

Phyllostegia floribunda
(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 floribunda* (no common name)

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5-YEAR REVIEW
***Phyllostegia floribunda* (no common name)**

1.0 GENERAL INFORMATION

1.1 Reviewers:

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

Lead Regional Office:

Interior Region 12, Portland Regional Office

Lead Field Office:

Pacific Islands Fish and Wildlife Office

Cooperating Field Office(s):

N/A

Cooperating Regional Office(s):

N/A

1.2 Methodology used to complete the review:

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 The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

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

1.3.2 Listing history:

Original Listing

FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered species status for 15

species on Hawaii Island; final rule. Department of the Interior, Federal Register 78: 64638–64690, October 29, 2013.

Date listed: October 29, 2013
Entity listed: *Phyllostegia floribunda*
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 *Phyllostegia floribunda*.

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 Island of Hawai'i
Date issued: October 2019
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes
 No

2.1.2 Is the species under review listed as a DPS?

Yes
 No

2.1.3 Was the DPS listed prior to 1996?

Yes
 No

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

Yes
 No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

Yes
 No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

Yes
 No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes
 No

2.2.2 Adequacy of recovery criteria.

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

Yes
 No

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

Yes
 No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

A synthesis of the threats (Listing Factors A, 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 floribunda is a short-lived perennial subshrub. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three populations should be documented on the island of Hawai'i where they now occur or occurred historically. Each of these populations must be naturally reproducing (i.e., viable seeds, seedlings) 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 floribunda*, 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) that is secure and well managed. Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

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

Downlisting Criteria

In addition to achieving 5 to 10 populations with 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:

Phyllostegia floribunda is a small shrub or subshrub with hairy stems. Leaves are opposite and ovate, lanceolate, or elliptic, 12 to 24 centimeters (cm) (4.7 to 9.4 inches (in)) long and 4.5 to 8.5 cm (1.8 to 3.3 in) wide, variably hairy (ranges from almost hairless to densely covered with soft hairs), with a pale lower surface; margins toothed; petioles 2.5 to 6.5 cm (1 to 2.6 in) long and hairy. Flowers are borne in axillary (where the leaf petiole meets the stem) inflorescences; flowers are two per whorl, pedicels (flower stems) are 8 to 10 millimeters (mm) (0.3 to 0.4 in) long; calyx (outermost sterile parts (sepals) below the petals) is obconical (the point of attachment at the small end), 2 to 5 mm (0.07 to 0.2 in) long, hairy, with 10 veins, teeth linear-lanceolate and 1.2 to 2.4 mm (0.05 to 0.1 in) long. Flowers are maroon to red and covered with long soft hairs, floral tube 8 to 10 mm (0.3 to 0.4 in) long with two unequal lips 2.5 and 5 mm (0.1 and 0.2 in) long; four short-styled (connection of stamen to ovary) stamens. Fruits are composed of four fleshy nutlets, 3 to 3.5 mm (0.1 to 0.13 in) long, and shiny black when mature (Wagner *et al.* 1999, p. 815; Pratt *et al.* 2011, p. 127).

Flowering has been observed in spring, summer, and fall, and fruiting in the spring and summer (VanDeMark *et al.* 2010 in Pratt *et al.* 2011, p. 125; PEPP 2014, 2015, 2016). 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). It is likely that *P. floribunda* is also capable of self-fertilization based

on observations of single plants of congener species reproducing successfully in the wild (Army Natural Resources Program (ANRP)-Oahu 2009, 2011). 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).

Some of the life history characteristics specific to *Phyllostegia floribunda* were studied by VanDeMark et al. (2010, pp. 2–60) at reintroduction sites in Hawai‘i Volcanoes National Park (HVNP). The botanists monitored 42 plants at two separate reintroduction sites from 2006 through 2008. Buds, flowers, and fruit were counted on each individual of plantings at two sites within the ‘Ōla‘a fence units. Sites were visited at two-week intervals to monitor timing of phenology and reproductive success. The soil seed bank was sampled and soil cores were planted in the HVNP Natural Resources Management greenhouse. Germination trials were conducted from this stock. Adult plant mortality was relatively low (21 percent) and was first observed when plants were almost four years old. Mean height of plants fluctuated around 3 feet (1 meter). When older stems died, younger stems typically re-sprouted. Almost all plants produced buds and flowers seasonally in both years with peaks between April and June or July. The number of mature fruit was less than a quarter the number of immature fruit counted. The peak month for mature fruit production was June in 2007. In 2008, the greatest number of mature fruits per plant was recorded in May and August (VanDeMark et al. 2010, pp. 2–60).

