5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Centaurium sebaeoides* (awiwi)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 70 species in Idaho, Montana, Oregon, Washington, and the Pacific Islands. Federal Register 73(83):23264-23266.

Lead Region/Field Office:

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

Name of Reviewer(s):

Marie Bruegmann, Pacific Islands Fish and Wildlife Office, Plant Recovery Coordinator
Marilet A. Zablan, Pacific Islands Fish and Wildlife Office, Assistant Field Supervisor for Endangered Species
Jeff Newman, Pacific Islands Fish and Wildlife Office, Acting Deputy Field Supervisor

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 April 29, 2008. The review was based on final critical habitat designations for *Centaurium sebaeoides* and other species from the islands of Oahu, Kauai and Niihau, Molokai, and Maui and Kahoolawe (USFWS 2003a-d) as well as a review of current, available information. The National Tropical Botanical Garden 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 Tamara Sherrill, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Assistant Field Supervisor for Endangered Species and Acting Deputy Field Supervisor before submission to the Field Supervisor for approval.

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).

Application of the 1996 Distinct Population Segment (DPS) Policy:

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designations for *Centaurium sebaeoides* published in the Federal Register on February 27, March 18, June 17, and May 14, 2003 (USFWS 2003a-d) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats and no significant new information

regarding the species biological status have come to light since listing to warrant a change in the Federal listing status of *C. sebaeoides*.

The annual, endemic, coastal herb is the only native Hawaiian species in the gentian family (Gentianaceae). It is also one of only 29 (three percent) Hawaiian plant species that have an annual life cycle. *Centaurium sebaeoides* appears to be a determinate annual. Declining hours of daylight trigger the plant to produce seeds and die, a pattern also typical of annual grasses in Mediterranean climates. Such populations develop extensive, long-lived seed banks to survive poor years and successfully exploit favorable years, resulting in wide fluctuations in the population depending on rainfall (Medeiros *et al.* 2000). Flower color is apparently variable. Although usually white, pink flowers have been reported from Kauai and Molokai (National Tropical Botanical Garden, 2009; M. Bruegmann, USFWS, pers. comm. 2009).

On Kauai, in 1990, 70 or more individuals of *Centaurium sebaeoides* were seen on a climb above the second cave in Kalalau and at Pohakuao near Hanalei (Wood 2009). Population fluctuations occurred in three successive seasons from 1997 to 1999. Prior to the spring of 1997 the total population of this species statewide was estimated at 80 to 110 individuals in eight populations. After ample rainfall in the following year, twelve populations totaling thousands of individuals were observed statewide (Medeiros *et al.* 2000). This included 1,000 or more individuals observed in 1998 at Wailena Gulch, West Maui, west of Hakuhee Point (Wood 2009). During the third year, an El Nino current induced drought conditions that produced little to no rainfall in coastal areas, and only 60 to 80 *C. sebaeoides* plants, or less than 1.3 percent of 1997 totals, were documented (Medeiros *et al.* 2000). Five of these populations were mapped with a global positioning system and counted. The numbers of individuals in the remaining seven populations were estimated. Such dramatic population fluctuations are believed to be related to the sporadic occurrence of winter rains (Medeiros *et al.* 2000). The cause of this population decline was mainly due to drought (International Union for Conservation of Nature and Natural Resources 2008).

A new taxonomic treatment of the polyphyletic genus *Centaurium* was published in 2004. This new classification defines monophyletic groups reflecting the phylogenetic relationships within the subtribe Chironiinae of the Gentianaceae family. For this purpose, the establishment of a new genus, *Zeltnera*, along with the reinstatement of the genera *Gyrandra* and *Schenkia*, resulted in numerous new species combinations. Fifteen genera were recognized, to include 108 species. Of them the genus *Schenkia* comprises only five species: *S. spicata* is broadly distributed in Eurasia and north Africa; *S. australis, S. clementii, and S. japonica* are confined to Australia and the Pacific region; while *S. sebaeoides* is the only species endemic to Hawaii (Mansion 2004). Therefore, this species will be referred to as *Schenkia sebaeoides* for the remainder of this review.

