5-YEAR STATUS REVIEW

Short Form Summary

Species Reviewed: *Peucedanum sandwicense* (makou)

Current Classification: Threatened

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawai‘i, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Lead Region/Field Office:

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

Name of Reviewer:

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Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO
Grant Canterbury, Biologist, Pacific Regional Office (RO)
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Methodology used to complete this 5-year status 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 or USFWS) beginning in October 2020. The review was based on a review of current, available information since the last 5-year status review for *Peucedanum sandwicense* (USFWS 2012). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager, and others as noted above.

Background:

For information regarding the species' listing history and other facts, please refer to its species profile page on the Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (*https://ecos.fws.gov/ecp/species/5579*).

Review Analysis:

Please refer to the previous 5-year status review for *Peucedanum sandwicense* published in the Federal Register on August 28, 2012 (available at *https://ecos.fws.gov/docs/five_year_review/doc4069.pdf*) for a complete review of the species' status, threats, and management efforts. Significant information regarding the species' biological status has been reported since listing to warrant recommending a change in the Federal listing status of *P. sandwicense* from threatened to endangered.

This short-lived perennial herb in the Apiaceae (parsley) family is listed as threatened and is endemic to Kauaʻi, Oʻahu, Molokaʻi, and Maui. The current status and trends for *Peucedanum sandwicense* are provided in the tables below.

New Status Information:

- In 2010, there were an estimated 1,000 to 2,000 plants on Kauaʻi (Wood pers. comm. 2010). That estimate has declined to a current estimate of 500-650 individuals. Each of the two largest populations, Kalalau and Waimea Canyon, has now dropped below 300 individuals. Occurrences along the Nā Pali coast of Kauaʻi fall in 3 general geographic areas, and have been recently confirmed (Makaha to Awaʻawapuhi [50 to 100 individuals]; Kalalau to Mānoa [fewer than 300 individuals in Kalalau, 30 to 50 individuals in Limahuli and Mānoa]; and Waimea Canyon [150 to 200 individuals]. Two additional locations, Oleke [status unknown]; and Hāʻupu [last observed in 1993]) have not been recently monitored (L. Weisenberger in litt. 2022). The latest technological advancements in surveying through use of UAV (unmanned aerial vehicle) have discovered new plants in inaccessible areas that had not been previously surveyed by foot (PEPP 2020), but previously known populations have also declined. Accuracy of population estimates is constrained by feasibility of physical access to cliff sites and the time required for detailed review of UAV footage.

  Once estimated to be as high as 85 individuals in 4 locations, there are currently no known individuals on Oʻahu. There were 2 known populations on Oʻahu totaling 17 individuals between 2000 and 2002. The species was observed in Kamaili sometime in 2016 to 2017, but could not be relocated in 2021 (Ching Harbin 2021, in litt.).

  On Molokaʻi over 30 individuals were estimated in 2016, but the current estimate is 20 individuals at most. One plant was observed at Anapuhi, and several plants were observed at both Kalaupapa and Waiehu. The last site, Wailau, has not been visited since 2009, when two plants were observed. There had previously been six known locations on Molokaʻi, but surveys in 2021 have recorded the extirpation of this species from two islets, Mōkapu and Huelo (A. Bakutis 2021, pers. comm.).

  On and around Maui, populations have remained stable since the last five-year review. Two populations on 2 islets, Makoloaka and Keōpuka, off of east Maui totaling approximately 50 individuals have recently been observed (Oppenheimer 2021, in litt.). There are currently no known individuals on the island of Maui, including Wailuku and Waiehu on West Maui, and Pauwalu Point and east of Hanawī Stream on East Maui, where the species was previously observed.

