

Peucedanum sandwicense
(Makou)

**5-Year Review
Summary and Evaluation**

**U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii**

5-YEAR REVIEW

Species reviewed: *Peucedanum sandwicense* (Makou)

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5-YEAR REVIEW
***Peucedanum sandwicense* (Makou)**

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia,
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Lead Field Office:

Pacific Islands Fish and Wildlife Office, Loyal Mehrhoff, Field Supervisor, (808)
792-9400

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 on April 8, 2010. The review was based on final critical habitat designation for *Peucedanum sandwicense* and other species from the islands of Kauai, Oahu, Molokai and Maui (USFWS 2003a-d), as well as a review of current, available information. The Bernice Pauahi Bishop Museum provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Samuel Aruch, biological consultant, was reviewed by a recovery biologist and the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:

USFWS. 2010. Endangered and threatened wildlife and plants; 5-year review status of 69 species in Idaho, Washington, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75(67):17947-17950.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 1994. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 24 plants from the island of Kauai, Hawaii; final rule. Federal Register 59(38):9304-9329.

Date listed: February 25, 1994

Entity listed: Species

Classification: Threatened

Revised Listing, if applicable

FR notice: N/A

Date listed: N/A

Entity listed: N/A

Classification: N/A

1.3.3 Associated rulemakings:

USFWS. 2003a. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 95 plant species from the islands of Kauai and Niihau, Hawaii; final rule. Federal Register 68(39):9116-9479.

USFWS. 2003b. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 101 plant species from the island of Oahu, Hawaii; final rule. Federal Register 68(116):35949-35998.

USFWS. 2003c. Endangered and threatened wildlife and plants; final designations and nondesignations of critical habitat for 42 plant species from the island of Molokai, Hawaii; final rule. Federal Register 68(52):12982-13141.

USFWS. 2003d. Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the Islands of Maui and Kahoolawe, Hawaii; final rule. Federal Register 68(93):25934-26165.

Critical habitat was designated for *Peucedanum sandwicense*, a multi-island species, on Kauai in four units totaling 781 hectares (1,931 acres) on State lands (USFWS 2003a), on Oahu in a single unit of 76 hectares (186 acres) on State lands (USFWS 2003b), on Molokai in three units totaling 149 hectares (369 acres) on State and private lands (USFWS 2003c), and on Maui in two units totaling 118 hectares (291 acres) on State and private lands (USFWS 2003d).

1.3.4 Review History:

Species status review [FY 2010 Recovery Data Call (August 2010)]:

Increasing

Recovery achieved:
1 (0-25%) (FY 2007 Recovery Data Call)

1.3.5 Species' Recovery Priority Number at start of this 5-year review:
8

1.3.6 Current Recovery Plan or Outline
Name of plan or outline: USFWS. 1995. Recovery plan for the Kauai plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 270 pages. Available online at <<http://www.fws.gov/pacificislands/recoveryplans.html>>.
Date issued: September 20, 1995
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 criteria?

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, B, C, D, and E) affecting this species is presented in Section 2.3.2 and Table 2.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Kauai plant cluster (USFWS 1995), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Peucedanum sandwicense* is a short-lived perennial, and to be considered stabilized, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on Kauai and, if possible, at least one other island where they now occur or occurred historically. For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population.

This recovery objective has not been met.

For downlisting, a total of five to seven populations of *Peucedanum sandwicense* should be documented on the island of Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

This recovery objective has not been met.

For delisting, a total of eight to ten populations of *Peucedanum sandwicense* should be documented on the island of Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered.

This recovery objective has not been met.

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:

Hank Oppenheimer (Plant Extinction Prevention Program, pers. comm., 2010) believes the species dies back to its stout taproot after seeding, and later re-sprouts. Additional research is needed to determine if this species truly is a short-lived perennial, defined as a lifespan of ten years or less. Little else is known about the life history of *Peucedanum sandwicense*. Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS 1995, 2003a-d, 2007).

