

Pseudognathalium sandwicense var. *molokaiense*
(‘ena‘ena)

**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: *Pseudognaphalium sandwicense* var. *molokaiense* ('ena'ena)

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5-YEAR REVIEW

Pseudognaphalium sandwicense var. *molokaiense* ('ena'ena)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Cheryl Phillipson, Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

Lead Regional Office:

Interior Region 12, Portland Regional Office

Lead Field Office:

Pacific Islands Fish and Wildlife Office

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 (Service), beginning in October 2020. The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations and species status report by the Service, State of Hawai'i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 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. 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.

1.3.2 Listing history:

Original Listing

FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants; endangered status for 49 species from the

Hawaiian Islands; final rule. Department of the Interior, Federal Register 81 (190): 67786–67860, Friday, September 30, 2016.

Date listed: September 30, 2016

Entity listed: *Pseudognaphalium sandwicense* var. *molokaiense*

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 *Pseudognaphalium sandwicense* var. *molokaiense*.

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

3

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Multi-Island Species

Date issued: August 2020

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

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 Service 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 Service 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.

Pseudognaphalium sandwicense var. *molokaiense* 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 three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three populations total should be documented on the islands of O‘ahu, Moloka‘i, Lāna‘i and/or Maui, where they now occur or occurred historically. Each of these populations must be naturally reproducing (i.e., viable seeds, seedlings) with a minimum of 50 mature individuals per population.

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

Interim Stage

To meet the interim stage of recovery of *Pseudognaphalium sandwicense* var. *molokaiense*, 300 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. Multi-island species should be represented by at least one population on each of the islands from which they were known historically as long as suitable habitat exists. 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, entire) that is secure and well managed. 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 500 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. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically as long as suitable habitat exists. 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 500 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. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically as long as suitable habitat exists. 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:

Pseudognaphalium sandwicense var. *molokaiense* ('ena'ena), a perennial herb in the Asteraceae (sunflower) family, is 10 to 65 cm (4 to 26 in) tall (Wagner et al. 1999, p. 321). The woolly erect to prostrate stems are 10 to 30 cm (4 to 12 in) long and olive green to white or gray in color. Leaves are spatulate to narrowly obovate, the lower ones usually 0.7 to 2 cm (0.3 to 0.8 in) wide, with only the tips of the whitish to pale yellow involucre bracts (below the flower) exposed, the remainder densely woolly (Wagner et al. 1986, pp. 115–116). Yellow flower heads are 1.5 to 7 millimeters (mm) (0.06 to 0.3 in) in diameter, arranged in terminal, corymbose (flat-topped) or sometimes nearly spherical, leafless, or nearly leafless clusters (Wagner et al. 1999, p. 321). Fruit and seeds are not described.

Pseudognaphalium sandwicense var. *molokaiense* is very densely woolly over the entire plant, and this is a distinguishing feature among the other varieties of this species (Wagner et al. 1986, pp. 115–116; Wagner et al. 1999, p. 321).

Collections occurred in all months except for June and September (BISH 1022303, 1022297, 1022296, 1022290, 1022294, 1022293, 1022305,

1022286, 1022299, 1022301). Flowering was noted in all observations and may be continually reproductive; numerous small seeds develop from each flower and are dispersed by the wind (Haase 2020, in litt.). Individuals die back after flowering (Haase 2020, in litt.).

The pollination vectors for *Pseudognaphalium sandwicense* var. *molokaiense* are unknown but may be insects as they have been observed visiting flowers. In general, the composite flower types of Asteraceae are attractive to bees and wasps (Lundin et al. 2018, p. 667).

Pseudognaphalium sandwicense var. *molokaiense* may produce compounds that protect the plant from insect pests. Hawaiians stored their feather standards (kāhili) with *P. sandwicense* to repel insects (Neal 1948, pp. 734–735). A study by Cotoras et al. (2001, p. 433) showed that extracts obtained from resinous exudates of other species of *Pseudognaphalium* reduced mycelial growth of a pathogenic fungus, likely due to the presence of flavonoids and diterpenoids. Extracts from *Pseudognaphalium moritzianum* showed antimicrobial activity against human pathogens, the bacteria *Staphylococcus aureus*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*, also possibly attributable to flavonoids (Rangel et al. 2002, pp. 719–720).

