Microlepia strigosa var. *mauiensis*
(palapalai)

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: *Microlepia strigosa* var. *mauiensis* (palapalai)

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5-YEAR REVIEW
Microlepia strigosa var. *mauiensis* (palapalai)

1.0 GENERAL INFORMATION

1.1 Reviewers:

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

Lead Regional Office:
Interior Region 12, Portland Regional Office

Lead Field Office:
Pacific Islands Fish and Wildlife Office

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), beginning in October 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 The review was based on the final rule listing this species; peer reviewed scientific publications; unpublished field observations and species status report by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information.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 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. 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.

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, Friday, September 30, 2016.

Date listed: September 30, 2016
Entity listed: *Microlepia strigosa* var. *mauiensis*
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 *Microlepia strigosa* var. *mauiensis*.

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

6

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Multi-Island Species
Date issued: August 2020
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.

Microlepia strigosa var. *mauiensis* is a short-lived perennial terrestrial fern and considered an obligate outcrosser. 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 total should be documented on the islands of Hawai‘i, Maui, and/or O‘ahu where they now occur or occurred historically. Each of these populations must be naturally reproducing (i.e., viable spores, gametophytes, and sporophytes) with a minimum of 100 mature individuals per population.

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

Interim Stage

To meet the interim stage of recovery of *Microlepia strigosa* var. *mauiensis*, 600 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. Multi-island species should be represented by at least one population on each of the islands from which they were known historically as long as suitable habitat exists. There should also be demonstrated regeneration of spores and growth to at least sporophyte stage 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 1,000 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. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically as long as suitable habitat exists. 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 1,000 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. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically as long as suitable habitat exists. 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:

Microlepia strigosa var. *mauiensis* is a terrestrial fern of the Dennstaedtiaceae (bracken fern) family. Plants are medium-sized, with fronds less than 100 centimeters (40 inches) long. Stipes (stalk joining root to blade) are straw colored, and blades are 2- to 3-pinnate pinnatifid (blade divided almost to rachis), ovate-lanceolate, and pale green. Rachises (blade midribs) are often zigzag, and costae (rib of pinnae) are pale green. Veins are prominently raised on abaxial surfaces. Sori (spore-bearing structure) are submarginal to marginal and indusia (covering of sori) are attached at the base and sides. This taxon is an extremely hairy variety of *Microlepia strigosa*, with the stipes, rachises, costae, and entire fronds covered with uniform, jointed hairs with pointed tips (Palmer 2003, p. 186).

Research shows that *Microlepia strigosa* in Hawai‘i is associated with mycorrhizal fungi (Gemma et al. 1992, p. 845). This indicates that mycorrhizal fungi may also be required for successful growth and reproduction of the variety *mauiensis*.

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, there were four populations of *Microlepia strigosa* var. *mauiensis* on the island of Hawai‘i (35 individuals total), eight populations on Maui (275 individuals total), and one population on O‘ahu (approximately 50 individuals) (HBMP 2010; National Tropical Botanical Garden (NTBG) 2011; USFWS 2020, unpublished data). Several populations have not been resurveyed to assess their status for five to 10 years.

Currently, on the island of Hawai‘i there are two locations at Upper Waiākea, one of which 20 individuals were known in 2004, however botanists have not been able to relocate individuals in this area, but more surveys are needed (VanDeMark 2020, pers. comm.). There had also been one population at Pi‘ihonua consisting of 15 individuals in 2004, and one population of an unknown number of individuals at Ka‘u last observed in 1991, however their current status is unknown. On O‘ahu, there is one population at Makaleha in the Wai‘anae mountains of approximately 50 individuals observed in 2015. On east Maui, there are two subpopulations in Kaukau‘ai, one of one individual observed in 2017, and the second of 100 individuals observed in 2018. There are also 3 individuals at Manawainui observed in 2015, an unknown number of individuals at Nu‘anu‘a‘āloa observed in 1997, 100 individuals at Haleakalā-Kahikinui observed in 2018, and 20 individuals at ‘Ohe‘o observed in 2016. On west Maui, there are 4 individuals at Pōhākea observed in 2018. These populations may total as many as 342 individuals on all three islands, but fewer than 300 individuals have been estimated from recent observations, and no individuals have been recently observed on Hawai‘i (PEPP 2019; NPS 2020a; VanDeMark 2020, pers. comm.).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
There are no genetic studies specifically for *Microlepia strigosa* var. *mauiensis*; however, research indicates that the genus is monophyletic (for the plants studied in Japan), and possibly diploid with a chromosome base number of x = 39, 40, 42, 43, and 44, with at least one example of tetraploidy and the presence of some infraspecific (e.g., subspecies and varieties) aneuploidism (abnormal chromosome number not including a full set of chromosomes) (Walker 1984 cited in Nakato and Ebihara 2011, pp. 75–76; Wolf 1995, p. 318).

