

Melicope hiiakae
(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 hiiakae* (alani)

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5-YEAR REVIEW
Melicope hiiaekae (alani)

1.0 GENERAL INFORMATION

1.1 Reviewers:

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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on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawai'i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 hiiakae*
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 hiiakae* is a perennial small tree listed as endangered on September 18, 2012 (77 FR 57648). Critical habitat was designated on O‘ahu for *M. hiiakae* at the same time, totaling 11 critical habitat units in the lowland wet ecosystem of the Ko‘olau mountains (25,114 ac, 10,162 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
 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
 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 hiiakae is a long-lived perennial monoecious (male and female flowers on the same plant) small 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 hiiakae*, 100 mature 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 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 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 hiiakae*. It has been observed flowering in August (National Tropical Botanical Garden (NTBG) 2013a, 2013b); however, pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors are largely unknown.

Melicope hiiakae, a member of the rue family (Rutaceae), is a small tree 6.6 to 23 feet (ft) (2 to 7 meters (m)) tall, new growth with densely white to pale brown hairs, becoming smooth. The opposite leaves are glossy, thin, leathery, and elliptic to obovate, 1.6 to 8 in (4 to 20 cm) long and 0.8 to 3.5 in (2 to 9 cm) wide. Five to 15 separate finely-haired male or female flowers occur in cymes arising between the stem and leaf or branch. Capsules (fruit composed of two or more carpels) are dark green, with fine hairs, 0.2 to 0.3 in (6 to 7 mm) long, 0.4 to 0.8 in (11 to 20 mm) wide, with 1 to 2 seeds per carpel (Stone *et al.* 1999).

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 was wide-ranging along the Ko'olau summit areas, from as far south as Mau'umae, north to Kawaihoa trail (Hawai'i Biodiversity and Mapping Program (HBMP) 2010). At the

time of listing in 2012, *Melicope hiiakae* was known from about 10 scattered occurrences from Kawailoa to Waimalu in the Ko‘olau mountains, totaling fewer than 60 individuals (77 FR 57648, September 18, 2012). Currently, there are about 50 individuals in three locations. Six other locations have not been surveyed since 2007 (O‘ahu Army Natural Resources Program (ANRP) 2018; Ching 2019, in litt.).

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 hiiakae was described by Rock as *Pelea wawraeana*; however, there was confusion with some taxonomic features of the capsules, and was later described by Stone as *Pelea Hiiakae* in 1963, from a collection in 1932 by Hosaka (Stone 1963). It was named in honor of Hi‘iaka, youngest sister of the goddess Pele. In 1989, Hartley and Stone placed *Pelea* A.Gray in synonymy of *Melicope* J.R. & G. Forster. Currently, this species is recognized as *Melicope hiiakae* in the most recent taxonomic treatment in the Manual of the Flowering Plants of Hawai‘i (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 wet *Metrosideros* (‘ōhi‘a)-*Dicranopteris* (uluhe) forest and cliff at 1,200 to 3,100 ft (366 to 950 m) elevation in the Ko‘olau mountains of O‘ahu, with the associated native species *Antidesma* sp. (hame), *Bobea* sp. (‘ahakea), *Dubautia laxa* (na‘ena‘e pua melemele), *Kadua affinis* (manono), *Machaerina* sp. (‘uki), *Melicope* sp. (alani), *Psychotria* sp. (kōpiko), *Sadleria* sp. (‘ama‘u), *Scaevola* sp. (naupaka), and *Syzygium sandwicensis* (‘ōhi‘a hā) (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 the effects of their activities have been observed from Kawailoa to Hālawa (HBMP 2010;

NTBG 2013a, b). 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 hiiakae* occurs (HBMP 2010; NTBG 2013a, b; Plant Extinction Prevention Program (PEPP) 2014, 2015). The nonnative species with the greatest impacts to *Melicope hiiakae* and its habitat are *Clidemia hirta* (Koster's curse), *Leptospermum scoparium* (manuka), and *Psidium cattleianum* (strawberry guava) (HBMP 2010; PEPP 2019). 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).

