5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Cyperus pennatiformis* (no common name)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Lead Region/Field Office:

Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

Name of Reviewer:

Cheryl Phillipson Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation & Restoration Team Manager, PIFWO

Methodology used to complete this 5-year review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office (PIFWO) of the U.S. Fish and Wildlife Service (Service) beginning in October 2020. The review was based on a review of current, available information since the last 5-year review for *Cyperus pennatiformis* (USFWS 2013). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

Background:

For information regarding the species' listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (*http://ecos.fws.gov/tess_public*).

Review Analysis:

Please refer to the previous 5-year reviews for *Cyperus pennatiformis* (as *Mariscus pennatiformis*) in the Federal Register on August 27, 2010 and July 30, 2013 (available at *https://ecos.fws.gov/docs/tess/species_nonpublish/1637.pdf* and *https://ecos.fws.gov/docs/tess/species_nonpublish/2065.pdf*) for a complete review of the species' status, threats, management efforts, and references cited. We are not aware of any significant new information regarding the species' biological status since listing to warrant a change in the Federal listing status of *C. pennatiformis*.

This short-lived perennial sedge in the Cyperaceae (sedge) family is endangered. There are two varieties: var. *pennatiformis*, endemic to the islands of Kaua‘i, O‘ahu, Maui, and Hawai‘i; and var. *bryanii*, endemic to Laysan Island (Kamole) in the Northwest Hawaiian Islands. The status and trends for *Cyperus pennatiformis* are provided in the tables below.

New Status Information:

- In 2012, critical habitat was designated for *Cyperus pennatiformis* var. *pennatiformis* on Oʻahu in three units in the lowland mesic ecosystem (2,373 hectares [ha], 5,864 acres [ac]) (77 FR 57648, September 18, 2012). In 2016, critical habitat was designated for *C. pennatiformis* var. *pennatiformis* on Maui in eight units in the coastal ecosystem (419 ha, 1,032 ac). (77 FR 34464, June 11, 2012; 81 FR 17790, March 30, 2016). Critical habitat as designated in 2003 on Laysan (for var. *bryanii*) and Kauaʻi (for var. *pennatiformis*) remains the same.
- In 2012, when critical habitat was designated for 124 species on Oʻahu, we addressed the change in taxonomy for *Mariscus pennatiformis* (77 FR 57648, September 18, 2012). We followed the taxonomic treatment of Strong and Wagner (1997, p. 39) and the accepted change in Wagner and Herbst (2003, pp. 52–53), who moved all the Hawaiian *Mariscus* to *Cyperus*, and changed the subspecies to varieties. The currently accepted taxonomy is *Cyperus pennatiformis* var. *pennatiformis* for plants on Maui and *C. pennatiformis* var. *bryanii* for plants on Laysan.
- Currently, on Maui, there are two wild populations of *C. pennatiformis* var. *pennatiformis* at Paʻakea-Waiohue and at the mouth of the Hanawī stream (PEPP 2013, 2014; Department of Land and Natural Resources-Division of Forestry and Wildlife [DLNR-DOFAW] 2019). In 2013, at Paʻakea there were estimated to be 118 mature and 50 immature plants (PEPP 2021). In 2018, there were five to eight wild individuals at Hanawī stream. Starr and Starr (2013, pp. 10, 12, 20, 32) reported that *Cyperus pennatiformis* var. *bryanii* was still present along the margin of the lagoon and scattered (but not common) elsewhere on Laysan, and this distribution was confirmed in 2018 (Kwon 2021, pers. comm.). These occurrences may contain reintroductions and total approximately 100 individuals.

New Threats:

- Drought, erosion, and treefall (associated with erosion and landslides) are observed to be threats to the occurrences at Paʻakea-Waiohue, Hanawī stream, and to the *inter situ* populations at Honomaʻele on Maui (PEPP 2013, 2014, 2015).
- Ungulate destruction and degradation of habitat is noted to be a threat to populations of *Cyperus pennatiformis* var. *pennatiformis* at Honomaʻele, Hanawī, and Paʻakea-Waiohue (PEPP 2019).
- Rat predation and herbivory is reported to be a threat to inter situ populations at Honomaʻele, Maui (PEPP 2019).
- Tsunamis are an additional threat to the individuals at Paʻakea-Waiohue on Maui (PEPP 2014, 2021). Tsunamis can destroy and modify habitat for species in Papahānaumokuākea (Northwest Hawaiian Islands) and in low-lying coastal areas of the main islands of Hawaiʻi. Major tsunamis occur worldwide about once every 10 years, on average, and almost 60 percent of those occur in the Pacific Ocean (Pacific Tsunami Warning Center 2016). In 2011, a tsunami swept over Kuaihelani's (Midway's) Eastern Island and Hōlanikū's (Kure's) Green Island, inundating individuals of an endangered plant, *Solanum nelsonii*, spreading plastic debris, destroying seabird nesting areas, and reaching about 150 m (500 ft)

