Cyrtandra kaulantha
(haʻiwale)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaiʻi

5-YEAR REVIEW

Species reviewed: *Cyrtandra kaulantha* (haʻiwale)

TABLE OF CONTENTS

1.0 GENERAL INFORMATION 3
1.1 Reviewers: 3
1.2 Methodology used to complete the review: 3
1.3 Background: 3
2.0 REVIEW ANALYSIS 4
2.1 Application of the 1996 Distinct Population Segment (DPS) policy 4
2.2 Recovery Criteria 5
2.3 Updated Information and Current Species Status 8
2.4 Synthesis 13
3.0 RESULTS 14
3.1 Recommended Classification: 14
3.2 New Recovery Priority Number: 14
3.3 Listing and Reclassification Priority Number: 14
4.0 RECOMMENDATIONS FOR FUTURE ACTIONS 14
5.0 REFERENCES 15

5-YEAR REVIEW
Cyrtandra kaulantha (ha‘iwale)

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:
Region 1, Endangered Species Program, Division of Recovery, (503) 231–6868

Lead Field Office:
Pacific Islands Fish and Wildlife Office, (808) 792–9400

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 (USFWS), beginning in October 2018. 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on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 completed by 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. 2017. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 138 species in Hawaii, Oregon, Washington, and California. Federal Register 82(75): 18665–18668, April 20, 2017.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; Endangered status for 23 species on Oahu and

designation of critical habitat for 124 species; final rule. Department of the Interior, Federal Register 77 (181): 57648–57862, September 18, 2012.

Date listed: September 18, 2012
Entity listed: *Cyrtandra kaulantha*
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 this species. *Cyrtandra kaulantha* is a shrub that was listed as endangered on September 18, 2012. Critical habitat was designated on O‘ahu for *C. kaulantha* at the same time, totaling 14 units in the lowland wet and wet cliff ecosystems (30,058 ac, 12,162 ha) (77 FR 57648). The draft recovery plan for this species is in preparation.

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 O‘ahu
Date issued: July 2018
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 USFWS 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 USFWS 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.

Cyrtandra kaulantha is a short-lived perennial shrub. 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 *ex situ* (secured off-site, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on O‘ahu where they now occur or occurred historically. Each of these populations must be naturally reproducing (*i.e*., viable seeds, seedlings, saplings) and increasing in number, 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 *Cyrtandra kaulantha*, 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). 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:
Little is known about the life history of *Cyrtandra kaulantha*. Its flowering cycles, pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors are unknown.

Cyrtandra kaulantha, a member of the African violet family (Gesneriaceae), is a shrub with several 3- to 10-feet (ft) (l to 3 meters (m)) long stems arising from a horizontal stem. The opposite leaves (with each succeeding pair set at right angles to the previous pair) are clustered on the upper 3 to 6 nodes. Leaves are fleshy, drying to thin and chartaceous (papery) and are oblanceolate (broadest point above the middle and tapering to the base) to elliptic-oblanceolate, 12 to 24 in (30 to 60 cm) long, 5 to 9.4 in (12 to 24 cm) wide. The upper surface is sparsely pilose (with long straight hairs) along veins and with a few scattered hairs over surface, and the lower surface hairs are sparsely appressed (pressed flat) short-pilose. Leaf margins are serrulate (small toothed), tapering gradually to attach directly to the base. Flowers are 7 to 30 in dense compound cymes (terminal flower blooms first) arising on lower one third of the erect stems, usually at the stem base, and are moderately appressed dark brown pilose throughout. The flower corolla is white, with a narrowly funnelform tube, curved, 0.7 to 0. 9 in (l7 to 22 mm) long, about 0.15 in (4 mm) in diameter medially, glabrous externally and hairy within. Berries are white, ovoid-ellipsoid to oblong-ellipsoid, 0.5 to 0.7 in (1.4 to 1.8 cm) long (Wagner *et al.* 1999).

