

Sesbania tomentosa
(ohai)

**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: *Sesbania tomentosa* (ohai)

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5-YEAR REVIEW
***Sesbania tomentosa* (ohai)**

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia,
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Lead Field Office:

Pacific Islands Fish and Wildlife Office, Loyal Mehrhoff, Field Supervisor, (808)
792-9400

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 29, 2008. The review was based on the final critical habitat designation for *Sesbania tomentosa* and other species from the islands of Kauai, Niihau, Oahu, Molokai, Maui, Kahoolawe, Hawaii, and the Northwest Hawaiian Islands, as well as a review of current, available information (USFWS 2003a-f). The National Tropical Botanical Garden provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next 5-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.

1.3 Background:

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

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

1.3.2 Listing history

Original Listing

FR notice: USFWS. 1994. Endangered and threatened wildlife and plants; endangered status for 12 plants from the Hawaiian Islands; final rule. Federal Register 59(217):56333-56351.

Date listed: November 10, 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 rule makings :

U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 95 plant species from the islands of Kauai and Niihau, Hawaii; final rule. Federal Register 68(39):9116-9479.

U.S. Fish and Wildlife Service. 2003b. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 101 plant species from the island of Oahu, Hawaii; final rule. Federal Register 68(116):35949-35998.

U.S. Fish and Wildlife Service. 2003c. Endangered and threatened wildlife and plants; final designations and nondesignations of critical habitat for 42 plant species from the island of Molokai, Hawaii; final rule. Federal Register 68(52):12982-13141.

U.S. Fish and Wildlife Service. 2003d. Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the islands of Maui and Kahoolawe, Hawaii; final rule. Federal Register 68(93):25934-26165.

U.S. Fish and Wildlife Service. 2003e. 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.

U.S. Fish and Wildlife Service. 2003f. Endangered and threatened wildlife and plants; designation of critical habitat for five plant species from the

Northwestern Hawaiian Islands, Hawaii; final rule. Federal Register 68(99):28054-28075.

Critical habitat was designated for *Sesbania tomentosa* in two units totaling 91 hectares (224 acres) on Kauai (USFWS 2003a), two units totaling 107 hectares (262 acres) on Oahu (USFWS 2003b), two units totaling 146 hectares (360 acres) on Molokai (USFWS 2003c), two units totaling 117 hectares (1,209 acres) on Maui (USFWS 2003d), two units totaling 1,289 hectares (3,185 acres) on Hawaii island (USFWS 2003e), and two units totaling 88 hectares (217 acres) on Nihoa and Necker islands in the Northwest Hawaiian islands (USFWS 2003f). Critical habitat was not designated for *S. tomentosa* on Kahoolawe because there was a lower likelihood that the biological features essential to these species would persist there because it had a low likelihood of being managed for conservation and it had a lower proportion of associated native species than other areas considered to be essential to the conservation of this species (USFWS 2003d). Critical habitat was not designated on Lanai because it was considered not essential for the conservation of the species; there were at least eight other places for this species that have more primary constituent elements or were less degraded, were already undergoing restoration, or were within a partnership, Natural Area Reserve, TNCH preserve, or on a refuge (USFWS 2003g). In addition, there were ten other locations that were designated to meet the recovery goal of eight to ten populations throughout their historical ranges on this and other islands (USFWS 2003d,g). These determinations may be revisited.

1.3.4 Review History:

Species status review [FY 2009 Recovery Data Call (August 2009)]:
Improving

Recovery achieved:

1 (0-25%) (FY 2007 Recovery Data Call – this was the last year this was reported)

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

8

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: Recovery plan for multi-island plants. U.S. Fish and Wildlife Service, Portland, Oregon. 206 pages, plus appendices.

Date issued: July 10, 1999.

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

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

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 criteria?

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 (Factors A, C, D, and E) affecting this species is presented in section 2.4. Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

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. *Sesbania tomentosa* is a short-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, weeding, etc.) and be represented in an *ex situ* (off-site) 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 50 mature individuals per population.

This recovery objective has been met for numbers of mature individuals.

For downlisting, a total of five to seven populations of *Sesbania tomentosa* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 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 *Sesbania tomentosa* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for short-lived perennials. 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

In addition to the status summary table below, information on the species' status and threats was included in the final critical habitat rule referenced above in section 1.3.3 ("Associated Rulemakings") and in section 2.4 ("Synthesis") below, which also includes any new information about the status and threats of the species.

Table 1. Status of *Sesbania tomentosa* from listing through 5-year review.

Date	No. wild individuals Main islands/NWHI	No. outplanted	Downlisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
1994 (listing)	2,600-2,700/several thousand	0	All threats managed in all 5-7 populations	No
			Complete genetic storage	No
			5-7 populations with 300 mature individuals each	No
			Naturally reproducing, stable, and increasing in number	Unknown
			Stable for five consecutive years	Unknown
1999 (recovery plan)	2,000-3,000/several thousand	200	All threats managed in all 5-7 populations	Partially
			Complete genetic storage	Partially
			5-7 populations with 300 mature individuals each	No
			Naturally reproducing, stable, and increasing in number	Unknown
			Stable for five consecutive years	Unknown
2003 (critical habitat)	~2,700/several thousand	200	All threats managed in all 5-7 populations	Partially
			Complete genetic storage	Partially
			5-7 populations with 300 mature individuals each	No
			Naturally reproducing, stable, and increasing in number	Unknown
			Stable for five consecutive years	Unknown
2009 (5-year review)	1,600-	128-419	All threats managed in	Partially

review)	2,000/1,000-5,500		all 5-7 populations	
			Complete genetic storage	Partially
			5-7 populations with 300 mature individuals each	No
			Naturally reproducing, stable, and increasing in number	Unknown
			Stable for five consecutive years	Unknown

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

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:

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

2.3.1.4 Taxonomic classification or changes in nomenclature:

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.):

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

2.3.1.7 Other:

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:

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

2.3.2.3 Disease or predation:

2.3.2.4 Inadequacy of existing regulatory mechanisms:

2.3.2.5 Other natural or manmade factors affecting its continued existence:

2.4 Synthesis

Studies of *Sesbania tomentosa* individuals at Kaena Point on Oahu revealed that *Hylaeus* species are the primary pollinators, with *Apis* species (American honey bee) primarily acting as nectar robbers (Hopper 2002).

Sesbania tomentosa has been reported as cultivated and naturalized in the tropics. The first specimen was collected in 1982 in Gurabo at an Agricultural Experiment Station (M. Caraballo, University of Puerto Rico, pers. comm. 2009), and it has been reported as naturalized in the towns of Gurabo and Lajas in Puerto Rico (Liogier 1988; Liogier and Martorell 2000).

