Phyllostegia haliakalae
(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: *Phyllostegia haliakalae* (no common name)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

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

Lead Regional Office:
Interior Region 12, Portland Regional Office

Lead Field Office:
Pacific Islands Fish and Wildlife Office

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), beginning in October 2019. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 of Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered 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: *Phyllostegia haliakalae*
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.

Critical habitat was designated for *Phyllostegia haliakalae* on Maui in 10 units in three ecosystems (lowland wet, montane wet, and wet cliff) (16,001 hectares (ha); 39,540 acres (ac)) and in one unit in the lowland mesic ecosystem on Molokaʻi (3,549 ha; 8,770 ac) (81 FR 17790, March 30, 2016). Six critical habitat units (dry cliff and wet cliff) on Lānaʻi were excluded because conservation actions of the landowner provide a greater benefit to the species than designation of critical habitat.

1.3.4 Review History:

This is the first 5-year review for *Phyllostegia haliakalae*.

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 Factor 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.

Phyllostegia haliakalae is a short-lived suberect perennial herb. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, *P. haliakalae* should be represented by at least three populations on each of the islands where it now occurs or occurred historically, as long as suitable habitat exists. Each of these populations must be naturally reproducing (*i.e*., viable seeds, seedlings) with a minimum of 50 mature, reproducing individuals per population.

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

Interim Stage
To meet the interim stage of recovery of *Phyllostegia haliakalae*, 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 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 five 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:

Phyllostegia haliakalae is a suberect herb with forward-bending hairs on the stems. Ovate to elliptic leaves are 9 to 22 centimeters (3.5 to 8.7 inches (in)) long, 4 to 10 cm (1.6 to 3.9 in) wide; thin and hairy, with more hairs along veins on the lower leaf, and inconspicuously glandular-dotted. Leaf margins are crenate (rounded-toothed). White flowers are borne 4 to 6 per racemose inflorescence. Nutlets are up to 2 mm (0.1 in) long (Wagner *et al.* 1999, p. 819).

The specific life history characteristics of *Phyllostegia haliakalae* have not been studied. Little is known about the phenology and reproduction of the *P. haliakalae* except time of flowering and fruiting in greenhouse conditions, which occurs year-round (Welton 2019, in litt.).

The flowers of Hawaiian *Phyllostegia* have prominent lower-lipped, mostly white pink-colored corollas, associated with insect pollination (Lindqvist and Albert 2002, p.3; Wood *et al* 2019, p.1).

Members of this taxon in Hawai‘i have well-developed fleshy fruits, a feature commonly found in plants requiring birds for dispersal (Carlquist 1980, p. 96).

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:
Phyllostegia haliakalae was first documented from a collection in the late 1870s in a dry ravine on the lower east side of Haleakalā (Wawra 1872). It was last documented on Moloka‘i and Lāna‘i in 1928 (Munro 247, BISH, Degener 5395, BISH). This species was treated as *Phyllostegia imminuta* by Wagner *et al.* (1999), but examination of the type *haliakalae* showed it to be the same taxon. In the most recent review of *Phyllostegia* Benth. (Wagner 1999, p. 269), populations of *P. mollis* Benth. from Maui and Moloka‘i were treated as synonyms for *P. haliakalae*. In 2009, a single individual was discovered in Kīpahulu above Palikea Stream (Haleakalā National Park) (Oppenheimer 2011, p. 7). In 2012, one wild individual was found in Kahikinui, and two individuals were found in Kaukau‘ai; however, these plants have not been relocated (Plant Extinction Prevention Program (PEPP) 2019). In 2017, during a nonnative plant removal project, a small population of 11 mature, 29 immature, and 70 seedlings was found at ‘Ohe‘o, with additional individuals found in 2018 (totaling 23 mature, 23 immature, and 70 seedlings) (PEPP 2019). Botanists continue to search for potentially suitable habitat near the last known locations on Moloka‘i and Lāna‘i (PEPP 2019). There are seeds and propagules in collections, with approximately 290 plants reintroduced in 23 subpopulations; however, outplanted populations are ephemeral, some with plants not remaining longer than two years (PEPP 2013, 2014, 2016, 2017, 2018, 2019, 2020). Currently, 67 to 111 wild individuals and 250 outplants survive (PEPP 2016, 2017, 2018, 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:
The type specimen for *Phyllostegia haliakalae* was collected by Wawra in 1869 or 1870, in a dry ravine at the foot of Haleakalā volcano on the island of Maui (Wawra 1872). The species was treated as *P. imminuta* by Wagner *et al.* (1990) until the nomenclature was revised to *P. haliakalae*

in 1999 (Wagner 1999, p. 269) and is the currently accepted taxonomy (Wagner and Herbst 2003).