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:

Pseudognaphalium sandwicense var. *molokaiense* occurs on the strand and consolidated dunes of western Moloka‘i and west Maui and was historically known from ridges on Moloka‘i at Alanuihipaka and from Lāna‘i and O‘ahu, in 15 populations (Wagner et al. 1986, p. 116; HBMP 2010; NTBG 1991, 1993). There is only one recorded occurrence on the island of Lāna‘i collected in 1960 on bare clay on outcrops and is currently assumed to be extirpated (BISH 1022303). On O‘ahu, the last known population of five individuals on Lē‘ahi (Diamond Head) were last observed in 1980 (HBMP 2010).

Pseudognaphalium sandwicense var. *molokaiense* currently occurs primarily on the island of Moloka‘i, but also occurs on the northwest coast of Maui at Kahakuloa between Pu‘ukoa‘e and Pu‘ukāhuli‘anapa (Haase 2020, in litt.; NTBG 2005, 2015).

The Moloka‘i populations at Mo‘omomi and ‘Īlio Point are actively managed; however the numbers of plants at Mo‘omomi have decreased drastically, likely due to predation by deer that are within the enclosure (Dunbar-Co 2021, in litt.; Bakutis 2021a, in litt.). The Plant Extinction Prevention Program (PEPP) surveyed Mo‘omomi in 2020 and observed

only two clusters of five to 10 plants each likely due to predation by axis deer present within the fenced area (Bakutis 2021a, in litt.).

The 'Īlio Point population is comprised of two subpopulations, one that encompasses the northwest point of the island that is not fenced or managed, and in 2010, an estimated six individuals were observed. Currently no plants were observed at 'Īlio Point, also likely due to predation by axis deer (Bakutis 2021b, in litt.). The second subpopulation along the western portion of Mokio is protected by an enclosure and its numbers show an increasing trend (at least 100 individuals), following invasive plant removal in the area and exclusion of ungulates (Haase 2020, in litt.).

In 2005, there were two populations at Kalaupapa National Historical Park (NHP), one on a cliff, and a second of approximately 150 plants located on the ocean side of the runway (KALA 2005; NTBG 2005). Their current status is unknown.

On Maui, *Pseudognaphalium sandwicensium* var. *molokaiense* occurred near 'Īao Valley, at Waiehu, and at Kahakuloa. The 'Īao valley population has not been surveyed since 1947, and its status is not known. The Waiehu population was last surveyed in 1990 and a few individuals were observed; however, their current status is has not been reported (BISH 1022305; HBMP 2010). The Kahakuloa population (20 individuals) was surveyed in 2018 by the PEPP. This area is heavily grazed by ungulates and these individuals are at risk of trampling and predation.

Assessment of population numbers is complicated by the propensity for populations to fluctuate in size seasonally, particularly following seed dispersal, or in the presence of prolonged periods of drought, when population size declines (Haase 2020, in litt.).

In summary, there are five populations known to be extant, and several more of unknown status. Currently, the four populations on Moloka'i total fewer than 300 individuals, largely due to axis deer herbivory. The population on west Maui is approximately 20 individuals.

Age classes of plants located on Maui are undescribed; however, recent surveys of plants on Moloka'i show that all age classes are represented at the Mokio, plants are producing viable seeds that successfully recruit.

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:

Initial collections were referred to as *Gnaphalium luteo-alum* (BISH 1022286, 1022287, 1022288, 1022295, 1022300, 1022301; SNMNH 264110). Specimens from of O‘ahu, Maui, and Moloka‘i examined by Sherff (1949, p. 504) were described as *Gnaphalium sandwicenseum* var. *typicum* f. *canum*, as well as a single specimen from the island of Hawai‘i collected in the 1850s. Another form, *Gnaphalium sandwicenseum* var. *typicum* f. *olivaceum*, occurred on O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i, frequently in gulches and higher elevations. Later, Wagner et al. (1997) placed members of *Gnaphalium* in the islands of Hawai‘i into three genera: *Euchiton*, *Gamochaeta*, and *Pseudognaphalium* (Wagner et al. 1997, p. 53). Each of the three *Gnaphalium* species as treated by Wagner et al. (1986, 1999) is placed in a different genus. Currently, *Pseudognaphalium sandwicenseum* is considered one species with four distinctive varieties: *Pseudognaphalium sandwicenseum* var. *sandwicenseum*, *Pseudognaphalium sandwicenseum* var. *hawaiiense*, *Pseudognaphalium sandwicenseum* var. *kilaueanum*, and *Pseudognaphalium sandwicenseum* var. *molokaiense* (Wagner et al. 1997, p. 54).

