Cyanea kunthiana
(hāhā)

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 kunthiana* (hāhā)

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5-YEAR REVIEW
***Cyanea kunthiana* (hāhā)**

1.0 GENERAL INFORMATION

1.1 Reviewers:

Jay Nelson, 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 June 2019. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations and species status report by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 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: *Cyanea kunthiana*
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:
FR notice: [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.

A total of 53,140 acres (ac) [21,505 hectares (ha)] of critical habitat has been designated on East and West Maui for this species. Eight of the units are in the lowland wet ecosystem, seven of the units constitute montane wet forest habitat, and one unit is montane mesic forest. Of these 16 units, nine are currently known to have *Cyanea kunthiana* (Lowland Wet unit 1, Lowland Wet unit 3, Lowland Wet unit 4, Montane Wet unit 1, Montane Wet unit 2, Montane Wet unit 3, Montane Wet unit 4, Montane Wet unit 6 and Montane Mesic unit 1) (USFWS 2016, pp. 17911 and 17973-17975). Additional surveys are needed for this species throughout all sites.

1.3.4 Review History:
This is the first 5-year review for *Cyanea kunthiana*.

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 Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui) (USFWS 2019, entire).
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, and D) affecting this species is presented in section 2.3.2 and Table 2. Maui Nui Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) and Factor E (other natural or manmade factors affecting its continued existence) are not known to be threats 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, life span, 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.

Cyanea kunthiana 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. 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 kunthiana*, 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 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 kunthiana is a shrub 1.6 to 5 feet (ft) [0.5 to 1.5 meters (m)] tall with sub-herbaceous stems that are woody at the base and unbranched or sparingly branched. Leaves are elliptic to narrowly obovate, with blades 4.7 to 12 inches (in) [(12 to 30 centimeters (cm)] long and 1.2 to 2.8 in (3 to 7 cm) wide, with the upper surface green and sparsely pubescent (covered in short hairs), and the lower surface whitish green and pubescent. Inflorescences are 8 to 24-flowered, with the stalk 0.24 to 1.0 in (6 to 25 millimeters [mm]) long. The flower is whitish with pale lilac longitudinal stripes, or dark purplish, 1.2 to 1.4 in (30 to 35 mm) long, 0.12 to 0.16 in (3 to 4 mm) wide, and with a slightly curved tube. Berries

are purplish orange, obovoid to ellipsoid and 0.28 to 0.31 in (7 to 8 mm) long (Wagner *et al.* 1990, p. 453). This species was first collected in the mid-1800s and described in Hillebrand's *Flora of the Hawaiian Islands* in 1888. It has also been known as *Cyanea bishopii* (Wagner *et al.* 1990, p. 453).

Little to no research has been done on *Cyanea kunthiana* to understand the individual requirements for this species in the wild. The tube-shaped flowers point to bird-pollination (Cory et al. 2015, pp. 255-256), most likely from the endemic Hawaiian honeycreepers (Drepandidae) or the now extinct ʻōʻō (Mohoidae). Currently, the most likely extant pollinator is the ʻiʻiwi (*Drepanis coccinea*), with secondary pollination likely from the Hawaii ʻamakihi (*Chlorodrepanis virens*) (Aslan et al. 2013, p. 480). The fruits of *C. kunthiana* were likely dispersed by birds as well (Givnish et al. 2009, p. 416). The now extinct frugivores, the ʻōʻū (*Psittirostra psittacea*) and the olomaʻo (*Myadestes lanaienis*), were probably the primary dispersers in the past. Currently, seed dispersion is likely facilitated by two non-native species: the Japanese white-eye (*Zosterops japonicus*) and the red-billed leothrix (*Leiothrix lutea*). Dispersal in *Cyanea* species was always likely limited due to its reliance on forest-dependent birds (Givnish et al. 2009, p. 408). Since the breeding system of *Cyanea kunthiana* 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 assumed breeding system of a colonist, the breeding system of the current species, the presumed pollinator of the colonists, and the presumed dispersal method. According to Sakai et al., the breeding system of the colonist's lineage was monomorphic, the breeding system of the colonist was hermaphroditic, and the breeding system of the current species in the *Clermontia* / *Cyanea* / *Delissea* / *Rollandia* genera was hermaphroditic. The presumed pollinator of the colonists were birds and the presumed original long-distance dispersal method was internally by birds. Based on the results of this study, the breeding system for *C. kunthiana* is hermaphroditic thus flowers have both functional male and female reproductive organs. From other research it is likely that *C. kunthiana* 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).

