Euphorbia remyi var. *remyi*
(‘Akoko)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

5-YEAR REVIEW

Species reviewed: *Euphorbia remyi* var. *remyi* (‘Akoko)

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5-YEAR REVIEW
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1.0 GENERAL INFORMATION

1.1 Reviewers:

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Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the 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 in June 2016. The review was based on the final rule listing this species; the final critical habitat designation; the recovery outline; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawaii, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Gregory Koob, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:

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

1.3.2 Listing history:

Original Listing
FR notice: USFWS. 2010a. Endangered and threatened wildlife and plants; determination of endangered status for 48 species on Kauai and designation of critical habitat, final rule. Federal Register 75(70): 18960–19165.
Date listed: April 13, 2010
Entity listed: Species
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings:

N/A

1.3.4 Review History:

This is the first 5-year review for this species. *Euphorbia remyi* var. *remyi* is a shrub that was listed as endangered, with designation of critical habitat, on April 13, 2010 (USFWS 2010a). The recovery outline for *E. remyi* var. *remyi* is included in the recovery outline for the Kauai Ecosystem, published in 2010 (USFWS 2010b). A draft recovery plan is in preparation.

1.3.5 Species' Recovery Priority Number at start of this 5-year review:

At the start of the 5-year review, the Recovery Priority Number proposed for *Euphorbia remyi* var. *remyi* is 6 (using the USFWS scale of 1 to 18), based on the high degree of threat, a moderate potential for recovery with some threats that are well understood and easily alleviated and others that are currently difficult to alleviate, and its status as a variety (USFWS 2010b).

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: USFWS. 2010b. Recovery outline for the Kauai ecosystem. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pages.
Date issued: June 17, 2010
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

_____ ***Yes***
__X__ ***No***

2.1.2 Is the species under review listed as a DPS?

____ ***Yes***

___ ***No***

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes***

___ ***No***

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ ***Yes***

____ ***No***

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ ***Yes***

____ ***No***

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ ***Yes***

___ ***No***

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

___ ***Yes***

_X_ ***No***

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

_____ ***Yes***

_____ ***No***

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

_____ ***Yes***

_____ ***No***

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

A synthesis of the threats (Factors A, B, C, D, and E) affecting this species is presented in section 2.3.2.

The recovery plan is currently being drafted. However, the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so USFWS also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, USFWS has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. A species with a narrow extant range is one currently known from one or two adjacent gulches or ridges within the same mountain range. Some species have historically been known from only one population. For these species, given the limited information known of their habitat requirements, the number of mature individuals needed to prevent extinction was doubled within the known population rather than expanding the known range of the species for preventing extinction and the interim stage. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

To prevent extinction of *Euphorbia remyi* var. *remyi* (a short-lived species with no specific characteristics known) the species needs a minimum of three

populations consisting of 50 mature individuals per population. In addition to achieving the numbers of reproducing individuals, all major threats must be controlled in the immediate vicinity of the populations, each population must show evidence of some stage of natural reproduction (*i.e.*, viable seeds or seedlings), and 50 mature individuals from each of three populations, or total number of individuals if fewer than 50 remain, must be represented in an *ex situ* collection that is secure and well managed.

The goals for the number of populations and number of plants per population have been met (see Table 1). Other goals have not. As they are also necessary to meet Interim Stabilization goals (described below), this taxon will be evaluated at the Interim Stage.

Interim Stage

To meet the interim stage of recovery of *Euphorbia remyi* var. *remyi*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant *et al.* 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target

populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

A recent study has confirmed that the Hawaiian species of *Euphorbia* are a diverse and unique lineage, with a North American origin. DNA analysis suggests that extensive hybridization was involved in the evolution of Hawaiian *Euphorbia*. C_4 photosynthesis is a physiological and anatomical system commonly associated with plants adapted to warm, dry climates. In the Hawaiian Islands there are many *Euphorbia* that use the C_4 system including *Euphorbia remyi* var. *remyi* that grow in mesic (wetter) habitats or have evolved into woody plants and trees, which is highly unusual for plants using this type of photosynthetic process (Yang and Berry 2011). Little else is known about the life history of *E. remyi* var. *remyi*. This species has been observed flowering in March, April, June, August, October, and December (NTBG 2009, 2012a, 2013a-b, 2014a, 2015a-b). Its pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS 2010a).