  These are the observed areas; however, habitat for *Peucedanum sandwicense* is precipitous and difficult to access, making the total number of individuals difficult to estimate. In addition, this species dies back depending on environmental

conditions, which leads to large fluctuations in numbers observed. The last estimated total for all 4 islands for the previous 5-year review in 2012 was between 1,135 to 2,135 individuals, compared to an estimated 1,000 to 5,000 at the time of listing. Recent trends based on population observations and estimates of total number of individuals per island suggest a substantial decline in numbers of individuals and/or range on all islands, including the possible extirpation of the species from Oʻahu. Populations that are persisting mostly occur along inaccessible portions of cliff habitat on Kauaʻi and offshore islets of Maui (Table 1).

- Critical habitat for listed species in Hawaii has been designated island-by-island. As *Peucedanum sandwicense* is a multi-island species, its 26 critical habitat units span three separate designations for different islands. In 2012, eight critical habitat units in the dry cliff ecosystem were designated for *Peucedanum sandwicense* in the dry cliff ecosystem of the Waiʻanae mountains of Oʻahu (7,788 acres [ac] [3,152 hectares (ha)]) (77 FR 57648, September 18, 2012). In 2016, 15 critical habitat units were designated for *P. sandwicense* on Maui in the coastal and lowland wet ecosystems (4,502 ac [1,824 ha]) and on Molokaʻi in the coastal and lowland wet ecosystems (11,969 ac [4,847 ha]) (81 FR 17790, March 30. 2016). Three critical habitat units designated on Kauaʻi in 2003 remain the same (1,928 ac [781 ha]) (68 FR 9116, February 27, 2003).

Table 1. Population trends by island for *Peucedanum sandwicense.*

Year	Kauaʻi	Oʻahu	Molokaʻi	Maui	Total	Number Outplanted
1994 (listing)	-	-	-	-	1,000 – 5,000	0
2003 (critical habitat - Kauaʻi, Oʻahu, Molokaʻi, Maui)	156-256	51	50	32	289 - 389	-
2012 (critical habitat - Oʻahu)	-	61	-	-	-	-
2012 (5-year status review)	1,000-2,000	< 100	few	32	1,135-2,135	16-19
2016 (critical habitat - Maui Nui)	-	-	32-37	15+	-	-
2022 (5-year status review)	500-650	0	20	50	570-720	0

New Threat Updates:

- Climate change-related loss or degradation of habitat—Climate change may pose a threat to this species. A landscape-based assessment of climate change

vulnerability for native plants of Hawai‘i using high-resolution climate change projections included *Peucedanum sandwicense*. Climate change vulnerability was defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. *Peucedanum sandwicense* is vulnerable to the impacts of climate change, with a vulnerability score of 0.413 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) (Fortini et al. 2013). Therefore, additional management actions may be needed to conserve this taxon into the future such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

- Feral goats have been identified as the main driver of decline in species viability for locations they can access (USFWS 2012). More thorough surveys across all previously known locations are recommended to better understand the extent of decline; however, current estimates on all islands range from at least 50% decline in range or total number of individuals up to 100%.

New Management Actions:

- Surveys and inventories—*Peucedanum sandwicense* populations on Maui, Moloka‘i and Kaua‘i are fairly regularly surveyed (Plant Extinction Prevention Program [PEPP] 2017, PEPP 2018, PEPP 2020). Plants observed in 2016 to 2017 in the Kamaili area of the Wai‘anae mountains, O‘ahu, could not be relocated upon recent survey in 2021 (Ching Harbin 2021, in litt.). No *P. sandwicense* could be identified on a survey of the coastline of Pauwalu Point on east Maui, although the plants were possibly dormant (Oppenheimer 2021, in litt.).
- Ungulate monitoring and control—Plants within Kalaupapa National Historical Park and on offshore islets of Moloka‘i are protected from habitat destruction by feral ungulates (National Park Service 2015, pp. 203, 269). Plants within the Nā Pali-Kona Forest Reserve on Kaua‘i are provided some protection from disturbance by feral ungulates by small fenced enclosures (Department of Land and Natural Resources-Division of Forestry and Wildlife (DLNR-DOFAW) 2009).
- Captive propagation for genetic storage and reintroduction—
    - In 2015, 10 seeds were stored representing 1 wild individual at Ku‘ia (Kaua‘i). In 2017, 179 seeds were added to the collection representing 1 wild plant from Kukui Trail (Kaua‘i), and 73 seeds were added representing 1 wild plant from Mākaha (Kaua‘i) (NTBG 2020). From 2015 through 2017, nursery propagation included both garden collections as well as representation of 2 wild plants from Kukui Trail. From 2015 through 2019, 24 individuals were planted at the Limahuli garden, representing living collections and wild plants at Kukui Trail and Mākaha (NTBG 2020).
    - The Olinda Rare Plant Facility (ORPF) on Maui reports storage of 13 plants representing 2 wild individuals from Kalaupapa on Moloka‘i (ORPF 2020).