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:

Before humans arrived in Hawaiʻi, *Cyanea kunthiana* may have been dispersed as a contiguous population across the northern and eastern slopes of Haleakalā, east Maui, in wet and mesic mid-elevation forests, as

well as on the upper elevation areas of West Maui. It would not have existed in the intervening isthmus, so these two populations would have been separated.

Currently, *Cyanea kunthiana* remains widespread across the northern and eastern slopes of Haleakalā. The known population on East Maui numbers in the hundreds, and there is potential suitable habitat to survey (USFWS unpubl. data 2019). Around eight poorly defined populations or sub-populations can be delineated on East Maui: Waikamoi, Wailuaiki/Kopiliula, Hanawī, NE rift zone (Hana bogs), lower Hana Forest Reserve, Kīpahulu Valley, Waihoʻi Valley, and Manawainui/Kaʻapahu (USFWS unpubl. data). It is likely that many of these populations are actually interconnected, particularly the Wailuaiki/Kopiliula, Hanawī, Hana Forest Reserve, and NE rift zone populations, as high quality, intact habitat exists between these populations that likely contains additional individuals. On West Maui, *C. kunthiana* is much rarer. At least two populations can be delineated: one on the summit bog area around Puʻu Kukui (particularly on the Kahoʻolewa ridge above ʻĪao Valley) and one to the north around and below ʻEke Crater. The populations on West Maui estimate 59 individuals total, with the Puʻu Kukui population about twice as big as the ʻEke population, though more individuals may be located with additional surveys. In addition, individuals that may constitute a third population area have been noted previously on the ridges between the Honolua and Honokōhau gulches, but have not been surveyed recently (H. Oppenheimer pers. comm. 2019).

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: N/A

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):
Cyanea kunthiana is primarily found in wet, montane forests at an elevation range between 3,600 to 6,000 ft (1,125 to 1,875 m), but can range up to 6,800 ft (2,125 m). Mean annual temperature in this range are generally below 15 degrees Celsius. Populations are known below this elevation in lowland wet forests from only two areas: Waihoʻi valley on far eastern Maui and below ʻEke crater on northern West Maui, where it

can be found down to around 3,000 ft (940 m), where mean annual temperatures can reach 16 degrees Celsius. *Cyanea kunthiana* is found mostly in areas where average annual rainfall exceeds 160 in (4,064 mm) per year, though in Waikamoi, populations are found in drier conditions with average rainfall down to 100 in (2,540 mm) per year (Giambelluca et al. 2013, p. 313). This area grades more into mesic forest from the normal wet forest habitat that *C. kunthiana* inhabits. Habitat modeling represents a good overview of the range of this species, though it is not known from the predicted range in the southeastern portion of West Maui near Hanaʻula peak (Price et al. 2012, p. 9).

Much of the habitat where *Cyanea kunthiana* occurs is dominated by the canopy tree ʻōhia (*Metrosideros polymorpha*), with koa (*Acacia koa*) also being co-dominant in some areas, particularly on the eastern and western boundaries of the range on East Maui. Other common associated species include the trees ʻōlapa (*Cheirodendron trigynum*), kawaʻu (*Ilex anomala*), pilo (*Coprosma* spp.), kōlea (*Myrsine lessertiana*), manono (*Kadua* spp.), and ʻalani (*Melicope* spp.). These areas also usually have a strongly-developed subcanopy and ground layers, dominated by ferns, kanawao (*Broussaissia arguta*), other lobeliads (*Cyanea* spp., *Clermontia* spp.), pukiawe (*Leptecophylla tameiameiae*), ʻōhelo (*Vaccinium* spp.), ʻalaʻala wai nui (*Peperomia* spp.), and a variety of sedges (*Carex* spp., *Machaerina* spp.).

