

5-YEAR REVIEW

Short Form Summary

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

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 70 species in Idaho, Montana, Oregon, Washington, and the Pacific Islands. Federal Register 73(83):23264-23266.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

Name of Reviewer(s):

Marie Bruegmann, Pacific Islands Fish and Wildlife Office, Plant Recovery Coordinator
Marilet A. Zablan, Pacific Islands Fish and Wildlife Office, Assistant Field Supervisor for Endangered Species

Jeff Newman, Pacific Islands Fish and Wildlife Office, Acting Deputy Field Supervisor

Methodology used to complete this 5-year 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 on April 29, 2008. The review was based on the proposed rule and final critical habitat designation for *Mariscus pennatiformis* and other species from the islands of Maui, Kahoolawe, Oahu, Northwestern Hawaiian Islands, Kauai, and Niihau (USFWS 2003a,b,c,d), as well as a review of current, available information. The National Tropical Botanical Garden provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Tamara Sherrill, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Assistant Field Supervisor for Endangered Species and Acting Deputy Field Supervisor before submission to the Field Supervisor for approval.

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).

Application of the 1996 Distinct Population Segment (DPS) Policy:

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designations for *Mariscus pennatiformis* published in the Federal Register on February 27, May 14, May 22, and June 17, 2003 (USFWS 2003a,b,c, d) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats or no significant new information

regarding the species' biological status have come to light since listing to warrant a change in the Federal listing status of *M. pennatiformis*.

Historically, *Mariscus pennatiformis* was known from Kauai, Oahu, East Maui, the island of Hawaii, and from Laysan in the Northwestern Hawaiian Islands (Wagner and Herbst 2009). Two subspecies are recognized: *Mariscus pennatiformis* ssp. *pennatiformis*, most recently found only on East Maui and Kauai, and *M. pennatiformis* ssp. *bryanii* found on Laysan. Both are listed as endangered under the former species name *Mariscus pennatiformis* (see taxonomic discussion below).

At the time of listing in 1994, a total of five populations of *Mariscus pennatiformis* ssp. *pennatiformis* were known on Kauai, Oahu, East Maui, and the island of Hawaii, with an unknown number of individuals. A sixth population from East Maui was represented in cultivation (USFWS 1994). The most recent observations documented five populations of this subspecies on Maui and Kauai, with approximately 30 individuals on Maui and an unknown number of individuals on Kauai, but this subspecies has been searched for but found for over ten years. The Oahu population from the Waianae Mountains, is no longer extant (USFWSd). In 1999, a single occurrence of *M. pennatiformis* ssp. *pennatiformis* totaling approximately 30 individuals was known on State-owned land, near the mouth of Hanawi Stream in Nahiku, East Maui. Of these, 20 percent were immature and 80 percent were mature (USFWS 2003b; National Tropical Botanical Garden 2009a). *Mariscus pennatiformis* ssp. *pennatiformis* was last observed on Kauai in 1997. On Kauai, four populations have been reported. On Waialae Ridge and the north side of the ridge above the falls at 950 to 1,000 meters (3,120 to 3,280 feet) elevation, *M. pennatiformis* ssp. *pennatiformis* was observed in 1991 and 1993. On Waimea Canyon Rim, between the 6 and 7 mile marker on the highway to Kokee, *M. pennatiformis* ssp. *pennatiformis* was observed at 671 meters (2,200 feet) elevation at Puu Ka Pele in 1993. In 1997, *M. pennatiformis* ssp. *pennatiformis* was observed in Nawaimaka, on northwest facing slopes of a ridge and gulch near Waialae Falls, at 823 meters (2,700 feet) elevation. In 1991, *M. pennatiformis* ssp. *pennatiformis* was observed in Kawaiiki Valley at 549 to 610 meters (1,800 to 2,000 feet) elevation (National Tropical Botanical Garden 2009b).

