Pleomele fernaldii
(hala pepe)

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: *Pleomele fernaldii* (hala pepe)

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5-YEAR REVIEW
Pleomele fernaldii (hala pepe)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Chelsie Javar-Salas, Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
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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on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 by Chelsie Javar-Salas, 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 status for 38 species

on Molokai, Lanai, and Maui; final rule. Department of the Interior, Federal Register 78 (102): 32014–32065, May 28, 2013.

Date listed: May 28, 2013
Entity listed: *Pleomele fernaldii*
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:

[USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe; final rule. Department of the Interior, Federal Register 81 (61): 17790–18110, March 30, 2016.

Ten units of critical habitat in the lowland dry, lowland mesic, lowland wet, dry cliff, and wet cliff ecosystems on Lānaʻi were excluded, because conservation actions of the landowner provided a greater benefit to the species (81 FR 17946).

1.3.4 Review History:

This is the first 5-year review for *Pleomele fernaldii*.

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

5

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui)
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
__X_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
__X_No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____Yes
____No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery?

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factors B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

The recovery plan is currently being drafted. However, the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so the 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.

Pleomele fernaldii 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. In addition, a minimum of three populations should be documented on Lānaʻi 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 individuals per population.

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

Interim Stage
To meet the interim stage of recovery of *Pleomele fernaldii*, 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 secured and well-maintained. 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:

Pleomele fernaldii, a member of the asparagus family (Asparagaceae), is a tree 6 to 8 meters (m) (19 to 26 feet (ft)) tall, usually few branched. Its leaves are spirally clustered toward the ends of branches and are long and strap-like, 17 to 40 centimeters (cm) (6.7 to 15.7 inches (in)) long, 1.2 to 2.3 cm (0.5 to 0.9 in) wide, gradually tapering in upper one-third. Panicles (branched inflorescences with hanging flowers on the second branches) are slender, slightly waxy, about 24 to 44 cm (9.4 to 17.3 in) long, the lower lateral branches about 5 to 10 cm (1.9 to 4 in) long, stalks 8 to 13 cm (3.1 to 5.1 in) long, and abruptly recurved. Flower petals are greenish-yellow and 23 to 30 millimeters (mm) (0.9 to 1.2 in) long. Berries are bright red, about 8 to 12 mm (0.3 to 0.47 in long containing 1 to 3 seeds (Wagner *et al.* 1999, pp. 1351-1352).

Pleomele fernaldii has been observed flowering in the spring through summer with variation observed between sites located in more drier and wetter sites and dependent on if it has been a wet or dry year (Oppenheimer 2019, pers. comm.). It was observed fruiting in the fall season with mature fruit in January (Oppenheimer 2019, pers. comm.). We do not have information about seed viability or under what conditions they germinate. However, we do know that *P. fernaldii* has very low seed storage potential as the seeds are recalcitrant (*i.e.,* desiccation-sensitive (do not withstand drying for frozen storage) and not storable by conventional methods) (Chau *et al.* 2019, p. 12; Keir and Weisenberger

2014, p. 62). Therefore, seeds of *P. fernaldii* require alternate *ex situ* storage methods. Other life history information is currently unknown, including information on plant growth stages, longevity, and the length of time it takes to flower.

Relatively few studies have been conducted on the breeding system of *Pleomele fernaldii*. The large bell shaped flowers that are yellowish in color and dark colored berries tend to favor the relationship with birds for pollination and seed dispersal of *Pleomele* species (Lu 2012, p. 171).

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, *Pleomele fernaldii* has been known throughout Lānaʻi on both the leeward and windward sides. Currently, *P. fernaldii* is found from Hulopoʻe and Kunoa Gulches southeast to Waiakeakua and Puhiʻelelu Ridge (St. John 1947, pp. 39–42; Hawaii Biodiversity and Mapping Program (HBMP) 2010; Plant Extinction Prevention Program (PEPP) 2008, p. 75). In 1999, *Pleomele fernaldii* was known from three populations totaling 200 to 2,000 individuals (USFWS 2005, p. 2; Oppenheimer 2008, pers. comm.). In 2008, there were several dozen individuals observed within the Kapōhaku-Kaunoa-Hoʻokiʻo population unit; however, the entire population unit was not surveyed (PEPP 2008, p. 75). In 2013, when this species was listed as Endangered, there were several hundred to perhaps as many as 1,000 individuals (USFWS 2013, p. 32025). Currently, that total estimate still stands; there are approximately 1,000 wild individuals of *P. fernaldii* in two population units called Lōpā-Waiʻopa-Haua and Kapōhaku-Kaunoa-Hoʻokiʻo (Oppenheimer 2019, pers. comm.). However, the number of individuals has decreased by about one-half in the past 10 years (there were more than 2,000 individuals in 1999), with very little recruitment observed recently (Oppenheimer 2008, pers. comm.; Oppenheimer 2019, pers. comm.).

