5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Neraudia angulata* (no common name)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 58 species in Washington, Oregon, California, and Hawaii. Federal Register 75(226):71726-71729.

Lead Region/Field Office:

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

Name of Reviewer(s):

Jiny Kim, Fish and Wildlife Biologist, PIFWO
Daniel Clark, Oahu, Kauai, Northwest Hawaiian and American Samoa Islands Team Manager, PIFWO
Marie Bruegmann, Plant Recovery Coordinator, PIFWO
Recovery Program Lead, PIFWO
Kristi Young, Programmatic Deputy Field Supervisor, PIFWO
Loyal Mehrhoff, Field Supervisor, PIFWO

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 January 31, 2012. The review was based on a review of current, available information since the last 5-year review for *Neraudia angulata* (USFWS 2008). The National Tropical Botanical Garden provided an initial draft of portions of the five-year review and recommendations for conservation actions needed prior to the next five-year review. The document was reviewed by the Fish and Wildlife Biologist, Islands Team Manager, and Plant Recovery Coordinator, followed by the Recovery Program Lead. It was subsequently reviewed and approved by the Programmatic Deputy Field Supervisor.

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 review for *Neraudia angulata* published on January 18, 2008 (available at http://ecos.fws.gov/docs/five_year_review/doc1853.pdf) for a complete review of the species' status, threats, and management efforts. No significant new information regarding the species' biological status has come to light since listing to warrant a change in the Federal listing status of *N. angulata.*

This short-lived shrub is endangered and occurs on the island of Oahu. The current status and trends for *Neraudia angulata* are provided in the tables below.

New status information:

- Four populations are being managed for stability: Kaluakauila, with 174 mature individuals; Makua, with 49 mature and 16 immature individuals and one seedling; Manuwai, where currently no wild plants remain; and Waianae Kai Mauka, with 16 mature and four immature individuals (OANRP 2012a). These numbers represent an overall increase from those reported in 2011 (U.S. Army Garrison 2011). Units being managed for genetic storage are: Kapuna, currently unoccupied; Punapohaku with one mature individual; Halona with 30 mature and four immature individuals; Leeward Puu Kaua with nine mature individuals; Makaha with six mature and seven immature individuals; and Waianae Kai Makai with 45 mature and 35 immature individuals and 25 seedling individuals (OANRP 2012a). Total numbers of plants in 2012 are 330 mature and 66 immature individuals and 26 seedlings, which is an increase of 218 individuals from 2011 (U.S. Army Garrison 2011). Of those reported in 2012, 204 were reintroduced (OANRP 2012a).

New taxonomic information:

- *Neraudia angulata* has two varieties: var. *angulata* and var. *dentata.* Populations that appear to be intermediate between the two varieties are also known in Waianae Kai Mauka and Halona. The Oahu Army Natural Resources Program (OANRP) has not distinguished them separately in population surveys therefore totals are reported for the species as a whole (OANRP 2012a).

New threats:

- Climate change - Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013.

New management actions:

- Ungulate exclosures
    - Construction began on the Manuwai management unit fence in 2010. It will protect the historic site and secure habitat for future reintroductions (U.S. Army Garrison 2011). The current status of this fence is unknown.
    - The Waianae Kai Makai fence was completed in 2010, and will provide protection from goats.
    - Three out of 11 populations are fenced, including three of the four which are being managed for stability. Additionally, three other populations are partially protected (U.S. Army Garrison 2011).
- Ecosystem-altering invasive plant species control – Weeding has been conducted at three populations: Kaluakauila, Makua, and Waianae Mauka (U.S. Army

Garrison 2010). In addition, ten person hours were spent weeding around *Neraudia angulata* in Makaha in 2010-2011(U.S. Army Garrison 2011).

- Predator / herbivore control:
    - Rat control has been conducted at the Kaluakauila population (U.S. Army Garrison 2010).
    - Black twig borer (*Xylosandrus compactus*) damage was evaluated, and determined to presently be at acceptable levels not requiring the implementation of controls (U.S. Army Garrison 2009).
- Fire protection - In July 2010, a fire in Makua burned within 20 meters (66 feet) of a *Neraudia angulata* reintroduction site in the Kaluakauila population and within 60 meters (197 feet) of the *Neraudia angulata* wild population at Punapohaku (U.S. Army Garrison 2010). The threat of fire is considered managed only in the Waianae Kai Makai population (U.S. Army Garrison 2010).
- Threats research:
    - Black twig borer damage was evaluated with the use of high-release ethanol traps to determine whether controls were required (U.S. Army Garrison 2009).
    - In 2009, slug control research using beer traps was conducted in the field at the Kahanahaiki population of *Neraudia angulata* to determine the frequency of slug activity (U.S. Army Garrison 2009, 2010). In October 2010, Sluggo was registered for use by the Hawaii Department of Agriculture for control of slugs and nonnative snails in forested areas for the protection of native, threatened, and endangered plants of Hawaii. However, since native snails also exist in areas where threatened and endangered plants occur, additional research is needed to find a control method that can be used in areas where native snail species co-occur with listed plants to prevent non-target effects of treatment (U.S. Army Garrison 2011).
- Captive propagation for genetic storage and reintroduction
    - The remaining wild plants in the Kapuna population died in 2010. This left a single plant at the Punapohaku population as the only wild individual of *N. angulata* var. *dentata*. Clones of all the known plants from populations with *N. angulata* var. *dentata* (Kapuna, Punapohaku, and Manuwai) were used in the reintroductions for the Kaluakauila population and maintained in the nursery for genetic storage (U.S. Army Garrison 2010).
    - OANRP nursery contained 186 individuals in 2012 (OANRP 2012b).
    - OANRP has completed genetic storage goals for 35 of 122 original founder plants (OANRP 2012c).
- Reintroduction / translocation
    - The Kaluakauila, Makua, Manuwai, and Waianae Kai Mauka populations are managed for stability, using reintroductions into those populations as a tool to help achieve stability (OANRP 2012a).
    - Reintroduction of 174 individuals was implemented into Kaluakauila and 35 individuals were reintroduced in Makua (U.S. Army Garrison 2010; OANRP 2012a).