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 scofra*) is a threat to *Cyanea kunthiana*. 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. Additionally, these ungulates may consume *C. kunthiana* when foraging for food, and directly damage roots and seedlings of *C. kunthiana*.

Established ecosystem-altering invasive plant modification and degradation of habitat—Habitat destruction and degradation and competition by invasive nonnative plant species are threats to *Cyanea*

kunthiana. 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; Vitousek et al. 1997, p. 6).

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" 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 interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19; Clark et al. 2019, p. 11). 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 *Cyanea kunthiana* is vulnerable to the impacts of climate change with a vulnerability score of 0.594 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) (Fortini et al. 2013, p. 71).

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. 7). 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 also displace species and alter or destroy natural ecosystems (USFWS 2013, p. 32047; Clark et al. 2019, p. 11). Data on precipitation in Hawai‘i show a steady and significant decline of about 15 percent over the last two decades of the 20th century (Chu and Chen 2005, pp. 4881-4900; Diaz et al. 2005, pp. 1-3). Downscaling of global climate models further 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). These data are supported by a steady decline in stream flow beginning in the early 1940s (Oki 2004, p. 1). Altered seasonal moisture regimes can have negative impacts on plant growth cycles and overall negative impacts on natural ecosystems (US-GCRP 2009, p. 79). 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, entire; Emanuel et al. 2008, entire; Yu et al. 2010, entire). 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. 749-750). Hurricanes destroy native vegetation and the habitat of *Cyanea kunthiana* by opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Gaps in the canopy also allow for the establishment of nonnative plants, which may be present as plants or as seeds incapable of growing under shaded conditions (Harrington et al. 1997, pp. 539–540).

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 slugs and rats—Predation by introduced slugs (*Derocerus* sp. and possibly *D. laeve*) is a potential threat to this species. Slugs impact individuals of *Cyanea* spp. through mechanical damage, destruction of plant parts, and direct mortality (Joe and Daehler 2008, p. 252). Rats impact native plants by eating seeds, flowers, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23), and can negatively impact regeneration. Plants with fleshy fruits such as *C. kunthiana* are particularly susceptible to rat predation (Cuddihy and Stone 1990, pp. 67–69).

Inadequacy of existing regulatory mechanisms (Factor D):
Existing Federal, State, or local laws, treaties, or regulations do not adequately address threats to this species (USFWS 2013, p. 32014).

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):
Loss of native pollinators and seed dispersal agents—*Cyanea* and other lobelioids coevolved with nectarivorous Hawaiian honeycreepers (Drepanididae) and honeyeaters (Meliphagidae) that served as plant pollinators, and native thrushes (*Myadestes*) and other frugivorous birds, such ‘O‘u (*Psittirostra pittacea*), that served as seed dispersers (Lunau 2004, p. 210; Banko and Banko 2009, pp. 30-31). Since human colonization of Hawai‘i, nectarivorous and frugivorous birds and native plant species that depend on them for pollination and seed dispersal have

undergone wide-scale declines and extinctions, including extinction on Maui of all native frugivorous birds and many species of native nectarivorous birds (Banko and Banko 2009, pp. 30–36; Cory *et al.* 2015, p. 255). For the most part avian malaria (*Plasmodium relictum*), which is transmitted in Hawai‘i by the mosquito species (*Culex quinquefaciatus*), has restricted remaining Hawaiian honeycreepers to higher elevations where average temperatures are too cold for mosquitoes to persist (LaPointe et al. 2012, p. 216-217). Loss of native forest birds that aided in pollination and seed dispersal likely was contributing factor to the decline historically of *Cyanea kunthiana* at middle and lower elevations. Fortini et al. 2015 (pp. 7-10) predict by mid-century with continued increasing temperatures that remaining native bird-pollinators of *C. kunthiana* will survive only at high elevations, overlapping only high elevation populations of *C. kunthiana* (Fortini et al. 2015, pp. 7-10).

