Nothocestrum breviflorum
(Aiea)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

5-YEAR REVIEW

Species reviewed: *Nothocestrum breviflorum* (Aiea)

TABLE OF CONTENTS

5-YEAR REVIEW
Nothocestrum breviflorum (Aiea)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia, (503) 231-2071

Lead Field Office:
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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 (USFWS), beginning on April 8, 2010. The review was based on the designation of critical habitat for *Nothocestrum breviflorum* and the Big Island plant cluster recovery plan (USFWS 2003, 1996), as well as a review of current, available information. The Bernice Pauahi Bishop Museum provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Samuel Aruch, biological consultant, was reviewed by a recovery biologist and the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; 5-year review status of 69 species in Idaho, Washington, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75(67):17947-17950.

1.3.2 Listing history

Original Listing
FR notice: USFWS. 1994. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 21 plants from the island of Hawaii, State of Hawaii; final rule. Federal Register 59(43):10305-10325.
Date listed: March 4, 1994
Entity listed: Species
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:

USFWS. 2003. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii, Hawaii; final rule. Federal Register 68(127):39624-39761.

Critical habitat was designated for *Nothocestrum breviflorum* in three units totaling 5,143 hectares (12,708 acres) on Hawaii Island. These designations include habitat on State and private lands (USFWS 2003).

1.3.4 Review History:

Species status review [FY 2011 Recovery Data Call (August 2011)]:
Declining

Recovery achieved:
1 (0-25%) (FY 2007 Recovery Data Call)

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: USFWS. 1996. Recovery plan for the Big Island plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 202 pages. + appendices. Available online at <http://www.fws.gov/pacificislands/recoveryplans.html>.
Date issued: September 26, 1996
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***
__X_ ***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***
__X_ ***No***

2.2 Recovery Criteria

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

__X_ ***Yes***
____ ***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?

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

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

__X_ ***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.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Big Island plant cluster (USFWS 1996), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Nothocestrum breviflorum* is a long-lived perennial, and to be considered stabilized, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and be represented in an *ex situ* (such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on the Big Island (Hawaii Island). For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

This recovery objective has not been met.

For downlisting, a total of five to seven populations of *Nothocestrum breviflorum* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

This recovery objective has not been met.

For delisting, a total of eight to ten populations of *Nothocestrum breviflorum* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 100 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered.

This recovery objective has not been met.

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:

Nothocestrum breviflorum is a long-lived, semi-deciduous tree (mostly) or shrub that produces seed infrequently (Wagner *et al*. 1999; USFWS 1994; National Tropical Botanical Garden 2011). The flowers are bisexual and are said to have a slightly sweet odor (National Tropical Botanical Garden 2011). Flowering occurs in January and February, and fruiting has been confirmed from December through August (Rock 1913; USFWS 1996, 2002; Bishop Museum 2011; National Tropical Botanical Garden 2011). The species is believed to have "nondormant" seeds (Baskin *et al*. no date).

Nothocestrum breviflorum is reportedly a host species for a cerambycid (long-horned) beetle, *Plagithmysus simplicicollis* (Giffin 2009). The foliage is also a host for the sphingid moth, *Manduca blackburni* (Blackburn's hawk moth) (Giffin 2009).

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:

At the time of its listing, the species was known from an estimated 9 populations with a total of 53 individuals (USFWS 1994).

When the recovery plan was released, *Nothocestrum breviflorum* was known from only six populations. Four of the six populations had only one to four individuals and the total numbers of individuals in the wild and reintroduced were unknown. The species was reported to be absent from nine of its known historical locations (USFWS 1996).

When critical habitat for *Nothocestrum breviflorum* was proposed, the species was known from 10 populations totaling over 150 individuals (USFWS 2002). When final critical habitat was designated (USFWS 2003), 66 occurrences were reported on Federal (Hawaii Volcanoes National Park, Hakalau Forest National Wildlife Refuge), State/local, and private lands. The overall population trend from 2002 to 2003 is difficult to determine due to the change to reporting "occurrences" rather than "populations." The term "occurrences" was used because the plant aggregations were not necessarily viable populations (USFWS 2003). One report (Giffin 2009) indicated that the species "... was locally common on ranch pastures at about 3,500 feet [1,066 meters] elevation" at

Puuwaawaa, but provided no further information in terms of numbers of populations or individuals.

In 2010, there were an estimated 10 wild populations of *Nothocestrum breviflorum* containing less than 150 total individuals (USFWS 2010).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Apart from the species *Nothocestrum latifolium*, the genus has not been widely included in phylogenetic studies of Solanaceae (Olmstead *et al*. 2008).

