Melicope makahae
(alani)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawai‘i

5-YEAR REVIEW

Species reviewed: *Melicope makahae* (alani)

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5-YEAR REVIEW
Melicope makahae (alani)

1.0 GENERAL INFORMATION

1.1 Reviewers:

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Lead Regional Office:
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Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the 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 in October 2018. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation completed by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2017. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 138 species in Hawaii, Oregon, Washington, and California. Federal Register 82(75): 18665–18668, April 20, 2017.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; Endangered status for 23 species on Oahu and

designation of critical habitat for 124 species; final rule. Department of the Interior, Federal Register 77 (181): 57648–57862, September 18, 2012.

Date listed: September 18, 2012
Entity listed: *Melicope makahae*
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings:

N/A

1.3.4 Review History:

This is the first 5-year review for this species. *Melicope makahae* is a perennial shrub or shrubby tree listed as endangered on September 18, 2012 (77 FR 57648). Critical habitat was designated on O‘ahu for *M. makahae* at the same time, totaling 11 critical habitat units in the lowland mesic and dry cliff ecosystems of the Wai‘anae mountains (7,311 ac, 2,960 ha). The draft recovery plan for this species is in preparation.

1.3.5 Species’ Recovery Priority Number at start of this 5-year review:

5

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Island of O‘ahu
Date issued: July 2018
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

____Yes
__X_No

2.1.2 Is the species under review listed as a DPS?

____Yes
____No

2.1.3 Was the DPS listed prior to 1996?

____Yes

____No

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____Yes
____No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____Yes
____No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____Yes
____No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

____Yes
__X_No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____Yes
____No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery?

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

The recovery plan is currently being drafted. However, the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so the USFWS also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, the USFWS has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. Narrow extant range and broad contiguous range are recognized as not needing different numbers of individuals or populations, but that the populations will be distributed more narrowly or more broadly, respectively, across the landscape. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

Stabilizing (interim), downlisting, and delisting objectives have been updated according to the draft revised recovery objective guidelines developed by the 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 makahae is a long-lived perennial monoecious (male and female flowers on the same plant) shrub or shrubby 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* (secured off-site, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on O‘ahu where they now occur or occurred historically. 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.

This recovery objective has not been met (see Table 1).

Interim Stage
To meet the interim stage of recovery of *Melicope makahae*, 100 mature, reproducing individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation’s guidelines (Guerrant *et al.* 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria
In addition to achieving 5 to 10 populations with 200 mature, reproducing individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria
In addition to achieving 5 to 10 populations with 200 mature, reproducing individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Little is known about the life history of *Melicope makahae*. Its flowering cycles, pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors are largely unknown.

Melicope makahae, a member of the rue family (Rutaceae), is a shrub or shrubby tree up to 10 feet (ft) (3 meters (m)) tall, with new growth and young branches densely hairy. The opposite leaves are leathery, narrowly ovate, 4 to 5 in (9.5 to 12 cm) long and 0.6 to 2 in (1.5 to 5 cm) wide, with leaf margins usually very slightly inrolled. One to seven sparsely to densely grayish-haired male or female flowers occur in cymes. Fruit are dark green, 0.4 to 0.6 in (10 to 15 mm) long, 0.8 to 1 in (20 to 24 mm) wide, and glabrous (smooth). Seeds are two per follicle, about 0.2 in (5 mm) long (Stone *et al.* 1999; Stone 1963).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Historical data for this species shows that it is known only from the ridges dividing Mākua and Mākaha valleys, ridges dividing the Mākaha and Waiʻanae Kai valleys, and on the Wailua side of Mākaha valley (Makaleha) in the Waiʻanae mountains (HBMP 2010). At the time of

listing in 2012, *Melicope makahae* was known from four occurrences in the same areas of the Waiʻanae mountains, totaling fewer than 200 individuals (77 FR 57648, September 18, 2012). Only two subpopulations have been re-observed since that time (ʻŌhikilolo in 2013 and Mākaha in 2015). Current estimates are 17 individuals at ʻŌhikilolo (Makua Military Reservation); 2 individuals at Makaleha; 28 individuals at Mākaha; and three to seven individuals at Waianae Kai (U.S. Army 2018). These four populations total 50 to 57 individuals. However, the location that contains the large majority of the known plants was last visited in 1999.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
N/A

2.3.1.4 Taxonomic classification or changes in nomenclature:
Melicope makahae was described by Stone as *Pelea makahae*, based on a collection by Pearsall in 1954. In 1989, Hartley and Stone placed *Pelea* A. Gray in synonymy of *Melicope* J.R. & G. Forster. Currently, this species is recognized as *Melicope makahae* in the most recent taxonomic treatment in the Manual of the Flowering Plants of Hawaiʻi (Stone *et al.* 1999).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):
See section 2.3.1.2 above for spatial distribution of the species.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
Typical habitat for this species is lowland mesic *Metrosideros* (ʻōhiʻa)-*Acacia koa* (koa) forest and dry cliffs at 2,200 to 4,000 ft (670 to 1,220 m) elevation in the Waiʻanae mountains of Oʻahu, with the associated native species *Diospyros* sp. (lama) (Hawaiʻi Biodiversity and Mapping Program (HBMP) 2010).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range (Factor A):
Ungulate degradation of habitat—Feral pigs and goats and the effects of their activities have been observed at the occurrences along the Waiʻanae Kai and Mākaha ridges (HBMP 2010). Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by

damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982).

