

Pritchardia lanigera
(loulu)

**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: *Pritchardia lanigera* (loulu)

TABLE OF CONTENTS

1.0	GENERAL INFORMATION	3
1.1	Reviewers:.....	3
1.2	Methodology used to complete the review:.....	3
1.3	Background:	3
2.0	REVIEW ANALYSIS.....	4
2.1	Application of the 1996 Distinct Population Segment (DPS) policy	4
2.2	Recovery Criteria.....	5
2.3	Updated Information and Current Species Status	8
2.4	Synthesis.....	19
3.0	RESULTS	20
3.1	Recommended Classification:.....	20
3.2	New Recovery Priority Number:	20
3.3	Listing and Reclassification Priority Number:	20
4.0	RECOMMENDATIONS FOR FUTURE ACTIONS.....	20
5.0	REFERENCES.....	21

5-YEAR REVIEW
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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 2019. The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 of 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. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing

FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered species status for 15 species on Hawaii Island; final rule. Department of the Interior, Federal Register 78: 63638–64690, October 29, 2013.

Date listed: October 29, 2013

Entity listed: *Pritchardia lanigera*

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 *Pritchardia lanigera*.

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

2

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Island of Hawai'i

Date issued: October 2019

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.

Pritchardia lanigera is a long-lived perennial tree. 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 should be documented on the island of Hawai‘i where they now occur or occurred historically. Each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, saplings) with a minimum of 25 mature, reproducing individuals per population.

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

Interim Stage

To meet the interim stage of recovery of *Pritchardia lanigera*, 100 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation’s guidelines (Guerrant *et al.* 2004) 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 200 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

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

Delisting Criteria

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

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

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

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

Pritchardia lanigera is a palm tree 7.6 meters (m) (25 feet (ft)) or taller; some at 14 m (45 ft). Variable, smooth grayish trunk 15 to 51 centimeters (cm) (6 to 20 inches (in)) in diameter. The crown contains up to 20 ascending, spreading to drooping leaves, 0.9 to 1.2 m (3 to 4 ft) long and 1.2 to 1.5 m (4 to 5 ft) wide, slightly wavy to nearly flat blades and 0.9 m (3 ft) -long leaf stalks, with a moderate amount of fibers at the base. Blades, glossy above and below, are deeply divided to nearly half into as many as 70 stiff-tipped segments. The spreading to drooping flower stalks have up to three moderately long primary branches, almost equal to leaf stalks in length, with fruit stalks longer than leaf stalks, but shorter than leaf blades. Flower and fruit branchlets are short, thick, and stubby, to 7.6 cm (3 in) long; densely clothed in thick, pinkish brown woolly hairs. Fruit are shiny, black, ellipsoid to spherical, up to 5.6 cm (2.2 in) long and 4 cm (1.6 in) wide when mature (Hodel 2012, pp. 102–104).

The similar *Pritchardia arecina* (east Maui) differs in leaf blades silvery gray underneath and abundant hairs at leaf stalk base; and *P. woodii* (east Maui) with flower/fruit branches covered in short, velvety hairs (Read and Hodel 1999, p. 1371).

Sakai et al. (1995) suggest that the pollinators of *Pritchardia lanigera* are insects and that the presumed dispersal mechanism for transport to the Hawaiian Islands was internally via birds and possibly by oceanic drift, as the tree produces fleshy fruits.

The flowers of *Pritchardia* are hermaphroditic (having male and female parts) and are coriaceous (leathery). Insects are attracted to the pollen and nectar, which are both abundant (MacCaughey 1918, p. 326). According to field biologists, pollination rates appear to be low for this species, and the absence of seedlings and juveniles at known locations suggests that regeneration is not occurring, which they believe to be caused, in part, by beetle, rat, and pig predation on the fruits, seeds, and seedlings (Bio 2011, pers. comm.; Crysedale 2013 in HVNP 2015, pp. 467–468).

The establishment of new populations of *Pritchardia* is likely a result of the heavy, hard, and durable fruit being carried by their own weight down steep slopes (MacCaughey 1918, p. 321). The fruit can also be transported in streams and lodge between cracks and crevices where they germinate and grow; it is common to observe *Pritchardia* growing along valley slopes and streams (MacCaughey 1918, p. 321). In addition, young *Pritchardia* are shade tolerant as they grow under the canopy of the wet forest (MacCaughey 1918, p. 321).