Endemic to Laysan in the Northwest Hawaiian archipelago, the subspecies *Mariscus pennatiformis* ssp. *bryanii* was found on the southeast end of the central lagoon and the west and northeast sides of Laysan Island. At the time of listing in 1994, three populations with a total of 30 individuals were known (USFWS 1994). Currently, 488 individuals are known (C. Rehkemper, Pacific Remote Islands National Wildlife Refuge Complex, pers. comm. 2008). Numbers have fluctuated from as many as 200 to only one individual from 1993 to 2003 (USFWS 2003c). In 1997, a single occurrence of about 200 individuals of *M. pennatiformis* ssp. *bryanii* remained on the southeast end of the lagoon (USFWS 1999, 2003c). In 2007, the population of *M. pennatiformis* ssp. *bryanii* was noted as extremely endangered and localized, but no numbers were reported (Athens *et al.* 2007). Individuals of *M. pennatiformis* ssp. *bryanii* on Laysan were closely monitored for 10 years, but the only flowering observed was of one individual from November 1994 to December 1995, coinciding with record high rainfall (USFWS 1999,

2003c). In 2007, natural recruitment from the existing population occurred on Laysan (Rehkemper *et al.* 2007). In 2008, there were 488 individuals of *M. pennatiformis* ssp. *bryanii* mapped in the naturalized colonies at Iki Ana, Lake Gauge, NorthWest Mud Flats, and the Cocos, more than half of which were immature (C. Rehkemper, pers. comm. 2008). This most recent survey suggests that there are fewer than 244 mature individuals of this subspecies in five areas on Laysan.

The genus *Mariscus* is no longer recognized. *Mariscus pennatiformis* ssp. *pennatiformis* and *M. pennatiformis* ssp. *bryanii* underwent a taxonomic change in which the genus was moved into *Cyperus*. In addition, the two subspecies were reclassified as varieties (Wagner and Herbst 2003). Therefore, this species will be referred to as *Cyperus pennatiformis*, with var. *pennatiformis* and var. *bryanii* for the remainder of this review.

On Maui, *Cyperus pennatiformis* var. *pennatiformis* was found on cliffs with brown soil and talus within reach of ocean spray in *Pandanus tectorius* (hala) coastal wet forests at elevations between sea level and 188 meters (sea level and 615 feet) and containing one or more of the following associated native plant species: *Cyperus laevigatus* (makaloa); *Eragrostis* sp. (kawelu); *Ipomoea* sp. (morning glory); *Lysimachia mauritiana* (no common name [NCN]); *Pandanus tectorius* (hala); or *Sadleria pallida* (amau ii) (USFWS 2003b; National Tropical Botanical Garden 2009b).

On Kauai, *Cyperus pennatiformis* var. *pennatiformis* occurred as an understory plant throughout both north and south facing forests. On Waialae Ridge and the north side of the ridge above the falls it grew in *Metrosideros polymorpha* (ohia) - *Acacia koa* (koa) mixed mesic forest with *Antidesma platyphylla* (hame), *Charpentiera elliptica* (papala), *Dianella sandwicensis* (uki uki), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Leptecophylla tameiameia* (pukiawe), *Panicum nephelophilum* (konakona), *Poa sandwicensis* (NCN), *Schiedea stellarioides* (lauhilihi), *S. viscosa* (NCN), and endemic ferns which are diverse in cool, shady gulches. Along Waimea Canyon at Puu Ka Pele, *C. pennatiformis* var. *pennatiformis* was observed on north facing slopes growing in *Acacia koa* – *Metrosideros polymorpha* mesic forest with *Bidens sandwicensis* (kookoolau), *Carex wahuensis* (NCN), *Cyperus phleoides* (NCN), *Hibiscus waimeae* ssp. *waimeae* (kokio keokeo), *Nestegis sandwicensis* (olopua), *Pleomele aurea* (hala pepe), and *Wilkesia gymnoxiphium* (iliau). At Waialae Falls, *C. pennatiformis* var. *pennatiformis* grew in mesic forest with *Acacia koa*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Pleomele aurea*, *Psychotria greenwelliae* (kopiko), and *P. mariniana* (kopiko) (National Tropical Botanical Garden 2009b).

On Laysan, *Cyperus pennatiformis* var. *bryanii* occurs in lakeside *Sesuvium portulacastrum* (akulikuli) - *Cyperus laevigatus* wetland. *Cyperus pennatiformis* var. *bryanii* - *Heliotropium curassavicum* (kipukai) herbaceous vegetation (Athens *et al.* 2007). Other associated native plants on Laysan include *Chenopodium oahuense* (aweoweo), *Portulaca lutea* (ihi), *Ipomoea indica* (koali awa), *Sicyos maximowiczii* (puaokama), *Sicyos pachycarpus* (kupala), *Fimbristylis cymosa* ssp. *spathacea*, and *Fimbristylis cymosa* ssp. *umbellata-capitata* (mauu) (USFWS 2003; Athens *et al.* 2007).

