5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Melicope knudsenii* (alani)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status reviews for 77 Species in Oregon, Washington, Idaho, and Hawaii. Federal Register 86(120):33726–33728, June 25, 2021.

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, Acting Recovery 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 2022. The review was based on a review of current, available information since the last 5-year review for *Melicope knudsenii* (USFWS 2018). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Acting Recovery 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/ecp/species/4668*).

Review Analysis:

Please refer to the previous 5-year reviews for *Melicope knudsenii* published in the Federal Register on July 21, 2009, March 31, 2014, and October 23, 2018 (available at *https://ecos.fws.gov/docs/tess/species_nonpublish/1384.pdf*, *https://ecos.fws.gov/docs/tess/species_nonpublish/2197.pdf* and *https://ecos.fws.gov/docs/tess/species_nonpublish/2647.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 *M. knudsenii*.

This long-lived perennial tree in the Rutaceae (rue) family is endangered and occurs on Kaua‘i and east Maui. The status and trends for *M. knudsenii* are provided in the tables below.

New Status Information:

- Currently, there is one wild individual of *Melicope knudsenii* on Kaua‘i (Kaua‘i Plant Extinction Prevention Program [PEPP] 2021) and two wild individuals on east Maui (PEPP 2022). A previously unnamed species resembling *M. knudsenii* on Kaua‘i differs from its congeners in physiological features with ramiflorous cymes (flowers arising on stems below the leaves), rounded leaf blades with lower surfaces covered with wooly hairs, and very long leaf stalks, and is now named *M. stonei* (Wood et al. 2017).
- *Melicope knudsenii* is polyphyletic with the individual from Kaua‘i sister to *M. barbigera,* and the two Maui samples sister to *M. hawaiensis*. It is anticipated that the Maui taxon will be resurrected under a name used in an earlier treatment, and that *M. knudsenii* would be restricted to Kaua’i (Paetzold et al. 2019). This change has yet to be published.When it is, both taxa will be protected as Endangered under the Endangered Species Act (ESA) as *M. knudsenii* until taxonomy is updated under 50 CFR 17.12.
- Currently, there are three founders (wild plants) from east Maui represented in *ex situ* storage and propagation. There are seven immature trees in the *inter situ* collection at Fleming Arboretum (Pu’u Mahoe), and 20 potted plants at Olinda Rare Plant Facility (ORPF) representing stock from Fleming as well as one of the wild trees (ORPF 2023). Attempts to air-layer the wild individual on Kaua‘i are ongoing (Kaua‘i PEPP 2021).

New Threats:

- None reported.

New Management Actions:

- Monitoring and surveys—The Kaua‘i PEPP monitors the remaining wild individual of *Melicope knudsenii* (Kaua‘i PEPP 2021). Maui PEPP monitors the *inter situ* collection at Pu‘u Mahoe Arboretum (PEPP 2022).

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

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	23–33	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2009 5-year review	4	49, 8 remain (Maui)	All threats managed in all 3 populations	Partially

			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2014 (5-year review)	6 (Kaua‘i) 2 (Maui)	0	All threats managed in all 3 populations	Partially, fenced at Auwahi
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
Date	**No. wild individuals**	**No. outplanted**	***Preventing Extinction Criteria identified by HPPRCC**	***Preventing Extinction Criteria Completed?**
2018 (5-year review)	1 (Kaua‘i) few (Maui)	0	All threats managed in all 3 populations	No
			Reproduction (i.e., viable seeds, seedlings, saplings) at all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2023 (5-year review)	3	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			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 *Melicope knudsenii* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts

Degradation and destruction of habitat by feral ungulates	A	Ongoing	Partial, one individual fenced
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, nonnative plant control in fenced area
Drought destruction and degradation	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Predation and herbivory by feral ungulates	C	Ongoing	Partial, one individual fenced
Predation and herbivory by invertebrates	C	Ongoing	None
Reduced viability due to low numbers	E	Ongoing	None

Synthesis:
Currently, there is one wild individual of *Melicope knudsenii* on Kaua‘i, and two individuals on east Maui. Monitoring, collections, and propagation is ongoing.

