

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Zanthoxylum hawaiiense* (a'e)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawai'i, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Lead Region/Field Office:

Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai'i

Name of Reviewer:

Daniel Adamski, 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 2020. The review was based on a review of current, available information since the last 5-year review for *Zanthoxylum hawaiiense* (USFWS 2015). The evaluation by Daniel Adamski, 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 reviews for *Zanthoxylum hawaiiense* published in the Federal Register on August 27, 2010 (available at: http://ecos.fws.gov/docs/five_year_review/doc3298.pdf) and published in the Federal Register on August 6, 2015 (https://ecos.fws.gov/docs/five_year_review/doc4565.pdf) for a complete review of the species' status, threats, management efforts, and references cited. 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 *Z. hawaiiense*.

This long-lived perennial tree in the *Rutaceae* (Rue) family is endangered and endemic to the islands of Kaua'i, Moloka'i, Lāna'i, Maui, and Hawai'i (USFWS 1996). Now found only on four of the five islands, *Zanthoxylum hawaiiense* was last seen on Lāna'i in 1947

(Hawai‘i Biodiversity Mapping Program (HBMP 2008). The status and trends for *Z. hawaiiense* are provided in the tables below.

New Status Information:

- On Kaua‘i, Moloka‘i, Maui, and the island of Hawai‘i, *Zanthoxylum hawaiiense* is categorized as Rare on Island (ROI) and is monitored by the Plant Extinction Prevention Program [PEPP 2020].
- It is estimated that there are 6 plants remaining on Moloka‘i in two populations (PEPP 2021, in. litt.)
- Currently on Kaua‘i there are 2 individuals in 2 separate locations.
- There are an estimated 40 total individuals on Maui in two populations (PEPP 2021, in. litt.).
- Recent surveys at Pōhakuloa on the island of Hawai‘i reported 493 mature trees and 140 seedlings (PTA 2020). There is one other population on the island of Hawai‘i with 19 individuals (PEPP 2020).
- In 2003, 1 critical habitat unit in 2 ecosystems (lowland dry and mesic forest) was designated for *Zanthoxylum hawaiiense* in northwest Kaua‘i (1292 ac, 523 ha) (68 FR 9116, February 27, 2003). In 2016, 7 critical habitat units in 3 ecosystems (lowland mesic, lowland wet, and montane wet) was designated for *Z. hawaiiense* on eastern Moloka‘i (21,998 ac, 8902 ha) (81 FR 17790, March 30, 2016). In 2016, 14 critical habitat units in 5 ecosystems (lowland dry, lowland mesic, montane mesic, montane dry, and montane subalpine) were designated for *Z. hawaiiense* on Maui 59,363 ac, 24024 ha) (81 FR 17790, March 30, 2016).

New Threat Information:

- 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 *Zanthoxylum hawaiiense* is vulnerable to the impacts of climate change, with a vulnerability score of 0.483 (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, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

New Management Actions:

- Surveys and inventories—PEPP continues to monitor, collect seeds, and attempt airlayers of individuals of *Zanthoxylum hawaiiense* (PEPP 2020, p. 2).
- Ungulate monitoring and control—Fencing is monitored and maintained at several management units on the island of Hawai‘i, and deer mesh collars were installed near trunks of individuals where ungulate browsing was observed (PEPP 2020, pp. 3-7).

- PEPP collected approximately 4,450 seeds from 16 individual trees in one population on the island of Hawai‘i in 2019 (PEPP 2020). Almost all seeds were opened at Volcano Rare Plant Facility after they failed to germinate and were discovered to be empty with no viable embryos inside (VanDeMark pers. comm. 2021).
- Captive propagation for genetic storage and reintroduction—
 - Olinda Rare Plant Facility (ORPF) reported 3 *Zanthoxylum hawaiiense* plants in storage in 2020 representing 2 wild individuals, one each from Maui and Moloka‘i (ORPF 2020).
 - National Tropical Botanic Garden (NTBG) reports 67 seeds in storage representing 3 founders from Maui (NTBG 2020).
 - The Lyon Seed Conservation Laboratory at Lyon Arboretum reports 722 seeds in storage from 44 founders. Seeds from 41 of the founders are maintained for genetic storage, while seeds from 3 founders are utilized for research (Lyon Arboretum 2020). However, no seeds germinated and these are from the same collection where VRPF found almost no viable seeds; this collection is therefore not expected to be viable.
 - The Pōhakuloa Controlled Propagation Facility (PCPF) reported 6 individual plants from 2 founders (PCPF 2020).
 - The Volcano Rare Plant Facility (VRPF) reported 4 individual plants maintained in propagation (VRPF 2020).
- Reintroduction—VRPF reported 45 individuals were outplanted between 2019-2020 at Pu‘u Wa‘awa‘a (VRPF 2020).