2.3.1.4 Taxonomic classification or changes in nomenclature:

Nothocestrum breviflorum, a member of the nightshade family (Solanaceae), was first collected on the U.S. Exploring Expedition in the early 1840s and was named by Gray (1862). Hillebrand (1888) described the variety *longipes*, but Wagner *et al*. (1999) did not recognize the variety as distinct. However, when the Smithsonian Institution first prepared a list of plant taxa of conservation concern, the name *N. breviflorum* var. *longipes* was used (USFWS 1994).

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.):

No new information.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

The known historical range of *Nothocestrum breviflorum* was from Hawaii Island in the southern part of the Kohala Mountains, the northern slope of Hualalai, and all but the northern slopes of Mauna Kea (USFWS 1994, 1996).

The species is often found in dry to occasionally mesic forests (Wagner *et al*. 1999) from 146 to 1,948 meters (500 to 6,390 feet) elevation on aa lava substrates, including dry cinder cones (USFWS 1996, 2002). The forests typically are dominated by *Metrosideros polymorpha* (ohia), *Acacia koa* (koa), or *Diospyros sandwicensis* (lama) (USFWS 1994). The soil groups on which *Nothocestrum breviflorum* is known to occur include histic placaquepts, lithic tropofolists, typic tropofolists, typic eutrandepts, and

eutrandept-tropofolist associations (Hawaii Biodiversity and Mapping Program 2010).

Native plant species associated with *Nothocestrum breviflorum* include *Bidens micrantha* (kokoolau), *Caesalpinia kavaiensis* (uhiuhi), *Colubrina oppositifolia* (kauila), *Delissea undulata* (no common name), *Dodonaea viscosa* (aalii), *Erythrina sandwicensis* (wiliwili), *Hibiscadelphus hualalaiensis* (hau kuahiwi), *Kokia drynarioides* (kokio), *Myoporum sandwicense* (naio), *Osteomeles anthyllidifolia* (ulei), *Psydrax odorata* (alahee), *Santalum paniculatum* (iliahi), *S. ellipticum* (iliahialoe), and *Sophora chrysophylla* (mamane) (USFWS 1996, 2002, 2003; National Tropical Botanical Garden 2011).

2.3.1.7 Other:

No new information.

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:

Threats:

- Ungulate degradation of habitat (USFWS 1994, 1996, 2002)
- Established ecosystem-altering invasive plant species degradation of habitat (USFWS 1994, 1996, 2002)
    - *Lantana camara* (lantana)
    - *Leucaena leucocephala* (koa haole)
    - *Pennisetum setaceum* (fountain grass)
    - *Schinus terebinthifolius* (Christmas berry)
- Agricultural and urban development – Land development for housing and commercial activities (USFWS 1994, 1996, 2002).

Current conservation efforts:

- Ungulate exclosure:
    - A 2 hectare (5 acre) fenced exclosure was erected in 1950 to keep cattle out of the population at Kaupulehu Mauka, and the cattle were removed. Fencing at the site was reinforced in 1996, given reports of occasional use of the area by feral animals (USFWS 2002).

- A fenced exclosure was constructed in 1999 by the North Kona Dry Forest Working Group at Kaupulehu Makai (USFWS 2002).
- A fenced exclosure containing reintroduced individuals of *Nothocestrum breviflorum* at Puuwaawaa Forest Bird Sanctuary was reported to be completely ungulate-free (Giffin 2009).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

No new information.

2.3.2.3 Disease or predation:

Threats:

- Ungulate predation or herbivory (USFWS 1994, 1996, 2002)
  - Cattle (*Bos taurus*)
  - Feral sheep (*Ovis aries*)
- Rodent predation or herbivory – Seedlings of *Nothocestrum breviflorum* were damaged by rodents (USFWS 2002)
  - Rats (*Rattus* spp.)
  - Mice (*Mus* spp.)

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Threats:

- Lack of adequate hunting regulation in areas with ungulates – The lack of adequate ungulate control and the existence of established hunting programs in areas where *Nothocestrum breviflorum* occurs outside of Hawaii Volcanoes National Park continue to threaten this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Threats:

- Fire (USFWS 1994, 1996, 2002).
- Hiking and trail maintenance – Human impacts such as trampling near trails (USFWS 1994, 1996, 2002).