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, *Cyrtandra kaulantha* was found in the Koʻolau mountains of Oʻahu in the Waiāhole and Waikāne Valleys, and as far south as Kahanahāiki stream in Kailua (Wagner *et al.* 1999; Hawaii Biodiversity and Mapping Program (HBMP) 2010). Takeuchi observed hundreds of plants in Waikāne in 1985 (Takeuchi 1985). In 2011, there were only five occurrences known in Manuwai and Waianu Valley, totaling about 30 individuals (77 FR 57648, September 18, 2012; Plant Extinction Prevention Program (PEPP) 2011). Currently, there are 16 mature and 6 immature *C. kaulantha* in Waianu Valley (PEPP 2019, 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:
In 1950, diagnoses of new *Cyrtandra* species by St. John and Storey included data for the type specimen of *C. kaulantha* from Waikāne Valley. Several morphologic features, including the extremely large opposite leaves, basal inflorescences, short calyx lobes, and glandular puberulent berries, distinguish this species from other *Cyrtandra* species. *Cyrtandra kaulantha* grows sympatrically with *C. hawaiensis*, *C. calpidicarpa*, *C. laxiflora*, and *C. propinqua*, and, although it is possible that some populations are hybrids, the plants occurred in such large numbers and often with only one putative parent; and so are treated as a species in Wagner *et al.* 1999. There are also several collections representing putative hybrids between *Cyrtandra kaulantha* and *C. laxiflora* and *C. hawaiensis* (Wagner *et al*. 1999). A new monograph for the Hawaiian *Cyrtandra* is in preparation and may provide further information about this species (Wagner 2018, in litt.). Planned genetic studies may also provide more detailed taxonomic information about Hawaiian *Cyrtandra* including this species (Roalson 2018, in litt.).

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):
Typical habitat for this species includes wet gulch bottoms, streambeds, and talus slopes in wet to mesic valleys at 787 to 1,050 ft (240 to 320 m) elevation in the Koʻolau mountains of Oʻahu (Wagner *et al.* 1999). The dominant forest species are *Urera glabra* (ōpuhe), *Touchardia latifolia*

(olonā), *Pisonia umbellifera* (pāpala kēpau), *Piper methysticum* (ʻawa), *Cyclosorus cyatheoides* (kikawaiō), and other *Cyrtandra* species (Takeuchi 1985).

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 degradation of habitat—Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs (*Sus scrofa*) and evidence of their activities are evident in both Waianu and Waikāne valleys (PEPP 2010, 2011, 2012).

Degradation of habitat by established ecosystem-altering invasive plant species—Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive nonnative plants negatively affects all habitat of *Cyrtandra kaulantha* (Takeuchi 1985; HBMP 2010; PEPP 2011, 2015). Nonnative plants with the greatest impacts include *Ardisia elliptica* (shoebutton ardisia), *Clidemia hirta* (Koster's curse), *Heliocarpus popayanensis* (moho), *Lantana camara* (lantana), *Oplismenus hirtellus* (basketgrass), *Passiflora* sp. (passion fruit), *Psidium cattleianum* (strawberry guava), and *Syzygium malaccense* (mountain apple) (Takeuchi 1985; HBMP 2010; PEPP 2011, 2015).

Landslides, erosion, and flooding destruction or degradation of habitat—Landslides are a threat to *Cyrtandra kaulantha* as this species occurs on rocky, talus slopes and along streambeds (PEPP 2010, 2011, 2012, 2015). Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations by destabilizing substrate, altering hydrological patterns, and by damaging and destroying individual plants (PEPP 2011, 2012; Stearns 1985).

Climate change loss or degradation of habitat—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 *Cyrtandra kaulantha* is extremely vulnerable to the impacts of climate

change with a vulnerability score of 0.894 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future.

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):
Slug predation and herbivory—Herbivory by slugs on *Cyrtandra kaulantha* is observed at Waianu (PEPP 2010). Slugs destroy species of *Cyrtandra* in the wild by eating fleshy stems, fruit and leaves (Joe 2006).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):
Not a threat.

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

Hybridization—Lammers discusses the possible hybridization between *Cyrtandra hawaiensis* and *C. laxiflora* to create *C. kaulantha* (Lammers in Wagner *et al.* 1999). At that time, the species occurred in large enough numbers and often with only one putative parent that it was continued to be treated as a valid species. The combination of *C. kaulantha* and *C laxiflora* has not been verified. In addition, possible hybridization of *C. kaulantha* and *C. hawaiensis* was observed in 1994 (HBMP 2010).

Stochastic events—Reduced viability due to low numbers—Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997).

Current Management Actions:

- Surveys and monitoring—PEPP regularly monitors occurrences of *Cyrtandra kaulantha* (PEPP 2010, 2011, 2012, 2015, 2016, 2017).
- Ungulate monitoring and control—At least three wild subpopulations are fenced to protect *Cyrtandra kaulantha* from the activities of feral pigs (PEPP 2010).

