5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Eugenia koolauensis* (nīoi)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2022. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status reviews for 167 Species in Oregon, Washington, Idaho, Montana, California, Hawaii, Guam, and the Northern Mariana Islands. Federal Register 87(90):28031–28034, May 10, 2022.

Lead Region/Field Office:

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

Name of Reviewer:

Cheryl Phillipson, Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Recovery Program 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 2023. The review was based on a review of current, available information since the last 5-year review for *Eugenia koolauensis* (USFWS 2019). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Recovery Program 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/ecp/species/742*).

Review Analysis:

Please refer to the previous 5-year reviews for *Eugenia koolauensis* published in the Federal Register on January 18, 2008, August 19, 2013, and September 26, 2019 (available at *https://ecos.fws.gov/docs/tess/species_nonpublish/1173.pdf, https://ecos.fws.gov/docs/tess/species_nonpublish/2072.pdf, and https://ecos.fws.gov/docs/tess/sepcies_nonpublish/2862.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 *E. koolauensis*.

This short-lived perennial shrub or small tree in the Myrtaceae (myrtle) family is endangered and known from the island of O‘ahu and historically from Moloka‘i. The status and trends for *Eugenia koolauensis* are provided in the tables below.

New Status Information:

- Currently, there are four populations that have been monitored in the last five years totaling 19 mature and 95 immature (some of the immature plants were classified as seedlings with a definition of <15 cm tall; without more information however, the seedling age class could not be applied). There may be an additional 6 populations totaling 27 mature and 41 immature, however these populations have not been monitored for the past 8 to 10 years (ANRPO 2023a appendices, p. 330; PEPP 2019–2023). These populations have not varied significantly since the 2020 observations (ANRPO 2020 appendices, p. 331; ANRPO 2021 appendices, p. 368; ANRPO 2022 appendices, p. 482; ANRPO 2023a appendices, p. 330), though most have declined substantially since the introduction of myrtle rust in 2005. In 2022, a census was conducted at four populations (Pahipahi‘ālua, ‘Ō‘io, Kaleleiki, and Kaunala). The largest decline (84 percent) was at Pahipahi‘ālua, and the smallest decline (29 percent) was at ‘Ō‘io. The observation that the rate of population size decline may have decreased might indicate some plants may have some resistance to myrtle rust (ANRPO 2022, p. 99). The population at Kaleleiki has been heavily impacted by myrtle rust and general management of this area is a lower priority until new options for rust management are available (ANRPO 2020, p. 47; ANRPO 2023a, p. 64).
- Approximately 159 founders from 10 populations (some of which are now extirpated) are represented in collections and propagation (ANRPO 2021, 2022, 2023a; Lyon Arboretum 2022; Native Ecosystems Protection & Management [NEPM] 2020). *Ex situ* living collections at botanical gardens total approximately 22 mature and 4 immature individuals with recruitment reported (Army Natural Resources Program of O‘ahu [ANRPO] 2023b).

New Threats:

- In 2018, drought was reported as a threat to *Eugenia koolauensis* (Keir 2018). Over the last 100 years, the islands of Hawai‘i have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008, p. 61; Chu and Chen 2005, pp. 4812–4813; Diaz et al. 2005, 4 pp.). Drought affects plants directly by desiccation. The increase in drought frequency and intensity also leads to a self-perpetuating cycle of increase in cover of nonnative plants, an increase in the number of fires, and an increase in erosion (US-GCRP 2009, pp. 18, 24; Warren 2011).

New Management Actions:

- Monitoring and management—The Army Natural Resources Program of O‘ahu (ANRPO) monitors all populations of *Eugenia koolauensis* (ANRPO 2023a appendices, p. 415; PEPP 2019–2023).
- Ungulate monitoring and control—ANRPO manages feral ungulates at Kaleleiki (fenced), Kaunalā (fenced), Pahipahi‘ālua (fenced), and ‘Ō‘io (fenced) (ANRPO 2020 appendices, p. 426; ANRPO 2021 appendices, p. 409; ANRPO 2022 appendices, p. 523).
- Nonnative invasive plant monitoring and control—ANRPO manages nonnative plants at Kaleleiki, Kaunalā, Pahipahi‘ālua, ‘Ō‘io, and Kamā‘ili (ANRPO 2020

appendices, p. 426; ANRPO 2021 appendices, pp. 115, 409; ANRPO 2022 appendices, p. 523).