Degradation of habitat by established ecosystem-altering invasive plant species—Nonnative plant species impact all locations where *Melicope makahae* occurs (HBMP 2010). The nonnative species with the greatest impacts to *Melicope makahae* and its habitat are *Ageratina riparia* (Hāmākua pamakani), *Melinis minutiflora* (molasses grass). *Pimenta dioica* (allspice), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), and *Schinus terebinthifolius* (Christmas berry) (HBMP 2010). Invasive nonnative plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and by changing the fire characteristics of the native plant community (Cuddihy and Stone 1990).

Landslides and rockfalls destruction or degradation of habitat—Landslides and rockfalls have been observed to be a threat to those individuals of *Melicope makahae* that occur on or near dry cliffs in the Wai‘anae mountains (USFWS 2012). Landslides and erosion due to natural weathering destabilizes substrates, damages and destroys individual plants, and alters hydrological patterns (Stearns 1985).

Climate change loss or degradation of habitat—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 concluded that *Melicope makahae* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.96 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat outside of its known range.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Not a threat.

2.3.2.3 Disease or predation (Factor C):
Invertebrate predation or herbivory—Black twig borer herbivory—A tiny beetle, the black twig borer (*Xylosandrus compactus*), is known to infest over 200 plant taxa in Hawaii, including *Melicope* species (Davis 1970; HBMP 2010; USFWS 2012). The black twig borer attacks living plants

and bores into branches, deposits eggs and a fungus called ambrosia that develops as food for the larvae. A severe infestation can kill host plants, including large trees (Extension Entomology and UH-CTAHR IPMP 2006).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D): Not a threat.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):
Invasive species—Established invasive plant species competition—Nonnative plant species including *Ageratina riparia*, *Melinis minutiflora*, *Pimenta dioica, Psidium cattleianum*, *Rubus argutus*, and *Schinus terebinthifolius* compete with *Melicope makahae* for water, light, and nutrients, and prevent the establishment of seedlings (Cuddihy and Stone 1990; HBMP 2010).

Stochastic events—Lack of regeneration—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Lack of regeneration is noted as a cause of loss of reproductive vigor of *Melicope makahae* at Mākua-Mākaha ridge (HBMP 2010).

Current Management Actions:

- Ungulate management and control—
  - A few individuals of *Melicope makahae* occurs within the Army's Natural Resources Program's management units at ʻŌhikilolo and Mākaha subunit I, and could benefit from fencing for exclusion of feral ungulates (U.S. Army Garrison Hawaiʻi 2010).
- Captive propagation for genetic storage and reintroduction—There is a collection from one individual propagated in 2017 at both the Lyon Micropropagation Laboratory as well as the Seed Conservation Laboratory (Lyon Arboretum 2018, in litt.). Seed germination tests are ongoing (Lyon Arboretum 2018, in litt.).

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

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2012 (listing and critical habitat)	< 200	0	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 25 mature individuals each	No
2019 (5-year review)	50–57	0	All threats managed in all three populations	No
			Complete genetic storage	Partial collection and storage
			Three populations with 25 mature individuals each	No

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

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, a few individuals may benefit from fencing
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	None
Landslides and rockfalls destruction or degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Invertebrate predation or herbivory	C	Ongoing	Partial, a few individuals may benefit from fencing
Established invasive plant species competition	E	Ongoing	None
Lack of regeneration	E	Ongoing	Partial, one collection

2.4 Synthesis

Numbers of *Melicope makahae* are reported to be about 50 to 57; however, only two subpopulations have reported survey data since 2003. 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. makahae* is extremely vulnerable to the effects of climate change. A few seeds are currently being propagated.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). 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 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 O‘ahu where they now occur or occurred historically and each of these populations must be naturally reproducing (*i.e*., viable seeds, seedlings, or saplings) with a minimum of 25 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There are an estimated 50 to 57 individuals, but only one population is estimated to have at least 25 mature individuals, and it has not been observed since 1999. Some fruit collections have been made but a genetic storage collection has not been established or completed (Table 1) and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Melicope makahae* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

____Downlist to Threatened
____Uplist to Endangered
____Delist
____*Extinction*
____*Recovery*
____*Original data for classification in error*
__X__**No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number:____
Reclassification (from Endangered to Threatened) Priority Number:____
Delisting (regardless of current classification) Priority Number:____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Surveys and inventories—Survey for *Melicope makahae* in historical locations and potentially suitable habitat. Monitor all known occurrences.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations.
- Insect predation or herbivory—Develop and implement control methods for the black twig borer.
- Captive propagation for genetic storage and reintroduction—Continue collection of seeds for storage and propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Reintroduce individuals to suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy and reduce the impacts from small population size.
- Climate change adaptation strategy—Research the suitability of habitat in the future due to the impacts of climate change
- Alliance and partnership development—Contribute to implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Melicope makahae* (alani)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Cheryl Phillipson, Fish and Wildlife Biologist, PIFWO
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Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

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_____
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