Stabilizing (interim), downlisting, and delisting objectives are provided in the Recovery Plan for the Kaua‘i Plant Cluster (U.S. Fish and Wildlife Service 1995) 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.

Melicope knudsenii 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 (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 Kaua‘i and Maui 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 as there are only three known wild individuals and no *ex situ* representation of the Kaua'i individual (Table 1). Threats, including drought and invertebrate predation or herbivory, are not sufficiently managed throughout the range of the species (Table 1, Table 2). Therefore, *Melicope knudsenii* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are updated or reiterated for the 5-year review for 2023.

- Surveys and inventories—Continue to survey for individuals of *Melicope knudsenii* in areas of potentially suitable habitat.
- Ungulate monitoring and control—Continue to construct and maintain exclosures to protect *M. knudsenii* from the negative impacts of feral ungulates.
- Invasive nonnative plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with *M. knudsenii*, at all populations.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and determine future landscape needed for its recovery.
- Invertebrate monitoring and control—Research and implement effective control methods for the black twig borer and other invertebrate pests.
- Captive propagation for genetic storage and reintroduction—
    - Continue collection of genetic resources for storage, propagation, and translocation into protected suitable habitat within historical range.
    - Evaluate genetic resources and determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
- Translocation and augmentation—Augment the current population and translocate individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Build resiliency, redundancy, and representation—Begin translocation of individuals into suitable habitat that is being managed for known threats to reduce impacts of drought, invertebrate predation and herbivory, and low numbers.
- Alliance and partnership development—Initiate work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon.

References:

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

[Kaua‘i PEPP] Kauai Plant Extinction Prevention Program. 2021. Kaua‘i plant species monitoring data. Excel table.

[ORPF] Olinda Rare Plant Facility. 2023. 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.

Paetzold, C., K. R. Wood, D. A. R. Eaton, W. L. Wagner, and M. S. Applehans. 2019. Phylogeny of Hawaiian *Melicope* (Rutaceae): RAD-seq Resolves Species Relationships and Reveals Ancient Introgression. Frontiers in Plant Science vol 10: https://doi.org/10.3389/fpls.2019.01074.

[PEPP] 2022. Plant Extinction Prevention Program fiscal year 2022 interim performance report (October 1, 2021-September 30, 2022), Cooperative Agreement F19AC00532 (Interim report), U.S. Fish and Wildlife Service CFDA Program #15.657 Endangered Species Conservation—Recovery Implementation Funds, University of Hawai‘i at Mānoa, Pacific Cooperative Studies Unit, Plant Extinction Prevention Program. 50 pp.

[USFWS] U.S. Fish and Wildlife Service. 1995. Recovery Plan for the Kaua‘i Plant Cluster. U.S. Department of the Interior. Portland. 270 pp.

[USFWS] 2009. *Melicope knudsenii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/tess/species_nonpublish/1384.pdf.*

[USFWS] 2014. *Melicope knudsenii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/tess/species_nonpublish/2197.pdf.*

[USFWS] 2018. *Melicope knudsenii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/tess/species_nonpublish/2647.pdf*.

[USFWS] 2021. Endangered and Threatened wildlife and plants; initiation of 5-year status reviews for 77 Species in Oregon, Washington, Idaho, and Hawaii. Federal Register 86(120): 33726–33728, June 25, 2021.

Wood, K.R., M.S. Appelhans, and W.L. Wagner. 2017. *Melicope stonei*, section Pelea (Rutaceae), a new species from Kaua‘i, Hawaiian Islands: with notes on its distribution, ecology, conservation status, and phylogenetic placement. PhytoKeys 83: 119–132.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Melicope knudsenii* (alani)

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**

LAUREN WEISENBERGER

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