The importance of a mycorrhizal fungus and phosphorus to the growth of *Sesbania tomentosa* was demonstrated in experiments where three levels of soil phosphorus and inoculation were used to grow seedlings in a greenhouse in native soils. The shoot dry mass of *S. tomentosa* plants increased significantly in response to mycorrhizal inoculation and to increasing soil phosphorus concentrations. There was a significant interaction between phosphorus and inoculation, indicating that the extent of increase in biomass resulting from inoculation depended upon the concentration of phosphorus in soil-solution. The experimental results also indicated that increased root and shoot mass and leaf phosphorus in response to inoculation were lost at the highest phosphorus concentration levels. The shoot dry mass of inoculated plants was 2.2 times greater than that of the non-inoculated plants at both of the lower soil phosphorus concentrations. This research suggests that *S. tomentosa* forms beneficial associations with mycorrhizal fungus when the plant is growing in soils with low phosphorus levels (Gemma *et al.* 2002).

The individuals of *Sesbania tomentosa* which grow at Mahana Bay's Green Sand Beach, at Papakolea, near South Point on the island of Hawaii are yellow-flowered (Wood 2009), a characteristic that apparently comes true from seed (National Tropical Botanical Garden 2009a). In contrast, flowers at Moomomi Beach on Molokai are deep red (Wood 2009), and flowers at Mana near Polihale on Kauai are salmon orange (Wood 2009).

On Necker Island, *Sesbania tomentosa* provides habitat for nesting red footed boobies (*Sula sula*), and sooty terns (*Sterna fuscata*). Associated species here include *Chenopodium oahuense* (aweoweo), *Panicum torridum* (kakonakona), *Portulaca*

lutea (ihi), and *Sesuvium portulacastrum* (akulikuli) (National Tropical Botanical Garden 2009a).

Historically, *Sesbania tomentosa* occurred on all eight of the main Hawaiian Islands and on the Northwestern Hawaiian Islands of Nihoa and Necker. Currently, *S. tomentosa* occurs on Kauai, Oahu, Molokai, Maui, Kahoolawe, Hawaii, Nihoa, and Necker. Although once found on Niihau and Lanai, it is no longer extant on those islands (USFWS 1999). At the time the recovery plan was written, populations of *S. tomentosa* on the main Hawaiian Islands contained an estimated 2,000 to 3,000 individuals. In the Northwestern Hawaiian islands, the largest population occurred on Nihoa and consisted of several thousand individuals (USFWS 1999). Currently, the estimated number of individuals in the main Hawaiian islands are 1,600 to 2,000 individuals and in the Northwest Hawaiian islands at 5,500 individuals, for a total of approximately 2,500 to 7,500 individuals in approximately 20 populations.

On Kauai, *S. tomentosa* was known from one occurrence, with 11 individuals, on State-owned land at Polihale State Park (USFWS 2003a). The population structure and numbers have changed in response to weather and threats, but the trend is a slow decline, although a seed bank remains in the soil. In 2004, 16 mature, 3 immature, and 1 seedling were counted, while later in the same year 13 mature, 2 immature, 1 seedling, and 3 dead individuals were tallied (National Tropical Botanical Garden 2009a). In early 2005, 7 mature and 27 immature individuals were counted. Later in that year 5 mature, 13 immature, 5 seedlings, and 17 dead individuals were counted (National Tropical Botanical Garden 2009a). In 2006, 9 mature, 12 immature, 19 seedlings, and 17 dead individuals were observed, while later that year 6 mature, 11 immature individuals, 3 seedlings, and 1 dead individual were seen (National Tropical Botanical Garden 2009a). In 2007, National Tropical Botanical Garden botanists counted 12 mature, 2 immature, 2 seedlings, and 13 dead individuals (National Tropical Botanical Garden 2009a), and in 2008 they counted only 2 mature, 3 immature, and 7 seedlings (National Tropical Botanical Garden 2009a; Wood 2009). A separate population of one individual of a somewhat different phenotype with salmon orange flowers was observed on the uphill side of lower Saki Mana Road, on the way into Polihale Beach about two miles (3.2 kilometers) off the main road, in a plantation drainage ditch in 2003 (National Tropical Botanical Garden 2009a; Wood 2009). It has not been seen in subsequent visits, but seed collected there has been propagated and subsequent generations outplanted elsewhere on Kauai at the Makauwahi Cave Reserve, where there are currently 27 mature individuals. Many volunteer seedlings have been produced around these plants, and some of them are now mature and reproducing themselves, suggesting that inbreeding depression has not been an issue so far (D. Burney, National Tropical Botanical Garden, pers. comm. 2008).

On Oahu, *Sesbania tomentosa* is known from 3 populations of 54 to 55 wild and approximately 200 outplanted individuals on State-owned land within the Kaena Point Natural Area Reserve and from Keawaula on State and private lands (USFWS 2003b). In 2007, approximately 75 individuals were counted at Kaena Point (D.

Cole, University of Hawaii at Manoa, pers. comm. 2008). In 2008, Steve Perlman of the National Tropical Botanical Garden observed five individuals near Kaena Point about 0.5 miles from the point along a dirt road on the Waianae side, above a natural arch by the ocean (National Tropical Botanical Garden 2009a).

On Molokai, *Sesbania tomentosa* was known from the south slopes of central Molokai from Kamiloloa to Makolelau and along Molokai's northwest coast from Moomomi to east of Hinanaulua. In 1999, these 4 populations on private and State-owned land from Kamiloloa to Makolelau totaled fewer than 2,000 individuals and grew in a 7- by 3- kilometer (4.5- by 2- mile) area. Three populations from Moomomi to east of Hinanaulua consisted of about 100 to 150 individuals growing on State and private land from sea level to 60 meters (0 and 200 feet) elevation in a 5- by 1- kilometer (3- by 0.5- mile) area. The Hawaii Division of Forestry and Wildlife's 10 acre (four hectare) Ohai Plant Sanctuary enclosure at Kamiloloa protected a population of several hundred plants (USFWS 1999). In lower Makolelau, above the subdivision the Kakahaia Natural Wildlife Refuge, near a water tank, in lowland mesic shrubland, Wood observed about 100 individuals in 1999 (Wood 2009). In 2003, *Sesbania tomentosa* was known from 9 populations with over 2,000 individuals, occurring from Moomomi to Nenehanaupo and from Kamiloloa to Makolelau on State- and privately owned lands (USFWS 2003c). On Oni Oni Road in a new subdivision there appeared to be hundreds of individuals in 2005 (Tangalin 2009). In 2007, 15 wild individuals and no seedlings were counted at Moomomi (Tangalin 2009). In 2007, another botanist estimated 1,000 individuals at the Kamiloloa - Kawela Plantation location and 35 at Moomomi (D. Cole, pers. comm. 2008).

