5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Kadua laxiflora* (pilo)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 76 species in Hawaii, Oregon, Washington, Montana, and Idaho. Federal Register 81(29): 7571–7573, February 12, 2016.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

Name of Reviewers:

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 August 2017. The review was based on a review of current, available information since the last 5-year review for *Kadua laxiflora* (as *Hedyotis mannii*) (USFWS 2011). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Gregory Koob, 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 *Kadua laxiflora* (as *Hedyotis mannii*) published in the Federal Register on August 2, 2011 (available at *https://ecos.fws.gov/docs/five_year_review/doc3811.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 *K. laxiflora*.

This short-lived perennial subshrub in the Rubiaceae (coffee) family is endangered and occurs on west Maui, with historical occurrences on Lāna‘i and Moloka‘i. The current status and trends for *Kadua laxiflora* are provided in the tables below.

New Status Information:

- In 2011, the 5-year review reported two populations on Lānaʻi totaling three individuals and six individuals on west Maui. Plants on Molokaʻi were extirpated. Currently, there are two populations totaling 33 individuals at ʻĪao Valley and Honokōhau on west Maui, and no wild individuals are known on Lānaʻi or Molokaʻi (Oppenheimer 2018, in litt.; PEPP 2010, 2011, 2012, 2016, 2017a).
- In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Hedyotis mannii* to *Kadua laxiflora* (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species.
- In 2016, critical habitat was designated on two islands for *Kadua laxiflora*: 12 critical habitat units in three ecosystems (lowland wet, dry cliff, and wet cliff) on west Maui (8,051 ac; 3,259 ha) and two critical habitat units in two ecosystems (lowland mesic and montane mesic) on Molokaʻi (9,586 ac; 3,879 ha) (81 FR 17790, March 30, 2016). The Service excluded critical habitat for this species on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015b; 81 FR 17790, March 30, 2016).

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 Hawaiʻi 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 *Kadua laxiflora* is vulnerable to the impacts of climate change, with a vulnerability score of 0.395 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future.

New Management Actions:

- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of *Kadua laxiflora* on west Maui and Lānaʻi (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017a). The National Tropical Botanical Garden has a recent herbarium specimen (Honokōhau, Maui) and an unknown number of seeds in storage (Hauola, Lānaʻi) collected in 2004 (NTBG 2016, 2017).
- Captive propagation for genetic storage and reintroduction—
    - Currently, there have been *in situ* collections made from individuals from populations at Lānaʻi hale, Lānaʻi (one founder collected), and from Honokōhau (14 of 15 founders collected), Iao (six of 15 founders

collected) and Kauaʻula (one founder collected) on west Maui (PEPP 2017b).

- The Lyon Arboretum Micropropagation Laboratory reports 92 containers of propagules representing at least five individuals from Hauola Gulch on Lānaʻi and two seedlings propagated from collections from Honokōhau, Maui. The Lyon Arboretum Seed Conservation Laboratory reports over 59,000 seeds in storage collected from two or more plants at Lānaʻi hale on Lānaʻi; over 25,000 seeds in storage from 13 wild plants at Honokōhau, west Maui; and almost 9,000 seeds in storage from nine plants at ʻĪao Valley, west Maui (Lyon Arboretum 2018).
- The Olinda Rare Plant Facility (ORPF) reports approximately 10 potted plants propagated from seeds collected from plants at Lānaʻi hale, Lānaʻi, between 2013 and 2017 (ORPF 2013, 2014, 2015, 2017).
- PEPP monitors wild individuals and reintroduces plants on west Maui and Lānaʻi (PEPP 2010-2017a). Currently, on west Maui, the three wild individuals at Kauaʻula have died, there are about 15 plants at Honokōhau, seven outplanted individuals at Waiheʻe, and 18 wild individuals at ʻĪao Valley. Six individuals were reintroduction at Ukumehame, west Maui (PEPP 2018). On Lānaʻi, there are about 12 outplants remaining at Hauola, five outplants in an exclosure at Puhielelu, and 12 outplants in an exclosure at ʻĀwehi (PEPP 2010-2017a).

Synthesis:
Currently, there are 33 wild individuals of *Kadua laxiflora* on west Maui. All wild individuals on Lānaʻi and Molokaʻi are believed to be extirpated. 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 *K. laxiflora* is 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. Genetic representation is complete for one population on Lānaʻi, and nearly complete for the two remaining populations on west Maui. Reintroduction into exclosures is ongoing on Lānaʻi.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Molokaʻi Plant Cluster(USFWS 1996), 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.

Kadua laxiflora 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 Maui and at least one other island where it occurred historically. 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 as there are no populations of at least 50 individuals, and, although genetic representation is nearly complete (Table 1), all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Kadua laxiflora* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.

- Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Lānaʻi and west Maui to determine the current status of all populations of *Kadua laxiflora.* Search historical habitat on Molokaʻi for occurrences of this species.
- Ungulate monitoring and control—Continue to construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *K. laxiflora* from the impacts of feral ungulates.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations.
- Fire destruction or degradation of habitat—Develop and implement fire prevention management plan for Lānaʻi.
- Captive propagation for genetic storage and reintroduction—
    - Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
    - Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
- Reintroduction and translocation—Augment current populations and reintroduce individuals into suitable habitat within historical range that is managed for known threats to this species.
- Rodent predation or herbivory—Implement effective methods to control rats at known populations.
- Invertebrate predation or herbivory—Identify insects that are seed predators and determine need for control methods.

- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species.
- Alliance and partnership development—Work with Hawai‘i Division of Forestry and Wildlife and other land managers on west Maui and Lāna‘i to initiate planning and contribute to implement of ecosystem-level restoration and management to benefit this taxon.

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

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1992 (listing)	2 (Moloka‘i) 9 (Lāna‘i)	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
1996 (recovery plan)	50–65 (Moloka‘i) 2 (Lāna‘i) 1 (Maui)	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
2003 (critical habitat)	5 (Moloka‘i) 35–40 (Lāna‘i) 20 (Maui)	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 50 mature individuals each	No
2011 (5-year review)	3 (Lāna‘i) 6 (Maui)	18	All threats managed in all three populations	No

			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2016 (critical habitat)	0 (Molokaʻi) 2 (Lānaʻi) 4 (Maui)	> 20	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?**
2018 (5-year review)	0 (Molokaʻi) 0 (Lānaʻi) ca 30 (Maui)	ca 40	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 *Kadua laxiflora* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, reintroductions within exclosures
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, some nonnative plant control within exclosures
Landslides and flooding destruction or degradation of habitat	A	Ongoing	None
Fire destruction or degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partial, reintroductions within exclosures
Rodent predation or herbivory	C	Ongoing	None
Invertebrate predation or herbivory	C	Ongoing	None
Stochastic events—Reduced viability due to low numbers	E	Ongoing	Partial, seed collection, propagation, and reintroduction ongoing

References:

See the previous 5-year review for a full list of references (USFWS 2011). Only references for new information are provided below.

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. Hawai‘i Cooperative Studies Unit, University of Hawai‘i at Hilo, Hawai‘i. 134 pp.

[HPPRCC] Hawai‘i and Pacific Plants Recovery Coordinating Committee. 2011. Revised recovery objective guidelines. 8 pp.

Lyon Arboretum. 2018. Micropropagation and seed conservation laboratory databases.

[NTBG] National Tropical Botanical Garden. 2016. NTBG database herbarium specimen detail for *Kadua laxiflora*. 074870, 27 JUL 2016.

[NTBG] 2017. Controlled propagation report.

[ORPF] Olinda Rare Plant Facility. 2013. Controlled propagation report.

[ORPF] 2014. Controlled propagation report.

[ORPF] 2015. Controlled propagation report.

[ORPF] 2017. Controlled propagation report.

Oppenheimer, H. 2018, in litt., GIS data and population information for *Kadua laxiflora*.

[PEPP] Plant Extinction Prevention Program. 2010. PEPP annual report fiscal year 2010 (July 1, 2009-June 30, 2010). 121 pp.

[PEPP] 2011. PEPP annual report fiscal year 2011 (July 1, 2010-June 30, 2011). 200 pp.

[PEPP] 2012. PEPP annual report fiscal year 2012 (July 1, 2011-June 30, 2012). 169 pp.

[PEPP] 2013. PEPP annual report fiscal year 2013 (July 1, 2012-June 30, 2013). 207 pp.

[PEPP] 2014. PEPP annual report fiscal year 2014 (July 1, 2013-June 30, 2014). 185 pp.

[PEPP] 2015. PEPP annual report fiscal year 2015 (July 1, 2014-June 30, 2015). 179 pp.

[PEPP] 2016. Plant Extinction Prevention Program FY 2016 annual report (Oct 1, 2015-Sep 30, 2016), US FWS CFDA Program #15.657; Endangered Species Conservation-Recovery Implementation Funds, Coop Agreement F14AC00174, December 24, 2016, UH Manoa, PCSU, PEPP. 237 pp.

[PEPP] 2017a. Plant Extinction Prevention Program FY 2017 annual report (Oct 1, 2016-Sep 30, 2017), US FWS CFDA program #15.657; Endangered species conservation-recovery implementation funds, Cooperative Agreement F14AC00174, December 12, 2017, UH Manoa, PCSU, PEPP. 235 pp.

[PEPP] 2017b. Statewide species totals *ex situ*, excel table.

[PEPP] 2018. PEPP report for April. Excel table.

[USFWS] U.S. Fish and Wildlife Service. 2011. *Hedyotis mannii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc3811.pdf.*

[USFWS] 2015a. Endangered and threatened wildlife and plants; technical corrections for 54 wildlife and plant species on the list of endangered and threatened wildlife and plants. Federal Register 80 (12) FR 35860–35869, June 23, 2015.

[USFWS] 2015b. Memorandum of understanding between Lanai Resorts, LLC, Castle & Cooke Properties, Inc., and U.S. Department of the Interior, Fish and Wildlife Service. 36 pp.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Kadua laxiflora* (pilo)

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**

GREGORY KOOB Digitally signed by GREGORY KOOB
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