- Invasive plant monitoring and control—PEPP conducts nonnative plant removal efforts at three locations (PEPP 2011, 2015).
- Captive propagation for genetic storage and reintroduction—
    - Lyon Arboretum Micropropagation Laboratory reports over 400 explants in micropropagation representing seven founders at Waianu, one founder at Waikāne, and one founder at Manuwai. The Lyon Arboretum Seed Conservation Laboratory reports over 147,000 seeds in storage representing 13 individuals from Waianu and one individual from Waikāne (Lyon Arboretum 2018, in litt.).
    - The Pahole Rare Plant Facility reports propagation of 109 individuals representing 15 plants at Waianu; 38 individuals representing one plant at Waikāne, and 5 individuals representing one plant at Manuwai (Pahole Rare Plant Facility 2018, in litt.).
- Reintroduction and translocation—
    - PEPP reports outplanting 16 individuals at Waianu (currently four remain), 50 individuals at a second site in Waianu (currently about 12 remain), 20 individuals at Manuwai (currently five remain), 53 individuals at Waikāne (current status not reported), and 25 individuals at Kīpapa (PEPP 2010, 2011, 2012, 2017)

Table 1. Status and trends of *Cyrtandra kaulantha* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2012 (listing and critical habitat)	28	31	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 50 mature individuals each	No
2019 (5-year review)	16–22	46	All threats managed in all three populations	No
			Complete genetic storage	Complete
			Three populations with 50 mature individuals each	No

Table 2. Threats to *Cyrtandra kaulantha* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, at least two occurrences are fenced
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	Partial, nonnative plant control at outplanting sites
Landslides destruction or degradation of habitat	A	Ongoing	None
Climate change degradation or loss of habitat	A	Ongoing	None
Invertebrate predation or herbivory	C	Ongoing	None
Hybridization	E	Ongoing	Nonw
Stochastic events– Reduced viability due to low numbers	E	Ongoing	Partial, seed collection, propagation, and outplanting ongoing

2.4 Synthesis

There are 16 mature and 6 immature wild individuals of *Cyrtandra kaulantha*. 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 *C. kaulantha* is extremely vulnerable to the effects of climate change, and that there is no overlapping future climate envelope for the species. There are seeds and propagules in collections. Outplanting is ongoing. A new monograph of the Hawaiian *Cyrtandra* is in preparation, along with planned genetic studies.

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 O‘ahu 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 as, although there is complete genetic representation, the number of wild individuals continues

to decline (Table 1), and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Cyrtandra kaulantha* 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 *Cyrtandra kaulantha* 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. kaulantha*.
- Landslides—Continue to fence and control feral ungulates to prevent erosion leading to landslides. Possibly relocate or augment populations outside of the possible range of landslide events.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Invertebrate predation or herbivory—Implement effective control methods for slugs.

- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock.
- Hybridization—
  - Assess genetic variability within the extant population and evaluate the risk posed by possible hybridization with other *Cyrtandra* species.
  - Collect cuttings and seeds from tagged individuals keeping close track of the maternal source for used in *ex situ* propagation.
- Stochastic events—Build resiliency and redundancy—Continue to reintroduce individuals into protected suitable habitat to increase numbers of individuals and reduce effects of low genetic variation.
- Alliance and partnership development—Continue to plan and contribute to implementation of ecosystem-level restoration and management to benefit this taxon.

5.0 REFERENCES

Barrett, S.C.H. and J.R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants–implications for conservation. *In* Genetics and Conservation of Rare Plants, D.A. Falk and K.E. Holsinger (eds.), Oxford University Press, New York and Oxford, Pp. 3–30.

Cuddihy, L.W. and C. P. Stone 1990. Alteration of native Hawaiian vegetation: effects of humans, their activities and introductions, Cooperative National Park Resources Studies Unit, University of Hawaii, Honolulu. 138 pp.

Fortini, L., J. Price, J. Jacobi, A. Vorsino, J. Burgett, K. Brinck, F. Amidon, S. Miller, S. Gon II, G. Koob, and E. Paxton. 2013. A landscape-based assessment of climate change vulnerability for all native Hawaiian plants. Technical report HCSU-044. Hawai‘i Cooperative Studies Unit, University of Hawai‘i at Hilo, Hawai‘i. 134 pp.

Guerrant, E.O., K. Havens, and M. Maunder. 2004. *Ex Situ* Plant Conservation: Supporting Species Survival in the Wild. Island Press, Washington, D.C. 504 pp.

[HBMP] Hawai‘i Biodiversity and Mapping Program. 2010. Plant species GIS data and Access database.