On Maui, *Sesbania tomentosa* was known only from 7 populations in two areas on West Maui and two areas on East Maui, with a total of 83 individuals (USFWS 2003d). On West Maui, the occurrences were located in the Lihau section of the West Maui Natural Area Reserve, where one individual grew on State-owned land below Lihau Peak. *Sesbania tomentosa* also occurred on a 6-kilometer (4- mile) stretch of the northeast coast of West Maui, from the lighthouse near Nakalele Point to Puu Kahulianapa. There a cluster of 4 populations contained an estimated 50 to 75 individuals at Olowalu, between Kahakuloa Head and at Puu Kahulianapa, Mahinanui, and Mokolea Point. Eight plants were seen at Kahakuloa Town, past the bell stone on the makai side of the road above the sea cliffs at 46 meters (150 feet) elevation (Tangalin 2009). A few plants remained in the Mokolea Point enclosure on State land, but these haven't been seen in several years (H. Oppenheimer, Plant Extinction Prevention Program, pers. comm. 2009). On East Maui, *Sesbania tomentosa* occurs on the southeastern slopes of Pimoe cinder cone, south of Puu Puou, at 450 and 500 meters (1,480 to 1,640 feet) elevation. This population consisted of 13 individuals located on the Hawaii National Guard Kanaio Training Area (USFWS 1999). In 2007, a total of 10 individuals were known from Puu Pimoe to Kanaio and 80 from Papanalaho to Nakalele Point (D. Cole, pers. comm. 2008). The Papanalaho Point population could be lower in numbers, from 45-50 individuals, including some seedlings. Most of the individuals there are in an

exclosure fenced by the Native Hawaiian Plant Society. Another small population near the lighthouse on private land was rediscovered as seedlings, and fenced, but their current status is unknown (H. Oppenheimer, pers. comm. 2009). *Sesbania tomentosa* also occurs in the Hana Forest Reserve (USFWS 2003d).

Off the south central coast of Kahoolawe, on a small islet, Puu Koa, which is a State-owned seabird sanctuary, rather dramatic fluctuations in the population of *Sesbania tomentosa* have been noted (Wood 2009). It appears that drought has caused this fluctuation. Before a drought in 2000, there were around 70 mature individuals, 15 immature individuals, and 15 seedlings. After the drought there appeared to be only one mature individual and 300 seedlings. Later there was a single mature individual with about 70 dead individuals. Seedling abundance is related to the heavy rains, but seedling survivorship depends on continued rainfall. Approximately 100 individuals of *S. tomentosa* were reported in 2003 (USFWS 2003d). Ken Wood of the National Tropical Botanical Garden observed 300 to 400 individuals in 2008 (National Tropical Botanical Garden 2009a; Wood 2009).

On the island of Hawaii, *Sesbania tomentosa* is known from two regions of the southeast coast and two areas along the northwestern coast. On the southeastern coast it occurs along 16 kilometers (ten miles) of coastline between Ka Lae and Kaalela. This cluster of populations grows between sea level and 25 meters (0 and 80 feet) elevation. As of 2007, 9 individuals were counted at Kamilo Point, 75 at Ka Lae to Mahana Bay, and 25 at Ka Lae Lighthouse (D. Cole, pers. comm. 2008). At a visit in January of 2009 to the sites at the South Point area, State botanists were only able to find 50 to 60 individuals (Kamilo 5, Mahana 22, and the lighthouse 28). The surveys didn't cover the whole coastline, and thus there are potentially more individuals.

The second cluster of five populations of *Sesbania tomentosa* on the island of Hawaii occurs in Hawaii Volcanoes National Park, including, as of 1999, Apua Point/Kahue, near sea level, with 80 individuals; Kipuka Nene, at 853 to 884 meters (2,800 to 2,900 feet) elevation with two subpopulations totaling 17 individuals; Kipuka Pepeiau and the adjacent area above Kukalauula Pali, at 270 to 660 meters (900 to 2,150 feet) elevation with 21 individuals; at Kamooalii, between 30 and 180 meters (100 and 600 feet) elevation, with 43 individuals; and Kuee in the far western lowlands of the Park where 16 individuals occurred at 30 to 230 meters (100 to 750 feet) elevation. This cluster of populations on federally owned land totaled 177 individuals in 1999 (USFWS 1999). In 2003, one population of 10 to 15 individuals existed within Hawaii Volcanoes National Park in the Pahala watershed at Waiwelawela Point and Halemaoli Point. A second population of 50 to 65 individuals grew at Kipuka Nenea in the Kapapala watershed (USFWS 2003e). A total of 170 individuals were thought to grow in the Hawaii Volcanoes National Park as of 2007 (D. Cole, pers. comm. 2008). On the northwestern coast a single individual occurred at 30 meters (100 feet) elevation on private land at Kaupulehu. The other northwest coast population is also on private land at Waiakailio, and consisted of 8 individuals with several seedlings at 300 meters (1,000 feet) elevation (USFWS 1999).

In the Northwest Hawaiian islands, this species has been described as relatively common in some areas, with one population on Nihoa, at an elevation of 91 meters (299 feet) below Dog's Head, on an east facing slope above Derby Beach, consisting of several thousand plants seen in 2004 (National Tropical Botanical Garden 2009a). In 2006, a conservative estimate of 5,000 *Sesbania tomentosa* individuals was made (Tangalin 2009). In 2007, about 1,000 plants were observed (D. Cole, pers. comm. 2008). On Necker, *S. tomentosa* is known from the tops of all hills of the main island. Hundreds of individuals were reported from Bowl Hill summit crest in 2004 (National Tropical Botanical Garden 2009a). A few individuals are found on the Northwest Cape as well (USFWS 2003f).

Genetic studies of *Sesbania tomentosa* are currently underway at the University of Hawaii, but results have not yet been published (D. Cole, pers. comm. 2008). Some revisions of the taxon *S. tomentosa* may occur as a result of this study (D. Cole, pers. comm. 2008).