- Waimea Valley Arboretum reported four seeds in storage representing one wild individual on Moloka‘i (Waimea Arboretum 2018).

Table 2. Stability and Preventing Extinction Criteria for *Peucedanum sandwicense* from listing through current 5-year status review.

Date	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	All threats managed in all 3 populations	No
1994 (listing)	Complete genetic storage	No
1994 (listing)	3 populations with 50 mature individuals each	Unknown
1995 (recovery plan)	All threats managed in all 3 populations	No
1995 (recovery plan)	Complete genetic storage	Partially
1995 (recovery plan)	3 populations with 50 mature individuals each	Unknown
2003 (critical habitat)	All threats managed in all 3 populations	No
2003 (critical habitat)	Complete genetic storage	Unknown
2003 (critical habitat)	3 populations with 50 mature individuals each	Unknown
2012 (5-year status review)	All threats managed in all 3 populations	Partially
2012 (5-year status review)	Complete genetic storage	Partially
2012 (5-year status review)	3 populations with 50 mature individuals each	Likely yes
2012 (critical habitat-O‘ahu)	All threats managed in all 3 populations	No
2012 (critical habitat-O‘ahu)	Complete genetic storage	No

Date	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
2012 (critical habitat-O‘ahu)	3 populations with 50 mature individuals each	No
2016 (critical habitat-Maui Nui)	All threats managed in all 3 populations	No
2016 (critical habitat-Maui Nui)	Complete genetic storage	Partially
2016 (critical habitat-Maui Nui)	3 populations with 50 mature individuals each	No

Date	*Preventing Extinction Criteria identified by HPPRCC	*Preventing Extinction Criteria Completed?
2022 (5-year status review)	All threats managed in all 3 populations	Partially
2022 (5-year status review)	Complete genetic storage	Partially, some plants on Kaua‘i and Moloka‘i
2022 (5-year status review)	Natural reproduction at all 3 populations	Unknown
2022 (5-year status review)	3 populations with 50 mature individuals each	Possibly on Kaua‘i

* The Preventing Extinction Stage was established by HPPRCC in 2011, and this 5-year status review is the first to address it for this species. Prior to 2011, the Interim Stabilization Stage was the first stage towards recovery (now it is the second stage after Preventing Extinction).

Table 3. Threats to *Peucedanum sandwicense* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A, D	Ongoing	Partial: ungulate control on Moloka‘i and Kaua‘i
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial: nonnative plant control at Mākua, O‘ahu

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Destruction and degradation by drought	A	Ongoing	None
Destruction and degradation by landslides and flooding	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Fire destruction or degradation of habitat	A	Ongoing	Partial: fire management (fuel breaks) as part of Oʻahu Army INRMP; fire management plan for Kalaupapa NHP
Ungulate predation or herbivory	C	Ongoing	Partial: ungulate control on Molokaʻi and Kauaʻi
Rodent predation or herbivory	C	Ongoing	Partial: control on Mōkapu
Slug herbivory	C	Ongoing	None
Hiking and trail maintenance	E	Ongoing	None
Military activities	E	Ongoing	Partial: nonnative plant and fire management on Oʻahu

