

Cyanea kauaulaensis
(no common name)

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: *Cyanea kauaulaensis* (no common name)

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5-YEAR REVIEW
***Cyanea kauaulaensis* (no common name)**

1.0 GENERAL INFORMATION

1.1 Reviewers:

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Chelsie Javar-Salas, Plant Biologist, 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 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 The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations and species status report by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 Jay Nelson, Biologist, was reviewed by Chelsie Javar-Salas, Plant Biologist, 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 Interior, Federal Register 81 (190): 67786–67860, September 30, 2016.

Date listed: September 30, 2016

Entity listed: *Cyanea kauaulaensis*

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 *Cyanea kauaulaensis*.

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, Moloka'i, Kaho'olawe, and Lāna'i (Maui Nui), 29 pp. + maps

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 for recovery. 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.

Cyanea kauaulaensis is a short-lived perennial shrub. 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 Maui 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 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 *Cyanea kauaulaensis*, 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. 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 secured 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. 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. 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:

Cyanea kauaulaensis, a member of the Campanulaceae (bellflower) family, is a short-lived unarmed shrub 2 to 4 meter (m) (6 to 12 foot [ft]) tall. Stems are light brown, erect to arching, up to 6 m (19 ft) long. Leaves are clustered near the end of the branches, glabrous on both surfaces. Flowers are white, tubular, round in cross section, and gently curved to sub-erect. Fruits are bright orange when ripe containing numerous small seeds. Stems often leaning on and tangled with adjacent vegetation, growing on lower talus slopes in riparian areas along perennial streams. Adult plants are clumped and often many branched from the base, the decumbent branches often rooting when in contact with the ground and forming “runners”, often with erect shoots. The species requires moist native forest along perennial streams to grow and reproduce (Oppenheimer and Lorence 2012, pp. 18–21).

Little research has been done on *Cyanea kauaulaensis* to understand the individual requirements for this species in the wild. However, *Cyanea* and other lobelioids coevolved with Hawaiian honeycreepers (Drepanididae) and honeyeaters (Meliphagidae) birds that served as plant pollinators (Lunau 2004, p. 210). The tube-shaped flowers of *C. kauaulaensis* point to bird-pollination (Cory et al. 2015, pp. 255–256), most likely from the endemic Hawaiian honeycreepers (Drepanididae) or the now extinct ‘ō‘ō (Mohoidae) (Banko and Banko 2009, pp. 30–31). The fruits of *C.*

kauaulaensis were likely dispersed by birds as well (Givnish et al. 2009, p. 416). Dispersal in *Cyanea* species was always likely limited due to its reliance on forest-dependent birds (Givnish et al. 2009, p. 408). The now extinct frugivores, the 'ō'ū (*Psittirostra psittacea*) and the oloma'ō (*Myadestes lanaiensis*), were probably the primary dispersers in the past. Currently, pollination and seed dispersion for some members of the Hawaiian lobelioids is facilitated potentially by introduced Japanese white-eye (*Zosterops japonicus*) (Aslan et al. 2013, entire).

Since the breeding system of *Cyanea kauaulaensis* is unclear, we used the general study conducted by Sakai et al. (1995, p. 2524) to make inferences for this species. Sakai et al. studied the colonists of the flora of the Hawaiian Islands to determine the breeding system of a colonist's lineage, the presumed pollinator of the colonists, and the presumed dispersal method. According to Sakai et al., the presumed breeding system of the species in the *Clermontia/Cyanea/Delissea/Rollandia* lineage was hermaphroditic. The presumed pollinator of the colonists were birds and the presumed original long-distance dispersal method was internally by birds. From other research and field observations it is likely that *C. kauaulaensis* is similar to many other species of *Cyanea* in being facultative autogamous, a sexual species that is able to reproduce without cross-pollination (Cory et al. 2015, p. 258).

We currently do not have information on the role of insect pollinators in *Cyanea* species. *Cyanea kauaulaensis* has been observed flowering from late summer through January, followed by fruits maturing in March and April. Sporadically, some individuals may possess a few flowers or fruits earlier in summer (Oppenheimer and Lorence 2012, p. 21).