Current Management Actions:

Primary on-the-ground management actions for this species are almost all related to habitat management, as little direct conservation for *Cyanea kunthiana* is ongoing. Currently, nearly all habitat for this species on both East and West Maui is managed for the exclusion of ungulates, though some lower elevation populations on East Maui, particularly in the Hana Forest Reserve, are not fenced. Limited collections of fruit have been made for this species for storage, though no *ex situ* cultivation is currently ongoing (H. Oppenheimer pers. comm. 2019). No management actions are ongoing to address other threats, though this species likely has benefited from rodent control for bird conservation that has occurred previously in Waikamoi and in Hanawī (Malcolm *et al.* 2008, Berthold *et al.* 2017).

- Surveys and monitoring—Haleakalā National Park regularly monitors wild populations of *Cyanea kunthiana* within the National Park (HALE 2016, p. 3, HALE 2017, p. 4; HALE 2018, p. 4).
- Ungulate monitoring and control—Most populations of *Cyanea kunthiana* are currently within fenced and ungulate free units.
- Ecosystem-altering invasive nonnative plant control—Federal and State conservation agencies, watershed partnerships, and some private landowners conduct nonnative plant control in some management units that harbor wild populations of *Cyanea kunthiana* (USFWS 2013, p. 32050-32051).
- Controlled propagation for genetic storage and reintroduction—There are 15 potted plants at Olinda Rare Plant Facility (ORPF) representing the wild population in ‘Ohe‘o, and another 10 potted plants representing a wild population in Haipua‘ena (ORPF 2019, p. 5).
- Other management actions—*Cyanea kunthiana* likely benefited from rodent control for bird conservation that occurred previously in Hanawī Natural Area Reserve and The Nature Conservancy’s

Waikamoi Preserve (Malcolm et al. 2008, entire; Berthold et al. 2017, entire).

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

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	165 known; estimated as many as 400	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 150 mature individuals each	No
2016 (critical habitat)	165 known; estimated as many as 400	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 150 mature individuals each	No
2020 (5-year review)	Approx. 457 on east Maui and 59 on west Maui	0	All threats managed in all 3 populations	Partial, some fencing
			Complete genetic storage	Limited
			3 populations with 50 mature individuals each	Partial, 5 with >50, maturity unknown

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

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Most populations fenced
Established ecosystem-altering invasive plant modification and degradation of habitat	A	Ongoing	Partial, nonnative plant management at some sites
Landslides and treefalls	A	Ongoing	None
Climate change degradation or loss of	A	Ongoing	None

habitat, including hurricanes			
Slug herbivory	C	Ongoing	None
Rat predation and herbivory	C	Ongoing	Partial, in the past traps set at some sites
Loss of pollinators and dispersal agents	E	Ongoing	None

2.3 Synthesis

There are 10 wild populations of *Cyanea kunthiana* consisting of approximately 457 individual plants in 8 populations on East Maui and 59 plants in 2 populations on West Maui. Climate change assessment concluded that *Cyanea kunthiana* is vulnerable to the impacts of climate change. Species wild populations have declined over the last century, likely from damage caused by feral ungulates and loss of native pollinators and seed dispersers. Most populations are protected from ungulates, but very little species-specific conservation activities are ongoing. Some collection and propagation hvae occurred.

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. Despite having five populations with estimates of greater than 50 individuals, it is unknown how many of these individuals are reproducing, and monitoring has been limited. Also, genetic representation is limited and incomplete (Table 1), and not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Cyanea kunthiana* 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 conduct surveys for *Cyanea kunthiana* 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.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *C. kunthiana*.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Rat and slug predation and herbivory—Continue to implement effective control methods for rats, and develop and implement effective control methods for slugs.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings for storage and propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of climate change and low numbers.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Cyanea kunthiana* (hāhā)

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:
Jay Nelson, Fish and Wildlife Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2020.09.28 12:02:08 -10'00'

For **Field Supervisor, Pacific Islands Fish and Wildlife Office**