[HPPRCC] Hawai‘i and Pacific Plants Recovery Coordinating Committee. 2011. Revised recovery objective guidelines. 8 pp.

Joe, S.M. 2006. Impact of alien slugs on native plant seedlings in a diverse mesic forest, Oahu, Hawaii, and a study of slug food plant preferences. Thesis for Master of Science, Department of Botany-Ecology, Evolution, and Conservation Biology, University of Hawaii at Manoa, Honolulu. 95 pp.

Lyon Arboretum. 2018, in litt. Report on controlled propagation of listed species, as designated under the U.S. Endangered Species Act. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

Loope, L. 1998. Hawaii and the Pacific islands. *n* Status and Trends of the Nation's Biological Resources, Volume 2. Pp. 747–774.

Newman, D. and D. Pilson. 1997. Increased probability of extinction due to decreased genetic effective population size: experimental populations of *Clarkia pulchella*. Evolution 51: 354–362.

Pahole Rare Plant Facility. 2018, in litt. Report on controlled propagation of listed species, as designated under the U.S. Endangered Species Act. Unpublished report submitted to the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

[PEPP] Plant Extinction Prevention Program. 2010. PEPP annual report fiscal year 2010 (July 1, 2009-June 30, 2010). 121 pp.

[PEPP] 2011. PEPP annual report fiscal year 2011 (July 1, 2010-June 30, 2011). 200 pp.

[PEPP] 2012. PEPP annual report fiscal year 2012 (July 1, 2011-June 30, 2012). 169 pp.

[PEPP] 2015. PEPP annual report fiscal year 2015 (July 1, 2014-June 30, 2015). 179 pp.

[PEPP] 2016. Plant Extinction Prevention Program FY 2016 Annual Report (Oct 1, 2015-Sep 30, 2016), US FWS CFDA Program #15.657; Endangered Species Conservation-Recovery Implementation Funds, Coop Agreement F14AC00174, December 24, 2016, UH Manoa, PCSU, PEPP. 237 pp.

[PEPP] 2017. Plant Extinction Prevention Program FY 2017 annual report (Oct 1, 2016-Sep 30, 2017), US FWS CFDA program #15.657; Endangered species conservation-recovery implementation funds, Cooperative Agreement F14AC00174, December 12, 2017, UH Manoa, PCSU, PEPP. 235 pp.

[PEPP] 2019, in litt. Plant Extinction Prevention Program FY 2019 annual report to the U.S. Fish and Wildlife Service, database summary.

Roalson, E. 2018, in litt., Email to USFWS regarding current taxonomic status of *Cyrtandra* species, 30 OCT 2018.

Stearns, H.T. 1985. Chapter 4, Geology, and Chapter 15 Water. *In* Geology of the State of Hawaii, 2nd edition, Pacific Books, Palo Alto. Pp. 99–107, 291–305.

St. John, H. and W.B. Storey. 1950. Diagnoses of new species of *Cyrtandra*

(Gesneriaceae) from Oahu, Hawaiian Islands. Hawaiian Plant Studies 20. Pp. 77–88.

Takeuchi, W.N. 1985. Voucher notes for *Cyrtandra kaulantha*. Bishop Museum Herbarium.

[USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; Endangered status for 23 species on Oahu and designation of critical habitat for 124 species; final rule. Department of the Interior, Federal Register 77 (181): 57648–57862, September 18, 2012.

[USFWS] 2017. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 138 species in Hawaii, Oregon, Washington, and California. Federal Register 82(75): 18665–18668, April 20, 2017.

[USFWS] 2018. Recovery outline for the island of O‘ahu. 42 pp.

van Riper, S.G. and C. van Riper. 1982. Pig, Pacific rat, goat, cattle, black-tailed deer, axis deer, Norway rat, and roof rat. *In* A Field Guide to the Mammals in Hawaii, The Oriental Publishing Company, Honolulu. Pp. 24-27, 34-37, 42-45, 56-59.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawaii. University of Hawaii Press and Bishop Museum Press, Honolulu. Bishop Museum Special Publication 97. 1,919 pp.

Wagner, W. 2018, in litt., Email to USFWS and Roalson regarding the current taxonomic status of *Cyrtandra* species, 6 NOV 2018.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Cyrtandra kaulantha*
(haʻiwale)

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:

for MEGAN LAUT Digitally signed by MEGAN LAUT Date: 2019.08.30 08:00:40 -10'00'

_____

Field Supervisor, Pacific Islands Fish and Wildlife Office