A study by Walters (2015, in litt.) was conducted to determine optimal seed bank storage methods for Hawaiian plants with non-recalcitrant seeds including two palm species *Pritchardia remota* and *P. aylmer-robinsonii*. The highest viability after stress challenges were achieved from embryos excised from fruits that were dark brown rather than green. Coloration of maturing fruits appeared to be linked to the water content of the embryo, a measure of maturity in freshly harvested fruits. Embryos with more water were less likely to survive freezing temperatures associated with preparation for storage. Embryos kept within whole fruits were found to survive the initial stress of freezing if strict methods used for drying and use of liquid nitrogen were optimal, with a resulting 80 to 100 percent viability. Embryos were excised from larger fruits for better temperature control. In addition, removal of embryos can save on the storage space required and maintenance costs.

Other life history information is currently unknown, including information the length of time it takes to cycle through each plant growth stage and the length of time it takes to flower.

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:

Pritchardia lanigera is endemic to island of Hawai‘i (Read and Hodel 1990, p. 1371). Historically, *P. lanigera* was known from the Kohala mountains-Hāmākua district and the windward slopes of Mauna Kea (National Park Service (NPS) 2015, pp. 467–468). The species occurs as

widely scattered individuals in two disjunct populations in northwest and southern parts of the island (Hodel 2012, p. 104).

In 1989, the Department of Land and Natural Resources (DLNR) determined there to be one occurrence (one individual) within Pu‘u o Umi Natural Area Reserve (NAR) in uluhe shrubland (DLNR 1989, pp. 10, 12). Subpopulations of *Pritchardia lanigera* near Kaiholena observed in 1980 were not relocated on a survey in 2008 (Wood et al. 2008, p. 6) and were thought to be extirpated. However three small subpopulations (possibly reintroduced plants) were located in 2009 by TNC staff working with local hunters and volunteers (TNC 2011, p.p. 10, 34; NPS 2015, pp. 267–468; HVNP 2019, p. 22). The individuals at ‘Āwini in the Kohala mountains were last observed in 1910 while individuals at Honopue were last observed in 1973 (USFWS 2020, unpubl. data).

Currently, there are approximately 150 to 200 widely scattered plants in Hāmākua-Pali and Kohala Forest Reserve (FR) with unknown numbers in the Hāmākua FR, Mānowai‘ale‘e FR and Hilo FR unknown number (likely fewer) of wild individuals in the Ka‘ū FR. (Hodel 2012, p. 104).

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:

Pritchardia lanigera was discovered by Lydgate in the Kohala mountains and Hillebrand then sent specimens to Berlin. Beccari described and named it “woolly loulu” in 1890, using the Latin epithet *lanigera*, meaning wool-bearing for the soft woolly or cottony dense reddish brown fibers on the flowering and fruiting stems (Native Plants Hawai‘i 2009). In 1910, Rock collected specimen in Kohala above ‘Āwini at 3,300 ft, and again at Waimea ca 4,000 ft. One plant found on southwest Mauna Loa by Rock in 1912 was named *P. eriostachya*; and another plant found in 1920 on windward Mauna Kea between Honoka‘a and Pa‘auhau was named *P. montis-kea* (Hodel 2012, p. 102). Both of these species are now recognized as in synonymy of *P. lanigera*. *Pritchardia lanigera* is the currently accepted taxonomy (Hodel 2012, pp. 101–105; Read and Hodel 1999, p. 1371).

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

See section 2.3.1.2 above for spatial distribution of the species.

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

Pritchardia lanigera occurs in a variety of wet to very wet habitats including shrublands, cliffs and ridges, bogs, and forest, from 457 to 1311 m (1500 to 4300 ft) elevation.

Pritchardia lanigera occurs in grassland- shrubland characterized shrubs and grasses between 1 to 3 m (3 to 10 ft) tall. Associated native species include *Dicranopteris linearis* (uluhe), *Dodonea viscosa* (‘a‘ali‘i), *Leptecophylla tameiameaie* (pūkiawe), *Euphorbia* spp. (‘akoko), and *Bidens* spp. (ko‘oko‘olau) (Ball et al. 2019, p. 4).

Cliff and ridge habitat of *Pritchardia lanigera* is characterized by different species of native shrubs including *Dubautia* spp., *Metrosideros* spp. (‘ōhi‘a), and *Cibotium* spp. (hāpu‘u) (Nelson et al. 2019, p. 3).