Historically, *Schenkia sebaeoides* was known from scattered localities on State and private land on the islands of Kauai, Oahu, Molokai, Lanai, and Maui. At the time of listing in 1991, seven populations on Kauai, Oahu, Molokai, and Maui containing less than 1,000 individuals were known (USFWS 1991). Undiscovered ephemeral

populations of *S. sebaeoides* undoubtedly occur elsewhere. The fact that *S. sebaeoides* resembles several common introduced species, including the naturalized herb *Anagallis arvensis* (scarlet pimpernel), which often occupy the same sites, means that it could be easily overlooked (Medeiros *et al.* 2000). Another species in the genus, *Centaurium erythraea* (bitter herb) is also naturalized and common in Hawaii (Pacific Basin Information Node 2009).

Since critical habitat was designated in 2003 for this species, trends in spatial distribution and population numbers for this species have been updated in some cases by field surveys for the islands of Molokai, Oahu, and Maui, but not Lanai or Kauai. When the recovery plan was published in 1999, *Schenkia sebaeoides* occurred on Kauai in Awaawapuhi Valley, on Kalalau Beach, and on Pohakuao sea cliffs. Kauai's three known populations totaled fewer than 100 individuals, about 4 miles (6 kilometers) apart (USFWS 1999). As of 2003, on Kauai there were a total of three populations with 22 to 52 individuals on State-owned land. This species is found at Puanaiea Point, the caves at Nakeikionaiwi, and Pohakuao within the Na Pali Coast State Park (USFWS 2003a).

In 1999 when the recovery plan was published, on Molokai, the species was known near Mokio Point and Manaeopapa with at least two individuals. Lanai had one population in Maunalei Valley with approximately 23 individuals (Hawaii Biodiversity and Mapping Program 2009; USFWS 1999). As of 2003, on Molokai there were at least two populations containing thousands of individuals, near Mokio Point on privately owned land, and in Kalaupapa National Historical Park, on State-owned land managed by the National Park Service (USFWS 2003b). It was also observed in 2005 at Puu o Kaiakai and Manaeopapa, Molokai (Starr and Starr 2009).

In 1999, on Oahu, the species had persisted at Kaena Point (possibly), and on the slopes above Halona Point with a population consisting of 500 individuals (USFWS 1999). As of 2003, two populations of this species on Oahu were noted with 60 and 80 individuals at Kaena Point and Koko Head on State, and City and County lands (USFWS 2003c). In 2005, 40 to 50 mature individuals, with additional seedlings, were noted at Halona, in Koko Head District Park (Hawaii Biodiversity and Mapping Program 2009).

In 1999, *Schenkia sebaeoides* was also known from West Maui, with one population between Waihee and Makamakaole, one population of one individual at Makamakaole, one population with an unknown number of individuals at Puu Koae, a population of 104 individuals at Pohakupule, a population of 1,636 individuals at Kahakuloa, and a population of 192 individuals at Mokulea (Hawaii Biodiversity and Mapping Program 2009; USFWS 1999). One population of 25 plants was documented by Hank Oppenheimer at Honolua Bay, West Maui, in May 1999 (Medeiros *et al.* 2000). One hundred or more individuals were seen in March 1998 at Wailena Gulch and on sea cliffs east to Hakuhee Point (National Tropical Botanical Garden 2009). In 2003, there were three populations of this species known, with a total of more than 50 individuals, on State and privately owned lands at Kahakuloa Head, Lahoole, and Kupaa Gulch (USFWS 2003d). *Schenkia sebaeoides* was also seen on Maui at Kahakuloa, and Mahinanui in 2005 (Starr and Starr 2009).