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:

Cyanea kauaulaensis was first documented from collections during a botanical survey in 1989 on Maui (USFWS 2016, p. 67793). Known historically only from the south fork of Kaua'ula Valley on leeward west Maui, surveys in the north fork of Kaua'ula Valley during 2008 and 2009 resulted in the discovery of additional plants. In July of 2011 a new population was discovered in Waikapū Valley nearly 5 kilometers (3 miles) from previously known plants and separated by several large valleys and canyon walls (Oppenheimer and Lorence 2012, p. 15).

Currently, *Cyanea kauaulaensis* exists in 3 wild populations: 116 mature individuals in the north fork, Kaua'ula Valley; a population of 2 mature and 2 immature individuals in the south fork, Kaua'ula

Valley, and 9 mature individuals in Waikapū Valley. Wild populations in Kaua‘ula Valley (south fork) and Waikapū Valley have been augmented by translocation of plants from *ex situ* propagation. There is a third population of a single mature plant by translocation in Olowalu Valley. Translocated plants totaled approximately 112 individuals in the early 2010s. However, virtually all *C. kauaulaensis* translocated to the south fork of Kaua‘ula Valley were destroyed in 2016 by landslide and flooding (PEPP 2018, p. 21). Translocated plants have not been observed to be naturally reproducing (i.e., viable seeds, seedlings, or saplings).

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

Little is known of the genetics of *Cyanea kauaulaensis*. A genetic study was conducted to estimate genetic variation and spatial genetic structure in single populations of the common *Cyanea pilosa* ssp. *longipedunculata* on the island of Hawai‘i and *Clermontia fauriei* on Kaua‘i (Jennings et al. 2015, p 1). Spatial genetic structure (differences in genetics between individual plants) is expected to be less pronounced for plant species that have robust mechanisms for seed dispersal, and occurs at distances more than 100 m (300 ft) (Jennings et al. 2015, p. 2). There was no evidence for spatial genetic structure (SGS) in *Cyanea pilosa*, and in *Clermontia fauriei* SGS was weak and restricted to small spatial scales less than 5 to 10 m (15 to 30 ft). The relative dearth of genetic diversity in these common lobeliads may reflect pre-existing conditions in this group, indications of a recently evolved lineage, and/or self-pollination in response to a decline in native avian pollinators, raising concerns that inbreeding and loss of genetic variation may be occurring in rare species of *Cyanea*, including *C. kauaulaensis* (Jennings et al. 2015, p. 5). Breeding systems, population sizes and generation times are important factors contributing to genetic structure of plant populations, and explanation of the observed levels of genetic variation in species of oceanic islands however requires the consideration of many interconnected physical and biological factors (Stuessy et al. 2013, p. 276).

2.3.1.4 Taxonomic classification or changes in nomenclature:

The type specimen for *Cyanea kauaulaensis* was collected by H. Oppenheimer and S. Perlman in 2008. Though this species was first discovered in 1989 during a botanical survey of the southern fork of Kaua‘ula Valley on Maui. Botanists at that time misidentified and believed those plants closely resembled *Cyanea glabra* (F. Wimmer) St. John [based on *Cyanea knudsenii* Rock var. *glabra* F. Wimmer]. In 2012, H. Oppenheimer and D. Lorence later determined the population as a new species, *Cyanea kauaulaensis* (Oppenheimer and Lorence 2012, p. 15).

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):

Cyanea kauaulaensis occurs on leeward west Maui in riparian sites, on talus or basalt boulder-strewn slopes along perennial streams at elevations of 732 to 914 m (2,400 to 3,000 ft) (Oppenheimer and Lorence 2012, p. 19). The plant community *C. kauaulaensis* is most closely associated with is *Metrosideros polymorpha* ('ōhi'a) lowland wet forest (Oppenheimer and Lorence 2012, p. 20; Clark et al. 2019, entire). Described by Oppenheimer and Lorence (2012, pp. 19–21), the most common associated native plants for *C. kauaulaensis* include: *Antidesma platyphyllum* (hame), *Boehmeria grandis* (akolea), *Broussaisia arguta* (kanawao), *Cheirodendron trigynum* ('ōlapa), *Clermontia* spp., *Coprosma* spp., *Cyrtandra* spp., *Dodonaea viscosa* ('a'ali'i), *Dubautia* spp., *Freycinetia arborea* ('ie'ie), *Ilex anomala* (kāwa'u), *Kadua acuminata* (au), *Perrottetia sandwicensis* (olomea), *Pipturus albidus* (māmaki), *Psychotria* spp. (kōpiko), *Urera glabra* (ōpuhe), and *Xylosma hawaiiense* (a'e). Ferns including species of *Asplenium*, *Cibotium*, *Cyclosorus*, *Deparia*, *Diplazium*, *Dryopteris*, *Elaphoglossum*, *Microlepia*, *Pteris*, *Sadleria*, *Tectaria gaudichaudii* (iwaiwa lau nui), and *Vandenboschia* are prevalent. Several herbaceous species of *Peperomia* are also present. The sedge genera *Machaerina* and *Rhynchospora* are also frequent.

