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. 2013. Endangered and threatened wildlife and plants; Initiation of 5-year status reviews of 44 species in Oregon, Hawaii, Guam, and the Northern Mariana Islands. Federal Register 78(24):8185-8187.

Lead Region/Field Office:

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

Name of Reviewer(s):

Chelsie Javar-Salas, Plant Biologist, PIFWO

Marie Bruegmann, Plant Recovery Coordinator, PIFWO

Kristi Young, Programmatic Deputy Field Supervisor, 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 4, 2013. The review was based on a review of current, available information since the last 5-year review for *Zanthoxylum hawaiiense* (USFWS 2010). The evaluation by Chelsie Javar-Salas, Plant Biologist, was reviewed by the Plant Recovery Coordinator. It was subsequently reviewed and approved by the Programmatic Deputy Field Supervisor.

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 at: *http://ecos.fws.gov/tess_public*.

Review Analysis:

Please refer to the previous 5-year review for *Zanthoxylum hawaiiense* published on August 27, 2010 (available at: *http://ecos.fws.gov/docs/five_year_review/doc3298.pdf*) for a complete review of the species’ status, threats, and management efforts. No significant new information regarding the species’ biological status has come to light since listing to warrant a change in the Federal listing status of *Z. hawaiiense*.

This long-lived perennial is endangered and historically known from the islands of Kauai, Molokai, Lanai, Maui, and Hawaii (USFWS 1996). Now found only on four of the five islands, *Zanthoxylum hawaiiense* was last seen on Lanai in 1947 (Hawaii Biodiversity Mapping Program 2008). The status and trends for *Z. hawaiiense* are provided in the tables below.

New status information:

- On Kauai, Molokai, and Maui, *Zanthoxylum hawaiiense* is categorized as Rare on Island (ROI) and is monitored by the Plant Extinction Prevention Program [PEPP]. On Hawaii Island, the numbers exceed 50 individuals in the wild and, thus; this species is not a priority for PEPP.
- On Kauai, *Zanthoxylum hawaiiense* was observed at Kawaiiki Ridge in 2013 (Wood 2013) and Koaia Canyon in 2012 (Tangalin 2012). There are two wild individuals on Kauai (PEPP 2014).
- On Molokai and Maui, this species is known from 5 or 6 populations totaling 14 individuals in 2008 (Hawaii Biodiversity and Mapping Program 2008). On Molokai, there are three mature individuals at Kamalo and Makolelau Gulch (Perlman 2001; PEPP 2014). On West Maui, there are approximately 48 individuals (PEPP 2014). On East Maui, there are three individuals (Wood 2007; PEPP 2009).
- On Hawaii Island, approximately 210 widely scattered individuals were observed within the Puu Waawaa Forest Reserve and Puu Anahulu Game Management Areas in 2003 to 2007 botanical surveys (State of Hawaii Department of Land and Natural Resources [DLNR] 2015). *Zanthoxylum hawaiiense* is relatively abundant and widely distributed at Pohakuloa Training Area (PTA); the most recent surveys reported approximately 650 individuals (U.S. Army 2012). Eighty percent of the plants at Pohakuloa Training Area grow in single occurrences and reproduction in this species has become problematic. The widely scattered distribution and dioecious (male and female flowers on separate plants) behavior of this species may suggest that larger areas are required to maintain viable populations for the survival and recovery of *Z. hawaiiense*.
- Overall, the numbers of individuals have increased from the approximately 550 wild individuals reported in the previous 5-year review to approximately 916 wild individuals in 2015.

New threats:

- Invasive species degradation of habitat – Established invasive plant species competition –
    - The wild population on east Maui is threatened by *Bocconia frutescens* (tree poppy), *Melinis minutiflora* (molasses grass), *Melinis repens* (natal red top), and *Neonotonia wightii* (glycine) (PEPP 2010).
    - On Kauai, *Schinus terebinthifolius* (Christmasberry) is a threat to the wild population (PEPP 2012).
- Ungulate herbivory – Feral axis deer (Axis axis) are a threat to the population on Maui (PEPP 2012)
- Stochastic events – Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *Z. hawaiiense* (U.S. Army 2012; PEPP 2012, 2014).
- Slug predation or herbivory – On Molokai, herbivory by slugs were reported as a threat (PEPP 2013).
- Landslides and flooding degradation of habitat – Erosion is a threat to this species on West Maui (PEPP 2012) and on Kauai (PEPP 2014).