On Kauai, *Sesbania tomentosa* is found on sandy beaches, dunes, or pond margins at sea level to 212 meters (0 and 694 feet) elevation, in *Scaevola taccada* (naupaka) shrubland or mixed coastal dry shrubland and dry cliffs with associated native plant species *Boerhavia repens* (alena), *Cassytha filiformis* (kaunaoa pehu), *Chamaesyce celastroides* var. *stokesii* (akoko), *Cuscuta sandwichiana* (kaunaoa), *Dodonaea viscosa* (aalii), *Heteropogon contortus* (pili), *Ipomoea imperati* (hunakai), *Myoporum sandwicense* (naio), *Nama sandwicensis* (hinahina kahakai), *Ophioglossum polyphyllum* (pololei), *Panicum niuhauense* (lauehu), *Sida fallax* (ilima), *Sporobolus virginicus* (aki aki), *Vitex rotundifolia* (kolokolo kahakai), and *Waltheria indica* (uhaloa) (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003a; Wood 2009).

On Oahu, *Sesbania tomentosa* is found on cliff faces, broken basalt, and sand dunes with rock outcrops in *Scaevola taccada* coastal dry shrubland and *Sporobolus virginicus* mixed grasslands between sea level and 152 meters (0 and 499 feet) elevation. Associated native plant species include *Boerhavia repens*, *Chamaesyce celastroides* var. *kaenana* (akoko), *Chamaesyce degeneri* (akoko), *Fimbristylis cymosa* (mauu aki aki), *Heliotropium anomalum* (ahinahina), *Jacquemontia ovalifolia* (pau o Hiiaka), *Melanthera* sp. (nehe), *Myoporum sandwicense*, *Sida fallax*, and *Vitex rotundifolia* (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003b; Wood 2009).

On Molokai, *Sesbania tomentosa* is found in *Scaevola taccada* - *Sida fallax* mixed coastal dry shrubland on windswept slopes, sea cliffs and weathered basaltic slopes between sea level and 516 meters (0 and 1,692 feet) in elevation. Associated plant species include *Chamaesyce degeneri*, *Chamaesyce skottsbergii* (akoko), *Dodonaea viscosa*, *Jacquemontia ovalifolia*, *Lipochaeta lavarum* (nehe), *Melanthera integrifolia* (nehe), *Sida fallax*, *Sporobolus virginicus*, and *Waltheria indica* (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003c; Wood 2009). On Oni Oni Road in a new subdivision, *S. tomentosa* is found in disturbed scrubland with

Leucaena leucocephala (haole koa), *Erythrina sandwicensis* (wiliwili), and *Prosopis pallida* (kiawe) (Tangalin 2009). At Moomomi Preserve, *Sesbania tomentosa* is found in *Sida fallax* (ilima) dominated coastal strand with *Boerhavia repens*, *Chamaesyce degeneri*, *C. skottsbergii* var. *skottsbergii*, *Chenopodium oahuense* (aheahea), *Cuscuta sandwichiana* (kaunaoa), *Fimbristylis cymosa*, *Heliotropium anomalum* var. *argenteum* (hinahina), *Ipomoea pes-caprae* (pohuehue), *Jacquemontia ovalifolia*, *Lipochaeta integrifolia*, *Nama sandwicensis*, *Pseudognaphalium sandwicense* var. *molokaiense* (ena ena), *Sesuvium portulacastrum* (akulikuli), *Sporobolus virginicus*, and both varieties of the threatened *Tetramolopium rockii* (no common name [NCN]) (Tangalin 2009).

On Maui, *Sesbania tomentosa* is found on windswept slopes, sea cliffs, and cinder cones in *Scaevola taccada* coastal dry shrub lands at sea-level and 608 meters (0 and 1,993 feet) elevation and containing one or more of the following associated native plant species: *Bidens* spp. (kookoolau), *Chamaesyce degeneri*, *Diospyros sandwicensis*, stunted *Dodonaea viscosa*, *Fimbristylis cymosa*, *Jacquemontia ovalifolia* subsp. *sandwicensis* (pau o Hiaka), *Lycium sandwicense* (ohelo kai), *Melanthera integrifolia*, *Osteomeles anthyllidifolia* (ulei), and *Sida fallax* (Tangalin 2009; USFWS 2003d). At Kanaio, East Maui *Sesbania tomentosa* is found at 433 meters (1,420 feet) elevation in introduced plant vegetation, degraded *Dodonaea viscosa* shrubland with *Argemone glauca* (pua kala), *Erythrina sandwicensis*, *Leptecophylla tameiameia* (pukiawe), and *Lipochaeta lavarum*. On West Maui north of Kahakuloa Bay, Mokolea Point, *Sesbania tomentosa* is in a fenced enclosure in coastal dry shrubland with *Scaevola taccada*, *Lipochaeta integrifolia*, *Jacquemontia ovalifolia*, *Fimbristylis cymosa*, *Osteomeles anthyllidifolia*, and *Sida fallax* (National Tropical Botanical Garden 2009a; Tangalin 2009; Wood 2009).

On Kahoolawe, *Sesbania tomentosa* grows in dry herb- and grassland with *Argemone glauca* var. *glauca*, *Artemisia australis* (ahinahina), *Bidens mauiensis* (kookoolau), *Capparis sandwichiana* (maiapilo), *Chamaesyce celastroides* var. *amplectens* (akoko), *Doryopteris decipiens* (kumuniu), *Eragrostis leptophylla* (love grass), *Heteropogon contortus*, *Ipomoea tuboides*, *Jacquemontia ovalifolia* subsp. *sandwicensis*, *Melanthera lavarum*, *Merremia aegyptia* (kuahulu), *Panicum torridum* (kakonakona), *Panicum fauriei* var. *latius* (NCN), *Portulaca molokiniensis* (ihi), *Sesuvium portulacastrum*, *Sida fallax*, and *Waltheria indica* (National Tropical Botanical Garden 2009a; Wood 2009)

On the island of Hawaii, *Sesbania tomentosa* grows in *Scaevola taccada* shrubland with *Sida fallax*, *Fimbristylis cymosa*, *Heliotropium* sp., *Jacquemontia ovalifolia*, *Lipochaeta integrifolia*, *Portulaca villosa*, and *Sporobolus virginicus* (Perlman 2009), or in *Sida fallax* mixed coastal dry shrubland, with *Heliotropium curassavicum* (kipukai) and *Waltheria indica* (Wood 2009).