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:

Historically, *Peucedanum sandwicense* was known from various locations on Kauai including along the Na Pali Coast, in Waimea Canyon, the Olokele region, and the Haupu Range (USFWS 1994, 1995). Wagner *et al.* (1999), after uniting previously described variants into a single species, described the habitat as windward cliffs from 1 to 250 meters (3 to 820 feet) elevation on Kauai, Molokai, West Maui, and Keopuka Islet off the coast of East Maui. In 1990, populations were discovered in the Waianae Range on Oahu, extending its range to four islands: Kauai, Oahu, Molokai, and Maui (USFWS 2003a-d, 2007).

The Kauai critical habitat designation in 2003 (USFWS 2003a) noted 15 populations on State (Haena State Park, Hono o Na Pali and Kuia Natural Area Reserves, Na Pali Coast State Park, and Na Pali-Kona Forest Reserve) and privately owned lands, containing about 156 to 256 individuals, encompassing Maunahou, Limahuli, Hoolulu, Hanakoa, Pohakuao, Kanakou, Kalalau, Honopu, Nualolo, Poopooiki, Kuia,

Mahanaloa, and Makaha Valleys on the Na Pali coast, Koaie Canyon, and Haupu Ridge south of Lihue (USFWS 2003a; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a). Some of the vouchered localities estimated substantial numbers of individuals, such as 50 to 100 individuals at Pohakuao in 1990, 50 individuals at Hanakoa in 1989, and 50 to 100 individuals on Kaaalahina Ridge in 1989, and 50 individuals at Kuia in 1999, all in the Na Pali area (Hawaii Biodiversity and Mapping Program 2010). A recent estimate of the total number of individuals across Kauai ranged between 1,000 and 5,000 individuals (USFWS 2007). Ken Wood (National Tropical Botanical Garden, pers. comm., 2010) estimates there may be about a dozen discrete populations on Kauai, with perhaps only the Waimea Canyon and Kalalau populations exceeding 300 individuals; because most habitats are on steep cliffs difficult to access and to estimate the total number of individuals, his educated guess is that there may be 1,000 to 2,000 wild individuals remaining on Kauai.

Discoveries in 1990 and 1991 extended the known distribution of *Peucedanum sandwicense* to the island of Oahu, where two populations totaling about 85 individuals were found in the Waianae Mountains on county and State land (USFWS 1994, 1995; Hawaii Biodiversity and Mapping Program 2010). In the Oahu critical habitat designation in 2003 (USFWS 2003f), 4 populations were reported, containing 51 individuals on State and county lands in Keaau Valley, Puu Kawiwi, Waianae Kai, and Kamaileunu Ridge. The number of individuals was later revised upward to roughly 100, including about 25 individuals in the Makua Military Reservation Action Area, which are subject to wildfire caused by military activities (USFWS 2007). While there has been no recent dedicated census of the species on Oahu, Kapua Kawelo (U.S. Army Garrison, pers. comm. 2010) estimates that the numbers are probably now lower, especially with feral goats (*Capra hircus*) in the area; the Army's last recorded observation was 15 mature individuals at Kamaileunu in 2002. Joel Lau (Botanist, pers. comm. 2010) concurs that Oahu populations are unstable and decreasing, primarily due to feral goat activity. At Waianae Kai, Lau recorded two individuals in 1991, four individuals in 1998, but none in his last couple of visits, most recently around 2005 (J. Lau, pers. comm. 2010; Hawaii Biodiversity and Mapping Program 2010). Therefore, currently on Oahu there are likely less than 100 individuals in three populations at Keaau Valley, Puu Kawiwi, and Kamaileunu Ridge, with none of the current populations having been surveyed since 2002. The fourth population, in Waianae Kai, appears to have been extirpated.