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

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	166+	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1996 (recovery plan)	250	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2003 (critical habitat)	203	Unknown	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially

			3 populations with 25 mature individuals each	No
2010 (5-year review)	550	Unknown	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2015 (5-year review)	916	24	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	Yes
Date	No. wild individuals	No. outplanted	*Preventing Extinction Criteria identified by HPPRCC	*Preventing Extinction Criteria Completed?
2021 (5-year review)	560 mature plants	45	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			Natural reproduction at all 3 populations	Partially, seedlings at PTA
			3 populations with 50 mature individuals each	Partially, 1 population

* 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 stage after Preventing Extinction).

Table 2. Threats to *Zanthoxylum hawaiiense* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, fence exclosures at PTA and Pu'u Wa'awa'a
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, weeds controlled at PTA and Pu'u Wa'awa'a
Drought destruction and degradation of habitat	A	Ongoing	None
Rodent predation or herbivory	C	Ongoing	Partial
Invertebrate predation or herbivory	C	Ongoing	None
Slug herbivory	C	Ongoing	None
Landslides and Erosion	E	Ongoing	None
Fire	E	Ongoing	None
Climate change degradation or loss of habitat, including hurricanes	E	Ongoing	None

Synthesis:

Currently there are 560 mature plants of *Zanthoxylum hawaiiense* on the islands of Kaua'i, Maui, Moloka'i, and Hawai'i, with over 100 seedlings observed at the largest population on Hawai'i. 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 *Zanthoxylum hawaiiense* is vulnerable to the effects of climate change. Individuals are provided protection by fencing and nonnative plant control. Seed collections, propagation, and outplanting are ongoing, though recent seed collections yielded little to no viable seeds.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Big Island II: addendum to the recovery plan for Big Island plant cluster (USFWS 1996) 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.

Zanthoxylum hawaiiense is a long-lived perennial tree. To prevent extinction, which is the first milestone 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 *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three populations should be documented on the islands of

Kaua‘i, Moloka‘i, Lāna‘i, Maui, and/or Hawai‘i 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 25 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. Although there are some individuals in genetic storage (Table 1), there is only one population totaling at least 25 reproducing individuals, and all threats are not being managed (Table 1, Table 2). Therefore, *Zanthoxylum hawaiiense* 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 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021.

- Surveys and inventories—
 - The historical range of *Zanthoxylum hawaiiense* should be surveyed intensively and determine if historical populations are extirpated.
 - Determine sites that have the highest likelihood of maintaining reintroductions.
- Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates.
- Invasive plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with *Zanthoxylum hawaiiense*.
- Site and habitat protection—Develop and implement effective control measures to reduce the impact of drought.
- Fire monitoring and control—Continue to develop and implement fire prevention management plans.
- Predator and herbivore monitoring and control—Determine and implement effective methods to control insect pests, including the black twig borer.
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction.
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy.
- Population biology research—
 - Determine which species may act as pollinators and which may assist with fruit dispersal.
 - Conduct genetic studies to determine genetic variation within the population (and between populations) and plan an effective breeding program.
- Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species.

- 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.

References:

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.

[HBMP] Hawai‘i Biodiversity and Mapping Program. 2010. Plant species GIS data and Access species database.

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

Lyon Arboretum. 2020. Report on controlled propagation of listed 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, Hawai‘i.

[NTBG] National Tropical Botanic Garden. 2020. Report on controlled propagation of listed 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, Hawai‘i.

[PEPP] Plant Extinction Prevention Program. 2020. Annual report for plant extinction prevention program fiscal year 2020 (July 1, 2019-June 30, 2020). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

[PEPP] Plant Extinction Prevention Program, 2021. Notes and evaluation of multi-island species on PEPP list. Unpublished report submitted to U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

[PCPF] Pohakuloa Control Propagation Facility. 2020. 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, Hawai‘i.

[PTA] Pōhakuloa Training Area. 2020. Annual report for Pōhakuloa Training Area, Hawai‘i island, Hawai‘i. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i. 95pp.

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- [USFWS] 2010. *Zanthoxylum hawaiiense* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI.
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https://ecos.fws.gov/docs/five_year_review/doc4565.pdf.
- [USFWS] 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Moloka‘i, Lanai, Maui, and Kahoolawe for 135 species; final rule. 81 FR 17790, March 30, 2016.
- [USFWS] 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawai‘i, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.
- [VRPF] Volcano Rare Plant Facility. 2020. 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, Hawai‘i.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Zanthoxylum hawaiiense* (a'e)

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

_____ Date _____