Euphorbia remyi var. *remyi*, is a vine-like, perennial shrub in the spurge family (Euphorbiaceae). Stems are erect to scandent (climbing) and 0.3 to 2 meters (1 to 6.6 feet) long. Leaves are oppositely arranged with each succeeding pair set at right angles to the previous pair, elliptic to oblong or broadly lanceolate in shape, 35 to 165 millimeters (mm) (1.4 to 6.5 inches (in)) long, and 15 to 75 mm (0.6 to 3 in) wide. Inflorescences are solitary cyathia (an inflorescence consisting of a cuplike cluster of modified leaves enclosing a female flower and several male flowers) with glabrous capsules protruding well beyond the top. Seeds are white to brown, 2 to 3

mm (0.08 to 0.12 in) long, and smooth to shallowly rugose (wrinkled) (Wood 1998; Koutnik 1999).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Euphorbia remyi var. *remyi* is historically known from widely distributed populations on Kauai (HBMP 2010). In 2010, *E. remyi* var. *remyi* was found in 10 populations totaling a little more than 350 individuals at Kalalau-Honopu, Koaie Canyon, Limahuli, Limahuli-Hanakapiai, Lumahai, Makaleha, Malamamaiki, Pohakupili, Puu Kolo and Wahiawa Drainage, (Wood 1998; HBMP 2010). Currently, there are approximately 11 populations totaling 300 individuals at Awaawapuhi, Iliiliula, Iole, Kalalau-Honopu, Kapalaoa, Lumahai, Waiahi, Wainiha, and the Wahiawa drainage including Kanaele Bog and Laauhihaihai (Wood 2000; HBMP 2010; NTBG 2009, 2010a-c, 2012a-c, 2013a, c-d, 2014b-c-, 2015a-b).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

First described as *Euphorbia remyi* by Boissier (*in* de Chandolle 1862), and transferred to *Chamaesyce remyi* in 1936 (Degener and Degener 1960), this species was recognized as *Chamaesyce remyi* var. *remyi* by Koutnik in Wagner *et al.* (1999). Steinmann and Porter (2002) studied the phylogenetic relationship of the tribe Euphorbieae, in the Euphorbiaceae. As a result of their work, *Chamaesyce* is no longer recognized as a separate genus from *Euphorbia*. This change in genus is recognized in the most recent treatment of the Hawaiian flora (Wagner *et al.* 2012). In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Chamaesyce remyi* var. *remyi* to *Euphorbia remyi* var. *remyi* (80 FR 35860, June 23, 2015b). The taxonomic change does not affect the range or endangered status of this species.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

See section 2.3.1.2 above for spatial distribution of the species.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Euphorbia remyi var. *remyi* is found in mesic to wet *Metrosideros polymorpha* (ohia)—*Dicranopteris linearis* (uluhe) forest between 366 to 900 meters (1,200 to 3,000 feet) elevation (HBMP 2010; TNCH 2007). At Awaawapuhi to Honopu-Kalalau the associated native plant species include *Acacia koa* (koa), *Alphitonia ponderosa* (kauila), *Alyxia stellata* (maile), *Antidesma platyphyllum* (hame), *Bobea brevipes* (ahakea lau lii), *Chrysodracon aurea* (hala pepe), *Dodonaea viscosa* (aalii), *Ilex anomala* (kawau), *Kadua affinis* (manono), *Leptechophylla tameiameiae* (pukiawe), *Melicope* spp. (alani), *Myrsine* spp. (kolea), *Nestegis sandwicensis* (olopua), *Planchonella sandwicensis* (alaa), *Polyscias* spp. (ohe), *Psychotria* spp. (kopiko), *Syzygium sandwicensis* (ohia ha), *Xylosma hawaiiensis* (maua), and *Zanthoxylum dipetalum* (kawau) (HBMP 2010; NTBG 2013c, 2014c, 2015a).

At Wainiha to Lumahai the associated native species include a rich fern understory with *Antidesma platyphyllum*, *Cheirodendron* spp. (olapa), *Coprosma* spp. (pilo, koi), *Cyrtandra* spp. (haiwale), *Dubautia* spp. (naenae), *Labordia* spp. (kamakahala), *Perrottetia sandwicensis* (olomea), *Polyscias* ssp., *Psychotria* spp., and *Syzygium sandwicensis* (NTBG 2014b).

At Iole to Waiahi the associated native plant species include *Alyxia stellata* (maile), *Antidesma platyphyllum, Alyxia stellata* (maile), *Broussaisia arguta*, *Coprosma kauaense*, *Cyanea* spp., *Cyrtandra* spp., *Dubautia* spp., *Elaeocarpos bifidus* (kalia), *Freycinetia arborea* (ie ie), *Ilex anomala*, *Kadua affinis*, *Labordia waialealae* (kamakahala lau lii), *Machaerina* spp. (uki, ahaniu), *Melicope* spp., *Myrsine* spp., *Peperomia hesperomannii* (ala ala wai nui), *Perrottetia sandwicensis*, *Pipturus* spp. (mamaki), *Pittosporum glabrum* (hoawa), *Polyscias* spp., *Pritchardia hardyi* (loulu), *Psychotria* spp., *Sadleria* spp. (amau), *Scaevola* spp. (naupaka), *Smilax melastomifolia* (hoi kuahiwi), *Syzygium sandwicensis*, *Touchardia latifolia* (olona), and *Vaccinium calycinum* (ohelo) (NTBG 2012b, 2013a-b, d, f).