- 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) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

Current conservation efforts:

- Captive propagation for genetic storage and reintroduction:
    - The National Tropical Botanical Garden (2011) has cultivated the species successfully to produce fruit and seed. In 2010, there were 77 seeds of *N. breviflorum* in storage at the National Tropical Botanical Garden (2010). The species evidently has been germinated and grown easily in the greenhouse (USFWS 1996).
    - The Volcano Rare Plant Facility (2011) has a single individual of *N. breviflorum* in their nursery for genetic storage purposes, collected from Puuwaawaa.
    - Waimea Arboretum (2010) had a single individual of *N. breviflorum* for genetic storage.
    - Seeds of *Nothocestrum breviflorum* have been cultivated successfully at Hawaii Volcanoes National Park in a mixture of cinder/soil/vermiculite/perlite (Hawaii Volcanoes National Park 2004). The source location for the seeds was Puuwaawaa (Hawaii Volcanoes National Park 2004).
- Reintroduction / translocation implementation:
    - At the time of the recovery plan, it was believed that some individuals of *Nothocestrum breviflorum* may have been cultivated at Kipuka Puaulu for ornamental purposes, but the approximately six individuals that were thought to grow there may have not been identified correctly (USFWS 1996).
    - In 2000, a total of 100 individuals were reintroduced at Kipuka Puaulu in Hawaii Volcanoes National Park (Hawaii Volcanoes National Park 2004). Of these, three died in 2000, and seven had died by 2004 (Hawaii Volcanoes National Park 2004). In 2004, an additional 31 individuals were reintroduced, including 15 at Naulu and 16 at Kipuka Puaulu (Hawaii Volcanoes National Park 2004). At Naulu, 4 of the 15 individuals succumbed, but all reintroduced

individuals at Kipuka Puaulu survived the first year, for a survival rate of 86 percent (Hawaii Volcanoes National Park 2004). By 2006, 12 of the 123 individuals reintroduced at Kipuka Puaulu had died and four of the 15 individuals at Naulu had died (Hawaii Volcanoes National Park 2009). No monitoring was conducted in 2007, 2008, or 2009 (Hawaii Volcanoes National Park 2009).

  - In 2007, 38 individuals of *Nothocestrum breviflorum* were reintroduced at Puuwaawaa Forest Bird Sanctuary (Plant Extinction Prevention Program 2007).
  - Individuals of *Nothocestrum breviflorum* were reintroduced at Puuwaawaa, although the exact number was not been reported (USFWS 2002).

- Fire protection – All *Pennisetum setaceum* (fountain grass), which has influenced the microclimate of the site, was removed from Kaupulehu Mauka to reduce the chances of disturbance by fire (USFWS 2002).

2.4 Synthesis

The interim stabilization goals for this species have only been partially met, as it is unclear if any of the 10 known populations contain greater than 25 individuals (Table 1), all threats are not being managed (Table 2), and it is unknown if natural regeneration is occurring. Therefore, *Nothocestrum breviflorum* meets the definition of endangered, as it remains in danger of extinction throughout its range.

Table 1. Status of *Nothocestrum breviflorum* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	53	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1996 (recovery plan)	Unknown	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2003 (critical habitat)	66-150	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2012 (5-year review)	<150	79	All threats managed in all 3 populations	Partially (see Table 2)
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No

Table 2. Threats to *Nothocestrum breviflorum* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – Degradation of habitat and herbivory	A,C, D	Ongoing	Partially: Ungulate exclosures at Kaupulehu Mauka, Puuwaawaa Forest Bird Sanctuary
Established ecosystem-altering invasive plant species	A	Ongoing	Partially: Control of *Pennisetum setaceum* at Kaupulehu Mauka
Agricultural and urban development	A	Ongoing	No
Rodent predation or herbivory – Rats and mice	C	Ongoing	No
Fire	E	Ongoing	Partially: Fire protection – control of Pennisetum setaceum at Kaupulehu Mauka
Hiking and trail maintenance	E	Ongoing	No
Climate change	A, E	Increasing	No

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: ____

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Captive propagation for genetic storage and reintroduction:
    - Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage.
    - Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in *ex situ* propagation
- Reintroduction / translocation site identification – Determine areas within the species native range that are most suitable for reintroduction.
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range.
- Ungulate exclosures:
    - Monitor fenced exclosures twice a year for evidence of breaching by feral ungulates.
    - Continue to construct fenced exclosure around all known populations.
- Ungulate control – Protect all populations against disturbances from feral ungulates.
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations.
- Fire protection:
    - Continue to control invasive introduced plant species around all populations, especially since a buildup of biomass of some species is enough to carry destructive fires.
    - Develop and implement fire management plans for all wild and reintroduced populations.
- Surveys / inventories – Resurvey the historical geographical range of the species for previously unknown populations or individuals, particularly given that nine or more of its historical locations are not now known to harbor the species.
- Predator / herbivore control – Implement effective control methods for rodents.
- Population biology research – Consider carrying out hand pollination on individuals in the wild to enhance reproductive success.
- Threat monitoring and control – Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods.
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of urban development and hikers and trail maintenance.
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and

contribute to implementation of ecosystem-level restoration and management to benefit this species.

- 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.

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Nothocestrum breviflorum* (Aiea)

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

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
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