Threats to *C. pennatiformis* var. *pennatiformis* on Maui included grazing and habitat destruction caused by ungulates (Factors A and C); competition with invasive introduced plant species, especially *Ardisia elliptica* (Factor E); and extinction from random naturally occurring events (Factor E). Threats to historical locations on Oahu were grazing and habitat degradation caused by ungulates (Factors A and C); competition for light, water, space, and nutrients from a variety of alien plant species (Factor E); and fire (Factor E) (USFWS 2003b). Threats to *C. pennatiformis* var. *pennatiformis* on Kauai included grazing and habitat destruction caused by ungulates, especially pigs (*Sus scrofra*) which are destroying the understory (Factor A); competition from invasive introduced plant species, including *Psidium cattleianum* (strawberry guava) and *Lantana camara* (lantana) which compete with and displace *C. pennatiformis* var. *pennatiformis* (Factor E); and extinction from random naturally occurring events such as landslides or hurricanes which do occur on Kauai (Factor E) (USFWS 2003; National Tropical Botanical Garden 2009b). At Puu Ka Pele, goats (*Capra hircus*) were a threat (Factor A), as were introduced invasive plants including *Lantana camara*, *Setaria parviflora* (yellow foxtail), and *Melia azedarach* (pride of India) (Factor E) (National Tropical Botanical Garden 2009b). At Waialae Falls, threats were habitat degradation by pigs and goats (Factor A); fire (Factor E); and introduced invasive plants including *Psidium cattleianum*, *Grevillea robusta* (silk oak), *Setaria parviflora*, *Bryophyllum pinnatum* (airplant), *Lantana camara*, and *Cyperus meyenianus* (NCN) (Factor E) (National Tropical Botanical Garden 2009b).

The initial decline of *Cyperus pennatiformis* var. *bryanii* was probably caused by the release of rabbits on Laysan and the subsequent defoliation of the island (Factors A and C). Many native plant species comprising the original habitat of Laysan were completely extirpated, including the *Pritchardia* palms (loulu) which were an important structural component of the habitat (Athens *et al.* 2007). The native beach morning glory *Ipomoea pes-caprae* (pohuehue) is another potential threat, since it periodically grows over the *C. pennatiformis* var. *bryanii* individuals (Factor E). In addition, native *Sicyos* spp. (anunu) vines, *Eragrostis variabilis* (kawelu), and *Boerhavia repens* (alena) appear to impede natural dispersal of *C. pennatiformis* var. *bryanii* into other suitable locations (Factor E) (USFWS 2003; Athens *et al.* 2007).

Seed predation by the endangered Laysan finch (*Telespiza cantans*) is a potential threat to *Cyperus pennatiformis* var. *bryanii*, since the finches have been observed feeding on the seeds (Factor C). Plants must be protected from Laysan finch predation (Factor C) and seabird roosting and nesting (Factor E). Bagging of seed heads has been partially successful, but some seed heads have become infected with mold as a result. Other methods of protecting the plants should be devised that will keep out Laysan finches and discourage roosting and/or nesting of seabirds in the immediate area. Protection from burrowing seabirds should also be implemented, possibly through sturdy wire mesh placed on the ground for 10 feet (3 meters) around each plant (USFWS 1999).

Climate change may also be a threat to *Cyperus pennatiformis* var. *bryanii*, as the island of Laysan is very low in elevation. However, additional research is needed on the

impacts of climate change to Hawaiian low elevation species, to determine what the full threat will be from climate change in terms of ocean temperature changes and sea level rise.

As of 2009, the National Tropical Botanical Garden has 1,000 seeds in storage from Hanawi headland (National Tropical Botanical Garden 2009c). The Center for Conservation Research and Training Seed Storage Facility on Oahu has no seeds of this variety in storage (Center for Conservation Research and Training Seed Storage Facility 2008).