At Wahiawa, Kanaele Bog, and Laauhihaihai the associated native plant species include *Antidesma platyphyllum*, *Bobea brevipes*, *Broussaisia arguta*, *Cheirodendron* spp., *Cyanea* spp. (haha), *Dicranopteris* spp., *Dubautia* spp., *Freycinetia arborea*, *Gahnia beecheyi* (NCN), *Ilex anomala*, *Kadua affinis*, *Labordia tinifolia*, *Lobelia kauaensis* (pue), *Machaerina angustifolia*, *Melicope* spp., *Metrosideros* spp. (ohia), *Myrsine helleri* (oliko), *Platydesma rostrata* (pilo kea lau lii), *Polyscias* spp., *Pritchardia flynnii* (loulu), *Psychotria mariniana*, *Sadleria pallida*,

Scaevola spp., *Sphenomeris chinensis* (palaa), *Syzygium sandwicensis*, and *Wikstroemia oahuensis* (akia) (NTBG 2010a-c, 2013e).

2.3.1.7 Other:

N/A

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range (Factor A):

Ungulate degradation of habitat—Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral ungulates are noted to be a threat to individuals of *Euphorbia remyi* var. *remyi* that occur at Honopu-Kalalau, Wainiha, Lumahai, Iliiliula, Iole, Wahiawa, and Laauhihaihai (Wood 2000, HBMP 2010; NTBG 2010b-c, 2012b-c, 2013c, 2014b-c, 2015a-b).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Euphorbia remyi* var. *remyi* are: *Adiantum hispidulum* (rough maidenhair fern), *Andropogon glomeratus* (bushy beardgrass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyclosorus dentatus* (paiiiha), *Cyperus meyenianus* (NCN), *Ehrharta stipoides* (meadow ricegrass), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Melastoma septemnervium* (NCN), *Morella faya* (firetree), *Oplismenus hirtellus* (basketgrass), *Paspalum conjugatum* (Hilo grass), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Pterolepis glomerata* (NCN), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), *Setaria parviflora* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2010a, 2012b-c, 2013b-d, f, 2014b-c, 2015b).

Landslides and flooding destruction or degradation of habitat—Individuals of *Euphorbia remyi var. remyi* occur on cliffs at Lumahai, Kalalau, and Wahiawa (Wood 2000; HBMP 2010; NTBG 2009, 2010b). Large herds of feral ungulates browse and cause erosion in the area where this species occurs (HBMP 2010; NTBG 2009). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985).

Hurricanes—Loss and degradation of habitat—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. 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).

Climate change loss or degradation of habitat—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. This assessment concluded that *Euphorbia remyi* var. *remyi* is vulnerable to the impacts of climate change with a vulnerability score of 0.498 (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.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):

Not a threat.

2.3.2.3 Disease or predation (Factor C):

Rodent predation or herbivory—Herbivory by rats (*Rattus* spp.) has been

noted as a threat to *Euphorbia remyi* var. *remyi* at Honopu, Kalalau, Awaawapuhi, Wainiha, Iole, Waiahi, Kanaele, and Wahiawa (HBMP 2010; NTBG 2009, 2010a, c, 2012a-c, 2013a-b, e-f, 2014a, c, 2015a-b). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

Invertebrate predation or herbivory—Infestation by the nonnative two-spotted leafhopper (*Sophonia rufofascia*) is noted to be a threat to *Euphorbia remyi* var. *remyi* at the Lumahai population (Wood 2000). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

Slug herbivory—Herbivory by slugs is noted to be a threat to the Wainiha, Iole, and Waiahi populations of *Euphorbia remyi* var. *remyi* (NTBG 2013b, d, f, 2014b; U.S. Army Garrison 2005).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

Lack of adequate hunting regulations—Historically known populations of *Euphorbia remyi var. remyi* at Koaie, Malamalamaiki, Papaa, Kamalii, and Makaleha were within state hunting areas. The currently known individuals of this species at Honopu-Kalalau are within state hunting areas. Feral pigs, goats, and deer, and the effects of their activities are noted to be a threat to *E. remyi* var. *remyi*. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Only those occurrences within Wainiha Preserve are provided some protection from ungulates by fencing. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010).

Lack of adequate biosecurity legislation—Introduction of invasive nonnative plant species to the State of Hawaii, destruction of habitat and competition by nonnative plants and predation by nonnative invertebrates are threats to *Euphorbia remyi* var. *remyi*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma *et al.* 2002).