New management actions:

- Surveys / inventories
  - A survey discovered approximately 85 new locations of *Z. hawaiiense* at PTA (U.S. Army 2015).
  - In 2012, a survey conducted on West Maui found 20 additional plants (PEPP 2012). In 2013, another survey was conducted below the known population and discovered three new individuals (PEPP 2014).
- Ungulate monitoring and control – In May 2014, a damaged 10-acre fenced exclosure in Upper Puu Anahulu/Puu Waawaa was repaired and will provide protected habitat for reintroducing individuals of *Z. hawaiiense* and other dry to mesic plants (DLNR 2014a).
- Captive propagation for genetic storage and reintroduction
  - The Volcano Rare Plant Facility (2013) has a single individual in their nursery. The Facility propagated two plants for reintroduction next year. Meanwhile, two individuals were reintroduced at Puu Waawaa. In 2014, the Volcano Rare Plant Facility had a single individual in their nursery and a single individual was reintroduced at Puu Waawaa (Volcano Rare Plant Facility 2014).
  - The Olinda Rare Plant Facility (2013) has one potted plant in their nursery.
  - The Lyon Arboretum's Seed Conservation Laboratory (2014) had 54 seeds from Molokai in storage; however, only four seeds remain in storage after conducting viability trials.
  - The Natural Resources Office PTA (U.S. Army 2015) has 45 seeds from two founders in genetic storage.
- Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for *Z. hawaiiense*. The trials indicated that seeds from *Z. hawaiiense* had a low germination rate over an extended yearly time span (exact amount of years not specified) and seeds remained viable for more than 10 years (U.S. Army 2015).
- Population viability monitoring and analysis
  - The wild individual on East Maui was monitored for seeds, none was collected (PEPP 2009, 2010, 2012).
  - The population on West Maui was monitored for seeds, none was collected (PEPP 2010). In 2011, the population was monitored again and all known plants were numbered and tagged (PEPP 2012). More than 200 seeds were collected from the ground under three wild individuals. The seeds were sent to Olinda Rare Plant Facility (PEPP 2012).
  - In April of 2012, the wild individual on Kauai was monitored and two air layers were created (PEPP 2012). In August of 2012, the individual was monitored again and one of the air layers died but the other air layer is surviving (PEPP 2013). In September of 2013, the plant was monitored (PEPP 2014). Another single wild individual on Kauai was monitored in March of 2014 (PEPP 2014).
  - In 2013, a single wild individual on Molokai was monitored (PEPP 2013, 2014).
  - The wild population at Kauaula on Maui was monitored and only one of the four trees known from the area was observed (PEPP 2014). That plant was in poor condition and heavily damaged by black twig borers.
- Reintroduction / translocation

- In 2014, two individuals of *Z. hawaiiense* were outplanted at Kipuka Kalawamauna North Fence Unit (U.S. Army 2015).
- During 2002 to 2012, a single individual of *Z. hawaiiense* was reintroduced at Kipuka Alala South Fence Unit; it was monitored in 2014 (U.S. Army 2015).
- At Puu Huluhulu, two individuals were reintroduced during 2002 to 2012, only one plant survived in 2014 (U.S. Army 2015).
- At Puu Waawaa Cone Unit, 22 individuals were reintroduced during 2005 to 2012. Monitoring conducted in 2014 revealed 19 individuals survived (U.S. Army 2015).
- At West Hawaii Veterans Cemetery, two individuals were outplanted during 2008 to 2012, no plants remained in 2014 (U.S. Army 2015).
- In 2013, a single individual was outplanted at Puu Waawaa (DLNR 2014b).

- Rodent predation or herbivory control – A rat trap was installed at the East Maui population with a single individual (PEPP 2010).
- Invertebrate predation or herbivory control – Coretect was applied to the wild population on Kauai to control invertebrate predation (PEPP 2013, 2014).
- Climate change adaptation strategy – 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 *Z. hawaiiense* has low vulnerability to the impacts of climate change.
- Listing and critical habitat designation – Fifteen units of critical habitat for *Z. hawaiiense* was proposed in the lowland dry, lowland mesic, montane mesic, montane dry, and subalpine ecosystems on Maui and 7 units of critical habitat in the lowland mesic, lowland wet, and montane wet ecosystems on Molokai (USFWS 2012). On Lanai, critical habitat for *Z. hawaiiense* was proposed in two units of unoccupied areas in the lowland wet ecosystem. The final rule for critical habitat designations has not been published at the time of this review.

Synthesis:
Stabilizing, downlisting, and delisting objectives are provided in the Big Island II: addendum to the recovery plan for Big Island plant cluster (USFWS 1996), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Zanthoxylum hawaiiense* is a long-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 Hawaii and, if possible, at least one other island where it now occurs or where it occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

The interim stabilization goals for this species have been met only for the number of individuals per population, as there are two populations on Hawaii Island and one population on Maui that contain more than 25 wild mature individuals (Table 1). However, none of the populations are naturally reproducing and increasing in number. In

addition, all threats are not being sufficiently managed throughout all of the populations (Table 2). Therefore, *Zanthoxylum hawaiiense* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status.
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
- Reintroduction / translocation – Additional populations should be established across the species' range to increase the number and occurrences of individuals to account for the dioecious behavior of this species.
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions.
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants.
- Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals.
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures.
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change.
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon.