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):
Phyllostegia haliakalae occurs in mesic forest (lowland and montane), wet forest (lowland and montane), and wet and dry cliff ecosystems of east Maui (TNCH 2007; HBMP 2010). This species was last documented in the lowland mesic ecosystem of Molokaʻi in 1928, and the dry cliff and wet cliff ecosystems of Lānaʻi (in 1916 and 1979, respectively) (TNCH 2007; HBMP 2010). Associated native species in wet areas include *Cibotium* spp. (hāpuʻu), *Cyanea hamatiflora* (hāhā), *C. kunthiana* (hāhā), *Cyrtandra* spp. (haʻiwale), *Gunnera petaloidea* (ʻapeʻape), *Hydrangea arguta* (kanawao), *Melicope* spp. (alani), *Perrottetia sandwicensis* (olomea), *Pipturus* spp. (māmaki), and *Sadleria* spp. (ʻamaʻu) (HBMP 2010). Associated native species in montane mesic forest of *Acacia koa* (koa) and *Metrosideros polymorpha* (ʻōhiʻa) include *Dodonaea viscosa* (ʻaʻaliʻi), *Cheirodendron trigynum* (ʻōlapa), *Coprosma* spp. (pilo), *Ilex anomala* (kāwaʻu), *Leptecophylla tameiameiae* (pūkiawe) *Myoporum sandwicense* (naio), *Myrsine* spp. (kōlea), and various native ferns (Gagne and Cuddihy 1999, pp. 97–99).

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—Destruction and degradation of habitat by feral pigs, goats, axis deer, and cattle is a threat to *Phyllostegia haliakalae* at Kaukauʻai, ʻOheʻo, Kahikinui, Manawainui Gulch, and Waiʻōpai (HBMP 2010; PEPP 2012, 2013, 2014, 2019). These 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 also promote the invasion of nonnative plants that will outcompete this species for space, water, light and nutrients. Additionally, these ungulates may consume *P. haliakalae*

when foraging for food, and directly damage roots and seedlings (Loope 1998, pp. 752–753; van Riper and van Riper 1982, p. 25; Oppenheimer 2019, pers. comm.). Individuals of *P. haliakalae* within exclosures are provided some protection from the effects of these ungulates; however, these exclosures must be monitored for ingress (PEPP 2019).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive introduced plants modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, changing nutrient cycling and the fire characteristics of the native plant community (Cuddihy and Stone 1990, pp. 73–91). Habitat modification and destruction by invasive nonnative plants negatively affected the last known wild populations of *Phyllostegia haliakalae* on Molokaʻi and Lānaʻi (HBMP 2010; PEPP 2017, 2018, 2019). Nonnative invasive plants with the greatest impacts on *P. haliakalae* include *Ageratina adenophora* (Maui pāmakani), *Bidens pilosa* (kī), *Bocconia frutescens* (no common name), *Cirsium vulgare* (bull thistle), *Clidemia hirta* (Koster's curse), *Fraxinus uhdei* (tropical ash), *Hedychium gardnerianum* (kāhili ginger), *Lythrum maritimum* (pūkāmole), *Pennisetum clandestinum* (kikuyu grass), *Rubus argutus* (prickly Florida blackberry), *R. niveus* (Mysore raspberry), and *R. rosifolius* (thimbleberry) (HBMP 2010; PEPP 2012, 2013, 2014, 2018).

Habitat degradation and destruction by fire—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 less frequent in wetter mountainous regions, extensive fires have recently occurred in lowland dry and lowland mesic areas on east and west Maui, 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, pp. 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; Tunison *et al*. 2002, p. 123). Fire is noted as a threat to *Phyllostegia haliakalae* at Manawainui Gulch and Waiʻōpai on east Maui (PEPP 2013, 2014).