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):

Invasive species—Established invasive plant species competition—Nonnative plant species including *Adiantum hispidulum, Andropogon glomeratus, Axonopus fissifolius, Blechnum appendiculatum, Buddleja asiatica, Clidemia hirta, Cyclosorus dentatus, Cyperus meyenianus, Ehrharta stipoides, Erigeron karvinskianus, Hedychium gardnerianum, Juncus planifolius, Kalanchoe pinnata, Lantana camara, Melastoma septemnervium, Morella faya, Oplismenus hirtellus, Paspalum conjugatum, Passiflora tarminiana, Psidium cattleianum, P. guajava, Pterolepis glomerata, Rhodomyrtus tomentosa, Rubus argutus, R. rosifolius, Sacciolepis indica, Setaria parviflora,* and *Sphaeropteris cooperi* compete with *Euphorbia remyi* var. *remyi* for space, water, light, and nutrients (HBMP 2010; NTBG 2010a, 2012b-c, 2013c-d, f, 2014b-c, 2015b).

Current Management Actions:

- Captive propagation for genetic storage and reintroduction—
    - This species is in an *ex situ* collection at NTBG as one plant has been planted on the garden grounds. Twenty-nine seeds and 75 cuttings have been brought to the NTBG nursery and represent three separate collections from Kalalau, Kalihi, and Wainiha (NTBG 2017). Their success is uncertain.
    - In 2012 and 2013, a total of 28 individuals were outplanted in an exclosure at Kanaele Bog (TNCH 2013).
- Invasive plant monitoring and control—
    - Since 2004, the Nature Conservancy of Hawaii has conducted eradication efforts to control *Sphaeropteris cooperi* in Lumahai Valley (TNCH 2008).
    - TNCH has constructed an exclosure fence at Wainiha Preserve, and conducts weed control measures (TNCH 2015).
    - TNCH constructed a protective fence around Kanaele Bog in 2003, with a 10-year management agreement with the landowner (TNCH 2013).
- Ungulate monitoring and control—TNCH received funding from 2009 through 2015 for installation of fencing for ungulate control in Wainiha Preserve.

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

Date	No. wild individuals	No. outplanted	Interim Stabilization Criteria identified by	Interim Stabilization

			HPPRCC	Criteria Completed?
2010 (listing and critical habitat)	< 350	0	All threats managed in all three populations	Partially
			Complete genetic storage	No
			Three populations with 300 mature individuals each	No
2016 (5-year review)	300	28	All threats managed in all three populations	Partially
			Reproduction (*i.e.*, viable seeds, seedlings) at all three populations	Unknown
			Complete genetic storage	No
			Three populations with 300 mature individuals each	Partially

Table 2. Threats to *Euphorbia remyi* var. *remyi* and conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	None
Established ecosystem-altering invasive plant modification and degradation of habitat	A	Ongoing	Partially
Landslides and flooding 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
Rodent predation or herbivory	C	Ongoing	None
Invertebrate predation or herbivory—Two-spotted leafhopper	C	Ongoing	None
Inadequacy of existing regulatory mechanisms—Lack of adequate hunting	D	Ongoing	None

regulations			
Inadequacy of existing regulatory mechanisms—Lack of adequate biosecurity legislation	D	Ongoing	None
Invasive species—Established invasive plant species competition	E	Ongoing	Partially

2.4 Synthesis

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To reach Interim Stabilization, the second 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 storage) 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 and increasing in number, with a minimum of 300 mature individuals per population.

The Interim Stabilization goals for this species have not been met, as there are not three populations with 300 individuals each (Table 1), genetic storage collections are incomplete (Table 1), and not all threats are sufficiently managed throughout the range of the species (Table 2). Therefore, *Euphorbia remyi* var. *remyi* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ **Delist**
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number: ____

Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Surveys and inventories—Survey for populations of *Euphorbia remyi* var. *remyi* in areas of potentially suitable habitat.
- Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations.
- Invasive plant monitoring and control
    - Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
    - Control invasive nonnative plant species around all populations that compete with the species.
- Predator and herbivore control research—Study *Euphorbia remyi* var. *remyi* populations to determine threat from invertebrate herbivory and need for additional recovery actions.
- Invertebrate herbivory monitoring and control—Research and implement effective invertebrate control methods.
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
- Based on the recovery criteria above, consider development of a recovery plan.

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Euphorbia remyi* var. *remyi*
('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

Appropriate Listing/Reclassification Priority Number, if applicable:_____

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

GREGORY KOOB Digitally signed by GREGORY KOOB
Date: 2017.09.13 11:16:55 -10'00'

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