5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Nototrichium humile* (kuluʻī)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

Lead Region/Field Office:

Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaiʻi

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 2019. The review was based on a review of current, available information since the last 5-year review for *Nototrichium humile* (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 *Nototrichium humile* published in the Federal Register on January 18, 2008 and August 8, 2013 (available at *https://ecos.fws.gov/docs/five_year_review/doc1857.pdf* and *https://ecos.fws.gov/docs/five_year_review/doc4229.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 *N. humile*.

This short-lived perennial shrub in the Amaranthaceae (amaranth) family is endangered and found on the island of Oʻahu and is extirpated from east Maui. The current status and trends for *Nototrichium humile* are provided in the tables below.

New Status Information:

- The number of wild individuals of *Nototrichium humile* continues to decline since the 2013 5-year review total of 1,021 individuals. Currently, there are 880 to 950 wild individuals in 10 populations in the Waiʻanae mountains of Oʻahu (U.S. Army 2018, appendices; Army Natural Resources Program-Oʻahu (ANRP) 2019, Appendix 4-1).
- In 2012, 17 critical habitat units in the lowland dry, lowland mesic, and dry cliff ecosystems were designated for *Nototrichium humile* in the Waiʻanae mountains of Oʻahu (3,152 hectares (ha); 7,788 acres (ac)) (77 FR 57648, September 18, 2012). In 2016, four critical habitat units were designated for *N. humile* on east Maui in the lowland dry ecosystem (1,216 ha; 3,005 ac) (81 FR 17790, March 30. 2016).

New Threats:

- Climate change loss or degradation of habitat—Climate change may pose a threat to this species. Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi 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 by Fortini *et al.* (2013) concluded that *Nototrichium humile* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.675 (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.
- Fire destruction and degradation of habitat—In the 2008 5-year review, fire was considered a potential threat to *Nototrichium humile* especially in the drier areas of the Waiʻanae mountains of Oʻahu with the predominance of nonnative grasses providing a high fuel load. In August, 2018, fire started by arson burned 2,023 ha (5,000 ac) in the Waiʻanae, Keaʻau, and Mākaha valleys. The fire destroyed plants in two exclosures in the Keaʻau Forest Reserve, impacting the largest wild populations and outplantings of other endangered plant species, *Gouania vitifolia* and *Hibiscus brackenridgei* subsp. *mokuleianus*, which was a major setback for restoration work (ANRP 2018; U.S. Army 2018, in litt.). Wildfire is becoming a more significant problem in the state. The mean annual area burned in Hawaiʻi from 2005 to 2011 accounted for 0.48 percent (8,427 ha yr^{-1}) of the State's total land area, greater than the proportion of land area burned across the entire U.S. mainland over this same time period (Trauernicht *et al.* 2015, p. 432).

New Management Actions:

- Surveys and inventories—The ANRP continues to monitor wild and reintroduced populations of *Nototrichium humile* in the Waiʻanae mountains of Oʻahu, pursuant to the requirements of the Service's Biological Opinion for military training at Mākua Military Reservation of 2003 and the reinitiation in 2007 (USFWS 2007).

- Ungulate monitoring and control—Ungulate monitoring and control is ongoing in the ANRP's population units and in the management units Kaluakauila, Waiʻanae Kai, Mākua South, Manuwai, and Kolekole (U.S. Army Garrison Hawaiʻi 2010, pp. 2-141, 2-146-147; ANRP-Oʻahu 2019, p. 16, Appendix 3-1). The Kahanahāiki and Palikea management units are ungulate-free with regular fence monitoring (ANRP-Oʻahu 2019, Appendix 3-1).
- Established ecosystem altering invasive plant species control—Nonnative plants are controlled within the exclosures at Kahanahāiki, Kaluakauila, Mākaha, Waiʻanae Kai, and Manuwai (ANRP-Oʻahu 2019, Appendix 4-7).
- Fire threat control by ANRP includes removing fuel (nonnative grasses), marking areas for water drops, and installing fuel breaks in fallow lands along accessible roads (ANRP-Oʻahu 2019, Appendix 4-7). Currently, one management unit, Kaimuhole-Palikea that includes *N. humile* has reached 100 percent of fire management goals and Waiʻanae Kai has reached 92 percent of fire management goals.
- Captive propagation for genetic storage and reintroduction—
    - The ANRP reported collection of more than 4,500 seeds representing 19 founders from five populations in three locations (Punapōhaku, Kaimuhole-Palikea, Kolekole) and are close to collection goals (ANRP-Oʻahu 2019, appendix 4-8). In 2018, 424 plants were propagated representing 124 founders from seven populations (U.S. Army 2018).
    - The National Tropical Botanical Garden (NTBG) reported three individuals of *Nototrichium humile* in a living collection at the Southshore Garden (NTBG 2019).
    - The Waimea Valley Arboretum reported between 67 to 86 individuals of *N. humile* representing six wild individuals in refugia (Waimea Arboretum 2013, 2014, 2017, 2018).
- Reintroduction and translocation—Between 2018 and 2019, the ANRP reported reintroduction or establishment of a living collection at botanical gardens of 435 plants representing approximately 190 individuals from seven populations (U.S. Army 2018). Currently, 256 of the individuals survive, 113 individuals in two reintroduction sites (one with 106 individuals), and the remaining of which are in the living collections at Schofield Barracks, Koko Crater Botanical Garden, and Waimea Valley Arboretum collections (U.S. Army 2018).
- Population biology research—Germination trials are ongoing, currently with a minimum viability of 66 percent. Bulk seed collections provide material for processing protocol and for storage and longevity research (ANRP-Oʻahu 2019, pp. 124–125).