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:
Pleomele fernaldii was first described by Harold St. John in 1947 (St. John 1947, pp. 39–42) and listed as Endangered under this taxonomic name (USFWS 2013). The isotype was collected from the south ridge of Holopoe [Hulopoʻe] Gulch on Lānaʻi (University of Michigan Library Digital Collections 2019). Otto Degener mistakenly named the species *Pleomele lanaiensis*, but did not officially publish the name (Degener and

Degener 1971, p. 9). Wagner *et al*. (1999, p. 1352) considered *P. lanaiensis* a synonym of *P. fernaldii*.

In 2014, Lu and Morden (2014, entire) conducted a phylogenetic analysis of dracaenoid plant genera and found that the Hawaiian *Pleomele* species are morphologically and phylogenetically distinct from other dracaenoids and should be recognized as a distinct genus, *Chrysodracon* (from the Greek "chryso," golden and "dracon," dragon, referring to the unique yellow flowers), and therefore new species combinations were made. The new combination for this species is *Chrysodracon fernaldii* in the most recent taxonomic treatment in the checklist of Hawaiian flora (Smithsonian 2019). This taxonomic change does not affect the range or endangered status of this species. We will refer to this species as *Chrysodracon fernaldii* throughout the following sections of this document.

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):
Currently, this species is found in the gulches and cliff faces of remnant dry forest, mesic forest, and mesic grassland and shrubland habitat types on Lānaʻi (Wagner *et al.* 1999, p. 1352; HBMP 2010; National Tropical Botanical Garden 2019; Oppenheimer 2019, pers. comm.). The populations are found between the elevations of 490 to 930 m (1,608 to 3,051 ft) (Wagner *et al.* 1999, p. 1352; National Tropical Botanical Garden 2019).

At Lōpā-Waiʻopa-Haua, *Chrysodracon fernaldii* is found in a mixed mesic forest habitat (National Tropical Botanical Garden 2019). Associated native plant species may include *Myrsine lessertiana* (kōlea), *Nestegis sandwicensis* (olopua), *Metrosideros polymorpha* (ʻōhiʻa), and *Diospyros sandwicensis* (lama) (National Tropical Botanical Garden 2019).

The habitat of *Chrysodracon fernaldii* at Kapōhaku-Kaunoa-Hoʻokiʻo is described as wet forest (HBMP 2010). Associated native plant species may include *Myrsine lessertiana*, *Metrosideros polymorpha*, and *Dicranopteris linearis* (uluhe) (Oppenheimer 2019, pers. comm.).

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—The effects of nonnative animals, such as axis deer (*Axis axis*) and mouflon sheep (*Ovis gmelina musimon*), to the habitat and populations of *Chrysodracon fernaldii* (USFWS 2013, pp. 32042, 32052; Oppenheimer 2019, pers. comm). Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998, entire; van Riper and van Riper 1982, pp. 34–35).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive plant species 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, entire). Habitat modification and destruction by invasive nonnative plants negatively affects all occurrences of *Chrysodracon fernaldii* (PEPP 2008, p. 75; Oppenheimer 2019, pers. comm.). Nonnative plants with the greatest impacts on *C. fernaldii* include *Psidium cattleianum* (strawberry guava), *Morella faya* (firetree), *Leptospermum scoparium* (tea tree), *Hedychium gardnerianum* (Himalayan ginger), *Melinis minutiflora* (molasses grass), *Cinnamomum burmanii* (padang cassia), and *Rubus rosifolius* (thimbleberry) (PEPP 2008, p. 75; Oppenheimer 2019, pers. comm.).