- Fire monitoring and prevention—ANRPO implements fire prevention actions at Pahipahi‘ālua and Palikea-Kaimuhole (ANRPO 2020 appendices, p. 426; ANRPO 2021 appendices, p. 409). After the 2007 fire that impacted a population at Kaukonahua, grass control is implemented with addition of a landing zone for reservoir water drops; the ranch is including fire mitigation in the management plan (controlling grass and *Eucalyptus* spp. and reintroducing common native dryland plants) (ANRPO 2023a appendices, p. 185).
- Collection and propagation for genetic storage and reintroduction—
    - The ANRPO genetic storage goals have been met for the populations at Aimuu, Kaiwiko‘ele-Kamana Nui, Mālaekahana, and ‘Ōhi‘a ‘ai-East ‘Ō‘io (ANRPO 2023a appendices, p. 415). Genetic representation is at least 50 percent or greater for populations at Kaleleiki, Kaunalā, ‘Ō‘io, Pahipahi‘ālua, Hanaimoa, and Palikea-Kaimuhole (ANRPO 2023a appendices, p. 415). In 2021, ANRPO focused on cloning and propagation of founders of *E. koolauensis* in the greenhouse (ANRPO 2021, p. 108). Also in 2021, ANRPO removed recollection intervals, as seeds of *E. koolauensis* do not store well under conventional seed banking conditions (are desiccation intolerant) (ANRPO 2021 appendices, p. 512). In 2022, ANRPO expanded *ex situ* holdings of *E. koolauensis* at Koko Crater Botanical Garden (52 founders from 9 populations), anticipating possible loss of founders (ANRPO 2022, p. 97; ANRPO 2023b). Also in 2022, plantings were initiated at Wahiawa Botanical Garden (founders from Pahipahi‘ālua) and Waimea Arboretum (founders from Kaunalā), and Schofield Barracks West (37 founders from 9 populations) for genetic storage and seed production (ANRPO 2022, p. 97; ANRPO 2023b). Recruitment is observed at the *ex situ* living collection at Koko Crater Botanical Garden and seedlings are being maintained with application of fungicide (ANRPO 2023a, p. 112). The ANRPO seed bank inventory indicates four seeds were removed from the collections for Kaunalā and ‘Ō‘io (ANRPO 2023b). In the nursery facility there are 771 individuals representing 211 founders from 10 populations (Palikea, Hau‘ula, Kaiwiko‘ele, Kamana Nui, Kaunalā, Mālaekahana, Nāmāhana, ‘Ō‘io, Paumalū, and Pahipahi‘ālua) (ANRPO 2023b).
    - In 2021, the Lyon Arboretum Micropropagation Laboratory reported storage of 102 explants representing 12 founders from 7 populations (Lyon Arboretum 2022). In 2008 and 2011, Lyon Arboretum Seed Conservation Laboratory reported storage of 82 seeds representing cultivated plants at the Pahole Rare Plant Facility (Lyon Arboretum 2022).
    - In 2019, the State’s Native Ecosystems Protection & Management Program (NEPM) reported propagation of 32 seedlings representing one or more founders and in 2022, storage of more than 300 seeds (NEPM 2020).
    - The O‘ahu Rare Plant Nursery reported propagation of one individual in 2018 stored at the Pahole Rare Plant Facility (O‘ahu RPN 2023).

- In 2019, the National Tropical Botanical Garden (NTBG) reported one individual in a living collection at the Southshore Garden representing one founder at Waimea (NTBG 2022).
- *Ex situ* living collections at botanical gardens were established at Waimea Arboretum, Wahiawa Botanical Garden, Koko Crater Botanical Garden, Kalauao, and at Schofield Barracks (ANRPO 2024, p. 3; ANRPO 2020, p. 47).

- Disease research—Research is ongoing regarding use of the diverse fungi (as inoculate) in leaf microbiome of *Eugenia koolauensis* leaves to promote resistance to *Austropuccinia psidii* (myrtle rust) (Chock 2018, 51 pp.). Myrtle rust originated in Central and South America, and its range has expanded to the neotropics worldwide. It infects *E. koolauensis* causing leaf necrosis and defoliation, leading to the death of the plant (Chock 2018, p. 35). This study showed that instead of relying on chemical fungicides to control myrtle rust, the isolation of a variety of other non-symptomatic fungi from leaves in a slurry and then inoculated, can act to control (inhibit) *A. psidii* (Chock 2018, p. 40).

Table 1. Status and trends of *Eugenia koolauensis* from listing through current 5-year review. Table 1a shows progress according to Interim Stabilization Goals; Table 1b shows progress according to Preventing Extinction Goals.

Table 1a.