Currently, on Kauai there are a total of three populations with approximately 22 to 52 individuals on State-owned land. On Molokai, there are at least four populations containing thousands of individuals. On Oahu, two populations have between 100 to 130 individuals total. On West Maui, the most recent estimates are 7 to 8 populations, with several 1,000 plants. The number of individuals fluctuates dramatically with the seasons. It almost disappears in drought years even within a known location. After rains, it germinates, lives only a couple months, flowers, seeds, and dies. It needs a flooding event to germinate to its potential. For this reason it is perceived as rarer when the weather has been dry (H. Oppenheimer, Plant Extinction Prevention Program, pers comm. 2009). The total number of populations statewide is estimated to be 17 or 18, with as many as 6,000 individuals when rainfall is abundant.

On Molokai, *Schenkia sebaeoides* grows in volcanic or clay soils or on cliffs in arid dune ecosystems at elevations between sea level and 409 meters (0 and 1,341 feet). Associated species include *Artemisia* sp. (ahinahina), *Bidens* sp. (kookoolau), *Chamaesyce celastroides* (akoko), *Cyperus phleoides* (no common name [NCN]), *Dodonaea viscosa* (aalii), *Fimbristylis cymosa* (mauu akiaki), *Heteropogon contortus* (pili grass), *Jacquemontia ovalifolia* (pauohiiaka), *Lipochaeta heterophylla* (nehe), *Melanthera integrifolia* (nehe), *Lipochaeta succulenta* (nehe), *Lycium sandwicense* (ohelo kai), *Lysimachia mauritiana* (kolokolo kuahiwi), *Panicum fauriei* (NCN), *Panicum torridum* (kakonakona), *Scaevola taccada* (naupaka kahakai), *Schiedea globosa* (NCN), *Sida fallax* (ilima), *Sporobolus virginicus* (aki aki), and *Wikstroemia uva-ursi* (akia) (USFWS 2003b). Immediately behind the coastal native vegetation band, invasive introduced plant species, especially *Prosopis pallida* (kiawe), become dominant, extending upslope. Some native communities persist inland, however, including the rare *Tetramolopium rockii* in coastal dry shrubland. Eight of the 38 native plant taxa reported from the Moomomi Preserve on Molokai are rare, including the candidate *Pseudognaphalium sandwicensium* var. *molokaiense* (ena ena), the endangered *Schenkia sebaeoides* and *Marsilea villosa* (ihi ihi), and both varieties of the threatened *Tetramolopium rockii* var. *rockii* (NCN) (USFWS 2003b).

On Kauai, *Schenkia sebaeoides* typically grows in volcanic or clay soils or on cliffs in arid coastal areas at elevations between sea level and 147 meters (483 feet). Associated native plant species include *Artemisia* spp. (ahinahina), *Bidens* spp. (kookoolau), *Chamaesyce celastroides* (akoko), *Cyperus phleoides* (NCN), *Dodonaea viscosa* (aalii), *Fimbristylis cymosa* (mauu akiaki), *Heteropogon contortus* (pili), *Jacquemontia ovalifolia* (pauohiiaka), *Lipochaeta succulenta* (nehe), *Lycium sandwicense* (ohelo kai), *Lysimachia mauritiana* (kolokolo kuahiwi), *Melanthera integrifolia* (nehe), *Panicum fauriei* (NCN), *P. torridum* (kakonakona), *Scaevola taccada* (naupaka kahakai), *Sida fallax* (ilima), and *Wikstroemia uva-ursi* (akia) (National Tropical Botanical Garden 2009; USFWS 2003a).

On Oahu, *Schenkia sebaeoides* typically grows in volcanic or clay soils or on cliffs in arid coastal areas or on coral plains below 368 meters (1,207 ft) elevation. Associated native species include *Artemisia* sp. (ahinahina), *Bidens* sp. (kookoolau), *Jacquemontia*

ovalifolia (pauohiiaka), *Lipochaeta succulenta* (nehe), and *Lysimachia* sp. (kolokolo kuahiwi) (USFWS 2003c).