The research group also monitored pollination, recruitment, and survival. Review of nearly 300 hours of video showed non-native honey bees, (*Apis mellifera*), unknown fruit flies (Drosophilidae), and a native geometrid moth caterpillar (*Lophoplusia giffardi*) visiting flowers of *Phyllostegia floribunda*. Over the course of two years of monitoring, 61 naturally-established seedlings were found at one site. Most seedlings appeared in April or October, but groups of seedlings also appeared in December, January, and several summer months. Despite initial reproductive success, seedling survival was poor. Six months after first appearance, the seedling mortality rate was 90 percent. Based on these data, if provided fenced areas and adequate soil moisture, the reintroduced plants were able to grow and reproduce successfully in the wild, but seedlings failed to thrive and did not transition to larger size classes (VanDeMark et al. 2010, pp. 2–60; Belfield et al. 2011, pp. 112).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Historically, *Phyllostegia floribunda* was known from four disjunct areas on the island of Hawai‘i: the Kohala Mountains; Honokaia Gulch; from

Laupāhoehoe to Kīlauea (including Hawai‘i Volcanoes National Park); and near Pāhala in Ka‘ū (Wagner *et al.* 1999, p. 815). The species was also collected in Kona by Nelson in 1779 and by Forbes in 1911, but is apparently extirpated from those sites (St. John 1976, pp. 23–25, 31–33).

In the 1990s, *Phyllostegia floribunda* was documented from Hawai‘i Volcanoes National Park at ‘Ōla‘a Forest and was likely extant in East Rift forest craters near Nāpau. It was also found in a kīpuka on the eastern park boundary near Pu‘u ‘Ō‘ō crater, but was destroyed by fire (Pratt *et al.* 2011, p. 127).

In 1999, Wagner analyzed the types and names of *Phyllostegia* as published in St. John (1976), and placed *P. forbesii* and *P. villosa* under *P. floribunda*, keeping the original historical range of the species (Wagner 1999, p. 268). Wagner also noted that *P. floribunda* was collected in 1982 and 1991 at the “Volcano Village dump,” and in 1982 between Ka‘awali‘i and Kaiwilahilahi streams. In addition, there were extant populations at Pu‘u Maka‘ala, Kahauale‘a, the East Rift Zone, Laupāhoehoe, and Kukuioipa‘e (Wagner 1999, p. 268).

In 2009, five populations totaling fewer than 50 individuals were known, but determination of exact numbers was difficult due to land access issues (PEPP 2009). In 2010, records indicated the species *Phyllostegia floribunda* was still known from the Kipāhoehoe, Pu‘u Maka‘ala, and Kahauale‘a Natural Area Reserves; the Kona Hema Preserve; the upper Waiākea Forest Reserve, and Hawai‘i Volcanoes National Park. A previously reported population from Hawai‘i Volcanoes National Park’s ‘Ōla‘a Tract could no longer be relocated (Pratt 2008, pers. comm.).

In 2015, there were 12 known occurrences of *Phyllostegia floribunda* totaling fewer than 100 individuals in Hawai‘i Volcanoes National Park (National Park Service 2015, p. 465). The individual at ‘Ōla‘a was not found in a survey in 2000 and was presumed to have died. It was observed in Nāpau Trail pit crater in 1995; however, this occurrence was not resurveyed since 1995 because there was no feral pig disturbance observed at the site (National Park Service 2015, p. 465).

Currently, there are three to four wild individuals at Kona Hema Preserve (though has not been monitored recently; 1 plant), Hawai‘i Volcanoes National Park (1 plant last monitored in 2014), and Waiākea Upper (2 plants) (PEPP 2017, 2019; VanDeMark 2020, in litt.).

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:

Phyllostegia floribunda was first collected in the late 1700s by Nelson and described by Bentham (1835, p. 653). In 1976, St John recognized *P. floribunda* as those plants occurring on the western slope of the island of Hawai‘i and recognized those occurring from eastern section of the island of Hawai‘i as *P. villosa* (at Glenwood, Pāhala, Kohala, Pu‘u Kīpū, Honokaia gulch, ‘Āwini, and the Kīlauea area) and those classified as *P. floribunda* var. *forbesii* (occurring in Kona at Kealapuali) as *P. forbesii* (St. John 1976, pp. 23–25, 31–33).