2.3.1.4 Taxonomic classification or changes in nomenclature:
Microlepia strigosa var. *mauiensis* was first described as *Microlepia mauiensis* by Wagner (Wagner 1993, pp. 73, 75). There is ongoing

taxonomic confusion regarding the variety *mauiensis* (Palmer 2003, p. 182; Kumari et al. 2010, entire; Hassler 2020 in litt.; Hassler 2020, pers. comm.; ITIS 2020; NatureServe 2020). Some pteridophyte (ferns and fern allies) taxonomists have lumped *M. strigosa* with *M. setosa* (Kumari et al. 2010, entire; Hassler 2020, pers. comm.); however, the Service relies on the most recent taxonomic treatment on the checklist of Hawaiian flora as the accepted taxonomy list for native plants of Hawai‘i, which recognizes *M. strigosa* var. *mauiensis* (Smithsonian National Museum of Natural History 2020). This treatment is retained in Ranker et al. (2019, p. 59) 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 section 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):
Typical habitat for *Microlepia strigosa* var. *mauiensis* is mesic and wet forest (O‘ahu, Maui, Hawai‘i) and mesic grassland and shrubland (Maui) at 425 to 1,830 meters (m) (1,394 to 6,004 feet (ft)) (Palmer 2003, p. 186; HBMP 2010; BISH 2020, USFWS 2020, unpublished data).

On O‘ahu, associated native species include *Antidesma platyphyllum* (hame), *Cheirodendron trigynum* (‘ōlapa), *Cibotium* spp. (hāpu‘u), *Cyanea grimesiana* subsp. *obatae* (hāhā), *Cyrtandra dentata* (ha‘iwale), *Dicranopteris linearis* (uluhe), *Melicope clusiifolia* (kūkaemoa), *Metrosideros* spp. (‘ōhi‘a), *Pipturus* spp. (māmaki), and *Syzygium sandwicense* (‘ōhi‘a hā) (NTBG 2020).

On the island of Hawai‘i, associated native species include *Cibotium* spp. (hāpu‘u) and *Metrosideros* spp. (‘ōhi‘a) (NTBG 2020).

On west Maui, associated native species include *Agrostis sandwicensis* (no common name (NCN)), *Argyroxiphium caliginis* (‘Eke silversword), *Bidens* spp. (ko‘oko‘olau), *Calamagrostis* spp. (NCN), *Cheirodendron* spp. (‘ōlapa), *Clermontia micrantha* (‘ōhā wai), *Ctenitis squamigera* (pauoa), *Cyrtandra* spp. (ha‘iwale), *Dicranopteris linearis*, *Dodonaea viscosa* (a‘ali‘i), *Dryopteris rubiginosa* (NCN), *Dubautia* spp. (na‘ena‘e), *Geranium hillebrandii* (nohoanu), *Huperzia haleakalae* (NCN), *Kadua laxiflora* (pilo), *Labordia hedyosmifolia* (kāmakahala), *Lysimachia* spp., *Machaerina* spp. (‘uki, ‘ahanui), *Metrosideros* spp., *Myrsine lessertiana* (kōlea lau nui), *Psychotria mariniana* (kōpiko), *Pteris lydgatei* (NCN), *Tetramolopium capillare* (pāmakani), Pipturus spp., and *Touchardia latifolia* (olonā) (NTBG 2020).

