Cyperus neokunthianus
(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: *Cyperus neokunthianus* (no common name)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

Christina Richards, Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
Chelsie Javar-Salas, Plant Biologist, 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 2020. The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations and species status report by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 by Christina Richards, Biologist, was reviewed by Chelsie Javar-Salas, Plant Biologist, 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. 2019. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawai‘i, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; endangered status for 49 species from the Hawaiian Islands; final rule. Department of the Interior, Federal Register 81(190): 67786–67860, September 30, 2016.

Date listed: September 30, 2016
Entity listed: *Cyperus neokunthianus*
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 *Cyperus neokunthianus*.

1.3.5 Species' Recovery Priority Number at start of this 5-year review:

5

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui)
Date issued: October 2019
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

____**Yes**
__X_**No**

2.1.2 Is the species under review listed as a DPS?

____**Yes**
____**No**

2.1.3 Was the DPS listed prior to 1996?

____Yes
____No

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

____Yes
____No

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

____Yes
____No

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

____Yes
____No

2.2 Recovery Criteria

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

____Yes
__X_No

2.2.2 Adequacy of recovery criteria.

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

____Yes
____No

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

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, B, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2.

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.

Cyperus neokunthianus 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 should be documented on Maui 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 individuals per population.

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

Interim Stage

To meet the interim stage of recovery of *Cyperus neokunthianus*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004, entire) 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:
Cyperus neokunthianus, a member of the Cyperaceae (sedge) family, is a perennial sedge with short and slightly thickened rhizomes (underground stem). The culm (hollow stalk) upon which the inflorescence occurs ranges between 15.7 to 47.2 inches (in) (40 to 120 centimeters [cm]) tall and 0.1 to 0.2 in (2 to 5 millimeters [mm]) in diameter near the base and has three sides (trigonous). The flat, herbaceous leaves arise from the base of the plant and are linear, 0.08 to 0.5 in (2 to 12 mm) wide, with reddish brown to dark brown sheaths (Wagner et al. 1999, p. 1855).

Like most members of the family Cyperaceae, the flowers of *Cyperus neokunthianus* are perfect, containing both male and female parts. The fruits of *C. neokunthianus* are achenes (nutlets), which are three-sided, and oblong shaped. Both the flowers and fruits form on spikelets, which are 0.06 to 0.1 in (1.5 to 2.5 mm) wide. The spikelet of *C. neokunthianus* is slightly wider than the introduced species, *Cyperus meyenianus*, which the species resembles. *Cyperus neokunthianus* is also usually taller than *C. meyenianus* (Wagner et al. 1999, p. 1855).

Given the limited numbers of individuals that have been collected, no research has been done on *Cyperus neokunthianus* to understand the individual requirements or life history traits for this species in the wild. Like its closest relatives, this species is likely wind-pollinated, a biotic relationship for reproduction is unknown. A mechanism for dispersal of fruits is unknown. Many species of *Cyperus* can reproduce vegetatively from the rhizome, but it is unclear whether this was the primary mode of reproduction for *C. neokunthianus*. The occurrence of the species along

riparian areas may indicate possible dispersal via water. It is also possible that birds dispersed the seeds, either through consumption and defecation or through external movement. This would have most likely been done by now extinct species, including rails, waterfowl, or small, seed-eating species similar to the extant Laysan finch (*Telespiza cantans*), which utilizes a similar species *Cyperus pennatiformis* var. *bryanii* in this way (Vetter 2021 in litt.).

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, *Cyperus neokunthianus* was found in the West Maui mountains on Maui. Historical collections have occurred from Helu and Hanaʻula in the southeast and the range extends around to at least Honokōhau Valley (USFWS 2016, p. 67794; NTBG 2020; Smithsonian 2020). The most recent collections that were attributed to this species were made on Helu peak in 1997 (Wood 2020 in litt.). At the time of listing in 2016, there were no known individuals in the wild (USFWS 2016, p. 67794).

Currently, no individuals of *Cyperus neokunthianus* are known. Additional individuals may still exist in the extremely steep and remote gulches of West Maui where this species has been collected previously. Surveys have been conducted in the type locality, as well as other recent collection areas, but only *Cyperus sandwichensis* has been noted. A possibility still exists for rediscovering the species in this extremely rugged terrain (Oppenheimer 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:
Cyperus neokunthianus was first collected by Freycinet and published under the name *Mariscus kunthianus*, and is also synonymous with *Cyperus kunthianus* and *Cyperus longeradiatus* (Wagner et al. 1999, p. 1855). All collections of *Cyperus neokunthianus* have occurred on West Maui within the deep valleys and on the surrounding ridges (HMBP 2010, Oppenheimer 2020 in litt.). The current taxonomy of collections made from Honokōhau identified as this species in the mid-1990s is undetermined (Wood 2020 in litt; Smithsonian 2020). A 1997 collection from Helu in the southern portion of the West Maui mountains was originally identified as *C. sandwichensis* upon collection, and later revised to be *C. neokunthianus* (Wood 2020 in litt.; NTBG 2020). This treatment was retained in the Manual of Flowering Plants of Hawaiʻi (Wagner et al.

1999, p. 1855). The 2012 supplement to the Manual of the Flowering Plants of Hawai‘i also accepts this classification (Wagner et al. 2012, p. 81) and is the currently accepted taxonomy for this species.