On Maui, associated native species include *Argemone glauca* (pua kala), *Artemisia australis* (ahinahina), *Bidens mauiensis* (kookoolau), *Chamaesyce degeneri* (akoko), *Chenopodium oahuense* (aheahea), *Cocculus orbiculatus* (huehue), *Pseudognaphalium sandwicensium* (enaena), *Heliotropium curassavicum* (kipukai), *Lycium sandwicense* (ohelo kai), *Lysimachia mauritiana* (NCN), *Cyperus javanicus* (ahu awa), *Melanthera integrifolia* (nehe), *Panicum fauriei* (NCN), *Panicum torridum* (kakonakona), *Portulaca lutea* (ihi), *Psydrax odorata* (alahee), *Scaevola taccada* (naupaka kahakai), *Schiedea globosa* (NCN), *Sesuvium portulacastrum* (akulikuli, sea purslane), and *Sida fallax* (ilima) (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2009; Wood 2009).

The major threats to *Schenkia sebaeoides* on all islands are competition with and overtopping by salt-tolerant, invasive introduced woody plant species, especially *Casuarina* spp. (Factor E); trampling and erosion of habitat by ungulates (Factor A); and damage caused by off-road vehicles (Factor E) (Medeiros *et al.* 2000).

On Molokai, other major threats to this species include competition with invasive introduced woody plant species (Factor E) such as *Casuarina equisetifolia* (ironwood), *Casuarina glauca* (saltmarsh), *Leucaena leucocephala* (koa haole), *Prosopis pallida* (kiawe), *Schinus terebinthifolius* (Christmasberry), *Syzygium cumini* (Java plum), and *Tournefortia argentea* (tree heliotrope); trampling and habitat degradation by feral goats (*Capra hircus*) and cattle (*Bos taurus*) (Factor A); and damage caused by off-road vehicles (Factor E) (USFWS 2003b). Management at Moomomi is currently focused on priority invasive introduced plants: *Prosopis pallida* and *Reichardia tingitana* (NCN), and other invasive introduced species in the sunflower family. *Prosopis pallida* has invaded large portions of the sand dune areas. Removal plot monitoring conducted from 1995 through 2000 showed encouraging natural regeneration of native grasses and herbaceous plants, including a total of seven native species. However, two other introduced invasive species, *Atriplex semibaccata* (Australian saltbush) and *Chenopodium murale* (lambs quarters), have also invaded the removal areas (The Nature Conservancy of Hawaii 2005).

On Maui, competing invasive introduced plant species (Factor E) include *Cynodon dactylon* (Bermuda grass), *Digitaria ciliaris* (crabgrass), and *Pluchea indica* (Indian fleabane) (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2009; Wood 2009).

The major threats to this species on Kauai include habitat degradation by feral goats and cattle (Factor A); competition from invasive introduced plant species (Factor E) including *Casuarina equisetifolia*, *Bryophyllum pinnatum* (airplant), *Furcraea foetida* (Mauritius hemp), *Pluchea carolinensis* (sourbush), *Portulaca pilosa* (pigweed), *Plantago lanceolata* (narrow-leaved plantain), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Prosopis pallida*, *Schinus terebinthifolius*, *Syzygium cumini* (Java plum), and

Tournefortia argentea (tree heliotrope); trampling by humans on or near trails (Factor E); and fire (Factor E) (National Tropical Botanical Garden 2009; USFWS 2003a; Wood 2009).