Occurrences of *Pritchardia lanigera* at Waimanu Valley (Kohala to Hāmākua) are within waterlogged sites and with standing water in forest openings with the native sedges *Carex alligata* (no common name) and *Cladium jamaicense* (‘uki) (Nelson et al. 2019, p. 3; Bishop Museum Herbarium 2020). At ‘Āwini in the Kohala mountains, this species occurred in sphagnum moss with *Metrosideros* spp. (Hodel 2012, pp. 102, 104).

The wet forest habitat at ‘Āwini and Honopue in the Kohala Forest Reserve (FR) is dominated by *Metrosideros polymorpha* with the associated native species including *Tetraplasandra* spp. (‘ohe‘ohe), *Perrottetia sandwicensis* (olomea), and various shrubs and ferns (Bishop Museum Herbarium 2020). Occurrences at Pu‘u O ‘Umi NAR occur in dense montane wet forest with *Metrosideros polymorpha* and *Cheirodendron trigynum* (olapa) canopy with *Dicranopteris linearis*, *Clermontia* spp. (‘ōhā wai), *Hydrangea arguta* (kanawao), and scattered stunted *Metrosideros polymorpha* (Bishop Museum Herbarium 2020).

There are two known populations of *Pritchardia lanigera* in the Ka‘ū region within wet forest consisting of *Metrosideros* spp. and *Cibotium* spp. with native shrubs (Naboa 2020, pers. comm.).

One population of *Pritchardia lanigera* at Pu‘u Kapu and Waipi‘o occurs in *Metrosideros* spp. and *Cheirodendron* spp. montane wet forest and shrubland as well as in mesic nonforest and in habitat that has been degraded and is considered a developed system (USFWS 2020, unpubl. data).

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 pigs (*Sus scrofa*), goats (*Capra hircus*), mouflon (*Ovis orientalis*), and cattle (*Bos taurus*) 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 increase erosion by creating large areas of bare soil (Cuddihy and Stone 1990, pp. 63–64; van Riper and van Riper 1982, pp. 24–27; Anderson et al. 2007, p. 2). Feral pigs and evidence of their activities have been observed in the Kohala mountains (Kohala Watershed Partnership (KWP) 2008, pp. 54–56). Herds of feral goats have been seen in the unfenced area of the Kohala mountains (Maly and Maly 2004 in KWP 2008, p. 55). In 1968, mouflon were introduced to Kahuku Ranch (now a unit of Hawai‘i Volcanoes National Park) for trophy hunting. By 2008, mouflon ranged over the southern part of Mauna Loa in the Kahuku area (Hess 2008, p. 1). Mouflon have high reproduction rates; for example, the original population of 11 individuals has increased to more than 2,500 in 36 years, even though these animals are actively hunted as game (Hess 2008, p. 3). The wet forests of the Kohala mountains are reported to have a feral cattle population of at least 100 individuals that are causing forest degradation by trampling and browsing, which leads to subsequent increased nitrogen availability through deposition of feces (Stone 1985, p. 253), all of which contribute to the influx of nonnative plant and animal species (KWP 2007, pp. 54–55; Laws 2010, in litt.), negatively affecting the habitat of *Pritchardia lanigera*.

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive introduced plants modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990, p. 74). Habitat modification and destruction by invasive nonnative plants negatively affects all populations of *Pritchardia lanigera*. The nonnative invasive plant species reported to have the greatest impacts to *P. lanigera* include as *Setaria palmifolia* (palm grass), *Psidium guajava* (common guava), *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (koster’s curse), *Tibouchina herbacea* (cane tibouchina), *Rubus rosifolius* (thimbleberry), *Paspalum conjugatum* (Hilo grass), *Axonopus fissifolius* (common carpetgrass), *Juncus effusus* (soft rush), *Passiflora ligularis* (sweet granadilla), and *Passiflora edulis* (passion fruit) (Naboa 2020, pers. comm.).

Climate change loss or degradation of habitat, including hurricanes—Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment concluded that *Pritchardia lanigera* is vulnerable to the impacts of climate change with a vulnerability score of 0.171 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). 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.

Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007, p. 4137; Emanuel *et al.* 2008, p. 348; Yu *et al.* 2010, pp. 1369–1372). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013, pp. 1–6). Hurricane Iselle was downgraded to a tropical storm on August 8, 2018 as it neared the southeast coast of the island of Hawai‘i with maximum sustained winds of 60 knots (69 miles per hour) (Kimberlain *et al.* 2018, p. 4). Significant damage by these strong winds occurred within the Ka‘ū and Puna district where populations of *Pritchardia lanigera* occur. Hurricanes pose an ongoing and ever-present threat because they can happen at any time. A destructive hurricane holds the potential of driving a localized endemic species such as *Pritchardia lanigera* to extinction in a single event.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):

Illegal collection of fruit and plants—*Pritchardia* species have become one of the most widely cultivated ornamental palm genera in the world (Maunder *et al.* 2001 in Chapin *et al.* 2004, p. 278). There are a number of internet websites that offer Hawaiian *Pritchardia* plants and seeds for sale, including *P. lanigera*. Based on the collections made from Hawaiian *Pritchardia* plants and seeds and the market for it, *P. lanigera* is vulnerable to the negative impacts of any collection (Chapin *et al.* 2004, p. 278). Overcollection of *P. lanigera* poses a serious and ongoing threat.

2.3.2.3 Disease or predation (Factor C):

Predation and herbivory by nonnative ungulates—Feral pig and goat herbivory on the seedlings, fruits, seeds, or leaves of *Pritchardia lanigera* has been observed and directly impacts this species (Warshauer *et al.* 2009, pp. 10, 24; Laws *et al.* 2010, in litt.; Loope 1998, pp. 752–753; van Riper and van Riper 1982, p. 25). *Pritchardia lanigera* occurs within the observed range of mouflon, and is potentially impacted by mouflon

browsing (Ikagawa 2011, in litt.). Two of the populations are fenced, but these fenced areas must be monitored for ingress.

Predation and herbivory by rats—Populations of *Pritchardia lanigera* are impacted by rats (HBMP 2010). Rats eat fleshy fruits, seeds, flowers, stems, leaves, roots, as well as other plant parts, and can seriously impact regeneration (Cuddihy and Stone 1990, pp. 68–69). The long term effects of rats may prevent the regeneration and persistence of *P. lanigera* (Campbell and Atkinson 1999 in Atkinson and Atkinson 2000, p. 24).

Predation and herbivory by nonnative invertebrates—The nonnative two-spotted leaf hopper (*Sophonia rufofascia*) has been reported to be a potential threat to *Pritchardia* spp. in the Hawaiian Islands (Chapin et al. 2004, p. 279). This insect damages the leaves it consumes and typically causes chlorosis (yellowing due to disrupted chlorophyll production) to browning and eventual death of the foliage (Jones et al 2000, pp. 171–180). This damage can also result in death of the entire plant, owing to the combined action of its feeding and oviposition (expulsion of eggs to the external environment). In addition to the mechanical damage, the insect may introduce pathogens that can also lead to loss of vigor and eventual plant death (Alyokhin et al. 2004, p. 1).

Nonnative beetles in the family Scolytidae and genus *Coccotrypes* spp. which bore into and feed on the nuts produced by native palm trees, including *Pritchardia* species. (Swezey 1927, in litt.; Science Panel 2005, 23 pp.; Magnacca 2011, pers. comm.). *Coccotrypes* beetles prefer trees with large seeds like those of *Pritchardia* species; they bore into the fruit causing the fruit to drop before reaching maturity which affects regeneration in the wild (Magnacca 2005, in litt; Science Panel 2005, 23 pp.) The impacts of *Coccotrypes* beetles on *Pritchardia* in Hawai‘i is expected to increase with time if these beetles are not controlled, and may significantly impact populations of *P. lanigera* (Magnacca 2005, in litt.).

In 2013, the nonnative coconut rhinoceros beetle (CRB, *Oryctes rhinoceros*) was discovered on O‘ahu and spread across the island within a few months (OISC 2015, in litt.). The CRB, a large scarab beetle about two inches long, is considered one of the most damaging insects to coconut and African oil palm trees in southern and southeast Asia, as well as to the western Pacific Islands, and could devastate populations of native and nonnative palm trees in Hawai‘i (OISC 2015, in litt.). The CRB bore into the crowns of palms where they feed on sap. When a beetle bores through developing leaves, those leaves grow out with distinctive V-shaped cuts. Adult beetles are active at night and can fly. Eggs are laid inside rotting coconut logs, mulch, or compost, and larvae develop to adults within four months, continuing the cycle. A rapid response team headed by Hawai‘i Department of Agriculture (with the USDA, University

of Hawai‘i, U.S. Navy, and other partners) has set up pheromone traps island-wide, and capture and range delineation efforts are ongoing, along with funding for support services to control the CRB. If the CRB should be transported to the island of Hawai‘i, effects on the remaining *Pritchardia lanigera* palms could be devastating.