On Molokai, *Peucedanum sandwicense* was historically known from Kalaupapa, Kui Point, and Waikolu and Wailau Valleys, and at the time of listing consisted of three populations totaling fewer than 30 individuals at

Pelekunu Preserve, Kalaupapa National Historical Park, and Huelo, an offshore islet east of Kalaupapa (USFWS 1994, 1995). In 2000, a population of 20 mature individuals was discovered on Mokapu Islet, also east of Kalaupapa (Hawaii Biodiversity and Mapping Program 2010), and the Molokai population numbers were revised to five totaling about 50 individuals (USFWS 2003c). Subsequent site visits, however, found only a few dead individuals in 2008 and no sign of individuals in 2009, although there may be a soil seed bank (Hank Oppenheimer, pers. comm. 2010). Plant Extinction Prevention Program (2010) reported two individuals at Lepau Point on Puu o Hoku Ranch land in Wailau Valley, and another plant observed on seacliffs above Waiehu in Olokui NAR. The latter observation was via helicopter survey, and there are likely more individuals in the area. Hank Oppenheimer (pers. comm. 2010) believes that a careful search of the north shore cliffs on Molokai from Kalaupapa Trail to Halawa Valley would reveal more populations and individuals. While some of the cliff habitat would be accessible via the Kalaupapa Trail, most of the survey would require helicopter reconnaissance. Currently on Molokai, only 2 populations at Lepau Point and Olokui NAR containing a total of 3 individuals are known.

Historically, *Peucedanum sandwicense* was known from Wailuku and Waiehu on West Maui (USFWS 1994, 1995; Hawaii Biodiversity and Mapping Program 2010). Currently, the only well-documented remaining population on Maui is located on the State-owned Keopuka Rock, an islet off the north coast of East Maui. Robert Hobdy reported 25 to 30 individuals in 1982 (Hawaii Biodiversity and Mapping Program 2010); a subsequent visit in 2005 by Ken Wood and Forest Starr counted about 15 individuals (Starr *et al.* 2006). The latter survey also noted “occasional” individuals of *P. sandwicense* on a helicopter reconnaissance of Makaloaka, another offshore rock near Papiha Point on the east side of Wailua Bay (Starr *et al.* 2006). The individuals were observed in a patch of *Scaevola taccada* (naupaka), about one-third of the way from the top on the west side. The USFWS (2003d) noted additional populations near Pauwalu Point and east of Hanawi Stream; along with individuals at Keopuka Rock, the total census on Maui was placed at 32 individuals. Hank Oppenheimer (pers. comm. 2010) has scanned the cliffs at Pauwalu Point several times and has yet to locate any individuals. Therefore, currently on Maui, there may be as many as 32 individuals in as many as four populations at Keopuka Rock, Makaloaka, Pauwalu Point, and east of Hanawi Stream, but the Pauwalu Point population may be extirpated.

The abundance of *Peucedanum sandwicense* is difficult to accurately determine since this species is a short-lived perennial herb and fluctuations in numbers are normal. Environmental conditions such as variation in rainfall likely contribute to these fluctuations. Many of its habitats are extremely precipitous, making access difficult and in some cases totally

unapproachable, with vertical valley walls of several hundred to several thousand feet (K. Wood, pers. comm. 2010). Estimates of total numbers over the years have consistently been listed as between 1,000 and 5,000 individuals in 16 to 18 populations (USFWS 1994, 1995, 2007, 2010), but the most recent observations on all islands estimate less than 1,135 to 2,135 individuals in 21 populations (K. Wood, pers. comm. 2010; H. Oppenheimer, pers. comm. 2010).

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

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information.