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

Date	No. wild indivs	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-yr 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-yr review)	ca 916	24	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	Yes

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

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – degradation of habitat and herbivory	A, C, D, E	Ongoing	Partially, fence exclosures at PTA and Puu Waawaa
Invasive introduced plants	A, E	Ongoing	Partially, weeds controlled at PTA and Puu Waawaa
Rodent predation or herbivory – rats	C	Ongoing	Partially, rodents controlled at PTA, snap trap on east Maui
Invertebrate predation – black twig borer	C	Ongoing	None
Slug herbivory (Molokai)	C	Ongoing	None
Military activities	E	Ongoing	Partially, agreements with U.S. Army
Drought	E	Ongoing	None
Fire	E	Ongoing	None
Landslides and erosion	E	Ongoing	None
Climate change	A, E	Increasing	None

References:

See previous 5-year review for a full list of references (USFWS 2010). 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. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Hawaii. 141 pages.

Hawaii Biodiversity and Mapping Program. 2008. Hawaii species database. GIS shapefiles and database. Unpublished.

Perlman, S. 2001. *Zanthoxylum hawaiiense* population information, National Tropical Botanical Garden. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2009. Annual report for plant extinction prevention program fiscal year 2009 (July 1, 2008-June 30, 2009). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2010. Annual report for plant extinction prevention program fiscal year 2010 (July 1, 2009-June 30, 2010). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2012. Annual report for plant extinction prevention program fiscal year 2012 (July 1, 2011-June 30, 2012). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2013. Annual report for plant extinction prevention program fiscal year 2013 (July 1, 2012-June 30, 2013). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2014. Annual report for plant extinction prevention program fiscal year 2014 (July 1, 2013-June 30, 2014). Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2014. Maui nui Plant Extinction Prevention Program monthly report for November 2014. Microsoft Excel worksheet. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[DLNR] State of Hawaii Department of Land and Natural Resources. 2014a. Department of Land and Natural Resources, Division of Forestry and Wildlife, Section 6 interim report for plant restoration and enhancement, threatened, endangered, candidate, and species of concern outplanting, Hawaii. July 1, 2013 – June 30, 2014. Unpublished.

[DLNR] State of Hawaii Department of Land and Natural Resources. 2014b. Department of Land and Natural Resources, Division of Forestry and Wildlife, Section 6 final report for plant habitat management, Natural Area Reserves, Hawaii. July 1, 2013 to December 30, 2013. Unpublished.

[DLNR] State of Hawaii Department of Land and Natural Resources. 2015. Department of Land and Natural Resources, Division of Forestry and Wildlife, 2003-2007 botanical survey data updated 16 April 2015. Microsoft Excel worksheet. Unpublished data submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

Tangalin, N. 2012. Rutaceae: *Zanthoxylum hawaiiense* Hillebr. Specimen ID 065739 . Herbarium database. National Tropical Botanical Garden, Kalaheo, Hawaii. Available online at <http://ntbg.org/herbarium>.

Wood, K.R. 2007. Records of the Hawaii Biological Survey for 2006 part 2: notes: new plant records, rediscoveries, range extensions, and possible extinctions within the Hawaiian Islands. Occasional Papers Bernice P. Bishop Museum 96: 13–17.

Wood, K. 2013. Rutaceae: *Zanthoxylum hawaiiense* Hillebr. Specimen ID 065207 . Herbarium database. National Tropical Botanical Garden, Kalaheo, Hawaii. Available online at <http://ntbg.org/herbarium>.

[U.S. Army] United States Army Garrison. 2012. Final programmatic biological assessment for (1) construction, maintenance, and operation of an infantry platoon battle area; and (2) *Branta sandvicensis* at Pohakuloa Training Area, Island of Hawaii. Prepared by the Natural Resources Office, Directorate of Public Works, United States Army Garrison – Pohakuloa Training Area. March 2012. 274 pp.

[U.S. Army] United States Army Garrison. 2015. FY 2014 annual report for the natural resources office, Pohakuloa Training Area, Island of Hawaii. 84 pages. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[USFWS] U.S. Fish and Wildlife Service. 1996. Recovery plan for the Big Island plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 252 pages.

[USFWS] U.S. Fish and Wildlife Service. 2010. *Zanthoxylum hawaiiense* 5-year review short form summary. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 10 pages.

[USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; listing 38 species on Molokai, Lanai, and Maui as endangered and designating critical habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 species; proposed rule. Federal Register 77(112):34464-34775.

Volcano Rare Plant Facility. 2013. Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. Unpublished.

Volcano Rare Plant Facility. 2014. Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. Unpublished.

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

Appropriate Listing/Reclassification Priority Number, if applicable:_____

for **Programmatic Deputy Field Supervisor, Pacific Islands Fish and Wildlife Office**

Maine M Bluegmann

Date 2015-08-04