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—Habitat destruction and modification by introduced feral goats (*Capra hircus*) and pigs (*Sus scrofa*) is a threat to *Cyanea kauaulaensis*. These introduced ungulates are highly destructive to the native vegetation by eating young trees and young shoots of plants before they can become established, contribute to erosion by creating trails that damage native vegetative cover through substrate destabilization and creation of gullies that alter hydrology, and by dislodging stones from ledges that can cause rockfalls and landslides damaging or destroying vegetation below (Cuddihy and Stone 1990, pp. 25–26, 63–64). These activities promote the invasion of nonnative plants that outcompete this species for space, water, light and nutrients. Although feral ungulates are present on west Maui, occurrences of *C. kauaulaensis* in Waikapū and Kaua'ula Valleys are less at risk from the direct effects

from ungulates because populations are located in extremely steep and rugged terrain (USFWS 2016, p. 67793; PEPP 2016, p. 93; PEPP 2018, p. 21; PEPP 2019, pp. 1–7).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive nonnative plant species are a threat to *Cyanea kauaulaensis*. Invasive nonnative plant species are responsible for modifying the availability of light; altering soil-water regimes; modifying nutrient cycling; altering the fire regime affecting native plant communities; and ultimately, converting native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; D’Antonio and Vitousek 1992, p. 73). Nonnative plants may also displace native species by preventing their reproduction, usually by shading and taking up available sites for seedling establishment (Cuddihy and Stone 1990, p. 74). Nonnative plants that affect habitat of *Cyanea kauaulaensis* include *Ageratina adenophora* (sticky snakeroot), *Buddleia asiatica* (dog tail), *Coffea arabica* (Arabian coffee), *Cortaderia jubata* (purple Pampas grass), *Erigeron karvinskianus* (Latin American fleabane), *Macaranga tanarius* (parasol leaf tree), *Melinis minutiflora* (molasses grass), *Rubus rosifolius* (thimbleberry), *Setaria palmifolia* (palm grass), and *Toona ciliata* (Mountain cedar or Australian red cedar) (Oppenheimer and Lorence 2012, p. 21). Direct effects of Arabian coffee are suspected on the Kaua‘ula Valley south fork subpopulation of *C. kauaulaensis*. The population was surveyed in 2004 and seemed stable with twelve plants. It was revisited in October 2010. Only three individuals remained, and the habitat had been significantly degraded by dense stands of *Coffea arabica* (Oppenheimer and Lorence 2012, p. 22).

Fire destruction and degradation of habitat—Alteration of fire regimes represents an ecosystem-level change caused by the invasion of nonnative grasses (D’Antonio and Vitousek 1992, p. 73). Beginning in the late 18th century, Europeans and Americans introduced nonnative grasses for pasturage and ranching (D’Antonio and Vitousek 1992, p. 67). Although fires were historically infrequent in mountainous regions, extensive fires have occurred in the last half of the 20th century in lowland dry and mesic areas as well as montane regions, leading to grass-fire cycles that convert forest to grasslands (D’Antonio and Vitousek 1992, p. 77). Successive fires that burn farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to conditions favorable to nonnative plants. Fire can destroy dormant seeds of these species as well as the plants themselves, even in steep or inaccessible areas. Although wildfire is not known as a direct threat to *Cyanea kauaulaensis*, it is potential threat to this species’ habitat (Clark et al. 2019, p. 9).

Flooding, landslides, rockfalls, and treefalls destruction or degradation of habitat—Flooding, landslides, rockfalls, and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities (Clark et al. 2019, entire). For those species that occur in small numbers in highly restricted geographic areas, such events have the potential to eradicate all individuals of a population, or even all populations of a species, resulting in extinction. *Cyanea kauaulaensis* grows in riparian areas along streams and below steep cliffs and is particularly vulnerable to flooding, landslides, and rockfalls. Many translocated plants were destroyed during the historic September 2016 flooding/landslide event in the south fork of Kaua‘ula Valley (PEPP 2018, p. 21).