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.):

No new information.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

On Kauai, *Peucedanum sandwicense* grows on cliff habitats in mixed shrub coastal dry cliff communities or diverse mesic forest between 90 and 915 meters (300 and 3,000 feet) elevation (USFWS 2003a; National Tropical Botanical Garden 2010a). At Kuia Valley on the Na Pali Coast, *Peucedanum sandwicense* is typically found in diverse mesic forests with *Acacia koa* (koa), *Carex meyenii* (No common name [NCN]), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Eragrostis variabilis* (kawelu), *Kokia kauaiensis* (kokio), *Panicum lineale* (panic grass), *Psychotria greenwelliae* (kopiko), *P. mariniana* (kopiko), and *Wilkesia gymnoxiphium* (iliau) (Wood 1999). Another recently described Na Pali habitat for *P. sandwicense* is Pohakuao Valley, located between Kalalau and Hanakoa Valleys (Wood *et al.* 2002). The upper hanging valley of Pohakuao, between 425 and 605 meters (1,400 and 2,000 feet) elevation, contains a relict diverse mesic cliff plant community dominated by the shrub *Euphorbia celastroides* var. *hanapepensis* (akoko) and two native grasses, *Eragrostis variabilis* (kawelu) and *Panicum lineale*. Other components include *Artemisia australis* (hinahina), *Bidens sandwicensis* subsp. *sandwicensis* (kookoolau), *Melanthera connata* var. *acris* (nehe), *Nototrichium sandwicense* (kului), *Dianella sandwicensis* (ukiuki),

Peperomia spp. (alaala wai nui), *Peucedanum sandwicense* (makou), *Plectranthus parviflorus* (alaala wai nui wahine), *Carex meyenii*, *Cyperus phleoides*, *Dodonaea viscosa*, *Diospyros* spp. (lama), *Hibiscus kokio* subsp. *saintjohnianus* (kokio ulaula), *Metrosideros polymorpha* var. *glaberrima* (ohia), and *Psydrax odorata* (alahee) (Wood *et al.* 2002). *Peucedanum sandwicense* grows on extremely steep or vertical cliffs on the northern face of Mount Haupu on the southeastern side of Kauai. This community is largely open shrubland and fernland with a sparse tree cover between 2 and 3 meters (6.5 to 10 feet) tall, including *Antidesma platyphyllum* var. *hillebrandii* (hame), *Ilex anomala* (kawau), *Kadua affinis* (manono), *Metrosideros polymorpha* (ohia), *Perrottetia sandwicensis* (olomea), *Pipturus albidus* (mamaki), *P. kauaiensis* (mamaki), *Pittosporum gayanum* (hoawa), *Psychotria mariniana* (kopiko), *Xylosma hawaiiense* (maua), *Bidens valida* (kookoolau), *Carex wahuensis*, *C. meyenii*, *Eragrostis variabilis*, *Machaerina angustifolia* (uki), *Dicranopteris linearis* (uluhe), and *Diplopterygium pinnatum* (uluhe lau nui) (Wood 2005).

Recent accounts (USFWS 2003b) describe the Oahu habitat as cliffs, slopes, and ridges in *Metrosideros polymorpha* lowland mesic forest between 666 and 906 meters (2,200 and 2,975 feet) elevation (J. Lau, pers. comm. 2010), associated with native species such as *Artemisia australis*, *Carex meyenii*, *Dodonaea viscosa*, *Eragrostis* spp., *Leptecophylla tameiameia* (pukiawe), and *Sida fallax*. Joel Lau (pers. comm. 2010) relates that all extant sites on Oahu are dominated by invasive introduced plant species, primarily *Schinus terebinthifolius* (Christmasberry), and that the most common native *Metrosideros* species at these sites is *M. tremuloides* (lehua ahihi).