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 and 2.3.1.4 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):

Pseudognaphalium sandwicenseum var. *molokaiense* occurs in coastal areas at sea level to 152 meters (m) (0 to 500 feet (ft)), in predominantly arid environments in sandy soil, directly on sand dunes, and on raised limestone plains and bare clay outcrops (BISH 1022301, 1022298, 1022290, 1022303; Haase 2020, in litt.). Associated native species along the cliffs of Moloka‘i from Ke Ala Pūpū a Kiha to Pueoao include *Chenopodium oahuense* subsp. *ilioensis* (‘āweoweo papa), *Euphorbia skottsbergii* var. *audens* (‘akoko), *Heliotropium anomalum* (hinahina kū kahakai) *Jacquemontia sandwicensis* (pā‘ūohi‘iaka), *Lipochaeta integrifolia* (nehe), *Lycium sandwicense* (‘ōhelo kai), *Nama sandwicensis* (hinahina kahakai), *Panicum fauriei*, *P. torridum* (hākonakona), *Portulaca lutea* (‘ihi), *Scaevola taccada* (naupaka kahakai), *Schiedea globosa*, *Sesbania tomentosa* (‘ōhai), *Sesuvium portulacastrum* (‘ākulikuli), *Sida fallax* (‘ilima), and *Solanum nelsoni* (pōpolo) (Cantley et al. 2020, p. 559, BISH 1022290). At Pu‘u Ka Pele and ‘Īlio Point, associated native species include *Fimbristylis cymosa* (mau‘u‘aki‘aki), *Heliotropium anomalum* (hinahina), *Heteropogon contortus* (pili) *Sporobolus virginicus* (‘aki‘aki), *Tetramolopium sylvae*, and *Wikstroemia uva-ursi* (‘ākia) (Cantley et al.

2020, p. 559; BISH 1022298). At Mokio, associated native species include *Dodonaea viscosa* (a‘ali‘i), *Myoporum sandwicense* (naio), *Scaevola taccada*, *Sesbania tomentosa*, *Sida fallax*, and *Wikstroemia* sp. (‘ākia) (Haase 2020, in litt.).

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 destruction and degradation of habitat—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 by increasing erosion by creating large areas of bare soil (Loope 1998, pp. 747–774; van Riper and van Riper 1982, pp. 34–35). Feral pigs (*Sus scrofa*), goats (*Capra hircus*), axis deer (*Axis axis*), and mouflon (*Ovis musimon*), and evidence of their activities are observed at the known occurrences of *Pseudognaphalium sandwicense* var. *molokaiense* where ungulate exclusion fencing has not been constructed and maintained (Bakutis 2021a, in litt., 2021b, in litt.; Dunbar-Co 2021, in litt.; Haase 2020, in litt.; PEPP 2015; The Nature Conservancy (TNC) 2017, pp. 10–11).

Established ecosystem-altering invasive plant modification and degradation of habitat—*Pseudognaphalium sandwicense* var. *molokaiense* colonizes bare open ground, and as such, is susceptible to habitat modifying species (native and nonnative) that form a canopy that would shade out or displace it and prevent its regeneration (Haase 2020, in litt.). Invasive plants adversely affect habitat by modifying availability of light and nutrient cycling processes, and by altering soil-water regimes (Cuddihy and Stone 1990, p. 74). Some invasive plants may release chemicals that inhibit growth of other plants. These competitive advantages allow invasive plants to convert native-dominated plant communities to nonnative plant communities. The most pervasive nonnative plant at Mokio is *Prosopis pallida* (kiawe) (Haase 2020, in litt.). *Prosopis pallida* is a tree with two root systems: a taproot system that often reach depths of 20 to 25 meters (m) (66 to 85 feet (ft)), and lateral roots that spread to 18 m (59 ft) or more from the base of the tree. This gives *P. pallida* an advantage over native species, including *P. sandwicense* var. *molokaiense*, for access to water resources (Gallaher and Merlin 2010, pp. 491–492). *Prosopis pallida* occurs in areas previously occupied by *P. sandwicense* var. *molokaiense*, and its continued proliferation in the environment is a direct threat to the presence and recruitment of *P. sandwicense* var. *molokaiense*. Other nonnative invasive plants that are the greatest threat to *Pseudognaphalium sandwicense* var. *molokaiense* between Ke ala pūpū a Kiha to Pueoao

includes *Sonchus oleraceus* (sow thistle, pualele) and at Pu‘u ka Pele includes *Plantago lanceolata* (narrow-leaved plantain) (Cantley et al. 2020, p. 559; Haase 2020, in litt.). *Cynodon dactylon* (mānienie, Bermuda grass) and *Chloris radiata* (radiate fingergrass) are noted nonnative plant threats on west Maui (BISH 1020027).

