianum* (strawberry guava), and *Schinus terebinthifolius* (Christmasberry). Feral animals including pigs (*Sus scrofa*) and goats (*Capra hircus*) degrade the habitat, causing erosion and landslides which further imperil this species (Perlman 2009; Wood 2009).

Seed predation by rats (*Rattus* spp.) and consumption of leaves and stems by slugs (unidentified species) are threats to *Euphorbia kuwaleana* (Perlman 2009; Wood 2009). Yellowing of leaves, believed to be associated with two-spotted leaf hopper (*Sophonia rufofascia*), was observed in the Kauaopuu population (Hawaii Biodiversity and Mapping Program 2010).

Climate change may also 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) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

Euphorbia kuwaleana is in storage at the Harold L. Lyon Arboretum Micropropagation Laboratory (Harold L. Lyon Arboretum 2008). The National Tropical Botanical Garden has 50 seeds from Kauaopuu Peak, collected in 1994, in long-term storage (National Tropical Botanical Garden 2009).

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for plants from the island of Oahu (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Euphorbia kuwaleana* is a short-lived perennial, and to be considered stable, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on the island of Oahu. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population.

The interim stabilization goals for this species have not been met (Table 1). Based on the most current surveys, only two populations contain more than 50 mature individuals and all threats are not being managed (Table 2). Therefore, *Euphorbia kuwaleana* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Conduct surveys to determine current status of the species.

- Collect seeds from each population for genetic storage and potentially, for reintroduction.

- Determine if augmentation and/or reintroduction are necessary for this species.

- Control rats in the vicinity of these populations.

- Develop and implement an effective control method for slugs.

- Develop and implement effective control methods for the two-spotted leaf hopper.

- Work with Hawaii Division of Forestry and Wildlife and U.S. Navy to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.

References:

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Wood, K.R. 2009. Notes on *Euphorbia* (*Chamaesyce*) *kuwaleana*. National Tropical Botanical Garden, Kalaheo, Hawaii. 3 pages. Unpublished.

Personal Communications:

Sporck, Maggie J. 2010. Ph.D candidate, University of Hawaii Botany Department, Honolulu, Hawaii. E-mail to Margaret A. Clark, National Tropical Botanical Garden, dated December 17, 2010. Subject: 5 year review, summary and evaluation of *Euphorbia* (*Chamaesyce*) *kuwaleana;* unpublished contributed data.

Wagner, Warren. 2009. Research Botanist and Curator, Chair of Botany, Smithsonian Institution, Washington, D.C. E-mail to Margaret A. Clark, National Tropical Botanical Garden, dated December 10, 2009. Subject: Chamaesyce to Euphorbia name change.

Wood, K.R. 2009. Research Biologist, National Tropical Botanical Garden, Kalaheo, Hawaii. E-mail to Margaret A. Clark, National Tropical Botanical Garden, dated December 16, 2009. Subject: *Chamaesyce kuwaleana*.

Table 1. Status of *Euphorbia kuwaleana* from listing through 5-year review.

Date	No. wild indivs	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1991 (listing)	several 100		All threats managed in all 3 populations	No
			Complete genetic storage	Unknown
			3 populations with 50 mature individuals each	No
1998 (recovery plan)	2,000		All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Yes
2003 (critical habitat)	2,000		All threats managed in all 3 populations	No
			Complete genetic storage	Unknown
			3 populations with 50 mature individuals each	Unknown
2010 (5-year review)	950-1,250		All threats managed in all 3 populations	No (Table 2)
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No

Table 2. Threats to *Euphorbia kuwaleana*.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – habitat modification and herbivory	A, C, D	Ongoing	No
Rats – herbivory	C	Ongoing	No
Slugs – herbivory	C	Ongoing	No
Two spotted leaf hopper – herbivory	C	Ongoing	No
Invasive introduced plants	A, E	Ongoing	No
Fire	E	Ongoing	No
Climate change	A, E	Increasing	No

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Chamaesyce kuwaleana* ('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

Field Supervisor, Pacific Islands Fish and Wildlife Office

Date 8/2/11