inland (Division of Forestry and Wildlife [DOFAW] 2011, in litt.; Starr 2011, in litt.; USFWS 2011, in litt.). This threat could occur at any time and negatively affect occurrences and habitat of both varieties of *Cyperus pennatiformis* on Laysan Island and at low elevation coastal sites on Maui.

- 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 *Cyperus pennatiformis* is vulnerable to the impacts of climate change with a vulnerability score of 0.31 (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.
- Plants at Pa‘akea (Maui) remain unmarked because of the likelihood of disturbance by human visitation (PEPP 2014).

New Management Actions:

- Surveys and inventories—
    - PEPP continues to survey and monitor populations at Pa‘akea-Waiohue, Hanawī stream, and Honoma‘ele on Maui (PEPP 2013, 2014, 2015, 2016).
    - Starr and Starr conducted a botanical survey of Laysan in 2013. U.S. Fish and Wildlife staff monitored populations on Laysan in 2018 (Kwon 2021, pers. comm.)
- Invasive nonnative plant control—Starr and Starr (2013, p. 5) reported that nonnative plant control is ongoing on Laysan.
- Collection and propagation—
    - Lyon Arboretum Seed Conservation Laboratory reported more than 440,000 seeds in storage representing more than 12 founders (var. *pennatiformis*) from Waiohue and Hanawī stream and more than 13,000 seeds in storage representing founders (var. *bryanii*) from Laysan (Lyon Arboretum 2020).
    - PEPP reported collection of seeds representing founders at Hanawī stream (PEPP 2013).
    - The Maui Nui Botanical Garden (MNBG) maintained five plants between 2012 to 2016 as a seed source. In 2019, the wild individuals at Pa‘akea and Hanawī stream were represented by eight plants and hundreds of seeds in storage (MNBG 2019, 2020).
    - The National Tropical Botanical Garden (NTBG) reported more than 7,000 seeds in storage representing one living collection from a founder of *C. pennatiformis* var. *bryanii* at Laysan in 2007 (NTBG 2020). NTBG also maintains living collections of *C. pennatiformis* var. *pennatiformis* at their Southshore (Kaua‘i) and Kahanu Gardens (Maui) (76 individuals) and has collected and stored 2,439 seeds from these individuals for storage (NTBG 2020).
- Reintroduction—

- In 2019, the Olinda Rare Plant Facility (ORPF) propagated eight plants representing two founders from Hanawī stream and 31 plants representing three plants from Waiohue for reintroduction. In 2020, ORPF propagated four plants representing two founders from Waiohue for reintroduction (ORPF 2020).
- In 2016, PEPP reported reintroduction of eight plants (sourced from Hanawī) to Pa‘akea. In 2014, PEPP established a new site for an *inter situ* population at Honoma‘ele (Kahanu Gardens), planting 155 individuals at four sites (PEPP 2015). By 2016, only 24 plants remained at Honoma‘ele and four plants remained at Hanawī (PEPP 2016).
- Starr and Starr (2013, pp. 5, 13) reported that *Cyperus pennatiformis* var. *bryanii* has been propagated and outplanted on Laysan.

Table 1. Status and trends of *Cyperus pennatiformis* from listing through current 5-year review.