Landslides, erosion, and flooding, and rockfall destruction or degradation of habitat—Some populations of *Pseudognaphalium sandwicensium* var. *molokaiense* are located on sea cliffs and an increase in stochastic events could lead to landslides and rockfalls that could destabilize substrate and alter hydrological patterns, and could damage or kill existing plants and destroy habitat for regeneration (BISH 1022301; PEPP 2015; Stearns 1985, pp. 99–107, 291–305).

Drought—While *Pseudognaphalium sandwicensium* var. *molokaiense* is drought and saltwater tolerant, intense periods of drought in 2020 have reduced the number of individuals at Mokio (Haase 2020, in litt.).

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):

Herbivory and predation by feral ungulates—Feral pigs, goats, axis deer, and mouflon, and evidence of their activities are observed at current and historical occurrences of *Pseudognaphalium sandwicensium* var. *molokaiense* outside of fencing (Bakutis 2021a, in litt., 2021b, in litt.; Dunbar-Co 2021, in litt.; Haase 2020, in litt.; PEPP 2015; TNC 2017, pp. 10–11). Drought events are driving deer farther into larger areas in search of food (Waring 1996, in litt; Nishibayashi 2001, in litt.; Haase 2020, in litt.). Feral pigs have been observed browsing on young shoots, leaves, and fronds of a wide variety of native plants (Diong 1982, p. 144). Feral goats forage in areas of extremely rugged terrain and are instrumental in the decline of native vegetation (Cuddy and Stone 1990, p. 64; van Riper and van Riper 1982, pp. 34–35; Tomich 1986, pp. 153–156). These animals damage and destroy plants by direct herbivory, bark stripping, and trampling.

Predation by nonnative invertebrates—A new potential threat to *Pseudognaphalium sandwicensium* var. *molokaiense* is the predation of plants by an unknown arthropod at Mokio on Moloka‘i. Managers have reported an unidentified caterpillar that forms a webbed enclosure around itself as it consumes the fleshy portions of the plant, and has led to death of the plants in some instances (Haase 2020, in litt.).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

Lack of adequate hunting regulations—Nonnative feral ungulates are a threat to *Pseudognaphalium sandwicense* var. *molokaiense* through destruction and degradation of the species' habitat, and directly by predation and herbivory; however, regulatory mechanisms are inadequate to address this threat. The State of Hawai'i provides game mammal hunting opportunities in State-designated public hunting areas (DLNR 2010). However, the State's management objectives for game animals range from maximizing public hunting opportunities (i.e., "sustained yield") in some areas to removal by State staff, or their designees (State of Hawai'i, H.A.R. 13-123). Current and historical occurrences of *P. sandwicense* var. *molokaiense* were within or adjacent to public hunting areas. Public hunting areas are not fenced and game mammals have unrestricted access for most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations of *P. sandwicense* var. *molokaiense* are at risk (DLNR 2010). Some individuals are within ungulate exclosures; however, not all axis deer have been removed and these exclosures must be monitored and maintained to prevent incursion.

Lack of adequate biosecurity legislation—Introduction of nonnative plants and insects—Currently, four agencies are responsible for inspection of goods arriving in Hawai'i (CGAPS 2009). The Hawai'i Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawai'i, especially insects or plant diseases. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations, focusing on non-propagative plant materials, and internationally regulated commercial species under the Convention in International Trade in Endangered Species (CITES). Also included are federally listed noxious seeds and plants, soil, and pests of concern for forests and agriculture. The U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ) inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities (HDOA 2009). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 et seq.) and prosecutes CITES violations. The State of Hawai'i allows the importation of most plant taxa, with limited exceptions. Many invasive plants established in Hawai'i have expanding ranges. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established nonnative invasive plants is largely focused on a few invasive species that cause significant economic or environmental damage to public and private lands, and comprehensive control of an array of invasive plants remains limited in scope. The introduction of new invasive plant and invertebrate species to

the State of Hawai‘i is a significant risk to federally listed species including any remaining wild or outplanted individuals of *Pseudognaphalium sandwicense* var. *molokaiense*.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):