On Molokai, *Peucedanum sandwicense* grows in coastal cliff habitats and on rocky offshore islands from sea level to 840 meters (0 to 2,755 feet) elevation (USFWS 2003c). The habitat of the Mokapu Islet population discovered in 2000 is *Euphorbia celastroides* var. *amplectens* (akoko) – *Chenopodium oahuense* (aweoweo) coastal dry shrubland, with scattered sections dominated by relictual *Diospyros sandwicensis* (lama) forest at 45 to 75 meters (150 to 250 feet) elevation, associated with native canopy species *Pritchardia hillebrandii* (loulu), *Polyscias sandwicensis* (ohe makai), and *Santalum ellipticum* (iliahialoe); understory species include *Artemisia australis* (ahinahina), *Lepidium bidentatum* var. *o-waihiense* (anaunau), *Osteomeles anthyllidifolia* (ulei), *Pittosporum halophilum* (hoawa), *Plumbago zeylanica* (iliee), *Scaevola taccada* (naupaka kahakai), and *Senna gaudichaudii* (kolomona); and groundcovers *Dianella sandwicensis* (ukiuki), *Eragrostis variabilis* (kawelu), *Melanthera integrifolia* (nehe), *Peperomia blanda* var. *floribunda* (alaala wai nui), *Plectranthus parviflorus*, *Portulaca lutea* (ihi), and *Schiedea globosa* (NCN), (Hawaii Biodiversity and Mapping Program 2010; National

Tropical Botanical Garden 2010a). Seasonally, patches of the endemic *Panicum torridum* (kakonakona) are found in the habitat (H. Oppenheimer, pers. comm. 2010).

At Lepau Point, the habitat is a *Pandanus tectorius* (hala) coastal mesic forest with associated canopy species including *Metrosideros polymorpha* var. *glaberrima* (ohia) and *Diospyros sandwicensis*; understory taxa *Artemisia australis*, *Bidens molokaiensis* (kookoolau), *Brighamia rockii* (alula), *Chenopodium oahuense*, *Euphorbia celastroides* var. *amplectens*, *Osteomeles anthyllidifolia*, *Scaevola taccada*, and *Sida fallax*; vines *Cocculus orbiculatus* and *Mucuna gigantea*; and ferns and groundcovers *Asplenium nidus* (ekaha), *Carex wahuensis*, *Eragrostis variabilis*, *Plectranthus parviflorus*, *Psilotum nudum* (moa), and *Schiedea globosa* (National Tropical Botanical Garden 2010a).

On Maui, *Peucedanum sandwicense* grows on sparsely vegetated steep to vertical cliff habitats with little soil in mesic or coastal communities between sea level and 1,132 meters (0 and 3,714 feet) elevation (USFWS 2003d). The habitat of the population located on Keopuka Rock was recently described as a thick tangle of introduced, invasive species including *Schinus terebinthifolius* (Christmasberry) and *Lantana camara* (lantana), with native species including *Pandanus tectorius* (hala) and *Osteomeles anthyllidifolia* on the narrow ridge top, and scattered native *Phymatosorus grossus* (lauae) in the understory. The sheer rocky slopes are vegetated with *Scaevola taccada* and the native sedges *Cyperus phleoides* and *Carex wahuensis*. *Peucedanum sandwicense* is found in the upper parts of these sheer walls, with *Sesuvium portulacastrum* (akulikuli) closer to the wave splash zone (Starr *et al.* 2006).

2.3.1.7 Other:

No new information.

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:

Threats:

- Ungulate degradation of habitat:
 - On Kauai (USFWS 2003; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)
 - Feral goats (*Capra hircus*)

- Pigs (*Sus scrofa*)
 - Mule deer (*Odocoileus hemionus*)
 - On Oahu (USFWS 2003b, 2007; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)
 - Feral goats
 - Pigs
 - On Molokai (USFWS 1994, 1995; Plant Extinction Prevention Program 2010; HMBP 2010; H. Oppenheimer, pers. Comm. 2010)
 - Feral goats
 - Axis deer (*Axis axis*)
- Established ecosystem-altering invasive plant species degradation of habitat
 - On Kauai (USFWS 1994, 1995, 2003a; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)
 - *Erigeron karvinskianus* (daisy fleabane)
 - *Grevillea robusta* (silk oak)
 - *Lantana camara* (lantana)
 - *Psidium cattleianum* (strawberry guava)
 - *Rubus argutus*(prickly Florida blackberry)
 - *Rubus rosifolius* (thimbleberry)
 - On Oahu (USFWS 1994, 1995, 2003a,b, 2007; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)
 - *Erigeron karvinskianus*
 - *Grevillea robusta*
 - *Lantana camara*
 - *Melinis minutiflora* (molasses grass)
 - *Psidium guajava* (common guava)
 - *Schinus terebinthifolius* (Christmasberry)
 - On Molokai (USFWS 1994, 1995; Plant Extinction Prevention Program 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. Comm. 2010)