On east Maui, associated native species include *Acacia koa* (koa), *Carex* spp. (NCN), *Cheirodendron* spp., *Coprosma* spp. (pilo), *Dodonaea viscosa*, *Dubautia* spp., *Hydrangea arguta* (kanawao), *Ilex anomala* (kāwaʻu), *Leptecophylla tameiameiae* (pūkiawe), *Melicope* spp. (alani), *Metrosideros* spp., *Myrsine* spp. (kōlea), *Peperomia* spp. (ʻalaʻala wai nui), *Perrottetia sandwicensis* (olomea), *Pipturus* spp., *Vaccinium* spp. (ʻōhelo), and various pteridophytes (NTBG 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, pp. 747–774; van Riper and van Riper 1982, pp. 34–35). Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) and evidence of their activities are reported at the Maui populations of *Microlepia strigosa* var. *mauiensis* (Oppenheimer 2007, in litt.; HBMP 2008; Bily 2009, in litt.; HBMP 2010). The Maui populations are within exclosures; however, Haleakalā National Park cites ungulates as a threat to this variety within the park (NPS 2020a, in litt., 2020b, in litt.). The population on Oʻahu is within a monitored exclosure.

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, p. 74). Habitat modification and destruction by invasive nonnative plants negatively affects all occurrences of *Microlepia strigosa* var. *mauiensis*. Nonnative plants with the greatest impacts on *M. strigosa* var. *mauiensis* on west Maui include *Tibouchina herbacea* and *Clidemia hirta* (Oppenheimer 2007, in litt.). On east Maui, the nonnative plants with the greatest impacts include *Juncus acuminatus* (rush), *Hedychium gardnerianum* (kāhili ginger), *Plantago major* (broad-leaved plantain), *Ageratina adenophora* (Maui pāmakani), and nonnative grasses (Bily 2009, in litt.; PEPP 2007; BISH 2020).

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):
Herbivory and predation by feral ungulates—Herbivory and predation by feral pigs and goats is a threat to *Microlepia strigosa* var. *mauiensis*, especially to those plants not fenced or monitored (Oppenheimer 2007, in litt.; HBMP 2008; Bily 2009, in litt.; HBMP 2010).

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):
Lack of adequate hunting regulations— Nonnative feral ungulates pose threat to *Microlepia strigosa* var. *mauiensis* through destruction and degradation of the species' habitat, but regulatory mechanisms are inadequate to address this threat. The State of Hawai‘i provides game mammal hunting opportunities in State-designated public hunting areas (DLNR 2010). However, the State's management objectives for game animals range from maximizing public hunting opportunities (e.g., "sustained yield") in some areas to removal by State staff, or their designees (State of Hawai‘i, H.A.R. 13-123). 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, any unfenced populations of *M. strigosa* var. *mauiensis* are at risk (DLNR 2010).

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

comprehensive control of an array of invasive plants remains limited in scope. The introduction of new invasive plant species to the State of Hawai‘i is a significant risk to federally listed species including any remaining wild or outplanted individuals of *Microlepia strigosa* var. *mauiensis*.

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

Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, 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. There is only one small population of *Microlepia strigosa* var. *mauiensis* on O‘ahu, already at risk of hybridization with other *Microlepia* species, possibly three small populations on the island of Hawai‘i, and an isolated population on west Maui. The greatest numbers of individuals occur on east Maui, within Haleakalā National Park, with an estimated 275 individuals remaining.

Hybridization—Hybridization with other species and varieties of *Microlepia* is a threat to variety *mauiensis* on O‘ahu and is compounded by the low number of individuals (Kawelo 2010, in litt.). Hybridization can lead to a loss of species diversity, local adaptations, and genetic representation of *Microlepia strigosa* var. *mauiensis* (Todesco et al. 2016, pp. 892, 901–902).

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. This assessment was not conducted for *Microlepia strigosa* var. *mauiensis*. The analysis for a more widespread, related variety, *Microlepia strigosa* var. *strigosa*, concluded that the variety has a relatively high tolerance with respect to changes in habitat due to climate change, with a vulnerability score of 0.0792 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). The analysis for the similarly widespread *M. spelunkae,* with a vulnerability score of 0.41, shows this species is less tolerant. Climate change may result in alteration of the environmental conditions and

ecosystems that support *Microlepia strigosa* var. *mauiensis*. Variety *mauiensis* is less common than other related plants and faces threats of habitat destruction and degradation by feral ungulates and nonnative plants, predation and herbivory, inadequate regulatory mechanisms, hybridization, and low numbers of populations and individuals. Therefore, *M. strigosa* var. *mauiensis* may be unable to tolerate or respond to changes in temperature or moisture or may be unable to move to areas with more suitable climatic regimes, and additional management actions may be needed to conserve this taxon into the future.