Reduced viability due to low numbers—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, pp. 3,7; Newman and Pilson 1997, pp. 354–355). Due to the small population sizes that exist across the range of the species there is a risk of genetic drift and inbreeding, where allele frequencies may undergo large fluctuations. Genetic drift can cause the fixation of alleles as well as an increase in differentiation among populations, while inbreeding increases homozygosity. Reduced gene flow can be detrimental for small populations because under certain conditions it can lead to reduced local variation, prevent adaptive differentiation, and reduce fitness through outbreeding depression (Ellstrand and Elam 1993, pp. 218–219, 232). 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. Observations of individuals of *Pseudognaphalium sandwicense* var. *molokaiense* *in situ* have revealed that any competing vegetation, including native species, can negatively affect its germination and recruitment (Haase 2020, in. litt.).

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. Vulnerability is ranked on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change. The assessment was conducted for *Pseudognaphalium* at the species level, with a score of 0.509. Varieties such as var. *molokaiense* with a very narrow range (coastal only) are likely to be impacted by the effects of climate change. Considering that and threats such as habitat destruction by feral ungulates, nonnative plants, landslides and rockfalls, predation and herbivory, and the small number of remaining populations (including extirpation from O‘ahu and Lāna‘i) are ongoing, it is likely that climate change could affect its ability to persist. 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.

Current Management Actions:

- Habitat management and protection—
 - Mokio, a 1,769 acre parcel that was donated to the Moloka'i Land Trust (MLT) by a private landowner, contains approximately 8 kilometers (5 miles) of rugged shoreline, remnant native coastal strand and dune ecosystems, seasonal wetland, and several ancient Hawaiian sites (Haase 2020, in litt.). Molokai Land Trust primarily conducts restoration activities at the fenced Anapuka Dune Restoration Site in this area (Haase 2020, in litt.). Restoration activities include ungulate control (exclosure) and restoration of common and rare native plants. The population of *P. sandwicensium* var. *molokaiense* in this area has responded to this management with increased recruitment (Haase 2020, in litt.).
 - The Mo'omomi Preserve is a 921 acre site on Moloka'i managed by The Nature Conservancy (TNC) in partnership with the State of Hawai'i's Department of Natural Resources Natural Area Partnership Program. Conservation actions include ungulate control, predator control, invasive plant control, monitoring and research, rare species protection, and community outreach (TNC 2011, p. 2).
 - The Kalaupapa National Historical Park (NHP) populations of *P. sandwicensium* var. *molokaiense* are managed by the National Park Service (NPS). One population is located adjacent to the Kalaupapa Airport and is likely offered a layer of protection from fencing for the facility.
- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) monitors, surveys, collects propagules, and collaborates with other conservation groups for restoration activities at Kahakuloa on Maui, and Kalaupapa and 'Īlio Point on Moloka'i (PEPP 2014, 2015). PEPP most recently surveyed for *P. sandwicensium* var. *molokaiense* at Mo'omomi and 'Īlio Point in 2020 (Bakutis 2021a, 2021b, in litt.).
- Ungulate control—
 - At Mo'omomi Preserve, 175 acres were fenced in 2017; however, the deer population has been difficult to eradicate (Dunbar-Co 2021, in litt.).
 - TNC conducts quarterly fence checks at Mo'omomi Preserve to assess if breaches by cattle and feral ungulates have occurred (TNC 2011, p. 11). As of 2019 there were deer remaining within the exclosure (TNC 2017, p. 10; Dunbar-Co 2021, in litt.). In addition, game cameras are used at key sites to monitor

- and detect the presence of cats, pigs, and deer (TNC 2017, p. 11).
- One population at Kalaupapa NHP is located adjacent to the airport and is likely offered a layer of protection from fencing for the facility.
 - Ecosystem-altering invasive nonnative plant control—
 - The MLT works removes invasive plants at Mokio with assistance of volunteers and partner organizations such as TNC and the USDA Natural Resources Conservation Service (Haase 2020, in litt.).
 - TNC implements a control strategy for removal of *Prosopis pallida* adjacent to native plant communities.
 - Captive propagation for genetic storage and reintroduction—
 - Lyon Arboretum reports 10,628 seeds in storage representing pooled collections from two populations on Moloka‘i at Mo‘omomi Preserve and Mokio (6,721 seeds) and one population on Maui at Kahakuloa (3,907 seeds) (Lyon Arboretum 2019).
 - The Maui Nui Botanical Garden (MNBG) reports propagation of 14 plants from seeds collected from Mo‘omomi on Moloka‘i. Additionally, MNBG has hundreds of seeds that are in storage, representing at least 20 founders from the Kahakuloa (Pu‘ukāhuli‘anapa) population on Maui. These seeds were collected in collaboration with PEPP (MNBG 2019).
 - PEPP reported collection of seeds from 24 individuals at Kahakuloa, Maui, in 2015 (PEPP 2015).
 - In the 1990s, the National Tropical Botanical Garden (NTBG) reported collection and storage of 10,000 seeds from Kaiehu Point at Mo‘omomi on Moloka‘i. The viability of this collection is unknown (NTBG 2019).
 - Population biology research—By tracking the resurgence of *P. sandwicensium* var. *molokaiense* after restoration management, MLT discovered a relationship between clearing and planting activities and the number of plants naturally recruiting. They found a delay of a year or two after clearing areas and recruitment. This is an example of the complexity of the Mokio ecosystem. Areas of Mokio need to be revegetated completely to reduce erosion while small areas should also be left open for recruitment by existing native plants like *P. sandwicensium* var. *molokaiense* (Haase 2020, in litt.).