- *Clidemia hirta* (Koster's curse)
- *Erigeron karvinskianus*
- *Lantana camara*
- *Melinis minutiflora*
- *Psidium guajava*
- *Schinus terebinthifolius*
- At Keopuka Rock off the north coast of East Maui (Starr *et al.* 2006; Hawaii Biodiversity and Mapping Program 2010)
 - *Ardisia elliptica* (inkberry)
 - *Digitaria ciliaris* (Henry's crabgrass)
 - *Lantana camara*
 - *Schinus terebinthifolius*
- At Makaloaka, an offshore rock located off Papiha Pt. on the east side of Wailua Bay, East Maui (Starr *et al.* 2006)
 - *Schinus terebinthifolius*
- Landslides and flooding – On Oahu, at Kalaupapa; on Huelo Rock and at Lepau Point on Puu o Hoku Ranch in Wailau Valley on Molokai (Plant Extinction Prevention Program 2010; USFWS 1994, 1995, 2003c, 2007; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a; H. Oppenheimer, pers. comm. 2010)

Current conservation efforts:

- Ecosystem-altering invasive plant species control – At Makua Military Reservation on Oahu (USFWS 2007).
- Ungulate control – Feral ungulate control on Molokai is currently conducted as a State/ Federal/ private partnership effort between the Molokai Natural Area Reserve System, Kalaupapa National Historical Park, and The Nature Conservancy of Hawaii, servicing Olokui and Puu Alii Natural Area Reserve System, The Nature Conservancy's Pelekunu Preserve, and Kalaupapa National Historical Park (H. Oppenheimer, pers. comm. 2010).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

This is not a threat.

2.3.2.3 Disease or predation:

Threats:

- Ungulate predation or herbivory – Potential threat on Kauai, Oahu, Molokai, and Mokapu (USFWS 1994, 1995, 2003a, b, 2007; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a; Plant Extinction Prevention Program 2010; H. Oppenheimer, pers. comm. 2010)
- Slug herbivory – A major threat to *Peucedanum sandwicense* throughout its range (H. Oppenheimer, pers. comm. 2010)
- Rodent predation or herbivory – Rats (K. Wood pers. comm. 2010)

Current conservation efforts:

- Predator/ herbivore control – Rats were eradicated from Mokapu islet during an aerial broadcast of rodenticide in February 2008 (K. Wood, pers. comm. 2010).

2.3.2.4 Inadequacy of existing regulatory mechanisms:**Threats:**

- Lack of adequate hunting regulation in areas with ungulates – The lack of adequate ungulate control and the existence of established hunting programs in areas where *Peucedanum sandwicense* occurs continue to threaten this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:**Threats:**

- Established invasive plant species competition:
 - On Kauai (USFWS 1994, 1995, 2003a; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)
 - *Blechnum appendiculatum* (no common name)
 - *Bryophyllum pinnatum* (airplant)
 - *Passiflora ligularis* (sweet granadilla)
 - *Pluchea carolinensis* (sourbush)
 - *Setaria parviflora* (yellow foxtail)
 - On Oahu (USFWS 1994, 1995, 2003a,b, 2007; Wood 1999; Wood *et al.* 2002; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)