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—The plants and animals of Hawai‘i evolved in nearly complete isolation from continental influences. Successful colonization of these remote volcanic islands was infrequent, and many organisms never succeeded in establishing populations. Grazing and browsing mammals were only introduced to Hawai‘i with the arrival of humans. In the absence of any grazing or browsing mammals, plants that became established did not need mechanical or chemical defenses against mammalian herbivory such as thorns, prickles, and production of toxins (Carlquist 1980, p. 173). *Cyanea kauaulaensis* lacks defenses against herbivory and is at risk of herbivory by introduced ungulates in areas where ungulates are present (USFWS 2016, p. 67793).

Herbivory and predation by rats—Rats impact native plants by eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23; Nelson et al. 2019, p. 8), and can seriously affect plant regeneration. In the Hawaiian Islands, rats may consume as much as 90 percent of the seeds produced by some trees, or in some cases prevent the regeneration of forest species completely (Cuddihy and Stone 1990, pp. 68–69). Plants with fleshy fruits are particularly susceptible to rat predation including the bellflower family (that includes *Cyanea*) and appear to be a target of rat predation (Cuddihy and Stone 1990, pp. 67–69). Rats occur in lowland wet forest where *Cyanea kauaulaensis* occurs and are a threat to this species (Oppenheimer and Lorence 2012, p. 21; PEPP 2015, p. 76; USFWS 2016, p. 67793).

Herbivory by slugs—Health and distribution of wet forests are affected by introduced herbivores, including nonnative slugs and snails (Clark et al. 2019, p. 10). Predation by nonnative snails and slugs adversely impacts

native plant species through mechanical damage, destruction of plant parts, and mortality. Joe and Daehler (2008, p. 252) found that native Hawaiian plants are more vulnerable to slug damage than nonnative plants. In particular, they found that the individuals of the endangered plants *Cyanea superba* and *Schiedea obovata* had 50 percent higher mortality when exposed to slugs when compared to individuals of the same species that were protected within slug exclosures (Joe and Daehler 2008, p. 251). Nonnative slugs have been observed to cause damage to *Cyanea kauaulaensis* by herbivory (Oppenheimer and Lorence 2012, p. 21; PEPP 2012, pp. 72–73).

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 degradation of habitat and/or herbivory. The State of Hawai‘i provides game mammal (feral pigs and goats) hunting opportunities within State-designated public hunting areas (DLNR 2010), including areas necessary for the recovery of *Cyanea kauaulaensis*. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., sustained yield) in some areas, with one animal allowed per day; to other areas with as little as one animal allowed per year (DLNR 2010). Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation. While some fences have been built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not adequate to prevent habitat destruction and degradation or the direct herbivory of *C. kauaulaensis*.

Lack of adequate biosecurity regulations—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) (U.S. CBP 2020, cbp.gov/about). 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, p. 1). The Service inspects arriving 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 (Hawaii Legislative Reference Bureau (HLRB) 2002; USDA-APHIS-PPQ 2010; CGAPS 2009). Many invasive plants established on 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 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 (CGAPS 2009). Adequate staffing, facilities, and equipment for Federal and State pest inspectors and identifiers in Hawaii devoted to invasive species interdiction are critical biosecurity gaps (HLRB 2002; USDA-APHIS-PPQ 2010; CGAPS 2009). 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 translocated individuals of *Cyanea kauaulaensis*.

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, p. 4; Newman and Pilson 1997, p. 361). 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 of outcrossing species may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. There are only approximately 129 individuals of *Cyanea kauaulaensis* distributed among 3 wild populations, and two of these populations contain less than 10 individuals making the species vulnerable to reduced viability due to low numbers of individuals, reduced reproductive vigor, and other effects associated with small population size (PEPP 2013, p. 68; PEPP 2018, p. 21; PEPP 2019, entire).