Current Management Actions:

- Surveys and monitoring—Surveys and monitoring have not been conducted for *Microlepia strigosa var. mauiensis* on the islands of Hawai‘i and Maui for five years or more. The Plant Extinction Prevention Program (PEPP) surveys and monitors on O‘ahu. The last survey was conducted in 2015 (PEPP 2011, 2013, 2015).
- Ungulate control—Occurrences of *M. strigosa var. mauiensis* on east and west Maui and O‘ahu are within ungulate exclosures; however, these exclosures must be monitored and maintained against incursion by feral ungulates. Several plants were discovered outside the exclosure on O‘ahu in 2015 (PEPP 2015).
- Ecosystem-altering invasive nonnative plant control—Exclosures may be maintained by invasive nonnative plant removal but there are no specific actions for *M. strigosa var. mauiensis*.
- Captive propagation for genetic storage and reintroduction—Lyon Arboretum reports explant collections representing one founder at Makaleha on O‘ahu (Lyon Arboretum 2020).

Table 1. Status and trends of *Microlepia strigosa* var. *mauiensis* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2016 (listing)	ca 40 (O‘ahu) <20 (Maui) 35 (Hawai‘i)	0	All threats managed in all 3 populations	Partially, occurrences on O‘ahu and Maui are within exclosures
			Complete genetic storage	Minimal, one founder from O‘ahu represented in collections
			3 populations with 100 mature individuals each	No

2021 (5-year review)	ca 50 (O‘ahu) 228 (Maui) unk (Hawai‘i)	0	All threats managed in all 3 populations	Partially, most occurrences on O‘ahu and all occurrences on Maui are within exclosures
			Complete genetic storage	Minimal, one founder from O‘ahu represented in collections
			3 populations with 100 mature individuals each	Partially, two populations on Maui <100 individuals, reproduction unknown
			Each population naturally reproducing	Not reported

Table 2. Threats to *Microlepia strigosa* var. *mauiensis* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Destruction and degradation of habitat by ungulates	A	Ongoing	Partial, most occurrences on O‘ahu and all occurrences on Maui are within exclosures, though ungulate presence uncertain within Maui units
Destruction and degradation of habitat by established ecosystem-altering invasive plants	A	Ongoing	Partial, nonnative invasive plants may be removed from some exclosures
Herbivory and predation by feral ungulates	C	Ongoing	Partial, most occurrences on O‘ahu and all occurrences on Maui are within exclosures
Inadequacy of regulatory mechanisms	D	Ongoing	None
Low numbers	E	Ongoing	Minimal, one founder represented in collections
Hybridization	E	Ongoing	None
Climate change degradation or loss of habitat	E	Ongoing	None

2.4 Synthesis

There are fewer than 350 wild individuals of *Microlepia strigosa* var. *mauiensis* on the islands of Hawai‘i, O‘ahu, and Maui, with recent observations of fewer than 300 individuals, none of which are on Hawai‘i. The largest numbers of individuals occur on east Maui within Haleakalā National Park (221). 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) for other species and varieties of *Microlepia* and their analyses showed that variety *strigosa* is the least vulnerable, and that *M. spelunkae* is vulnerable to the effects of climate change. Based on the current status and range of *M. strigosa* var. *mauiensis*, and the ongoing threats, this variety may be vulnerable to the effects of climate change and may require additional management actions. There are collections in storage representing one founder from O‘ahu. Most occurrences on Maui and O‘ahu are within ungulate exclosures; however, these must be maintained and monitored for incursion by feral ungulates. The population on O‘ahu is at risk of hybridization.

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 total should be documented on the islands of O‘ahu, Maui, and/or Hawai‘i where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable spores, sporophytes) with a minimum of 100 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met as, although there are two populations estimated to have 100 individuals on east Maui, it is unknown how many individuals are mature and reproductive, and there is only one individual with *ex situ* genetic representation (from O‘ahu) (Table 1) and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Microlepia strigosa var. mauiensis* 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 *Microlepia strigosa var. mauiensis* 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 *M. strigosa var. mauiensis*.
- Captive propagation for genetic storage and reintroduction—Continue to collect spores and propagules for storage and propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Begin reintroduction efforts to increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of habitat destruction and degradation, hybridization, and climate change.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Microlepia strigosa* var. *mauiensis*
(palapalai)

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:
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FIELD OFFICE APPROVAL:

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