In 1990, Wagner et al. analyzed the types and names of *Phyllostegia* as published in St. John (1976), and only five of the new species were recognized as distinct, returning St. John’s *P. forbesii* and *P. villosa* to synonymy of *P. floribunda*, using the same delimitation as Sherff.

In 1999, Wagner analyzed the types and names of *Phyllostegia* as published in St. John (1976), and kept *P. forbesii* and *P. villosa* under *P. floribunda*, in agreement with Wagner *et al.* (1990) (Wagner 1999, p. 268), and is the currently accepted taxonomy.

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 floribunda occurs in mesic to wet *Metrosideros-Acacia-Cibotium* (‘ōhi‘a-koa-hāpu‘u) forest (Wagner *et al.* 1990, p. 815) with the associated native species *Cheirodendron* sp. (‘ōlapa), *Clermontia* sp. (‘ōhā wai), *Coprosma ochracea* (pilo), *Cyrtandra* sp. (ha‘iwale), *Hydrangea arguta* (kanawao), *Melicope clusiifolia* (kolokolo mokihana), *Myrsine* sp. (kōlea), *Polyscias oahuensis* (‘ohe mauka), and *Psychotria* sp. (kōpiko) (HBMP 2010). Pratt *et al.* (2011, p. 127) observed that in ‘Ōla‘a forest, *P. floribunda* occurred at elevations higher than the published upper range for the species (1,220 m, 4,000 ft).

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 and cattle is a threat to *Phyllostegia floribunda* especially at Kipāhoehoe, Pu‘u Maka‘ala, and Waiākea Upper

(DLNR 2002, pp. 8, 10; HBMP 2010; Pratt *et al.* 2011, p. 127; PEPP 2014, 2015). 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 *P. floribunda* for space, water, light and nutrients. Additionally, these ungulates may consume this species when foraging for food, and directly damage roots and seedlings (Loope 1998, pp. 752–753; van Riper and van Riper 1982, p. 25). Individuals of *P. floribunda* 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 floribunda* on the island of Hawai‘i (HBMP 2010; PEPP 2014, 2015). The nonnative invasive plants observed to have the greatest impacts on *P. floribunda* include *Cyperus haspan* (McCoy grass), *Delaria odorata* (German ivy), *Ehrharta stipoides* (meadow ricegrass), *Passiflora edulis* (passion fruit), *P. ligularis* (sweet granadilla), *P. tarminiana* (banana poka), *Pennisetum clandestinum* (kikuyu grass), *Plantago major* (broad-leaved plantain), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Rubus argutus* (prickly Florida blackberry), *R. ellipticus* (yellow Himalayan raspberry), and *Setaria palmifolia* (palmgrass) (DLNR 2002, p. 8–10, 19; HBMP 2010).

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). 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). Fire is noted as a threat to *Phyllostegia floribunda*. In 2011, the Nāpau Crater wildfire, ignited by an eruption at

the Kamoamoa fissure in Hawai'i Volcanoes National Park (HVNP), consumed over 840 ha (2,076 ac), including 40 ha (100 ac) of the 1,113-ha (2,750-ac) east rift zone's special ecological area (Ainsworth 2011, in litt.; Kakesako 2011, in litt.). In HVNP, fires were three times more frequent and 60 times larger, on average, from the late 1960s to 1995, when compared to data spanning 1934 to the late 1960s (Tunison *et al.* 2001 in La Rosa *et al.* 2008, p. 231). The historical fire regimes have been altered from typically rare events to more frequent events, largely a result of continuous fine fuel loads associated with the presence of the fire-tolerant, nonnative fountain grass and the grassfire feedback cycle that promotes its establishment (La Rosa *et al.* 2008, pp. 240–241; Pau 2009, in litt.).

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 floribunda* is vulnerable to the impacts of climate change with a vulnerability score of 0.0626 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

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

Drought is observed to be a threat to the mesic habitat of *Phyllostegia floribunda* (Gregg 2018, pp. 109–112). 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. 4881–4900; Diaz *et al.*

2005, pp 1–3). 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. 221–226).

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):

Disease—Powdery mildew—Powdery mildew (*Neoerysiphe galeopsidis*) is a threat to *Phyllostegia floribunda* (Koko et al. 2018, 4 pp.; Zahn and Amend 2017, pp. 1–2; PEPP 2020). Powdery mildew grows as thin layers of mycelium (fungal tissue) on the surface of the affected plant parts appearing as white, powdery spots. This fungus causes leaves to turn chlorotic, necrotic, and to fall off (Davis et al. 2008, p. 2). Spores, which are the primary means of dispersal for the fungus, make up the bulk of the visible, white, powdery growth (Davis et al. 2008, p. 2). This fungal disease can impede growth or destroy wild and reintroduced populations of *P. floribunda*.