In the Northwest Hawaiian islands, *Sesbania tomentosa* is found in shallow soil on sandy beaches and dunes in *Chenopodium oahuense* coastal dry shrubland or mixed coastal dry cliffs at elevations up to 84 meters (276 feet) (Hawaii Biodiversity and

Mapping Program 2009). Associated plant species on Nihoa include *Chamaesyce celastroides*, *Chenopodium oahuense*, *Eragrostis variabilis* (kawelu), *Heliotropium curassavicum*, *Portulaca villosa* (ihi), *Pritchardia remota* (loulou), *Scaevola taccada*, *Sida fallax*, *Solanum nelsonii* (popolo), *Schiedea verticillata* (NCN), and *Tribulus cistoides* (nohu) (National Tropical Botanical Garden 2009a; USFWS 2003f). On Nihoa, *S. tomentosa* is rarely dominant between 9.1 to 46 meters (30 to 150 feet) elevation and otherwise co-dominant with *Solanum* spp. up to about 91 meters (300 feet) elevation and scattered elsewhere (Tangalin 2009). *Sesbania tomentosa* provides habitat for nesting red footed boobies (*Sula sula*), and sooty terns (*Sterna fuscata*). On Necker, associated species include *Chenopodium oahuense*, *Panicum torridum*, *Portulaca lutea* (ihi), and *Sesuvium portulacastrum* (National Tropical Botanical Garden 2009a).

The primary threats to *Sesbania tomentosa* on Kauai are habitat degradation caused by competition with various invasive introduced plant species (Factor E) including *Cenchrus ciliaris* (buffelgrass), *Chloris barbata* (swollen fingergrass), *Digitaria insularis* (sourgrass), *Leucaena leucocephala* (haole koa), *Pluchea carolinensis* (sourbush), *P. indica* (Indian fleabane), *Portulaca pilosa* (Pink purslane), *Prosopis pallida* (kiawe), and *Verbesina encelioides* (golden crown-beard). Other threats include lack of adequate pollination (Factor E); fire (Factor E); destruction by off-road vehicles (Factor A); other human disturbances (Factor A); and storms (Factor E) (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003a; Wood 2009).

The primary threats to *Sesbania tomentosa* on Oahu are competition with invasive introduced plant species (Factor E) including, *Acacia farnesiana* (klu), *Leucaena leucocephala*, *Lantana camara* (lantana), and *Pluchea carolinensis*; lack of adequate pollination (Factor E); fire (Factor E); trampling by hikers, motorcycles, and all-terrain vehicles (Factor A); road widening (Factor A); and a risk of extinction from naturally occurring events like tsunami or hurricanes (Factor E); and/or reduced reproductive vigor due to the small number of occurrences and individuals (Factor E) (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003b).

The primary threats to *Sesbania tomentosa* on Molokai are competition with various invasive introduced plant species (Factor E), such as *Atriplex semibaccata* (Australian saltbush), *Cenchrus ciliaris*, *Chenopodium murale* (pigweed), *Cynodon dactylon* (Bermuda grass), *Dactyloctenium aegyptium* (beach wiregrass), *Digitaria ciliaris* (crabgrass), *Lantana camara*, *Leucaena leucocephala*, *Prosopis pallida*, and other invasive introduced grass species; habitat degradation by feral cattle (*Bos taurus*) (Factor A); lack of adequate pollination (Factor E); destruction by random environmental events such as fire (Factor E); and off-road vehicles (Factor A) (Perlman 2009; USFWS 2003c).

The primary threats to *Sesbania tomentosa* on Maui are habitat degradation caused by competition with various invasive introduced plant species (Factor E) such as *Casuarina equisetifolia* (common ironwood), *Chamaecrista nictitans* (partridge pea),

Cynodon dactylon, *Digitaria ciliaris*, *Lantana camara*, *Leucaena leucocephala*, *Nicotiana glauca* (tree tobacco), *Oplismenus* sp. (basketgrass), *Melinis repens* (Natal redtop), *Schinus terebinthifolius* (Christmasberry), and various other invasive introduced grass species; lack of adequate pollination (Factor E); fire (Factor E); and destruction by off-road vehicles and other human disturbances including construction (Factor E) (Tangalin 2009; USFWS 2003d; Wood 2009).

Threats to *Sesbania tomentosa* on Kahoolawe include habitat degradation caused by competition with various invasive introduced plant species (Factor E) such as *Atriplex semibaccata*, *Cenchrus ciliaris*, *Chloris barbata*, *Setaria parviflora* (marsh bristlegrass), *Melinis repens*, *Nicotiana glauca*, *Portulaca oleracea* (pigweed), and *Tragus berteronianus* (bur grass); and drought and erosion (National Tropical Botanical Garden 2009a; Perlman 2009; USFWS 2003d; Wood 2009).

Threats to *Sesbania tomentosa* on the island of Hawaii include habitat degradation caused by competition with various invasive introduced plant species (Factor E) such as *Atriplex semibaccata*, *Cenchrus ciliaris*, *Cynodon dactylon*, *Chloris barbata*, *Dactyloctenium aegyptium*, *Lantana camara*, *Portulaca pilosa*, and *Prosopis pallida* (Perlman 2009; Wood 2009). Human disturbance, including human and vehicle trampling (Factor E), and goats (*Capra hircus*) (Factors A and C) near the Kamilo site are also threats (K. Bio, Plant Extinction Prevention Program, pers. comm. 2009).

The primary threats to *Sesbania tomentosa* on Nihoa and Necker include competition with various invasive introduced plant species (Factor E), lack of adequate pollination, drought, and fire (Factor E) (National Tropical Botanical Garden 2009a; USFWS 2003f).

Trampling and destruction by off-road vehicles at a number of beaches is a major cause of mortality for this species (Factor A). Observations since 2004 at Polihale State Park on Kauai include two adult plants that were run over and killed by four-wheel-drive vehicles and one adult plant which may have died first and then was run over, but could have died from wheel impacts. There is another procumbent adult that has been run over several times and continues to live. Its main trunk is buried in the sand which may be how it survives. Four-wheel-drive vehicles and more maneuverable all-terrain-vehicles have cut new roads into *Sesbania tomentosa* habitat and disturbed areas where *S. tomentosa* patches have died out and where seedlings are most likely to regenerate. Four-wheel-drive vehicles have taken a huge toll on seedling regeneration and habitat, but have not always led to the mortality of adult plants (USFWS 1999, 2003a,b,c,d,e; Wood 2009).