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

All populations of *Pritchardia lanigera* occur within or adjacent to a State hunting area. The State of Hawai‘i provides game mammal hunting opportunities (e.g., “sustained yield”) in public hunting areas on the island of Hawai‘i (DLNR 2012). Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Wild and reintroduced populations of *P. lanigera* are protected by two exclosures; however, this fencing must be maintained and monitored for ungulate ingress. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced wild and reintroduced populations are at risk (DLNR 2010).

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 2010) 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 species to the State of

Hawai‘i is a significant risk to *Pritchardia lanigera* and other federally listed species.

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

Lack of regeneration—The lack of or very low levels of regeneration of *Pritchardia lanigera* has been observed in the wild (Bio 2011, pers. comm.; Magnacca 2011, pers. comm.). The reasons for this are still unknown and not well understood; however, seed predation by rats, ungulates, and nonnative invertebrates is believed to contribute to the lack of natural regeneration.

Loss of dominant canopy tree—Rapid ‘Ōhi‘a Death—Two species of the fungal genus *Ceratocystis* are known to cause mortality of *Metrosideros polymorpha*. This disease caused by these fungi is known as rapid ‘ōhi‘a death or ROD. *Metrosideros polymorpha* is the most common and widespread native tree occurring at sea level to often the dominant species in the lowland, montane wet, and montane cloud forest (Clark et al. 2019, p. 11). *Metrosideros polymorpha* is an ecologically important component of native forest succession and ecosystem function, and provides habitat to many native plant and animal species, including *Pritchardia lanigera* (Clark et al. 2019, p. 11). Young *P. lanigera* individuals are shade tolerant and grow under the canopy of wet forest; therefore, the impacts to the canopy and amount of sunlight caused by ROD could greatly impact the growth and survival of *P. lanigera* seedlings.

Current Management Actions:

- Surveys and monitoring—
 - The Plant Extinction Prevention Program (PEPP) monitors populations of *Pritchardia lanigera* at Kaiholena and Pu‘u O Umi NAR (PEPP 2014, 2018, 2019). Twenty-six immature individuals were discovered on a survey of Kaiholena in 2013 (PEPP 2014).

- PEPP estimated at least two populations on the island of Hawai‘i totaled 150 mature plants (PEPP 2014).
- In 2011, on a survey of Kaiholena (Ka‘ū), TNC discovered an additional previously outplanted individual of *Pritchardia lanigera* (TNC 2011, pp. 10, 34).
 - Feral ungulate control—
 - Two populations are fenced within the Pu‘u O ‘Umi NAR (USFWS 2020, unpubl. data).
 - TNC has fenced the Kaiholena Unit at Ka‘ū Preserve (TNC 2011, p. A4).
 - Control of established ecosystem-altering invasive plants—TNC prioritizes and manages invasive plants at Ka‘ū Preserve (TNC 2011, p. A5).
 - Captive propagation for genetic storage and reintroduction—
 - In 2017, the Volcano Rare Plant Facility (VRPF) reported 50 plants in inventory representing six founders from Kohala; and in 2019 an additional 39 individuals representing five more founders from Kohala (VRPF 2017-2019). A total of 22 founders have been propagated for outplanting. Currently, there are 40 plants representing six founders in inventory (VRPF 2019).
 - In 2011, at Kaiholena (Ka‘ū), TNC placed netting under trees and conducted seed collection. Seeds were sent to VRPF to propagate for reintroduction (TNC 2011, pp. 10, 34).
 - PEPP collected from at least 50 percent of the known populations, but less than 1 percent of the individuals for storage and propagation (PEPP 2014).
 - Reintroduction—
 - Between 2017 and 2019, VRPF reported reintroduction of a total of 101 plants representing 22 founders: 21 plants representing one founder from Ka‘ū-Kaiholena and 20 founders from Kohala in 2017, and 84 plants representing 12 founders at Kohala were reintroduced in 2019 (VRPF 2013-2019).
 - In 2011, HVNP reintroduced 22 individuals to the Kahuku Paddock #2 (HVNP 2019, p. 22). One year post planting 95 percent had survived. Unfortunately since that time the protective ungulate proof fences deteriorated and some of the plants were damaged by feral pigs. In 2014, the fence was repaired and one additional plant was reintroduced. Three years post planting (March 2014) 12 were alive (57 percent). No activity was conducted from 2015 to 2018. Monitoring was conducted in 2019 at the planting site in lower Kahuku paddocks. At least nine are surviving and are growing vigorously; however, no fruiting or recruitment has been observed (HVNP 2019, p. 22; HVNP 2020).
 - Reintroductions by TNC in 2008 showed a survival rate of 92 percent by 2010 (TNC 2011, pp. 10, 34).