In 1995, USFWS personnel on Laysan began an ongoing monitoring and protection program for the current wild individuals of *Cyperus pennatiformis* var. *bryanii*, which included bagging seed heads to prevent predation by Laysan finch. Mature seed was also spread in suitable areas. Control of beach morning glory was conducted when it began to cover *C. pennatiformis* var. *bryanii*. A Laysan albatross (*Diomedea immutabilis*) chick was relocated when it began to tear pieces from a *C. pennatiformis* var. *bryanii* individual. Most of the individuals have been enclosed by a small fence erected to prevent albatrosses from trampling the plants (USFWS 1999). The National Tropical Botanical Garden has one seed accession of *Cyperus pennatiformis* var. *bryanii*, which was collected in 2007 from a Waimea Arboretum collection. The original wild seeds were collected in 1994 from the population located on the southeastern edge of the hypersaline lake on Laysan (National Tropical Botanical Garden 2009b). Seeds from a single flowering individual of *Cyperus pennatiformis* var. *bryanii* were collected by USFWS personnel in October 1994 and propagated at the University of Hawaii's Lyon Arboretum and Waimea Arboretum. As of 1997, 219 individuals were in cultivation at Lyon and Waimea Arboretum that originated from Laysan (USFWS 1999). The Center for Conservation Research and Training Seed Storage Facility on Oahu has no seeds of this variety in storage (Center for Conservation Research and Training Seed Storage Facility 2008). The Harold L. Lyon Arboretum Micropropagation Laboratory has one cloned plant from a single seed collected on Laysan in 1997 (Harold L. Lyon Arboretum 2008). Waimea Arboretum currently has four individual plants representing four wild individuals (Waimea Arboretum 2009). In 2008, there were 52 seeds planted in the Pacific Remote Islands National Wildlife Refuge Complex greenhouse for reintroduction purposes on Laysan (C. Rehkemper, pers. comm. 2008). As of 2009 on Laysan, the Pacific Remote Islands National Wildlife Refuge Complex has 450 seeds in storage representing 20 wild individuals, and has reintroduced 48 plants to the wild (Rehkemper 2009).

The present status of *Cyperus pennatiformis* var. *pennatiformis* on Oahu, Maui, and Kauai is unknown. It has not been seen for over ten years. *Cyperus pennatiformis* var. *bryanii* is recruiting naturally in the wild, and is monitored regularly by USFWS refuge staff.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the multi-island plants (USFWS 1999), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Cyperus pennatiformis* is a short-lived perennial, and to be considered stable, the taxon must be managed to control

threats (*e.g.*, fenced) and be 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 islands of Maui, Kauai, Laysan, or any of the islands on which it occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population.

The stabilization goals for this species have not been met for *Cyperus pennatiformis* var. *bryanii* or for *C. pennatiformis* var. *pennatiformis* (see Table 1), as fewer than 244 mature individuals of the former variety are in one population on a small island and the latter variety is possibly extirpated. In addition, although threats are being addressed for *C. pennatiformis* var. *bryanii*, threats for *C. pennatiformis* var. *pennatiformis* are not being managed.

Recommendations for Future Actions:

For *Cyperus pennatiformis* var. *pennatiformis*:

- Test viability on the accession stored at the National Tropical Botanical Garden.
- Conduct surveys at all known historical locations.
- If located, collect seed for genetic storage from all known locations.
- Propagate to maintain an *ex situ* population until an appropriate area can be protected for outplanting within historical suitable habitat.
- Work with the appropriate land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

For *Cyperus pennatiformis* var. *bryanii*:

- Continue ongoing monitoring, fence maintenance, and protection program for the current wild individuals.
- Determine additional methods besides bagging of the seed heads to prevent Laysan finch predation.
- Directly sow mature seed in suitable areas.
- Control *Ipomoea pes-caprae* when it begins to cover *Cyperus pennatiformis* var. *bryanii*.
- Collect seed for long term genetic storage and possible establishment of another population.

- Assess Lehua Islet and other Northwest Hawaiian Islands for potential reintroduction sites.
- Continue to work with the Pacific Remote Islands National Wildlife Refuge Complex to implement ecosystem-level restoration and management to benefit this species.

For both varieties:

- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.

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

| Date | No. wild indivs. (var. <i>pennatiformis</i>/ var. <i>bryonii</i>) | No. outplanted | Stability Criteria identified in Recovery Plan | Stability Criteria Completed? |
|-------------------------|--|-----------------------|---|--------------------------------------|
| 1994 (listing) | Unknown/30 | 0 | All threats managed in all 3 populations | No |
| | | | Complete genetic storage | No |
| | | | 3 populations with 50 mature individuals each | No |
| 1999 (recovery plan) | Unknown/200 | 0 | All threats managed in all 3 populations | Partially |
| | | | Complete genetic storage | No |
| | | | 3 populations with 50 mature individuals each | No |
| 2003 (critical habitat) | 0/200 | 0 | All threats managed in all 3 populations | Partially |
| | | | Complete genetic storage | No |
| | | | 3 populations with 50 mature individuals each | No |
| 2009 (5-year review) | 0/488 | 48 | All threats managed | Partially |
| | | | Complete genetic storage | Partially |
| | | | 3 populations with 50 mature individuals each | Unknown |

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Mariscus 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
- No Change in listing status

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



Date AUG 27 2010