At Polihale, threats include seed predation by rats (*Rattus* spp.) and mice (*Mus* spp.) (Factor C); and introduced insects including twig borers, black ants, and scale have been observed (Factor C) (National Tropical Botanical Garden 2009a). On Maui, grazing and trampling by feral cattle (Factor A) and seed predation by rats, mice, and, potentially, introduced insects are threats (Factor C) (USFWS 2003d; Wood 2009). These are also threats to Oahu's *Sesbania tomentosa* populations (National Tropical

Botanical Garden 2009a; Perlman 2009; USFWS 2003b) as well as those on Molokai (USFWS 2003c). In the Northwestern Hawaiian Islands, potential introduction of rats and mice (Factor C), and predation by nonnative insects (Factor C), are threats (National Tropical Botanical Garden 2009a; USFWS 2003f).

The *Sesbania tomentosa* population at Polihale State Park on Kauai is declining rapidly due also to an infestation of scale insects (Factor C) believed to be *Neolecanium cornuparyum* (magnolia scale). The scales were first observed in August of 2004. Ongoing field surveys by a botanist from the National Tropical Botanical Garden show a steady decline in the number of adult plants. Almost all of the larger plants (1.5 to 2 meters (5 to 7 feet)) have died, leaving smaller, younger adults which produce fewer seeds and are more likely to be run over by all-terrain vehicles. The potential of this pest to impact *S. tomentosa* was not known at the time of initial observations because the plants were entering a normal dormant phase following seed set (Tangalin and Fulton 2005). Black ants and scales are observed only on immature individuals 30 centimeters (12 inches) or more in height. The larger adult plants are most heavily infested. Eleven of the fifteen original mature individuals observed in 2004 appear to have been killed by scales. Exoskeletons of a round scale and threadlike white scale fill the grooves of the bark. Two of the original fifteen trees were run over by four-wheel-drive vehicles or all-terrain vehicles and the remaining two are feeble and infested with ants and scales. After a wet year, there were many surviving immature individuals. Immature individuals seem less susceptible to scales. An integrated pest management approach was proposed to the State Park by National Tropical Botanical Garden staff. It would begin with treatment of affected plants with diatomaceous earth, a non-toxic pesticide, followed by application of an insect growth regulator which controls white flies, fungus gnats, and other pests of foliage and ornamental plants. Lastly, a systemic insecticide would be applied quarterly to plant roots for uptake to prevent future infestations (Tangalin and Fulton 2005).

The gray bird grasshopper (*Schistocerca nitens*) has occurred on the main Hawaiian Islands since 1964 and was first reported from Nihoa in 1977. In 2002 to 2004, there was an outbreak of this grasshopper that compounded the effects of drought and denuded most of the island's vegetation (Factor C). Since then, grasshopper numbers have crashed, most probably due to insufficient soil moisture for embryonic development (Latchininsky 2008). On Nihoa in April 2006, the population was healthy with no sign of predation by the grasshopper. Insect damage (Factor C) was also observed on Molokai at Oni Oni Road in a new subdivision where many *Sesbania* individuals were skeletal and dead, though with no obvious scale. A few individuals had white triangular sucking insects and holes in the stems (Factor C) (Tangalin 2009).

In addition, the introduced aphid species *Aphis craccivora* has been observed feeding on *Sesbania tomentosa* (Factor C). Aphids feeding on Hawaiian plants are known to vector numerous plant viruses. To date, there is no evidence that invasive aphids are having major effects on the survival or reproduction of native Hawaiian plants.

Given aphid biology and the efficiency with which these insects vector devastating viral diseases, documentation of aphid feeding on endemic plants calls for increased vigilance to prevent the incursion of additional aphid species and renewed biological control efforts to mitigate the impacts of existing species (Messing *et al.* 2007).

A study of hybridization between native and introduced plant species (Daehler and Carino 2001) indicates a potential risk to *Sesbania tomentosa* (Factor E). It noted that small populations of rare native species are particularly susceptible to cross pollination from introduced plant species, but that even larger populations can be affected over time. *Sesbania sesban* (river hemp), introduced from Asia where it is used as a forage crop and green manure, is rated as a high invasion risk (Pacific Island Ecosystems at Risk 2008) and does hybridize with *Sesbania tomentosa* (Daehler and Carino 2001). However field observations of such hybridization have not been reported.

Off road driving of all-terrain vehicles, dirt bikes, and sand dune buggies is extremely popular in Hawaii. While their use has been identified as damaging to native beach plants including *Sesbania tomentosa* on most islands (Factor A)(K. Bio, pers. comm. 2009; D. Cole, pers. comm. 2008; Perlman 2009; USFWS 1999, 2003 a,b,c,d,e), the activity has been difficult to control. Regulations prohibiting or controlling off road vehicle on Hawaii's beaches exist in some areas, but are controversial and often difficult to enforce (Hawaii State Senate 2007; Hawaii Department Of Land and Natural Resources 2008).

Climate change may also pose a threat to *Sesbania tomentosa* (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.

Seeds are in storage and plants are in *ex situ* (off-site, such as a nursery or arboretum) locations at a number of facilities in Hawaii. The National Tropical Botanical Garden has at least 12,000 seeds from Kauai, Oahu, Molokai, Maui, Kahoolawe, and Hawaii islands and 18 plants on their grounds (National Tropical Botanical Garden 2009b, c). Maui Nui Botanical Gardens have 50 seeds and a few plants from Kahakuloa, Maui (Maui Nui Botanical Garden 2009). The Oahu Division of Forestry and Wildlife Nursery, Dillingham has 1,000 seeds and plants from 40 wild Kaena Point individuals and 1 Kaohikaipu Island individual (Oahu Division of Forestry and Wildlife Nursery 2009). The Waimea Valley Arboretum on Oahu has 18 plants from Oahu, Kauai, and Niihau from 4 wild individuals (Waimea Valley Arboretum 2009). Volcano Rare Plant Facility has 70 plants from 4 wild individuals from Kau, Mahana Bay, and Kaulana, Hawaii (Volcano Rare Plant Facility 2009). The Hawaii Volcanoes National Park nursery has 20 plants from five individuals from Apua Point (Hawaii Volcanoes National Park 2009). The Center for Conservation Research and Training Seed Storage Facility has 5,239 seeds in long-term storage (Center for Conservation Research and Training Seed Storage Facility 2008).

Plants have been outplanted into *inter-situ* sites (sites not within historical range but within reasonably suitable habitat, used to increase seed sources) and reintroduced at a number of current and historic sites. Attempted reintroductions using at least 419 plants have been made in 11 populations across the state, but the most recent surveys as of 2007 report 128 surviving individuals in 7 populations (D. Cole, pers. comm. 2008).