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 sections 2.3.1.2 and 2.3.1.4 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):
The most recent collections referable to *Cyperus neokunthianus* occurred in wet forests, on wet talus cliffs or on vertical rock walls (Smithsonian 2020; NTBG 2020). These areas have moisture regimes classified as moderately wet, although the original range of the species may have gone into areas classified as very wet, as well (Price et al. 2012, entire). Annual rainfall in its suspected range varies between 100 in/yr (2,540 mm/yr) up to 250 in/yr (6,350 mm/yr) (Giambelluca et al. 2014, entire). Mean annual temperatures in these areas are between 59 °F (15 °C) and 68 °F (20 °C) (Giambelluca et al. 2013, entire). Recent individuals of *C. neokunthianus* were found in *Metrosideros polymorpha* (‘ōhi‘a) forests. Other associated species from these collections include the grasses *Eragrostis grandis* (kāwelu), *Deschampsia nubigena* (hairgrass), and *Isachne distichophylla* (‘ohe), and the shrubs *Dubautia plantaginea* (na‘ena‘e) and *Dubautia scabra* (na‘ena‘e), and *Kadua centranthoides* (manono). *Dryopteris* and *Cibotium* fern species are also associated with collections of *C. neokunthianus* (Smithsonian 2020).

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—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*) have been reported in the area where *Cyperus neokunthianus* was last observed and are a potential threat to the species if it is rediscovered (HBMP 2010).

Established ecosystem-altering invasive plant modification and degradation of habitat—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). Invasive plants with the greatest impacts on *C. neokunthianus* include *Tibouchina herbacea* (cane tibouchina) and *Buddleja asiatica* (butterfly bush). Habitat modification and destruction by invasive nonnative plants are a potential threat to *Cyperus neokunthianus* if it is rediscovered (USFWS 2016, p. 67830).

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):
Not a threat.

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):
Lack of adequate hunting regulations—Nonnative feral ungulates pose a major ongoing threat to native species through destruction and degradation of habitat, and/or direct herbivory or predation. The State of Hawai‘i provides game mammal (feral pigs) hunting opportunities within State-designated public hunting areas (DLNR 1999a, b, 2003), including areas necessary for the recovery of *Cyperus neokunthianus*. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., sustained yield) in some areas, with one animal allowed per day; to other areas with as little as one animal allowed per year. Public hunting areas are not fenced and game mammals have unrestricted access for most areas across the landscape, regardless of underlying land use designation; therefore, if the species is rediscovered any unfenced populations of *C. neokunthianus* are at risk (DLNR 1999a, b, 2003).

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):
Reduced viability due to low numbers—*Cyperus neokunthianus* faces the threat of limited numbers as it is known only from its original collection location on Maui, and it has not been relocated since 1997 (Wood 2020 in litt.; USFWS 2020, unpubl. data) Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, pp. 3,7; Newman and Pilson 1997, pp. 354–355). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very

small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression.

Climate change loss or degradation of habitat—Currently, *Cyperus neokunthianus* has no known wild individuals remaining on Maui with no propagules or propagative materials in storage. Any remaining individuals that may exist are vulnerable to ungulates and nonnative plant species in addition to environmental impacts that may result from changes in climate and subsequent impacts to its wet forests habitat. Changes in environmental conditions that may result from global climate change include increasing temperatures, decreasing precipitation, and increasing storm intensities. The consequent impacts on *C. neokunthianus* are related to changes in microclimate conditions in the species' habitat. These changes may lead to loss of native species associated in this habitat due to direct physiological stress, the loss or alteration of habitat, or changes in disturbance regimes (e.g., droughts, storms, and rockslides). Because the specific cumulative effects of climate change on *C. neokunthianus* are presently unknown, we are not able to determine the magnitude of this possible threat with confidence.

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. Unfortunately *Cyperus neokunthianus* was not included in this analysis.

Current Management Actions:

- Surveys and monitoring—Surveys have been conducted by the Maui Plant Extinction Prevent Program at Honokōhau and Waihe‘e Stream in areas where the species was last observed, but no individuals have been found (Oppenheimer 2020 in litt.).
- Ungulate control—The area where *Cyperus neokunthianus* was last collected is fenced (USFWS 2020, unpubl. data).

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

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2016 (listing)	0	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2021 (5-year review)	0	0	All threats managed in all populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
			Each population naturally reproducing	No

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

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Destruction and degradation of habitat by ungulates	A	Ongoing	Partial, the area where this species was last found in the wild is fenced for ungulates
Destruction and degradation of habitat by established ecosystem-altering invasive plants	A	Ongoing	None
Inadequacy of regulatory mechanisms	D	Ongoing	None
Low numbers	E	Ongoing	None
Climate change degradation or loss of habitat	E	Ongoing	None

2.4 Synthesis

There are no known wild individuals of *Cyperus neokunthianus* on Maui and the last known collection of the species was made in 1997 on Helu peak. Surveys have been conducted in the type locality at Helu peak, as well as other recent collection areas, but only *Cyperus sandwichensis* has been observed. A possibility still exists for rediscovering of this species in this extremely rugged terrain (Oppenheimer 2020 in litt.). There are no seeds or propagules in collections for storage or propagation. No reintroductions have been conducted.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCCs Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on Maui where they 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. There are no known individuals, there is no genetic representation (Table 1), and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Cyperus neokunthianus* 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 *Cyperus neokunthianus* in historical locations and potentially suitable habitat.

- Ungulate monitoring and control—If rediscovered, continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species and those that compete with *C. neokunthianus* throughout its known range.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Captive propagation for genetic storage and reintroduction—If rediscovered, collect seeds for storage and propagation efforts for maintenance of genetic stock.
- 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 *Cyperus neokunthianus*
(no common name)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Christina Richards, Fish and Wildlife Biologist, PIFWO
Chelsie Javar-Salas, Plant Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2021.08.17 14:26:13 -10'00'

for _____
Field Supervisor, Pacific Islands Fish and Wildlife Office