The major threats to *Schenkia sebaeoides* on Oahu are habitat degradation by feral goats and cattle (Factor A); competition from invasive introduced plant species (Factor E) *Leucaena leucocephala*; trampling by humans on or near trails; and fire (Factor E) (USFWS 2003c). Invasive introduced woody plant species (Factor E) capable of invading and modifying *S. sebaeoides* habitat include *Casuarina equisetifolia*, *C. glauca*, *Leucaena leucocephala*, *Prosopis pallida*, *Schinus terebinthifolius*, *Syzygium cumini*, and *Tournefortia argentea*. Site invasion by *Casuarina* spp. appears to be particularly damaging because of the smothering leaf litter layers that exclude most other plant species. Indirect effects of overgrazing, such as trampling and erosion, are also likely contributors to the decline or disappearance of the species depending on the severity, timing, longevity, and nature of the disturbance. Destruction of plants growing in coastal sites by off-road vehicles (Factor E) may also be an important source of mortality (Medeiros *et al.* 2000).

Climate change may also pose a threat to *Schenkia sebaeoides* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species.

Maui Nui Botanical Garden currently has 100 plants in the nursery and 2,000 seeds in storage from Kahakuloa Head (Maui Nui Botanical Garden 2009). The Center for Conservation Research and Training Seed Storage Facility (2008) has 8,836 seeds in storage. *Schenkia sebaeoides* was outplanted in 2005 at Kanaha Beach on Maui, but apparently no seedlings resulted (Starr and Starr 2009, F. Starr, Starr Environmental, pers. comm. 2009).

Since USFWS listed *Schenkia sebaeoides* (formerly *Centaurium sebaeoides*) as endangered on 29 October 1991, reports of its presence throughout the state have been sporadic and difficult to track, with the exception of the intensive surveying done from 1997 to 1999 (Medeiros *et al.* 2000). Whether the periodic "disappearance" of the species is solely due to fluctuations in winter rainfall or is the result of a combination of additional factors is unknown, but precipitous drops in numbers emphasize the fact that *S. sebaeoides* is at risk. The long-term survival of the species is tenuous because its habitat is currently subject to a variety of detrimental factors including displacement and modification by invasive introduced plants, trampling by feral and domestic ungulates, and heavy recreational use by humans (Medeiros *et al.* 2000). Additionally, because the species inhabits coastal areas and is a determinate annual (is sensitive to day length), global warming may also have detrimental effects (Van Dijk and Hautekeete 2007; Hawkins *et al.* 2008.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the multi-island plants (USFWS 1999), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Schenkia sebaeoides* is an annual, 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 islands where they now occur or occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 100 mature individuals per population.

The interim stabilization goals for this species have probably been met, at least in terms of numbers of individuals and populations, as Molokai has at least four populations and Maui has seven to eight populations, and both islands have individuals numbering in the thousands.

For the taxon to be downlisted from endangered to threatened status, a total of five to seven populations should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 500 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

The downlisting goals for this species have not been met (see Table 1), because although one island (Maui) has seven to eight populations with individuals numbering in the thousands, it is unknown whether there are five populations with at least 500 individuals each. Due to the ephemeral nature of some populations and the observed year to year fluctuations of population numbers, these estimated numbers cannot be assumed to have persisted for five consecutive years. In addition, all threats are not being managed. Therefore, *Schenkia sebaeoides* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Construct exclosures and remove ungulates in wild populations.
- Control invasive introduced plant species in wild populations.
- Develop and implement fire management plans for populations at risk of fire.
- Monitor populations which are fluctuating or ephemeral based on rainfall, since the former presence of the species at a given location would indicate that a seed bank might be present.
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.
- Collect material for genetic storage and propagation for reintroduction.

- 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.

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Table 1. Status of *Schenkia sebaeoides* from listing through 5-year review.

Date	No. wild indivs.	No. outplanted	Downlisting Criteria identified in Recovery Plan	Stability Criteria Completed?
1991 (listing)	>1,000	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 500 mature individuals each	No
1999 (recovery plan)	>580-2,250	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 500 mature individuals each	No
2003 (critical habitat)	212-thousands	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 500 mature individuals each	No
2009 (5-year review)	6,000	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	Partially
			5-7 populations with 500 mature individuals each	No

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Centaurium sebaeoides* (awiwi)

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

Field Supervisor, Pacific Islands Fish and Wildlife Office

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Date AUG 2 7 2010