Date	No. wild individuals	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1994 (listing)	ca 30 ssp. *bryanii* (Laysan)	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1999 (recovery plan)	ca 200 ssp. *bryanii* (Laysan)	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	0 ssp. *pennatiformis* (Kaua‘i, O‘ahu, Hawai‘i); ca 30 ssp. *pennatiformis* (Maui); ca 200 ssp. *bryanii* (Laysan)	0	All threats managed in all 3 populations	Partially

			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2010 (5-year review)	unknown ssp. *pennatiformis* (Kaua‘i) 0 ssp. *pennatiformis* (O‘ahu) ca 30 ssp. *pennatiformis* (Maui) <244 ssp. *bryanii* (Laysan)	900+ ssp. *bryanii* (Laysan)	All threats managed in all 3 populations	Partially, spp. *bryanii*
			Complete genetic storage	Partially, spp. *bryanii*
			3 populations with 50 mature individuals each	Unknown
2012 (critical habitat, O‘ahu)	0 var. *pennatiformis* (O‘ahu)	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2013 (5-year review)	20 + var. *pennatiformis* (Maui) 962 var. *bryanii* (Laysan)	290 var. *bryanii* (Laysan) with >900 surviving from previous reintroductions	All threats managed in all 3 populations	Partially, var. *bryanii*
			Complete genetic storage	Partially, for both varieties
			3 populations with 50 mature individuals each	Partially, var. *bryanii*
2016 (critical habitat, Maui Nui)	unknown var. *pennatiformis* (Maui)	155 at Honoma‘ele, Kahanu Gardens, Maui	All threats managed in all 3 populations	Partially, some nonnative plant control on Maui

			Complete genetic storage	Partially, for both varieties
			3 populations with 50 mature individuals each	Partially, var. *bryanii*
Date	**No. wild individuals**	**No. outplanted**	***Preventing Extinction Criteria identified by HPPRCC**	***Preventing Extinction Criteria Completed?**
2021 (5-year review)	123–126 mature, ca 50 immature var. *pennatiformis* (Maui) ca 100 var. *bryanii* (Laysan)	>200, ca 75 var. *pennatiformis* remain (Maui) unknown # var. *bryanii* (Laysan)	All threats managed in all 3 populations	Partially, some nonnative plant control at Hanawī stream, Honomaʻele, and Laysan
			Complete genetic storage	Partially
			Natural reproduction at all 3 populations	None reported
			3 populations with 50 mature individuals each	Partially, 1 population for each variety

* The Preventing Extinction Stage was established in 2011. Prior to 2011, the Interim Stabilization Stage was the first stage towards recovery (now it is the second stage after Preventing Extinction).

Table 2. Threats to *Cyperus pennatiformis* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Degradation and destruction of habitat by feral ungulates	A	Ongoing	None
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, nonnative plant control at occurrences on Maui and Laysan
Landslides and drought destruction and degradation	A	Ongoing	Partial, some reintroduction efforts

of habitat—with associated erosion and treefall			
Predation and herbivory by rats and Laysan finch	C	Ongoing	None
Predation and herbivory by nonnative invertebrates—mealybugs, aphids, ants, and slugs	C	Ongoing	None
Stochastic events—tsunami	E	Ongoing	Partial, some reintroduction efforts
Human disturbance	E	Ongoing	Partial, plants not marked
Climate change degradation or loss of habitat	E	Ongoing	Partial, some reintroduction efforts

Synthesis:
Currently there are approximately 126 mature and 50 immature wild individuals of *Cyperus pennatiformis* var. *pennatiformis* on Maui. On Laysan Island, there are approximately 100 individuals of *C. pennatiformis* var. *bryanii* along the inland lagoon and scattered elsewhere on the island. The occurrences on Laysan were likely augmented by previous outplanting efforts. Nonnative plant control is ongoing at the Maui and Laysan occurrences. Seeds and propagules are in storage representing more than 50 founders. Propagation is ongoing and more than 200 plants have been outplanted since the last 5-year review, with approximately 75 remaining.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for the Multi-Island Plants (USFWS 1999) and have been updated according to the draft revised recovery objective guidelines developed by the Hawai‘i and Pacific Plants Recovery Coordinating Committee (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.

Cyperus pennatiformis is a short-lived perennial sedge. 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 of each variety should be documented 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 approximately 100 individuals of one variety, *Cyperus pennatiformis* var. *bryanii*, in one population on Laysan Island in the Northwest Hawaiian Islands. There are two small populations of the variety *pennatiformis* on east Maui, totaling 123 to 126 wild mature and 50 immature plants, but only one f them have over 50 mature individuals. The populations from the islands of Kaua‘i, O‘ahu, and Hawai‘i are possibly extirpated. Two populations on Maui have been augmented and a new *inter situ* population (at four sites) has been established; however, no recruitment has been reported (Table 1). Additional threats have been noted since the last 5-year review including predation by rats and possible inundation and extirpation by tsunami (Table 2). Therefore, *Cyperus pennatiformis* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
Predation and herbivory by rats and inundation and extirpation by tsunami are new threats; however, we are not aware of any other significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2021.