Date	No. wild individuals	No. Outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	<60	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2008 (5-year review)	2,166	0	All threats managed in all 3 populations	Partial
			Complete genetic storage	Partial
			3 populations with 25 mature individuals each	Partial
2013 (5-year review)	1,202	0	All threats managed in all 3 populations	Partial
			Complete genetic storage	Partial

			3 populations with 25 mature individuals each	Partial, only on O‘ahu

Table 1b.

Date	No. wild individuals	No. outplanted	*Preventing Extinction Targets identified by HPPRCC	*Preventing Extinction Targets Completed?
2019 (5-year review)	70–200	205	All threats managed in all 3 populations	Partial, 4 populations fenced
			Complete genetic storage	Complete for 4 populations
			Reproduction (i.e., viable seeds, seedlings, saplings) at all 3 populations	Partial, recruitment in 5 managed areas but longevity unknown
			3 populations with 25 mature individuals each	No
2024 (5-year review)	≥19 mature 95 immature	0	All threats managed in all 3 populations	Partial, 4 fenced populations
			Complete genetic storage	Yes
			Natural reproduction at all 3 populations	No
			3 populations with 25 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 stage after Preventing Extinction).

Table 2. Threats to *Eugenia koolauensis* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Degradation and destruction of habitat, and herbivory, by feral ungulates	A, C	Ongoing	Partial, 4 fenced areas
Established ecosystem altering invasive plant species degradation of habitat and competition	A, E	Ongoing	Partial, management in 4 areas
Drought destruction and degradation of habitat	A	Ongoing	None
Fire destruction and degradation of habitat	A	Ongoing	Partial, implementation of fire management plan in Army training areas
Climate change degradation or loss of habitat	A	Ongoing	None
Disease—Rust	C	Ongoing	Partial, managed *inter situ* populations established, research for rust control methodology ongoing
Human impacts	E	Ongoing	Partial, 4 fenced areas
Hybridization	E	Potential	None
Small populations and lack of reproductive vigor	E	Ongoing	Partial, mixed breeding and some rust control

Synthesis:
Currently, four populations that have been monitored in the last five years totaling 19 mature and 95 immature individuals. There may be an additional 6 populations totaling 27 mature and 41 immature, however these populations have not been monitored in the past 8 to 10 years and the species is in decline primarily due to myrtle rust and limited threat management. Seedling presence at *ex situ* botanical gardens has been observed, indicating viable seed production when rust infestation is controlled. Out of the four populations monitored most recently, in 2022, none have observed reproduction, and it is unknown whether there are any reproducing trees of this species. Four populations are withing fenced and managed areas. Propagation is ongoing, with more than 150 founders from 10 populations represented, including in micropropagation, by seedlings and plants in nursery facilities, and plants in *ex situ* living collections. The rust, *Austropuccinia psidii*, continues to impact wild plants and prohibit reintroductions.

Stabilizing (interim), and downlisting and delisting criteria are provided in the Recovery Plan for the Oʻahu Plants (USFWS 1998) and preventing extinction targets have been added and criteria 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.

Eugenia koolauensis is a short-lived perennial shrub or small 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 (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 that are well managed. In addition, a minimum of a total of three populations should be documented on O‘ahu where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, saplings) with a minimum of 25 mature, reproducing individuals per population.

The preventing extinction goals for *Eugenia koolauensis* have not been met. The number of wild individuals continues to decline, and there are no known reproducing individuals, and no population with 25 mature individuals (Table 1, Table 2). Preventing extinction genetic storage goals have been met, as more than 150 founders from 10 populations are represented in genetic storage and propagation (Table 1). The disease, myrtle rust, continues to impact plants and drought, climate change, and potential hybridization are not addressed (Table 2). Therefore, *Eugenia koolauensis* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
Drought is added as a threat to *Eugenia koolauensis* but no significant new information regarding the species’ biological status has been reported since the last 5-year review in 2019. Thus, the following recommendations for future actions are updated or reiterated for the 5-year review for 2024.

- Surveys and monitoring—Continue to monitor extant populations on O‘ahu and survey in suitable and historical habitat for additional populations, especially on Moloka‘i.
- Ungulate monitoring and control—Continue to construct and maintain exclosures to provide protection from the negative impacts of habitat degradation and browsing by feral ungulates.
- Nonnative invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with *Eugenia koolauensis* at all populations.
- Fire destruction and degradation of habitat—Continue to implement fire management plans.

- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery.
- Captive propagation for genetic storage and reintroduction—
    - Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction.
    - Continue to maintain inter situ populations for representation of founders, prioritizing those that my otherwise be lost.
    - Continue to assess genetic variability within the extant populations and implement a plan for conserving the species' genetic diversity in *ex situ* and wild populations.
- Hybridization—Research the effects of intergradation between *E. koolauensis* and *E. reinwardtiana* and determine the level of threat and if actions are required.
- Build resiliency, redundancy, and representation—Increase species' viability through habitat restoration, threat control, and reintroduction and translocation to reduce impacts of drought, climate change, and potential hybridization.
- Population biology research—
    - Continue research on the impacts and long-term effects of the rust disease *Austropuccinia psidii* and potential controls and permit options for use of control agents in a natural area.
    - Continue prohibition of importation of ornamental species in the Myrtaceae family to avoid introduction of additional rust strains.
- Alliance and partnership development—Continue to work with ANRPO, NEPM, and other land managers and partners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

References:

[ANRPO] Army Natural Resources Program of Oʻahu. 2020. 2020 Status report for the Mākua and Oʻahu Implementation Plans. Office of the Vice President for Innovation and Research, University of Hawaiʻi. 214 pp. + appendices, 516 pp.

[ANRPO] 2021. 2021 Status report for the Mākua and Oʻahu Implementation Plans. Office of the Vice President for Innovation and Research, University of Hawaiʻi. 207 pp. + appendices, 623 pp.

[ANRPO] 2022. 2022 Status report for the Mākua and Oʻahu Implementation Plans. Office of the Vice President for Innovation and Research, University of Hawaiʻi. 228 pp. + appendices, 690 pp.

[ANRPO] 2023a. 2023 Status report for the Mākua and Oʻahu Implementation Plans. Office of the Vice President for Innovation and Research, University of Hawaiʻi. 255 pp. + appendices, 534 pp.

[ANRPO] 2023b. 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.

[ANRPO] 2024. Implementation Team meeting notes, day 2, plants. 7 MAR 2024, 9 pp.

Chock, M.K. Jr. 2018. Foliar fungal diversity related to Myrtle Rust (*Austropuccinia psidii*) antagonism and its implications for pathogen resistance in the endangered Hawaiian Nīoi (*Eugenia koolauensis*). Thesis for Master of Science in Botany, University of Hawai‘i at Mānoa. 51 pp.

Chu, P-S. and H. Chen. 2005. Interannual and interdecadal rainfall variations in the Hawaiian Islands. Journal of Climate 18: 4796–4813.

Diaz, H.F., P-S. Chu, and J.K. Eischeid. 2005. Rainfall changes in Hawaii during the last century. 16th Conference on Climate Variability and Change, abstract.

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

Keir, M. 2018. *Eugenia koolauensis*. The IUCN Red List of Threatened Species 2018:e.T30778A83799421. *http://dx.doi.org/10.2305/IUCN.UK.20182.RLTS.T30778A83799421.en.*

Lyon Arboretum. 2022. 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 Botanical Garden. 2022. 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.

[NEPM] Native Ecosystems Protection & Management. 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] 2019–2023. Plant Extinction Prevention Program fiscal years 2019 to 2023 interim performance report (October 1, 2018-September 30, 2023). U.S. Fish and Wildlife Service CFDA Program $15.657 Endangered Species Conservation—Recovery Implementation Funds, Cooperative Agreement: F18AC00502 (Final performance report), University of Hawaii at Manoa, Pacific Cooperative Studies Unit. 105 pp.

[USFWS] U.S. Fish and Wildlife Service. 1998. Recovery Plan for the O‘ahu Plants. Portland. 207 pp. + appendices.

[USFWS] 2008. *Eugenia koolauensis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc/1173.pdf.*

[USFWS] 2013. *Eugenia koolauensis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc/2072.pdf.*

[USFWS] 2019. *Eugenia koolauensis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc/2862.pdf.*

[USFWS] 2022. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status reviews for 167 Species in Oregon, Washington, Idaho, Montana, California, Hawaii, Guam, and the Northern Mariana Islands. Federal Register 87(90): 28031–28034, May 10, 2022.

[US-GCRP] US GCRP Advisory Committee. 2009. Global climate change impacts in the United States. Karl, T.R., J.M. Melilo, and T.C. Peterson (eds.), Cambridge University Press. 189 pp.

[US-NSTC] US National Science and Technology Council. 2008. Scientific assessment of the effects of global change on the United States. Committee on Environment and Natural Resources. 261 pp.

Waimea Arboretum. 2018. 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.

Warren, R. 2011. The role of interactions in a world implementing adaptation and mitigation solutions to climate change. Philosophical Transactions of the Royal Society A 369: 217–241.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Eugenia koolauensis* (nīoi)

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 Reclassify from Endangered to Threatened status
_____ No Change in listing status

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

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2024.08.22 08:47:03 -10'00'

Date_____