Climate change loss or degradation of habitat, including hurricanes—“Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or

both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of climate interactions with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19; Clark et al. 2019, p. 12). In the main Hawaiian Islands, predicted changes associated with increases in temperature include a shift in vegetation zones upslope, shift in species' ranges, changes in mean precipitation with unpredictable effects on local environments, increased occurrence of drought cycles, and increases in the intensity and number of hurricanes (Loope and Giambelluca 1998, pp. 514–515; Nelson et al. 2019, p. 6). The warming atmosphere is creating increase in tropical storm frequency and intensity (e.g., tropical storms and hurricanes), and altered precipitation patterns that contribute to regional increases in floods, heat waves, drought, and wildfires that displace species and alter or destroy natural ecosystems (Clark et al. 2019, p. 12). Climate models predict increased tropical cyclone activity in the subtropical central Pacific through years 2075 to 2099 (Murakami et al. 2013, pp. 749–750). Data on precipitation in Hawai'i show a steady and significant decline of about 15 percent since the 1980s (Chu and Chen 2005, pp. 4881–4900; Diaz et al. 2005, pp. 1–3) and steady decline in stream flow beginning in the early 1940s (Oki 2004, p. 1). Downscaling of global climate models indicates that wet-season (winter) precipitation will decrease by 5 percent to 10 percent, while dry-season (summer) precipitation will increase by about 5 percent (Timm and Diaz 2009, pp. 4261–4280). Altered seasonal moisture regimes can have negative impacts on plant growth cycles and overall negative impacts on natural ecosystems (US-GCRP 2009, p. 79).

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. Unfortunately *Cyanea kauaulaensis* was not included in this analysis.

Hurricanes adversely impact native Hawaiian terrestrial habitat, including all habitat types in which *Cyanea kauaulaensis* occurs (Clark et al. 2019, p. 12). They do this by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species (Asner and Goldstein 1997, p. 148; Harrington et al. 1997, pp. 539–540).

Current Management Actions:

- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) regularly monitors occurrences of *Cyanea kauaulaensis* (PEPP 2010, 2011, 2012, 2013, 2015, 2016, 2019). Surveys in the north fork

of Kaua‘ula Valley during 2008 and 2009 resulted in the discovery of additional plants of *C. kauaulaensis* (PEPP 2010, pp. 57–58).

- Ungulate monitoring and control—The Kaua‘ula Valley population is known to be ungulate free and the Olowalu translocated population is protected by ungulate fencing (PEPP 2016, p. 93; PEPP 2018, p. 21; PEPP 2019, pp. 1–7).
- Ecosystem-altering invasive nonnative plant control
 - PEPP regularly controls nonnative plants at the wild and reintroduced occurrences of *Cyanea kauaulaensis* (PEPP 2020).
 - The Maui Invasive Species Committee has been working to control *Cortaderia jubata* (purple Pampas grass) in Kaua‘ula and Waikapū Valleys on the surrounding, vertical cliffs of the two wild populations of *Cyanea kauaulaensis* (Oppenheimer and Lorence 2012, p. 22).
- Captive propagation for genetic storage and reintroduction—
 - PEPP collected seeds from 32 of the 45 individuals of *Cyanea kauaulaensis* in the north fork subpopulation of Kaua‘ula Valley in April of 2009 (Oppenheimer and Lorence 2012, p. 22). In 2013, seeds were collected from wild plants of the Waikapū Valley population (PEPP 2013).
 - In 2020, the Lyon Arboretum Seed Conservation Laboratory reported approximately 97,000 seeds of *Cyanea kauaulaensis* in genetic storage, representing multiple founders from the south fork of Kaua‘ula Valley and three founders from Waikapū Valley (Lyon Arboretum Seed Conservation Laboratory 2020).
 - National Tropical Botanical Garden (NTBG) reported 487 seeds of *C. kauaulaensis* in genetic storage from multiple founders (NTBG 2019).
 - Lyon Arboretum Micropropagation Laboratory reported 142 explants in storage representing founders from three population reference locations in Kaua‘ula Valley (Lyon Arboretum 2019, pp. 32–33).
 - The Olinda Rare Plan Facility (ORPF) reported approximately one potted plant at the ORPF greenhouses in 2019 (ORPF 2019).
- Reintroduction and translocation—
 - In October 2010 PEPP reported outplanting 84 plants from seeds collected in the north fork of Kaua‘ula Valley to augment the wild population on the south fork of Kaua‘ula Valley (PEPP 2012, p. 72–73).
 - In September of 2011, 16 plants grown from seeds representing the population in the north fork of Kaua‘ula Valley were translocated near the Waikapū Valley wild population (Oppenheimer and Lorence 2021, p. 22).
 - PEPP translocated 12 plants of *C. kauaulaensis* to Olowalu Valley in 2014 (PEPP 2014, pp. 73–74). Many translocated plants in the south fork of Kaua‘ula Valley and Olowalu Valley were destroyed

during the historic September 2016 flooding/landslide event (PEPP 2018, p. 21, PEPP 2019, p. 1).