Habitat degradation and destruction by treefall—*Phyllostegia haliakalae* is crushed or destroyed by treefall at Manawainui Gulch, Waiʻōpai, and

Makawao-Olinda caused by disturbance such as heavy winds and rain associated with storms (PEPP 2012, 2013, 2015, 2018).

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 *Phyllostegia haliakalae* is vulnerable to the impacts of climate change with a vulnerability score of 0.517 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

Drought is observed to be a threat to populations of *Phyllostegia haliakalae* at Kahikinui, Manawainui Gulch, Wai‘ōpai, and Makawao-Olinda (PEPP 2012, 2013, 2014, 2018). 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, 4 pp.). 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). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Not a threat.

2.3.2.3 Disease or predation (Factor C):
Rodent predation and herbivory—Herbivory by rats is noted to be a threat to *Phyllostegia haliakalae* at all wild and most reintroduced populations at Kaukau‘ai, Makawao-Olinda, ‘Ohe‘o, and Wai‘ōpai (PEPP 2018, 2019). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980, pp. 269–272; Cuddihy and Stone 1990, pp. 68–69). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

Slug herbivory—Herbivory by slugs is noted as a threat to this species at Makawao-Olinda, ʻOheʻo, Waiʻōpai, Manawainui Gulch, and Kahikinui. Slug herbivory can lead to reduced vigor and death of individual plants (Joe and Daehler 2008, pp. 252–253; PEPP 2012, 2019).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D): Currently, four agencies are responsible for inspection of goods arriving in Hawaiʻi (CGAPS 2009). The Hawaiʻi Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawaiʻi, 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 Hawaiʻi allows the importation of most plant taxa, with limited exceptions. Many invasive plants established in Hawaiʻi 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 Hawaiʻi is a significant risk to *Phyllostegia haliakalae* and other federally listed species.

Nonnative feral ungulates are an ongoing threat to *Phyllostegia haliakalae* through destruction and modification of habitat and by direct predation. The State of Hawaiʻi provides game mammal (feral pigs, goats, and axis deer) hunting opportunities (e.g., "sustained yield") in public hunting areas on Maui, Molokaʻi, and Lānaʻi (DLNR 2012). One wild and most reintroduced populations of *P. haliakalae* are fenced; however, the exclosures must be monitored for ingress by feral pigs, goats, and deer. Public hunting areas are not fenced and game mammals have unrestricted access for most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations of *P. haliakalae* are at risk (DLNR 2010).

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

Established invasive plant species competition—Competition by *Ageratina adenophora* (Maui pāmakani), *Bidens pilosa* (kī), *Bocconia frutescens* (no common name), *Cirsium vulgare* (bull thistle), *Clidemia hirta* (Koster's curse), *Fraxinus uhdei* (tropical ash), *Hedychium gardnerianum* (kāhili ginger), *Lythrum maritimum* (pūkāmole), *Pennisetum clandestinum* (kikuyu grass), *Rubus argutus* (prickly Florida blackberry), *R. niveus* (Mysore raspberry), and *R. rosifolius* (thimbleberry) is reported to be a threat to *P. haliakalae* (HBMP 2010; PEPP 2018).

Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, pp. 3, 7; Newman and Pilson 1997, pp. 354–355). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small numbers are noted as a cause of loss of reproductive vigor of *Phyllostegia haliakalae*. *Phyllostegia haliakalae* is extirpated from Molokaʻi and Lānaʻi, and currently, there is only one wild population totaling fewer than 50 individuals and possibly one other wild population (totaling one individual) last observed in 2017 (PEPP 2019). More than 290 individuals have been reintroduced since 2013; however, there has been no recruitment observed in these populations (PEPP 2013, 2014, 2015, 2016, 2017, 2018, 2019).