Fire destruction and degradation of habitat—Increasing episodes of drought, expansion of invasive grass cover, and temperature increases have led to an increase in the number of wildfires in the Hawaiian Islands (Trauernicht *et al*. 2015, pp. 439-440). Although fires are infrequent in the mountainous regions of Lānaʻi, extensive fires have recently occurred in lowland dry and lowland mesic areas, leading to grass/fire cycles that convert native dry forest and native wet forest to nonnative grassland (D'Antonio and Vitousek 1992, p. 77). Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to native Hawaiian ecosystems (Brown and Smith 2000, p. 163, 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74). Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants (D'Antonio and Vitousek 1992, p. 77; Tunison *et al*. 2002, p. 123). Fire can destroy dormant seeds as well as individual plants. Fire is a threat to *Chrysodracon fernaldii* at all occurrences.

Climate change loss or degradation of habitat, including hurricanes and drought—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 *Chrysodracon fernaldii* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.969 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions may be needed to conserve this taxon into the future, such as ensuring that adequate viable genetic storage is maintained and identifying suitable microsites where climate change effects are anticipated to occur more slowly.

Drought is observed to be a threat to all populations of *Chrysodracon fernaldii* (Oppenheimer 2019, pers. comm.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008, p. 61; Chu and Chen 2005, pp. 4812–4813; Diaz *et al*. 2005, entire). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009, pp. 18, 24; Warren 2011, pp. 221–223).

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; Emanuel *et al.* 2008; Yu *et al.* 2010). 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). 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 to extinction in a single event.

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):
Predation and herbivory by rats—Predation of seeds by introduced rats

(*Rattus* sp.) is a threat to *Chrysodracon fernaldii* in the wild (PEPP 2008, p. 75; Oppenheimer 2019, pers. comm.).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D): Lack of adequate hunting regulations—Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Although, most of the wild populations are fenced ungulates were able to breech the fences and remain inside the fenced areas. The State of Hawai‘i provides game mammal (feral mouflon sheep and axis deer) hunting opportunities (e.g., “sustained yield”) in public hunting areas on the island of Lāna‘i (DLNR 2012). 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 populations of *Chrysodracon fernaldii* 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) 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 *Chrysodracon fernaldii* and other federally listed species.

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

Established invasive plant species competition—Nonnative plant species including *Psidium cattleianum* (strawberry guava), *Morella faya* (firetree), *Leptospermum scoparium* (tea tree), *Hedychium gardnerianum* (Himalayan ginger), *Melinis minutiflora* (molasses grass), *Cinnamomum burmanii* (padang cassia), and *Rubus rosifolius* (thimbleberry) compete with *Chrysodracon fernaldii* for water, light, and nutrients (PEPP 2008, p. 75; Oppenheimer 2019, pers. comm.).

Loss of native pollinators and seed disperser agents—Loss of native pollinators (affecting seed set) and seed disperser agents are a threat to *Chrysodracon fernaldii* (Oppenheimer 2019, pers. comm.). The loss of native nectar-feeding birds that aid in pollination and seed dispersal may have contributed to the decline of this species. Many native nectar-feeding passerine birds which have acted as pollinators have become extinct or declined drastically from historic levels (Banko and Banko 2009, pp. 30–36). This is largely caused by avian malaria, the most impactful avian disease affecting the native forest birds of Hawai‘i. For the most part avian malaria has restricted these native forest birds to the upper elevations, where average temperatures are too cold for mosquitoes (which are the vectors of avian malaria), and *Plasmodium relictum* (the parasite that causes avian malaria) to persist. With a continued increase in temperatures at higher elevations, it is likely that most or all of the bird-pollinated species could be lost if the birds are lost to these or other threats.

No regeneration—Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed and is a threat to *Chrysodracon fernaldii* (Oppenheimer 2019, pers. comm.). Although there are currently approximately 1,000 individuals, very little recruitment has been observed at the known locations as rats are eating the seeds or feral ungulates are eating seedlings that are able to germinate (Oppenheimer 2019, pers. comm.).

Current Management Actions:

- Surveys and monitoring—The Maui Nui PEPP and Pūlama Lāna‘i monitors occurrences of *Chrysodracon fernaldii* (Oppenheimer 2019, pers. comm.; PEPP 2008, p. 75).
- Captive propagation for genetic storage and reintroduction—The Pūlama Lāna‘i reported 275 potted plants of *Chrysodracon fernaldii* in their nursery representing a single individual from Kapōhaku collected in January 2020. The Pūlama Lāna‘i propagated a single individual collected from one founder from ‘Āwehi. Thirty-seven individuals were propagated from two founders collected from Kapōhaku in January 2019. These plants were propagated for eventual translocation in the wild (Pūlama Lāna‘i 2020).