- Management of predation and herbivory slugs—In 2014, the PEPP Program began application of a molluscicide, Sluggo® to protect *Cyanea kauaulaensis* and *Cyanea magnicalyx* from slugs (PEPP 2014, p. 11).

Table 1. Status and trends of *Cyanea kauaulaensis* from listing through 5-year review.

Date	No. wild individuals	No. Translocated	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2016 (listing)	ca 100	Only a few translocated plants are surviving due to historic 2016 flooding/landslide event	All threats managed in all 3 populations	Partially, ungulates excluded and some slug control
			Complete genetic storage	Partially, <i>ex situ</i> seeds and tissue culture collected from many founders
			3 populations with 50 mature individuals each	No, one population with >80 mature individuals
2021 (5-year review)	ca 129	Few translocated plants surviving due to the historic 2016 flooding/landslide event	All threats managed in all 3 populations	Partially, ungulates excluded and some slug control
			Complete genetic storage	Partially, <i>ex situ</i> seeds and tissue culture present from many founders
			3 populations with 50 mature individuals each	No, one population with 116 mature individuals, two other populations very small
			Each population naturally reproducing	Partially, one population

Table 2. Threats to *Cyanea kauaulaensis* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Destruction and degradation of habitat by ungulates	A	Ongoing	Partial, two wild populations protected by natural barriers; one translocated population fenced
Destruction and degradation of habitat by established ecosystem-altering invasive plants	A	Ongoing	Partial, some nonnative plant management at all sites
Fire destruction and degradation of habitat	A	Ongoing	None
Flooding, landslides, rockfalls, and treefalls destruction or degradation of habitat	A	Ongoing	None
Predation and herbivory by ungulates	C	Ongoing	Two wild populations protected by natural barriers; one translocated population fenced
Predation and herbivory by rats	C	Ongoing	None
Predation and herbivory by slugs	C	Ongoing	Partial, molluscicide used at some sites
Inadequacy of regulatory mechanisms	D	Ongoing	None
Low numbers and loss of reproductive vigor	E	Ongoing	Partial, seed collection, propagation, and reintroduction
Climate change degradation or loss of habitat, including hurricanes	E	Ongoing	None

2.4 Synthesis

There are 3 wild populations of *Cyanea kauaulaensis* consisting of approximately 129 individuals on Maui. There are 9 mature plants at Waikapū Valley and 116 mature plants at Kaua‘ula Valley (north fork) and 4 plants (2 mature and 2 immature) at Kaua‘ula (south fork) and three small translocated populations. The Waikapū Valley translocated population contains 16 plants, while the Kaua‘ula Valley translocated population contains a few plants, and the Olowalu Valley translocated population contains one plant. Wild populations are naturally reproducing but it is not known if translocated populations are naturally reproducing. The species has seeds from multiple founders in genetic storage and explants in micropropagation from three population reference locations in

Kaua‘ula Valley. There is one potted plant in *ex situ* propagation. Translocation efforts have not occurred since the historic September 2016 flooding/landslide event, which destroyed many translocated individuals in the south fork of Kaua‘ula Valley and Olowalu Valley.

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 Maui 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 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There is only one wild population with over 50 mature individuals and translocated populations are not known to be naturally reproducing. Additionally, while considerable progress has been made establishing *ex situ* genetic representation through seed collection and tissue culture, there is only partial genetic representation for this species (Table 1). Lastly, not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Cyanea kauaulaensis* 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 *Cyanea kauaulaensis* in historical locations and other suitable habitat.
- Ungulate monitoring and control—Continue to construct and maintain fenced enclosures as needed to protect individuals from negative effects of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *Cyanea kauaulaensis*.
- Fire management—Develop and implement a fire management plan for all wild and reintroduced populations.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Rat and slug predation and herbivory—Implement effective control methods for rats, and continue to develop and implement effective control methods for slugs.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Continue to increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of climate change, reduced reproductive vigor, and effects of landslides and flooding events.
- Alliance and partnership development—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 *Cyanea kauaulaensis* (no common name)

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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for

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