Current Management Actions:

- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) monitors outplanted individuals and surveys for wild individuals of *Phyllostegia haliakalae* on east Maui (PEPP 2016, 2017, 2018, 2019). The Endangered Wildlife Management Program of Haleakalā National Park is responsible for surveying and monitoring wildlife species within the park (USFWS 2012, p. 13). The largest remaining wild population is within the Park (PEPP 2019).
- Ungulate control—
    - The East Maui Watershed Partnership (EMWP) works in coordination with landowners to protect and monitor the native ecosystems of east Maui (*http://eastmauiwatershed.org/explore-the-watershed/management/*, accessed 28 JAN 2020). The partnership addresses ungulate removal and exclosure construction

(over 11 kilometers (7 miles) of fencing). Most of the reintroduced populations of *P. haliakalae* are fenced.
    - Leeward Haleakala Watershed Restoration Partnership (LHWRP) manages lands where there are several outplanted subpopulations of *P. haliakalae* (LHWRP 2006, pp. 22–23). LHWRP recommends fencing and hunting to protect native forest watershed from ungulates (LHWRP 2006, pp. 35–36).
    - The Nature Conservancy of Hawai‘i’s Waikamoi Preserve encompasses 2,117 ha (5,230 ac) along the northern boundary of Haleakalā National Park on east Maui (TNCH 2011, p. 4). Ungulate control is the focus of the Waikamoi Preserve’s resource management program, utilizing a combination of fencing, hunting, and snaring (TNCH 2011, pp. 13–14). Individuals of *P. haliakalae* that occur within the preserve are provided protection by these conservation activities.
    - Haleakalā National Park (HNP) controls feral ungulates by removal and fencing of over 6,070 hectares (15,000 acres) (National Park Service 1995). The Feral Animal Removal and Management program of HNP is responsible for effective management of feral animals within the park (USFWS 2012, p. 13).
    - The Plant Extinction Prevention Program (PEPP) constructs and maintains fencing and conducts nonnative plant control at wild and reintroduced populations of *P. haliakalae on* east Maui (PEPP 2016, 2017, 2018, 2019).
    - The State’s Nakula Natural Area Reserve (NAR) has been used for reintroduction of *P. haliakalae* by PEPP, and management actions include invasive species control, fire prevention, and response to insect and disease threats (DLNR 2015, pp. 1–2).
- Lāna‘i’s land manager, Pūlama Lāna‘i, is implementing an island-wide conservation plan. The plan provides for landscape-scale management that will benefit the unique native species, including *P. haliakalae* if it is located in future surveys. The plan calls for: control of nonnative species (including ungulates), implementation of immediate protective intervention efforts for rare plants, and restoration of terrestrial habitat for plants and animals (Donoho 2015, in. litt.).
- Nonnative invasive plant control—
    - The EMWP has also initiated nonnative plant control planning and implementation in areas where *P. haliakalae* occurs (*http://eastmauiwatershed.org/explore-the-watershed/management/*, accessed 28 JAN 2020).
    - The LHWRP focuses on chemical and mechanical control of *Bocconia frutescens*, with the goal of eradicating this nonnative invasive plant from the partnership’s boundaries (LHWRP 2006, p.

36). Other nonnative invasive plant species are addressed on a case-by-case basis.
    - The Plant Extinction Prevention Program (PEPP) conducts nonnative plant control at reintroduced populations of *P. haliakalae* on east Maui (PEPP 2012, 2014, 2016, 2017, 2018, 2019).
    - The TNCH conducts nonnative plant control within Waikamoi Preserve including the *Rubus* species mentioned as threats to *P. haliakalae* (TNCH 2011, p. 19).
    - The Vegetation Management program of HNP is responsible for invasive species management, native plant restoration, and threatened and endangered plant management (Service 2012, p. 14).
- Captive propagation for genetic storage and reintroduction—
    - The Lyon Arboretum Micropropagation Laboratory reports propagation of more than 300 explants in storage representing three individuals from the Fleming Arboretum collection (Lyon Arboretum 2019). The Lyon Arboretum Seed Conservation Laboratory reports 886 seeds in storage representing three plants of unidentified founders; six seeds collected in 2012 representing plants from Waikamoi; 2,089 seeds representing three founders from ʻOheʻo; 629 seeds representing one subpopulation from ʻOheʻo and 20,013 seeds representing 14 individuals also from ʻOheʻo; and 1,320 seeds representing one individual from Waiʻōpai.
    - In 2016, Haleakala National Park (HNP) reported 68 plants in storage representing two founders from Kīpahulu (HNP 2016). In 2019, HNP reported propagation of 161 plants representing 25 founders from ʻOheʻo, and 103 plants in storage representing four founders from Kaukauʻai (HNP 2019).
    - The Olinda Rare Plant Facility (ORPF) reports propagation of 112 individuals representing 12 founders from ʻOheʻo; and three plants representing one founder from Koolau Gap (Palikea Camp) (ORPF 2019).
- Reintroduction and translocation—
    - PEPP has reintroduced more than 240 individuals at four locations (16 locations).
    - Haleakala National Park reports reintroduction of 29 individuals at Kīpahulu, 27 individuals at ʻOheʻo, and 27 individual representing two founders at Kaukauʻai Gulch also at ʻOheʻo (HNP 2019).
    - ORPF reports 21 plants reintroduced to Manawainui Gulch-Kahikinui, representing living collections at Fleming Arboretum, and eight plants sent out to an unidentified location representing one founder at ʻOheʻo (ORPF 2019).