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 hiiakae* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.834 (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—Unidentified insects are boring into seeds of *Melicope hiiakae* at the Hālawa-Kalauao occurrence (PEPP 2015). Severe insect infestations can prevent the establishment of new individuals by killing seeds.

Herbivory and predation by rats—Herbivory by rats is noted to be a threat to *Melicope hiiakae* at Kaiwipo'o (Hālawa-Kalauao) (NTBG 2013a, b). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980;

Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

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 *Clidemia hirta*, *Leptospermum scoparium*, and *Psidium cattleianum* compete with *Melicope hiiakae* for water, light, and nutrients, and prevent the establishment of seedlings (Cuddihy and Stone 1990; HBMP 2010; NTBG 2013a, b; PEPP 2014, 2015, 2019).

Human disturbance—Human disturbance (hiking) is noted as a threat to individuals of *Melicope hiiakae* (77 FR 57648, September 18, 2012). Human activities can disrupt and degrade habitat and damage or kill individual plants.

Hybridization—This species may hybridize with the more common *Melicope* species which could lead to loss of species diversity, local adaptations, and genetic representation of *M. hiiakae* (PEPP 2014)

Reduced viability due to low numbers—There are about 50 individuals total across three locations of *Melicope hiiakae* that are currently monitored, the status of other occurrences is unknown. 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).

Current Management Actions:

- Build resilience and redundancy—
 - The Army's Natural Resources Program tracked and monitored 17 individuals in 10 occurrences through 2007 (ANRP 2018). One plant was reintroduced at Poamoho; however, its current status has not been reported.
 - The PEPP reports collection of propagative materials from eight locations representing 27 founders (PEPP 2019), although the majority of seeds were collected recently and germination is variable and may take more than a year.
 - Lyon Seed Conservation Laboratory reports two fruit collections were received from two different populations;

however, all 25 were propagated leaving none in storage (Lyon Arboretum 2018, in litt.).

- There is one plant in storage at Pahole Rare Plant Facility Mid-elevation Nursery (Pahole Rare Plant Facility 2018, in litt.).

Table 1. Status and trends of *Melicope hiiakae* 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)	<60	1	All threats managed in all three populations	No
			Complete genetic storage	No
			Three populations with 25 mature individuals each	No
2019 (5-year review)	ca 50	0	All threats managed in all three populations	No
			Complete genetic storage	Partial
			Three populations with 25 mature individuals each	No

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

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	None
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Invertebrate predation or herbivory	C	Ongoing	None
Rodent predation or herbivory	C	Ongoing	None
Established invasive plant species competition	E	Ongoing	None
Human disturbance	E	Ongoing	None
Reduced viability due to low numbers	E	Ongoing	Partial, seed collection and storage is ongoing

2.4 Synthesis

There are three monitored populations of *Melicope hiiakae* estimated to total approximately 50 individuals, the largest totaling approximately 39 individuals. 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. hiiakae* is highly vulnerable to the effects of climate change. Collection and storage of seeds is ongoing.

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 is only one population with over 25 mature individuals, and it is uncertain how many are reproducing. There are only about 50 individuals total for the species. Collection efforts are ongoing but genetic storage is incomplete (Table 1) and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Melicope hiiakae* 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

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 hiiakae* in historical locations and potentially suitable habitat. Monitor all known occurrences.
- Ungulate monitoring and control—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.
- Rodent predation or herbivory—Implement effective control methods for rodents at all known occurrences.
- Invertebrate predation or herbivory—Research insect species that impact *Melicope hiiakae* and develop and implement control methods.
- 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 to overcome reduced viability due to low numbers of individuals.
- Climate change adaptation strategy—Research the suitability of habitat in the future due to the impacts of climate change
- Human interaction monitoring and management—Develop and implement effective measures to reduce the impact of hikers.
- Alliance and partnership development—Contribute to implementation of ecosystem-level restoration and management to benefit this taxon.

5.0 REFERENCES

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

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:

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FIELD OFFICE APPROVAL:

for

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