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

Date	No. wild individuals	No. outplanted	Downlisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
1991 (listing)	1,500–3,000 (O‘ahu) Unknown (Maui)	0	All threats managed in all 5–7 populations	No
			Complete genetic storage	No
			5–7 populations with 300 mature individuals each	No
1998 (recovery plan)	1,500–1,600 (O‘ahu) Unknown (Maui)	1	All threats managed in all 5–7 populations	No
			Complete genetic storage	No
			5–7 populations with 300 mature individuals each	No
2003 (critical habitat)	775-995 (O‘ahu) Unknown (Maui)	0	All threats managed in all 5–7 populations	Partially
			Complete genetic storage	No
			5–7 populations with 300 mature individuals each	No
2008 (5-year review)	1,245 (O‘ahu) extirpated (Maui)	0	All threats managed in all 5–7 populations	Partially
			Complete genetic storage	Partially

			5–7 populations with 300 mature individuals each	No
2012 (critical habitat–O‘ahu)	>1,000 (O‘ahu)		All threats managed in all 5–7 populations	Partially
			Complete genetic storage	Partially
			5–7 populations with 300 mature individuals each	Partially
2013 (5-year review)	1,021 (O‘ahu)	0	All threats managed in all 5–7 populations	Partially
			Complete genetic storage	Partially
			5–7 populations with 300 mature individuals each	No
Date	**No. wild individuals**	**No. outplanted**	**Interim Criteria identified by HPPRCC***	**Interim Criteria Completed?**
2020 (5-year review)	ca 880–950 (O‘ahu)	113	All threats managed in all 3 populations	Partially, 3 populations are fenced
			Adequate representation of populations in *ex situ* genetic storage	Partially
			Regeneration (new seedlings grow into mature plants) at all 3 populations	Yes
			3 populations with 300 mature individuals each	No

* 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 *Nototrichium humile* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, 2 exclosures ungulate-free, 5 other areas managed
Established ecosystem altering invasive plant species degradation of habitat	A	Ongoing	Partial, nonnative plant control at 5 populations
Fire	A		Partial, fire management plan for O‘ahu training areas
Climate change degradation or loss of habitat	A	Ongoing	None
Herbivory by slugs	C	Ongoing	Partial, previous bait testing and label for use
Established invasive plant species competition	E	Ongoing	Partial, nonnative plant control at 5 populations
Reduced viability due to low numbers	E	Ongoing	Partial, seed storage, propagation, and reintroduction efforts are ongoing

Synthesis:
Currently there are 880 to 950 wild individuals on O‘ahu, and this number has been steadily declining since listing. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *Nototrichium humile* is highly vulnerable to the effects of climate change. A wildfire in 2018 approached populations. Wild and reintroduced populations are provided protection from feral ungulates by fencing and ungulate control. Nonnative plants are controlled within five managed areas. Seed collection, propagation, and reintroduction are ongoing, with three populations nearing the ANRP’s collection goals. Germination and seed storage studies are ongoing.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for Oahu Plants (USFWS 1998), 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.

Nototrichium humile is a short-lived perennial shrub. 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 the islands of O‘ahu or Maui where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, saplings), with a minimum of 50 mature, reproducing individuals per population, with all threats controlled.

As *Nototrichium humile* has a substantial amount of individuals, despite declines, and is close to meeting or has met the preventing extinction goals, we have decided to evaluate the species at the interim level. To reach the interim stabilization level, 300 mature individuals are needed in each of three populations, with at least one population on each of the islands from which it was known historically as long as suitable habitat exists. All major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation’s guidelines (Guerrant *et al.* 2004) 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.

The interim goals for this species have not been met. *Ex situ* genetic storage collections only adequately represent one population (Table 1), there are no populations totaling at least 300 reproducing individuals or any populations on Maui, and all threats are not being managed (Table 1, Table 2). Therefore, *Nototrichium humile* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
Fire has increased in significance as a threat (after the previous 5-year review in 2013) since a large wildfire approached known populations in 2018. There is no 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 2020.

- Surveys and inventories—Continue to conduct thorough surveys of all historical and suitable habitat for new occurrences.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates.

- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with *Nototrichium humile*.
- Fire monitoring and control—Establish populations in areas where damage or destruction by fire is less likely. Continue to develop and implement fire prevention management plans and coordinate effective fire suppression efforts, especially for Mākaha and Waiʻanae Kai.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species.
- Slug control—Continue to develop and implement effective control measures for slugs.
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction.
- Reintroduction and translocation—Determine optimal sites and continue to reintroduce individuals into areas that are being managed for known threats.
- Population biology research—
    - Determine the number of genetically distinct plants in the populations of *N. humile*.
    - Study *N. humile* with regard to population size and structure, geographical distribution, breeding system, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. Continue germination trials and seed storage studies.
    - Determine suitability of habitat on Maui for reintroduction.
- Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this species.

References:

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[USFWS] 2013. *Nototrichium humile* 5-year review summary and evaluation. USFWS Pacific Islands Fish and Wildlife Office, Honolulu, HI. *https://ecos.fws.gov/docs/five_year_review/doc4229.pdf.*

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Nototrichium humile* (kuluʻī)

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**

_____ Date_____