Synthesis:
Currently there are fewer than 700 known wild individuals of *Peucedanum sandwicense* on Kauaʻi, Oʻahu, Molokaʻi, and Maui, with the large majority of populations persisting in cliff locations inaccessible to feral ungulates on Kauaʻi. The individuals on Maui are on offshore islets where feral ungulates are not present, but that are also difficult if not impossible for humans to access, and susceptible to sea-level rise, storms and landslides. This represents a 50 to 100 percent decline in the number of populations and/or number of individuals throughout the islands. New locations of plants were discovered on Kauaʻi due to survey efforts with new UAV technology, but declines have been observed at the largest Kauaʻi populations, as well as at known wild populations on Oʻahu and Molokaʻi. More thorough surveys are needed to better assess the current status of this species, but the number of populations and population size has declined. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections showed that *P. sandwicense* is vulnerable to the effects of climate change (Fortini et al. 2013). Few individuals are provided protection by feral ungulate and nonnative plant control on Molokaʻi and Kauaʻi. Seed collections from plants on Kauaʻi and Molokaʻi are ongoing, with some propagation and planting in living collections.

It should be noted that this species was originally proposed for listing as endangered (56 FR 55862; October 30; 1991), based on an estimated total population size of 250 to 350 individuals. The final decision to list the species as threatened (59 FR 9317; February 25, 1994) was informed by new survey results, primarily on the Kalalau Valley rim in Kauaʻi, that increased the estimated total population to 1,000 to 5,000 individuals. However, current surveys estimate that the Kalalau population has now declined to fewer than 300 individuals.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Kauai Plant Cluster (USFWS 1995) and have been 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. Biology and threats for this species have also been addressed in a species account in the Kauai Islandwide Recovery Plan (USFWS 2021, pp. 1056-1069); however, this recovery plan established updated recovery criteria only for species entirely endemic to Kauaʻi, so it has not superseded the objectives that were provided for this species in the previous recovery plan.

Peucedanum sandwicense is a short-lived perennial herb. 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 3 populations represented in *ex situ* (secured off-site, such as in a nursery or seed bank) collections that are well managed. In addition, a minimum of 3 populations should be documented 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 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. Genetic storage is documented for populations on Kauaʻi and Molokaʻi but is not complete (Table 2). There are 3 localities on Kauaʻi with known populations that may total at least 50 individuals each. How many of those individuals were reproducing in a given season has not been documented, and difficulty in accessing populations has limited monitoring and collection. In addition, some threats are not being managed (Tables 2 and 3). The number of populations and/or their size have been observed in decline on all islands, to the extent that the species may now be extirpated on Oʻahu. Therefore, *Peucedanum sandwicense* may now meet the definition of endangered, as it appears to be in danger of extinction throughout its range.

Recommendations for Future Actions:
We are not aware of any significant new information regarding management recommendations or threats to the species since the last 5-year status review in 2012. Thus, the following recommendations for future actions identified in the 2012 5-year status review are reiterated for the 5-year status review for 2022.

- Surveys and inventories—Continue to conduct thorough surveys on all islands where individuals occur and suitable habitat to more accurately assess the current status of the species.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates.
- Invasive plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with *Peucedanum sandwicense*.
- Predator and herbivore monitoring and control—Implement effective methods to control predation by rats and slugs.
- Drought, landslides, and flooding—Implement prevention measures where possible and increase efforts to control ungulates and nonnative invasive plants that contribute to habitat destruction.
- Fire monitoring and control—Continue to develop and implement fire prevention management plans for all populations.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species.
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction, especially for plants on O‘ahu and Maui.
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Hiking and trail maintenance—Educate maintenance crews and provide signage to notify hikers regarding rare plants.
- Alliance and partnership development—Continue to work with partners including DOFAW and the U.S. Army in planning and implementation of ecosystem-level restoration and management to benefit this species.

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[USFWS] 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR STATUS REVIEW of
***Peucedanum sandwicense* (makou)**

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year status review:

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

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Project Leader,
Pacific Islands Fish and Wildlife Office

Acting ARD, Jodi Bush Digitally signed by Jodi Bush
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