Table 1. Status and trends of *Phyllostegia haliakalae* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	0	ca 100	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Yes
			3 populations with 50 mature individuals each	No
2016 (critical habitat)	0	>100	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Yes
			3 populations with 50 mature individuals each	Partial, one reintroduced population >50 individuals, no recruitment observed
2020 (5-year review)	67–111	ca 300, ca 250 remain in total	All threats managed in all 3 populations	Partially, ungulate and nonnative plant control ongoing
			Complete genetic storage	Yes
			3 populations with 50 mature individuals each	No, no recruitment observed at reintroduction sites

Table 2. Threats to *Phyllostegia haliakalae* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, most reintroduced populations are fenced
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	Partial, nonnative plant control within exclosures
Fire degradation and destruction of habitat	A	Ongoing	Partial, fire management as part of watershed partnership goals

Degradation and destruction of habitat by treefalls	A	Ongoing	None
Climate change degradation or loss of habitat, including drought	A	Ongoing	None
Predation and herbivory by rats	C	Ongoing	None
Herbivory by slugs	C	Ongoing	None
Inadequacy of existing regulatory mechanisms	D	Ongoing	Partial, one wild and most reintroduced populations in exclosures
Competition with invasive plant species	E	Ongoing	Partial, nonnative plant control within exclosures
Reduced viability due to low numbers	E	Ongoing	Partial, seed collection, propagation, and reintroduction ongoing; however no natural recruitment observed

2.4 Synthesis

There are two populations of *Phyllostegia haliakalae* on east Maui, one of one individual, and the second of 66 to 110 individuals. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *P. haliakalae* is vulnerable to the effects of climate change. Genetic representation in collections and storage is complete. Collection, propagation, and reintroduction are ongoing. More than 300 individuals representing at least 10 founders were reintroduced. Most of the reintroduced populations are provided some protection from ungulates within exclosures. Nonnative invasive plant control is conducted within some 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 Maui, Moloka‘i, and Lāna‘i where they now occur or occurred historically and each of these populations must be naturally reproducing (*i.e.*, viable seeds, seedlings) with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There is only two wild populations (one of only one individual) on Maui, and, although more than 300 individuals have been reintroduced, only one of these populations totals more than 50 mature individuals and no natural recruitment has been observed. The reintroduced populations are only on Maui and do not represent the range of this species on Molokaʻi or Lānaʻi. In addition, although genetic representation is complete (Table 1), not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Phyllostegia haliakalae* 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 search suitable habitat for individuals of *Phyllostegia haliakalae* in recent and historical locations.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *P. haliakalae* at all populations.

- Predation and herbivory by rats and slugs—Implement effective control measures for rats and slugs at all populations.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and propagation efforts.
- Reintroduction and translocation—Continue to increase numbers of populations and individuals in suitable habitat to reduce the impacts of predation and climate change.
- Population biology research—Research the possible causes of lack of natural recruitment.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Phyllostegia haliakalae*
(no common name)

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:
Cheryl Phillipson, 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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