- Surveys and inventories—Continue to survey geographical and historical range for a current assessment of the species' status, especially in areas where the taxon was recently extirpated.
- Ungulate monitoring and control—Construct ungulate exclosures or strategic fencing where possible to protect all occurrences on Maui.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species at all occurrences.
- Rat control—Implement effective rat control methods at populations when necessary.
- Nonnative invertebrate control—Develop and implement effective control methods for slugs, ants, aphids, and mealybugs.
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction.
- Reintroduction and translocation—Continue reintroductions into suitable habitat within historical range to increase numbers of populations and individuals to build resiliency and redundancy and reduce the impacts of landslides, drought, erosion, tsunamis, and climate change.
- Humans interaction monitoring and management—Develop and implement effective measures to reduce the impact of hiking and collecting.
- Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon.

References:

[DLNR-DOFAW] Department of Land and Natural Resources-Division of Forestry and Wildlife. 2019. DLNR-DOFAW Rare Plant Program Rare plant program Section

6 interim performance report, grant number: F16AF00882, July 1, 2018-June 30, 2019. 192 pp.

[DOFAW] Division of Forestry and Wildlife. 2011, in litt., Kure Atoll State Wildlife Sanctuary field camp update, 11 MAR 2011.

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, Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Hawai‘i. 134 pp.

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

Lyon Arboretum 2020. 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, Hawai‘i.

[MNBG] Maui Nui Botanical Garden. 2019. 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, Hawai‘i.

[MNBG] Maui Nui Botanical Garden. 2020. 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, Hawai‘i.

[NTBG] National Tropical Botanical Garden. 2020. 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, Hawai‘i.

[ORPF] Olinda Rare Plant Facility. 2020. 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, Hawai‘i.

Pacific Tsunami Warning Center. 2016. Frequently asked questions about tsunamis. NOAA National Weather Service. 5 pp.

[PEPP] Plant Extinction Prevention Program. 2013. PEPP annual report fiscal year 2013 (July 1, 2012-June 30, 2013). 207 pp.

[PEPP] 2014. PEPP annual report fiscal year 2014 (July 1, 2013-June 30, 2014). 185 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] 2021. Plant Extinction Prevention Program, interim reports for 2020. Excel table.

Starr, F. 2011, in litt., Email regarding the effects of the 2011 tsunami on plants of Midway, 19 MAR 2011.

Starr, F. and K. Starr. 2013. Botanical survey of Laysan Island, Hawaiian Islands National Wildlife Refuge. Prepared for U.S. Fish and Wildlife Service. 60 pp.

Strong, M.T. and W.L. Wagner. 1997. Records of the Hawaii biological survey for 1996. New and noteworthy Cyperaceae from the Hawaiian Islands. Bishop Museum Occasional Papers 48: 37–50.

[USFWS] U.S. Fish and Wildlife Service. 1999. Recovery plan for the multi-island plants. Portland, OR. 206 pp. + appendices.

[USFWS] 2010. *Mariscus pennatiformis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/tess/species_nonpublish/1637.pdf.*

[USFWS] 2011, in litt., Midway Atoll National Wildlife Refuge, Tsunami 2011. *http://www.fws.gov/midway/tsunami.html*.

[USFWS] 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, 77(181) FR 57648–57862, September 18, 2012.

[USFWS] 2013. *Mariscus pennatiformis* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/tess/species_nonpublish/2065.pdf.*

[USFWS] 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 species. Department of the Interior. 81 FR 17790–18110, March 30, 2016.

[USFWS] 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

Wagner, W.L. and D.R. Herbst. 2003. Supplement to the *Manual of the Flowering Plants of Hawai'i*. Version 3.1. 77 pp.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Cyperus pennatiformis*
(no common name)

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year review:

_____ Delisting
_____ Reclassify from Endangered to Threatened status
_____ Reclassify from Threatened to Endangered status
__X__ No Change in listing status

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

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