- The National Tropical Botanical Garden (NTBG) reported planting two individuals representing two founders from Kohala-Waimanu Rim as a living collection in Southshore Gardens (NTBG 2019).
- PEPP reported seven individuals reintroduced at Pu‘u O Umi NAR-Palikai (PEPP 2018, 2019).

Table 1. Status and trends of *Pritchardia lanigera* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	<220	Unknown	All threats managed in all 3 populations	Partially, exclosures at Pu‘u O Umi NAR
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No, no regeneration
2020 (5-year review)	150–200	<116 (ca 130 planted)	All threats managed in all 3 populations	Partially, exclosures at Pu‘u O Umi NAR and Ka‘ū
			Complete genetic storage	No
			3 populations with 25 mature individuals each	Partially

Table 2. Threats to *Pritchardia lanigera* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, exclosures at Pu‘u O Umi NAR and Ka‘ū
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	Partial, nonnative plant control at Pu‘u O Umi NAR and Ka‘ū
Climate change degradation or loss of habitat, including hurricanes	A	Ongoing	None

Overcollection	B	Ongoing	None
Predation and herbivory by ungulates	C	Ongoing	Partial, exclosures at Pu‘u O Umi NAR and Ka‘ū
Predation and herbivory by rats	C	Ongoing	None
Predation by nonnative invertebrates—Two-spotted leafhopper, beetles, coconut rhinoceros beetle	C	Potential	None
Inadequacy of regulatory mechanisms	D	Ongoing	Partial, exclosures at Pu‘u O Umi NAR and Ka‘ū
Lack of regeneration	E	Ongoing	Partial, collection, propagation, and reintroduction ongoing

2.4 Synthesis

There are approximately 150 to 200 wild individuals of *Pritchardia lanigera* in nine populations in two different locations on the island of Hawai‘i. Unfortunately most populations have not been monitored since 2010. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *P. lanigera* is vulnerable to the effects of climate change. Feral ungulate control is ongoing within exclosures at Pu‘u O Umi NAR and Ka‘ū; however, not all ungulates have been removed and fencing must be monitored for ingress. Nonnative plant control is conducted at the fenced areas. Seed collection, storage, propagation, are ongoing. Research into best seed storage practices is ongoing. At least 130 individuals have been reintroduced, but the long-term success of these reintroductions is unknown and there is no regeneration observed.

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 that is well managed. In addition, a minimum of three populations should be documented on the island of Hawai‘i where they now

occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, or saplings) with a minimum of 25 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There are approximately 150 to 200 wild individuals at two locations, but the majority are isolated into a single population. Natural regeneration is not observed. Genetic storage goals have not been met (Table 1). In addition, not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Pritchardia lanigera* 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 search suitable habitat for individuals of *Pritchardia lanigera* in recent and historical locations.
- Ungulate monitoring and control—Continue to construct and maintain fenced enclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. Monitor enclosures for ingress.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *P. lanigera* at all populations.

- Predation and herbivory by ungulates—Continue to fence and monitor populations for ungulates.
- Predation and herbivory by rats—Implement effective rat control at all wild and reintroduced populations.
- Predation by nonnative invertebrates—Research the potential effects of the two-spotted leaf hopper, beetles, and the coconut rhinoceros beetle, and develop and implement effective control methods if necessary.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts.
- Reintroduction and translocation—Continue to establish and augment populations to increase numbers of populations and individuals in suitable habitat to reduce the impacts of competition with nonnative plants, ungulate and rat predation, climate change, and hurricanes.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Alliance and partnership development—Continue to collaborate with partners in planning and implementation of ecosystem-level restoration and management to benefit this species.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Pritchardia lanigera* (loulou)**

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: _____

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FIELD OFFICE APPROVAL:

for

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