

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. 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 Reviewer(s):

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 *Melicope knudsenii* (USFWS 2014). 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 reviews for *Melicope knudsenii* published in the Federal Register on July 21, 2009 and March 31, 2014 (available at http://ecos.fws.gov/docs/five_year_review/doc2449.pdf and https://ecos.fws.gov/docs/five_year_review/doc4404.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 *M. knudsenii*.

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

New Status Information:

- Molecular studies by Appelhans *et al.* (2014) show that *Melicope knudsenii* is not monophyletic and that it represents three distinct groups which should be regarded as different species. *Melicope multiflora* should be used for the specimens from Maui. Those plants on Kaua‘i, one with 30-60 mm-long cymose peduncles and the other with cauliflorous peduncles, represent two lineages, the first is *M. knudsenii* and the second requires proposal of a new name. Each of these species has only one or a few individuals left in the wild and they are extremely vulnerable to any catastrophic event.
- Currently, there is only one *Melicope knudsenii* tree on Kaua‘i (Kishida 2018, in litt.; NTBG 2016; PEPP 2014, 2015).
- In 2003, critical habitat was designated in two units on Kaua‘i for *M. knudsenii* (3,311 ac; 1,340 ha) (68 FR 9116, February 27, 2003). In 2016, critical habitat was designated in one unit in the montane dry ecosystem on Maui (3,524 ac; 1,426 ha); however, since genetic analysis shows that those individuals are now *M. multiflora*, critical habitat will need to be reevaluated on Maui, and possible evaluation for proposal of critical habitat for the new, unnamed, *Melicope* on Kaua‘i.

New Threats:

- Climate change loss or degradation of habitat—We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini *et al.* (2013) concluded that *Melicope knudsenii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.722 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are likely needed to conserve this taxon into the future to insure the best locations for recovery are identified.

New Management Actions:

- Surveys and monitoring—PEPP manages one individual of *Melicope knudsenii* on Kaua‘i (PEPP 2014, 2015).
- Captive propagation for genetic storage and reintroduction—
 - Lyon Arboretum reported nine containers in storage representing collections from Miloli‘i (Lyon Arboretum 2017).
 - The National Tropical Botanical Garden (NTBG) reported three cuttings and leaf material collected for genetic studies from an individual at Kawai Iki in 2013. In 2014, 27 cuttings were taken from plants at the Ku‘ia enclosure (NTBG 2013, 2014), but they currently have no material of this species (NTBG 2018).
 - Two of the Maui plants are represented at the Olinda Rare Plant Nursery (ORPF 2018).

Synthesis:

Currently, there is one individual of *Melicope knudsenii* on Kaua‘i. A 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 *M. knudsenii* is highly 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. At least one founder from Kaua‘i is represented in collections. Of the plants from Maui, which are proposed to be a new species, *M. multiflora*, there are no known wild plants and two extirpated plants are represented in *ex situ* storage.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Kaua‘i Plant Cluster (USFWS 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 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* (at other than the plant’s natural location, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on Kaua‘i. Each of these populations must be naturally reproducing (*i.e.*, viable seeds, seedlings, saplings) and increasing in number, with a minimum of 25 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met as there are no populations of at least 25 individuals, and, although genetic representation may be complete for current extant founder (Table 1), all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Melicope knudsenii* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

Drought is observed to be a threat to *Melicope knudsenii* on Kaua‘i; however, we are not aware of any significant new information regarding the species’ biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.

- Population viability and monitoring—Continue monitoring the wild individual of *Melicope knudsenii*. Continue to survey the geographical and historical range of the species for additional individuals and populations.
- Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *M. knudsenii* from the impacts of feral ungulates.
- Drought destruction and degradation of habitat—Continue to control feral ungulates and nonnative plants at all populations of *M. knudsenii*. Carefully monitor any reintroductions.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all individuals.
- Invertebrate predation or herbivory—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 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—Continue augmenting current population and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery.
- 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 *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 three populations	No
			Complete genetic storage	No
			Three populations with 25 mature individuals each	No
1995 (recovery plan)	24–34	0	All threats managed in all three populations	No

			Complete genetic storage	No
			Three populations with 25 mature individuals each	No
2003 (critical habitat)	10 (Kaua'i) 4 (Maui)	Unknown	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 25 mature individuals each	No
2009 (5-year review)	4	49, 8 remain (Maui)	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three populations with 25 mature individuals each	No
2014 (5-year review)	6 (Kaua'i) 2 (Maui)	0	All threats managed in all three populations	Partially, fence at Auwahi
			Complete genetic storage	Partially
			Three populations with 25 mature individuals each	No
2016 (critical habitat)	2 (Maui)	0	All threats managed in all three populations	Partially
			Complete genetic storage	Partially
			Three 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 three populations	No
			Complete genetic storage	Partially
			Reproduction (<i>i.e.</i> viable seeds, seedlings) at all three populations	No
			Three 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 after Preventing Extinction).

** These individuals were recently determined to be new species, *Melicope multiflora*.

Table 2. Threats to *Melicope knudsenii* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, one individual fenced
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, nonnative plant control at known individual
Drought degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partial, one individual fenced
Invertebrate predation or herbivory	C	Ongoing	Partial, treat with insecticide
Stochastic events—Reduced viability due to low numbers	E	Ongoing	None

References:

See the previous 5-year reviews for a full list of references (USFWS 2009, 2014). Only references for new information are provided below.

Appelhans, M.S., J. Wen, K.R. Wood, G.J. Allan, E.A. Zimmer, and W.L. Wagner. 2014. Molecular phylogenetic analysis of Hawaiian Rutaceae (*Melicope*, *Platydesma*, and *Zanthoxylum*) and their different colonization patterns. *Botanical Journal of the Linnean Society* 174: 425–448.

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.

Kishida, W., 2018, in litt, Email regarding status of two Kaua'i plants, *Melicope knudsenii* and *Kadua cookiana*, 11 JAN 2018.

Lyon Arboretum. 2017. Micropropagation and seed conservation laboratory databases.

[NTBG] National Tropical Botanical Garden. 2013. Controlled propagation database.

[NTBG] 2014. Controlled propagation database.

[NTBG] 2016. NTBG database herbarium specimen detail for *Melicope knudsenii*. 072202, 20 JUN 2016.

[NTBG] 2018. Controlled propagation report.

[ORPF] Olinda Rare Plant Facility. 2018. Controlled propagation report.

[PEPP] Plant Extinction Prevention Program. 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] 2017. Statewide species totals *ex situ*, excel table.

[USFWS] U.S. Fish and Wildlife Service. 2014. *Melicope knudsenii* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. https://ecos.fws.gov/docs/five_year_review/doc4404.pdf.

[USFWS] 2016. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 76 species in Hawai‘i, Oregon, Washington, Montana, and Idaho. Federal Register 81(29): 7571–7573, February 12, 2016.

[USFWS] 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 species; final rule. Federal Register 81 (61): 17790–18110, March 30, 2016.

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
- No Change in listing status

For Field Supervisor, Pacific Islands Fish and Wildlife Office