- Reintroduction and translocation—In 2020, 19 plants of *Chrysodracon fernaldii* collected in January 2019 were translocated and planted at three sites in Lōpā by the Pūlama Lānaʻi (Pūlama Lānaʻi 2020).
- Ungulate control—The two population units containing *Chrysodracon fernaldii* are fenced; however, ungulates are still present within these fences (Oppenheimer 2019, pers. comm.). Therefore, individuals of *C. fernaldii* are not protected from the damaging impacts caused by feral ungulates.
- Nonnative plant control—The Maui Nui PEPP and Pūlama Lānaʻi removed invasive plants around individuals of *Chrysodracon fernaldii* within the Lōpā-Waiʻopa-Haua population unit (Oppenheimer 2019, pers. comm.).
- Rat control—Rat control conducted by Pūlama Lānaʻi for seabird populations may also benefit populations of *Chrysodracon fernaldii* that occur in the near vicinity (Oppenheimer 2019, pers. comm.).

Table 1. Status and trends of *Chrysodracon fernaldii* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	Several hundred–1,000	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	None
			3 populations with 25 mature individuals each	Partially, two populations <1,000
2016 (critical habitat)	Several hundred–1,000	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	None
			3 populations with 25 mature individuals each	Partially, two populations <1,000
2020 (5-year review)	~1,000	19	All threats managed in all 3 populations	Partially
			Complete genetic storage	None
			3 populations with 25 mature individuals each	Partially, two populations ~1,000

Table 2. Threats to *Chrysodracon fernaldii* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, fencing but ungulates inside of fence
Established ecosystem-altering invasive plant modification and degradation of habitat	A	Ongoing	Partial, nonnative plant control within exclosures
Fire destruction and degradation of habitat	A	Ongoing	None
Climate change loss or degradation of habitat, including hurricanes and drought	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partial, fencing but ungulates inside of fence
Predation or herbivory by rats	C	Ongoing	Partial, some rat control around seabird populations, which benefit two known populations
Inadequacy of existing regulatory mechanisms	D	Ongoing	None
Established invasive plant species competition	E	Ongoing	Partial, nonnative plant control within exclosures
Loss of pollinators and dispersal agents	E	Ongoing	None
No regeneration	E	Ongoing	Partial, some rat control and ungulate fencing

2.4 Synthesis

There are approximately 1,000 wild individuals of *Chrysodracon fernaldii* on Lānaʻi, a number that has not changed from what was reported at the time of listing in 2013. However, the population trend is in a decline from the 2,000 individuals reported in 1999. There is little to no recruitment or regeneration at either population. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *C. fernaldii* is extremely vulnerable to the effects of climate change. Collection, propagation, and translocation are ongoing. Fenced exclosures provide some protection from habitat degradation and browsing by feral ungulates; however, feral ungulates are located inside of the fenced exclosures.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on Lānaʻi 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. While there may be two populations with approximately 1,000 individuals (Table 1), genetic storage goals have not been met (Table 1), and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Chrysodracon fernaldii* 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*
__X__**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 assess the status of known occurrences of *Chrysodracon fernaldii* in historical locations and potentially suitable habitat.

- Ungulate monitoring and control
    - Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates.
    - Remove ungulates from currently fenced exclosures.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *C. fernaldii*.
- Predation and herbivory by rats—Continue to implement effective control methods for rats at all populations.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and translocation.
- Reintroduction and translocation—Continue to augment populations and increase numbers of populations and individuals in suitable habitat to reduce the impacts of predation and climate change.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Fire protection—Develop and implement fire management plans for all populations.
- Drought protection—Continue to monitor and control feral ungulates and nonnative plants to protect and increase vigor of *C. fernaldii* during times of drought.
- Population biology research—Research the possible causes of lack of natural recruitment and determine possible treatments. Research the impacts of loss of pollinators and seed disperser agents. Research the unknown life history traits for this species.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Chrysodracon fernaldii*
(hala pepe)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Chelsie Javar-Salas, Fish and Wildlife Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

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for _____

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