Ungulate predation and herbivory—Herbivory by feral pigs is noted to be a threat to *Phyllostegia floribunda* at all wild and most reintroduced populations at Kīpāhoehoe, Pu‘u Maka‘ala, and Waiākea Upper (DLNR 2002, pp. 8, 10; PEPP 2014, 2015). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

Slug herbivory—Slugs are suspected seedling predators (VanDeMark et al. 2010, in Pratt et al. 2011, p. 127). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

Predation and herbivory by invertebrates—Alien invertebrates (not identified) may damage foliage of *Phyllostegia floribunda* and are a potential threat (Pratt et al. 2011, pp. 3, 127).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

Lack of adequate hunting regulations—Wild and reintroduced populations of *Phyllostegia floribunda* occur in or adjacent to a State hunting area. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory. Only two individuals are fenced and habitat destruction and modification, and predation, by feral pigs have been noted as threats to the species. In addition, public hunting areas are not fenced and game

mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010).

Currently, four agencies are responsible for inspection of goods arriving in Hawai‘i (CGAPS 2009). The Hawai‘i Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawai‘i, especially insects or plant diseases. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations, focusing on non-propagative plant materials, and internationally regulated commercial species under the Convention in International Trade in Endangered Species (CITES). Also included are federally listed noxious seeds and plants, soil, and pests of concern for forests and agriculture. The U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ 2010) inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities (HDOA 2009). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 et seq.) and prosecutes CITES violations. The State of Hawai‘i allows the importation of most plant taxa, with limited exceptions. Many invasive plants established in Hawai‘i have expanding ranges. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established nonnative invasive plants is largely focused on a few invasive species that cause significant economic or environmental damage to public and private lands, and comprehensive control of an array of invasive plants remains limited in scope. The introduction of new invasive plant species to the State of Hawai‘i is a significant risk to *Phyllostegia floribunda* and other federally listed species.

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

Established invasive plant species competition—Competition by *Cyperus haspan*, *Delaria odorata*, *Ehrharta stipoides*, *Passiflora edulis*, *P. ligularis*, *P. tarminiana*, *Pennisetum clandestinum*, *Plantago major*, *Psidium cattleianum*, *P. guajava*, *Rubus argutus*, *R. ellipticus*, and *Setaria palmifolia* is reported to be a threat to *P. floribunda* (DLNR 2002, p. 8–10, 19; HBMP 2010).

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; Newman

and Pilson 1997). 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 floribunda*.

Koa logging—Koa logging and habitat disturbance associated with this activity on land adjacent to Kīpāhoehoe NAR may be a threat to *Phyllostegia floribunda* because there is no fencing or other demarcation of land ownership in the area (DLNR 2002, p. 9).

Current Management Actions:

- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) monitors outplanted individuals and surveys for wild individuals of *Phyllostegia floribunda* on the island of Hawai‘i (PEPP 2014, 2015, 2016, 2017, 2019)
- Ungulate control—
 - The Department of Land and Natural Resources (DLNR) fences and manages Kīpāhoehoe Natural Area Reserve (NAR) for control of feral ungulates (DLNR 2002, pp. 8, 10).
 - Hawai‘i Volcanoes National Park (HVNP) controls feral ungulates through fencing and removal (NPS 2016, p. 42).
- Captive propagation for genetic storage and reintroduction—
 - PEPP collects fruit and cuttings from all wild plants for propagation at the HVNP and the Volcano Rare Plant Facility (PEPP 2014, 2015, 2016, 2019).
 - The Lyon Arboretum Seed Conservation Laboratory reports collection of 215 seeds representing one founder; however, all seeds were used in testing (Lyon Arboretum 2019).
 - The Volcano Rare Plant Facility (VRPF) reports four plants in refugia representing two founders from Honomalino; three plants in refugia representing one founder from Kukuiopa‘e-Kīpāhoehoe NAR; seven plants in refugia representing four founders from Hawaii Volcanoes National Park; and four plants in refugia representing two founders from Tom’s Trail. In addition, 17 plants representing two founders from Tom’s Trail were sent for reintroduction to Kūlani and 10 plants representing one founder from Upper Waiākea FR were sent for reintroduction to Kūlani (VRPF 2019).
- Reintroduction and translocation—
 - PEPP summarizes current outplanting totals as 529 individuals at seven sites, with an unknown number of individuals at an eighth site (PEPP 2019). One individual out of 56 survives from a 2016