- *Ageratina riparia* (spreading mist flower)
 - *Bryophyllum pinnatum*
 - *Stachytarpheta* spp. (vervain)
- On Molokai (USFWS 1994, 1995; Hawaii Biodiversity and Mapping Program 2010; Plant Extinction Prevention Program 2010; H. Oppenheimer, pers. Comm. 2010)
 - *Ageratina riparia*
 - *A. Adenophora* (Maui pamakani)
 - *Bryophyllum pinnatum*
 - *Buddleia asiatica* (dog tail)
 - *Conyza bonariensis* (hairy horseweed)
 - *Cordyline fruticosa* (ti)
 - *Cyrtomium falcatum* (holly fern)
 - *Digitaria ciliaris* (Henry's crabgrass)
 - *Lythrum maritimum* (pukamole)
 - *Nephrolepis brownii* (swordfern)
 - *Pluchea carolinensis*
 - *Phymatosorus grossus* (lauae)
 - *Syzygium cumini* (Java plum)
- At Mokapu, an offshore islet east of Kalaupapa Peninsula, Molokai (Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. Comm. 2010)
 - *Ageratum conyzoides* (ageratum)
 - *Bryophyllum pinnatum*
 - *Pluchea carolinensis*
 - *Portulaca oleracea* (pigweed)
- At Keopuka Rock off the north coast of East Maui (Starr *et al.* 2006; Hawaii Biodiversity and Mapping Program 2010)
 - *Malvastrum coromandelianum* (false mallow)
 - *Phymatosorus grossus* (lauae)
 - *Pluchea carolinensis*
 - *Portulaca oleracea*
- Hiking and trail maintenance – Especially for the trailside Hanakapiai population on Kauai, and on Oahu (USFWS 1994, 1995, 2003a,b, 2007; Wood 1999; Wood *et al.* 2002; Hawaii

Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2010a)

- Fire – At Makua Military Reservation, Oahu caused by military activities (USFWS 2007) and on Kauai during droughts (Hawaii Biodiversity and Mapping Program 2010)
- Drought (Hawaii Biodiversity and Mapping Program 2010)
- Military activities – At Makua Military Reservation, Oahu (USFWS 2007)
- Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

Current conservation efforts:

- Captive propagation for genetic storage and reintroduction:
 - Kalaupapa National Historical Park (2010), using source material from Kalaupapa Trail, reported propagating 22 individuals, having five individuals growing in the nursery, and 1,000 seeds in storage.
 - National Tropical Botanical Garden (2010b) reported 1,225 seeds stored from a source population on Kukui Trail, augmented by 10 seeds from Molokai. The same numbers of seeds were still in storage in 2011 (National Tropical Botanical Garden 2011).
 - The Center for Conservation Research and Training (2010) reported no seed storage or micropropagation efforts for this species.
 - The Plant Extinction Prevention Program (2010) reported that an unspecified number of seeds were collected by staff of the National Tropical Botanical Garden during late 2009 from plants located on Molokai at Kalaupapa and Lepau Point in Wailau Valley for deposit at Harold L. Lyon Arboretum and Kalaupapa National Historical Park.
 - In 2008, the Kauai Division of Forestry and Wildlife (2008) reported that 41 seeds were stored at their mid-elevation nursery; the 2011 report does not indicate any storage or reintroduction efforts for this species (Kauai Division of Forestry and Wildlife 2011).

- The Pahole Rare Plant Facility (2008) reported controlled propagation of a single individual.
- Reintroduction / translocation implementation:
 - Kalaupapa National Historical Park (2010), using source material from Kalaupapa Trail, reported reintroducing six to nine individuals into the park.
 - The National Tropical Botanical Garden (2010b) reported reintroducing 17 individuals at their garden at Limahuli and Lawai.
 - In 2008, the Kauai Division of Forestry and Wildlife (2008) reported 10 individuals were reintroduced into the Kalalau enclosure.
- Reintroduction / translocation site identification:
 - Kalaupapa National Historical Park (2010) reintroduction plans are to augment the existing single population located along the Kalaupapa Trail (currently totaling less than 15 individuals) and to create two new populations of 75 reproductive individuals along the east coast of Kalaupapa between Waialeia Stream and Kaaia, and at Kauhako Crater.
 - The U.S. Army Garrison Hawaii recently built a population unit-sized fence in Keaau to protect habitat of the related *Sanicula mariversa*, which would allow for ecosystem-level management efforts inside the fence; unfortunately, the existing population of *P. sandwicense* at Keaau is not inside the fence (K. Kawelo, pers. comm. 2010), but it does present reintroduction possibilities.