    - Regeneration was noted under some reintroduced individuals (U.S. Army Garrison 2010).
- Population viability monitoring - A new site with two mature plants was observed in Makaha in 2010 and is being managed by OANRP as part of the Makaha population (OANRP 2012a).

Synthesis:
Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for plants from the island of Oahu (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Neraudia angulata* 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 island of Oahu. 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 (Table 1), since only two populations of 50 or more mature individuals exist and all threats are not being sufficiently managed throughout all populations (Table 2). Therefore, *Neraudia angulata* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:
- Captive propagation for genetic storage and reintroduction
    - Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in *ex situ* propagation.
    - Continue to collect seeds from all existing populations and send to at least two or three different facilities for propagation and storage.
- Reintroduction / translocation
    - While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions.
    - Continue to reintroduce the species back into its known historical range.
- Ungulate exclosures – Construct and monitor ungulate-proof exclosures around the last of the four population units managed for stability.
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations.
- Predator / herbivore control – Implement effective control methods for rodents, slugs and black twig borer.
- Fire protection – Implement fire management plans for all wild and reintroduced populations.
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species.

- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Genetic research – Assess genetic variability within extant populations.
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

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

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1996 (listing)	15	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1998 (recovery plan)	70-100	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2003 (critical habitat)	69-80	12	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	No
2008 (5-yr review)	353	27	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Partially, one population
2013 (5-yr review)	217	205	All threats managed in all 3 populations	Partially (see Table 2)
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Partially, 2 populations

Table 2. Threats to *Neraudia angulata* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Fire	E	Ongoing	No
Ungulates – feral goats, cattle and pigs degrade habitat and herbivory	A, C, D	Ongoing	Partially: 3 populations fenced, 3 more partially
Established ecosystem-altering invasive plant species	A, E	Ongoing	Partially, for 3 populations
Black twig borers damage plants	C	Ongoing	Not at present
Rodent predation or herbivory – rats	C	Ongoing	Partially: Rat control at one location
Slugs - herbivory	C	Ongoing	Not at present
Climate change	A, E	Increasing	No

References:

See previous 5-year review for a full list of references (USFWS 2008). Only references for new information are provided below.

[OANRP] Oahu Army Natural Resources Program. 2012a. Makua implementation plan - population unit status; *Neraudia angulata.* 1 page. Unpublished.

[OANRP] Oahu Army Natural Resources Program. 2012b. Army nursery inventory summary. 1 page. Unpublished.

[OANRP] Oahu Army Natural Resources Program. 2012c. Genetic storage summary. 9 pages. Unpublished.

U.S. Army Garrison. 2009. 2009 status report for the Makua and Oahu implementation plans. U.S. Army Garrison, Hawaii and Pacific Cooperative Park Studies Unit. Schofield Barracks, Hawaii. 711 pages. Available online at <http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/2009_OIP_Edited.pdf>.

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U.S. Army Garrison. 2011. 2011 status report for the Makua and Oahu implementation plans. U.S. Army Garrison, Hawaii and Pacific Cooperative Park Studies Unit. Schofield Barracks, Hawaii. 269 pages. Available online at <http://manoa.hawaii.edu/hpicesu/DPW/2011_YER/2011_YER_Edited.pdf>.

[USFWS] U.S. Fish and Wildlife Service. 1998. Recovery plan for the Oahu plants. Portland, Oregon. 207 pages + appendices.

[USFWS] U.S. Fish and Wildlife Service. 2008. *Neraudia angulata* (no common name) 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 6 pages. Available online at <http://ecos.fws.gov/docs/five_year_review/doc1853.pdf>.

U.S. FISH AND WILDLIFE SERVICE

SIGNATURE PAGE for 5-YEAR REVIEW of *Neraudia angulata* (no common name)

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

Recommendation resulting from the 5-year review:

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

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Maine M Burgmann Date 2013-08-09