outplanting at Honomalino within a 4-hectare (10-acre) enclosure. Forty-seven individuals were reintroduced at Kiolaka‘a Cabin (year not provided). A large number of individuals have been outplanted at Kipāhoehoe NAR since 2001 and 88 currently remain. Ninety-five individuals were reintroduced at Manukā NAR in 2007 but current numbers are unknown; over 100 individuals representing two founders were outplanted at the ‘Akū Unit of Pu‘u Maka‘ala-‘Ōla‘a from 2006-2007; 27 were recently planted in 2019 into Kulani; and 100 individuals were outplanted at Wright Road (Waiākea Upper forest reserve) in 2006 and 2011 (PEPP 2014, 2015, 2016, 2019; VRPF 2019).

- HVNP reported outplanting of 258 individuals between 2002 and 2004 at the ‘Ōla‘a Koa and Small Tract units (National Park Service 2015, p. 465; Pratt *et al.* 2011, p. 127). When this outplanting was monitored in 2009, there was a 21 percent survival rate (Pratt *et al.* 2011, p. 127). Sites supporting this species in HVNP are within feral pig enclosures in Special Ecological Areas (SEA) in the ‘Ōla‘a Forest Ag Unit and the East Rift SEA. More than 170 plants were recently planted in the Koa Unit and Small Tract, and more than 20 percent persisted for four to six years (Pratt *et al.* 2011, p. 127). A more recent experimental planting of 75 seedlings failed in ‘Ōla‘a (VanDeMark *et al.* 2010 in Pratt *et al.* 2011, p. 127).
- Disease-Powdery mildew control research—Recently, researchers have experimented with inoculation of native species with probiotic fungal cultures and have found them to protect other *Phyllostegia* species individuals at some reintroduction sites (Zahn and Amend 2017, p. 1).

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

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	<100	>400	All threats managed in all 3 populations	Partially, ungulate control ongoing
			Complete genetic storage	Yes
			3 populations with 50 mature individuals each	Partially, 2 reintroduced populations >50, no recruitment observed

2020 (5-year review)	9	ca 120 (>500 planted)	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

Table 2. Threats to *Phyllostegia floribunda* 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
Climate change degradation or loss of habitat, including hurricanes and drought	A	Ongoing	None
Disease—Powdery mildew	C	Potential	Partial, control research ongoing
Predation and herbivory by feral ungulates	C	Ongoing	None
Herbivory by slugs and other invertebrates	C	Ongoing	None
Competition with invasive plant species	E	Ongoing	Partial, nonnative plant control at HVNP
Reduced viability due to low numbers	E	Ongoing	Partial, seed and cuttings collection, propagation, and reintroduction ongoing; however no natural recruitment observed
Koa logging	E	Potential	None

2.4 Synthesis

There are four wild individuals of *Phyllostegia floribunda* on the island of Hawai‘i. 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. floribunda* is vulnerable to the effects of climate change. Genetic representation in collections and storage is complete. Collection, propagation, and reintroduction are ongoing. More than 500 individuals representing at least 12 founders were reintroduced since 2012, though survivorship is low. Two 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 the island of Hawai‘i where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings) with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There are only four plants in three populations and no known regeneration at outplantings. It is assumed that these populations are recruiting, but currently there are no reports of direct observations of recruitment. Genetic representation is complete (Table 1); however, not all threats are being sufficiently managed throughout the range of the species (Table 2). Therefore, *Phyllostegia floribunda* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist

Extinction

Recovery

Original data for classification in error

No change is needed

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number: _____

Reclassification (from Endangered to Threatened) Priority Number: _____

Delisting (regardless of current classification) Priority Number: _____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Surveys and inventories—Continue to search suitable habitat for individuals of *Phyllostegia floribunda* in recent and historical locations.
- Ungulate monitoring and control—Continue to construct and maintain fenced enclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *P. floribunda* at all populations.
- Disease control—Develop and implement effective controls for powdery mildew.
- Predation and herbivory by rats and invertebrates—Implement effective control measures for rats and slugs at all populations. Determine the extent of nonnative insect damage to plants, and research and implement effective control methods if necessary.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings 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.
- 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 floribunda*
(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: _____

Review Conducted By:

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Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
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FIELD OFFICE APPROVAL:

for _____
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