Table 1. Status and trends of *Pseudognaphalium sandwicense* var. *molokaiense* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2016 (listing)	ca 20,000 (Moloka‘i) <25 (Maui)	0	All threats managed in all 3 populations	Partially, 2 populations in exclosures, some nonnative plant control
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Partially, 1 population >50
2021 (5-year review)	<300 (Moloka‘i) ca 20 (Maui)	0	All threats managed in all 3 populations	Partially, 2 populations in exclosures, some nonnative plant control
			Complete genetic storage	Partially, 20 Maui founders represented; 2 populations from Molokai represented
			3 populations with 50 mature individuals each	Partially, 1 population was >50; however, numbers have declined dramatically due to axis deer herbivory
			Each population naturally reproducing	Partially, recruitment observed at Mokio

Table 2. Threats to *Pseudognaphalium sandwicense* var. *molokaiense* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Destruction and degradation of habitat by ungulates	A	Ongoing	Partial, 2 populations in exclosures
Destruction and degradation of habitat by established ecosystem-altering invasive plants	A	Ongoing	Partial, some nonnative plant control within exclosures
Landslides, erosion, and rockfall destruction or degradation of habitat	A	Ongoing	Partial, collections in storage
Predation and herbivory by ungulates	C	Ongoing	Partial, 2 populations in exclosures
Predation by nonnative invertebrates	C	Potential	None
Inadequacy of regulatory mechanisms	D	Ongoing	Partial, 2 populations in exclosures
Low numbers and loss of viability	E	Ongoing	Partial, seeds and plants in storage
Climate change degradation or destruction	E	Ongoing	None

2.4 Synthesis

There are fewer than 300 wild individuals of *Pseudognaphalium sandwicense* var. *molokaiense* on Moloka‘i and 20 wild individuals on Maui; however, populations on Lāna‘i and O‘ahu are extirpated. The numbers of individuals on Moloka‘i have declined drastically due to herbivory by deer. This species may be vulnerable to the effects of climate change. Two wild populations are within exclosures, however one of these exclosures have axis deer remaining within that continue to eat *P. sandwicense* var. *molokaiense*. There is ungulate control and some plant control within exclosures. Twenty founders from Maui are represented in collections and two populations (an unknown number of founders) from Moloka‘i (Mo‘omomi and Mokio) are represented in collections.

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 total should be documented on the islands of Hawai‘i 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. Only one population sometimes has more than 50 mature individuals. At least 20 founders from Maui and an unknown number of founders from Moloka'i are represented in collections (Table 1); however, not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Pseudognaphalium sandwicensium* var. *molokaiense* 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—Continue to conduct surveys for *Pseudognaphalium sandwicensium* var. *molokaiense* in historical locations and potentially suitable habitat.
- Ungulate monitoring and control—Continue to construct and maintain fenced enclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with

P. sandwicensium var. *molokaiense*

- Predation and herbivory control—Implement ungulate control and continue to monitor and maintain ungulate exclosures. Investigate the identity of the undescribed invertebrate threat and determine control methods if required.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Begin reintroductions and population augmentations to increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of habitat destruction, nonnative plant competition, predation, and climate change.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Alliance and partnership development—Continue to contribute to planning and 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 *Pseudognaphalium sandwicense* var. *molokaiense*
(‘ena‘ena)

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:

Cheryl Phillipson, Fish and Wildlife Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

for _____
Field Supervisor, Pacific Islands Fish and Wildlife Office