2.4 Synthesis

The interim stabilization goals for this species have at least been partially met, as there are likely, at least three populations containing 50 or more mature individuals and material is located in *ex situ* collections (Table 1). In addition, all threats are only being partially managed (Table 2). However, downlisting criteria are far from being met. Therefore, *Peucedanum sandwicense* meets the definition of threatened as it remains likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Table 1. Status of *Peucedanum sandwicense* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	1,000-5,000	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Unknown
1995 (recovery plan)	1,000-5,000	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Unknown
2003 (critical habitat)	282-387	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	Unknown
			3 populations with 50 mature individuals each	Unknown
2012 (5-year review)	1,135 – 2,135	10	All threats managed in all 3 populations	Partially (see Table 2)
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Likely Yes

Table 2. Threats to *Peucedanum sandwicense* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – Degradation of habitat, herbivory	A, C, D	Ongoing	Partially: Ungulates controlled on Molokai
Established ecosystem-altering invasive plant species degradation of habitat	A	Ongoing	Partially: Ecosystem-altering invasive plant species controlled at Makua, Oahu
Landslides and flooding	A	Ongoing	No
Slug herbivory	C	Ongoing	No
Rodent predation or herbivory – Rats	C	Ongoing	Partially: Rats eradicated from Mokapu
Established invasive plant species competition	E	Ongoing	No
Hiking and trail maintenance	E	Ongoing	No
Fire	E	Ongoing	No
Drought	E	Ongoing	No
Military activities	E	Ongoing	No
Climate change	A, E	Increasing	No

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

- Captive propagation for genetic storage and reintroduction:
 - Continue to collect seeds for adequate genetic storage.
 - Collect seeds from Maui populations, as populations appear to be unrepresented in *ex situ* collections.
- Reintroduction / translocation implementation – Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Surveys / inventories:
 - A population census and monitoring of *Peucedanum sandwicense* on Kauai should be undertaken to come up with firmer population estimates and how much they fluctuate from year to year. For recovery purposes, there is a need to clarify how many discrete populations exist on the island of Kauai.
 - Re-census and monitor populations on Oahu, whose welfare is relatively neglected.
- Ungulate control – Protect all populations against browsing and disturbances from feral ungulates.
- Ungulate exclosures – Construct and maintain fenced exclosures around all populations.
- Ecosystem-altering invasive plant species control – Continue to control ecosystem-altering invasive plant species around all populations.
- Competitive invasive plant species control – Control invasive nonnative plant species in the immediate vicinity of *P. sandwicense* populations.
- Predator / herbivore control – Determine and implement effective control methods for slugs.
- Predator / herbivore control:
 - Implement effective control methods for rodents.
 - Continue to monitor for rats on Mokapu.
- Site / area / habitat protection:
 - Develop and implement effective measures to reduce the impacts of hikers and trail maintenance, drought, and military activities.
 - Implement erosion control measures to prevent landslides.
- Fire protection – Develop and implement fire management plans for all wild and reintroduced populations.
- Population biology research:

- Study *P. sandwicense* populations with regard to population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
- Research the life history of *P. sandwicense* in reference to designating the taxon from a short-lived perennial to long-lived perennial.
- Alliance and partnership development – Work with the Hawaii Division of Forestry and Wildlife, State Parks, Kauai Watershed Alliance, The Nature Conservancy of Hawaii, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Peucedanum sandwicense* (Makou)

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

Appropriate Listing/Reclassification Priority Number, if applicable: _____

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