Hawaii Volcanoes National Park broadcast 330 seeds at Kipuka Nene in 2007. From these seeds 128 seedlings germinated of which 18 are still alive (Hawaii Volcanoes National Park 2008). In 2008, they outplanted 30 individuals from Apua Point at Kipuka Nene (Hawaii Volcanoes National Park 2009).

The State Division of Forestry and Wildlife Nursery, at Dillingham, on Oahu reintroduced 87 individuals at Kaena State Park in 2007 and 19 more in 2008. They also outplanted at Mokuleia (90 plants), Mokuhoa Islet (13 plants), and Mokuauia Islet (20 plants) in 2008 (Oahu Division of Forestry and Wildlife 2008, 2009).

Maui County has 25 individuals outplanted at Kanaha Beach. The Division of Forestry and Wildlife on Maui outplanted *Sesbania tomentosa* in a new ungulate proof fence on lands adjacent to the Kanaio Natural Area Reserve, of which five were surviving in 2007 (D. Cole, pers. comm. 2008). They have also outplanted the species at Kahakuloa (Maui Division of Forestry and Wildlife 2009). The Native Plant Society outplanted several individuals inside the fenced enclosure at Papanaloha Point, of which about ten were surviving in 2007 (R. Nakagawa, Division of Forestry and Wildlife, pers. comm. 2009).

Sixty individuals of *Sesbania tomentosa* were grown at the Division of Forestry and Wildlife Kokee Rare Plant Facility on Kauai for outplanting. These were outplanted at the Kawaiele Sanctuary site, and watering, weeding, and fertilizing was ongoing in 2007 (Hawaii Department of Land and Natural Resources 2008). Reproducing populations of the rare and apparently otherwise extinct Mana form have been established in an *inter-situ* situation at Makauwahi Cave Reserve (27 mature individuals and many seedlings) (D. Burney, pers. comm. 2008).

On the island of Hawaii, an outplanting of material propagated from seeds of several Kau-South Point populations is planned in a protected area in the Kamilo Forest Reserve (K. Bio, pers. comm. 2009). Twenty-five individuals have been outplanted in Puu Waawaa - Kaupulehu Reserve areas by the State Department of Land and Natural Resources (D. Cole, pers. comm. 2008).

Despite numerous and various threats enumerated above, populations of *Sesbania tomentosa* remain on most of the main Hawaiian Islands and two of the Northwestern Hawaiian Islands. Their numbers, however, are in decline. Indications are that genetic studies now underway may demonstrate that the species is actually a complex of as many as four species (D. Cole, pers. comm. 2008).

The downlisting goals for this species have not been met as there are only three or possibly four populations with more than 300 individuals and not all threats are being managed (see Table 1). Therefore, *Sesbania tomentosa* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.3 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist

Extinction

Recovery

Original data for classification in error

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

- Collect seed from all populations and maintain them separately so that if the species is split into numerous species, each species is maintained separately.
- Fence all populations against trampling by cattle, goats, humans, and off road vehicles.
- Monitor insect threats and treat as necessary.
- Clarify genetic diversity within the species with ongoing studies.
- If taxonomy is revised, update the listed entity on 50 CFR 17 to match the currently recognized taxonomy.
- Determine if propagation and additional reintroductions are necessary for this species.
- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

5.0 REFERENCES

- Center for Conservation Research and Training Seed Storage Facility. 2008. Seed conservation lab database report for *Sesbania tomentosa*. University of Hawaii at Manoa, Honolulu, Hawaii. Unpublished.
- Daehler, C.C., and D.A. Carino. 2001. Hybridization between native and alien plants and its consequences. In J. Lockwood, L., and M. L. McKinney (editors), Biotic homogenization. Kluwer Academic/Plenum Publishers, New York. 289 pages.
- Gemma, J.N., R. E. Koske, and M. Habte. 2002. Mycorrhizal dependency of some endemic and endangered Hawaiian plant species. *Tropical Biology* 89:337-345.
- Hawaii Biodiversity and Mapping Program. 2009. Program database. University of Hawaii at Manoa, Honolulu, Hawaii.
- Hawaii Department of Land and Natural Resources. 2008. Fiscal year 2008 rare plant species end of year report, statewide endangered plant program, Endangered Species Act, Section 6. Division of Forestry and Wildlife. 88 pages. Unpublished.
- Hawaii Division of Forestry and Wildlife, Department of Land and Natural Resources. 2008. Controlled propagation report to U. S. Fish and Wildlife Service. 15 pages. Unpublished.
- Hawaii Division of Forestry and Wildlife, Department of Land and Natural Resources. 2009. Controlled propagation report to U. S. Fish and Wildlife Service. 16 pages. Unpublished.
- Hawaii State Senate, 24th Legislature. 2007. Senate resolution 72 SD1. Available online at <http://209.85.173.132/search?q=cache:G04tsFF50TUI:www.capitol.hawaii.gov/session2007/bills/sr72_sd1_.pdf+off+road+vehicles+hawaii+beaches&hl=en&ct=clnk&cd=1&gl=us&client=firefox-a>. Accessed 2 February 2009.
- Hawaii Volcanoes National Park. 2008. Controlled propagation report to U.S. Fish and Wildlife Service, Hawaii Volcanoes National Park, Hawaii. 1 page. Unpublished.
- Hawaii Volcanoes National Park. 2009. Controlled propagation report to U.S. Fish and Wildlife Service, Volcano, Hawaii. 1 page. Unpublished.
- Hopper, D.R. 2002. The reproductive biology and conservation of the endangered, Hawaiian legume, *Sesbania tomentosa*, with emphasis on its pollination systems. Dissertation in fulfillment of PhD degree, Department of Zoology, University of Hawaii at Manoa, Honolulu, Hawaii. 215 pages.

- Latchininsky, A.V. 2008. Grasshopper outbreak challenges conservation status of a small Hawaiian Island (Abstract only). *Journal of Insect Conservation* 12(3-4):343-357.
- Liogier, H. A. 1988. *Sesbania tomentosa*. Page 211 in *Descriptive flora of Puerto Rico and adjacent islands, Volume II: Leguminosae to Anacardiaceae*. University of Puerto Rico.
- Liogier, H. A. and L. F. Martorell. 2000. *Sesbania tomentosa*. Page 86 in *Flora of Puerto Rico and adjacent islands: a systematic synopsis, second edition revised*. University of Puerto Rico.
- Maui Division of Forestry and Wildlife, Department of Land and Natural Resources. 2009. Controlled propagation report to U. S. Fish and Wildlife Service. 5 pages. Unpublished.
- Maui Nui Botanical Garden. 2009. Controlled propagation report to U.S. Fish and Wildlife Service, Kahului, Hawaii. 15 pages. Unpublished.
- Messing, R.H., M.N. Tremblay, E.B. Mondor, R.G. Foottit, and K.S. Pike. 2007. Invasive aphids attack native Hawaiian plants. *Biological Invasions* 9(5):601-607.
- National Tropical Botanical Garden. 2009a. Records from living collections database for *Sesbania tomentosa*. National Tropical Botanical Garden, Kalaheo, Hawaii. Unpublished.
- National Tropical Botanical Garden. 2009b. Hawaiian native seed inventory. National Tropical Botanical Garden, Kalaheo, Hawaii. Unpublished.
- National Tropical Botanical Garden. 2009c. Controlled propagation report to U.S. Fish and Wildlife Service. National Tropical Botanical Garden, Kalaheo, Hawaii. 48 pages. Unpublished.
- Pacific Island Ecosystems at Risk (PIER). 2008. *Sesbania sesban* (L.) Merr., Fabaceae. Available online at <http://www.hear.org/pier/species/sesbania_sesban.htm>. Accessed 12 February 2009.
- Perlman, S. 2009. *Sesbania tomentosa*. National Tropical Botanical Garden, Kalaheo, Hawaii. 6 pages. Unpublished.
- State of Hawaii Department of Land and Natural Resources. 2008. Testimony of the chairperson of the department of land and natural resources on senate bill 1891, senate draft 1 - relating to public lands, before the house committee on water, land, ocean resources and Hawaiian affairs, March 19, 2008.
- Tangalin, N. 2009. *Sesbania tomentosa*. National Tropical Botanical Garden, Kalaheo, Hawaii. 3 pages. Unpublished.

- Tangalin, N., and W. Fulton. 2005. Proposed management for *Neolecanium cornuparyum* infestation on *Sesbania tomentosa* at Polihale State Park. National Tropical Botanical Garden, Kalaheo, Hawaii. 6 pages. Unpublished.
- [USFWS] U. S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; endangered status for 12 plants from the Hawaiian islands. Federal Register 59(217):58333-56351.
- [USFWS] U.S. Fish and Wildlife Service. 1999. Recovery plan for the multi-island plants. U.S. Fish and Wildlife Service, Portland, Oregon. 206 pages + appendices.
- [USFWS] U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 95 plant species from the islands of Kauai and Niihau, Hawaii; final rule. Federal Register 68(39):9116-9479.
- [USFWS] U.S. Fish and Wildlife Service. 2003b. Endangered and threatened wildlife and plants; final designation or nondesignation of critical habitat for 101 plant species from the island of Oahu, Hawaii; final rule. Federal Register 68(116):35949-35998.
- [USFWS] U.S. Fish and Wildlife Service. 2003c. Endangered and threatened wildlife and plants; final designations and nondesignations of critical habitat for 42 plant species from the island of Molokai, Hawaii; final rule. Federal Register 68(52):12982-13141.
- [USFWS] U.S. Fish and Wildlife Service. 2003d. Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the Islands of Maui and Kahoolawe, Hawaii; final rule. Federal Register 68(93):25934-26165.
- [USFWS] U.S. Fish and Wildlife Service. 2003e. 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.
- [USFWS] U.S. Fish and Wildlife Service. 2003f. Endangered and threatened wildlife and plants; designation of critical habitat for five plant species from the Northwestern Hawaiian Islands, Hawaii; final rule. Federal Register 68(99):28054-28075.
- [USFWS] U.S. Fish and Wildlife Service. 2003g. Endangered and threatened wildlife and plants; final designation of critical habitat for three plant species from the island of Lanai, Hawaii; final rule. Federal Register 68(6): 1220-1274.
- Volcano Rare Plant Facility. 2009. Controlled propagation report to U.S. Fish and Wildlife Service. Hawaii Volcanoes National Park, Volcano, Hawaii. 18 pages. Unpublished.
- Waimea Valley Arboretum. 2009. Controlled propagation report to U.S. Fish and Wildlife Service. Waimea Valley Arboretum, Waimea, Hawaii. 18 pages. Unpublished.

Wood, K.R. 2009. *Sesbania tomentosa*. National Tropical Botanical Garden, Kalaheo, Hawaii. 10 pages. Unpublished.

Personal Communications

Bio, Kealii. 2009. Plant extinction prevention coordinator, Hawaii island, Plant Extinction Prevention Program. E-mail to Margaret Clark, National Tropical Botanical Garden, dated February 3, 2009. Subject: *Sesbania tomentosa*.

Burney, David A. 2008. Director of Conservation, National Tropical Botanical Garden, Kalaheo, Hawaii. E-mail to Margaret Clark, National Tropical Botanical Garden, dated August 8, 2008. Subject: five year review of *Sesbania tomentosa*.

Caraballo, Marcos. 2009. Field botanist, University of Puerto Rico Botanic Garden Herbarium. E-mail to Christian W. Torres-Santana, U.S. Fish and Wildlife Service, dated March 30, 2009. Subject: naturalization of *Sesbania tomentosa* in Puerto Rico.

Cole, David. 2008. PhD candidate, University of Hawaii at Manoa, Honolulu, Hawaii. Letter addressed to the U.S. Fish and Wildlife Service, dated June 10, 2008. Subject: *Sesbania tomentosa*.

Nakagawa, Richard. 2009. Division of Forestry and Wildlife (retired), Department of Land and Natural Resources, Kahului, Hawaii. Telephone conversation by Tamara Sherrill, biological consultant, dated December 30, 2009. Subject: *Sesbania tomentosa* outplants at Kahakuloa, Maui.

Oppenheimer, Hank. 2009. Plant extinction prevention coordinator, Maui Nui, Plant Extinction Prevention Program, Lahaina, Hawaii. E-mail to Margaret Clark, National Tropical Botanical Garden, dated February 5, 2009. Subject: *Sesbania tomentosa*.

Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Sesbania tomentosa* / (ohai)

Current Classification: _____ E _____

Recommendation resulting from the 5-Year Review:

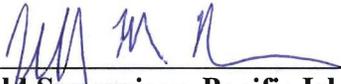
- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:

Marie Brueggemann, Plant Recovery Coordinator
Marilet A. Zablan, Assistant Field Supervisor for Endangered Species
Jeff Newman, Acting Deputy Field Supervisor

Approved _____


for _____

Field Supervisor, Pacific Islands Fish and Wildlife Office

Date _____

AUG 27 2010