

50 CFR Part 17
RIN 1018-AB94

2315-94

Endangered and Threatened Wildlife and Plants; Endangered Status for 12 Plants From the Hawaiian Islands

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: The U.S. Fish and Wildlife Service (Service) determines endangered status pursuant to the Endangered Species Act of 1973, as amended (Act), for 12 species of Hawaiian plants: *Adenophorus periens* (pendant kihi fern), *Bonamia menziesii* (no common name (NCN)), *Diellia erecta* (NCN), *Flueggea neowawraea* (meamehame), *Hibiscus brackenridgei* (ma'o hau hele), *Mariscus pennatifolius* (NCN), *Neraudia sericea* (ma'aloa), *Plantago princeps* (ale), *Sesbania tomentosa* ('ohai), *Solanum incompletum* (thorny popolo),

Spermolepis hawaiiensis (NCN), and *Vigna o-wahuensis* (Oahu vigna). These 12 species are found on 1 or more of the following Hawaiian Islands: Laysan, Necker, Nihoa, Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii. The 12 species and their habitats have been variously affected or are currently threatened by one or more of the following: habitat degradation and/or predation by wild, feral, or domestic animals (pigs, goats, deer, cattle); competition for space, light, water, and nutrients by naturalized, introduced vegetation; habitat loss from

fires; human impacts from recreational activities; and insect infestations. Due to the small number of existing individuals and/or their very narrow distributions, these species and most of their populations are subject to an increased likelihood of extinction and/or reduced reproductive vigor from stochastic events. This rule implements the protection provisions provided by the Act for these plant taxa.

EFFECTIVE DATE: December 12, 1994.

ADDRESSES: The complete file for this rule is available for public inspection,

by appointment, during normal business hours at the Pacific Islands Office, U.S. Fish and Wildlife Service, 300 Ala Moana Boulevard, Room 6307, P.O. Box 50167, Honolulu, Hawaii 96850.

FOR FURTHER INFORMATION CONTACT: Robert P. Smith, Field Supervisor, at the above address (808/541-2749).

SUPPLEMENTARY INFORMATION:

Background

Adenophorus periens, *Bonamia menziesii*, *Diellia erecta*, *Flueggea*

neowawraea, *Hibiscus brackenridgei*, *Mariscus pennatifolius*, *Neraudia sericea*, *Plantago princeps*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, and *Vigna o-wahuensis* are currently known from 11 Hawaiian Islands: Laysan, Necker, Nihoa, Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii. The current and historical distribution by island is presented in Table 1 for each of the 12 species.

TABLE 1.—SUMMARY OF ISLAND DISTRIBUTION OF THE PROPOSED SPECIES

Species	Hawaiian Island										
	La	Ne	N	Ni	K	O	Mo	L	Ka	M	H
<i>Adenophorus periens</i>					C	H	C	H		H	C
<i>Bonamia menziesii</i>					C	H	C	C		C	C
<i>Diellia erecta</i>					H	H	C	H		C	C
<i>Flueggea neowawraea</i>					C	C	H			C	C
<i>Hibiscus brackenridgei</i>					C?	C	H	C	H	C	C
<i>Mariscus pennatifolius</i>	C				H	H				C?	H
<i>Neraudia sericea</i>							C	H	H	C	C
<i>Plantago princeps</i>					C	C	C			C	H
<i>Sesbania tomentosa</i>		C	C	C	C	C	C	C	C	C	C
<i>Solanum incompletum</i>					C?		C?	H		H	C
<i>Spermolepis hawaiiensis</i>					H	C	C	C		H	C?
<i>Vigna o-wahuensis</i>				H	H	H	C	C	C	H	C

C = current; population last observed within the past 50 years.
 H = historical; population not seen for over 50 years.
 ? = questionable locality or inconsistent information in sources.
 La—Laysan
 Ne—Necker
 N—Nihoa
 Ni—Niihau
 K—Kauai
 O—Oahu
 Mo—Molokai
 L—Lanai
 Ka—Kahoolawe
 M—Maui
 H—Hawaii

The Hawaiian archipelago includes eight large volcanic islands (Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii), as well as offshore islets, shoals, and atolls set on submerged volcanic remnants at the northwest end of the chain (the Northwestern Hawaiian Islands). The archipelago covers a land area of about 16,600 square kilometers (sq km) (6,400 sq miles (mi)), extending roughly between latitude 18°50' to 28°15' N and longitude 154°40' to 178°70' W, and ranging in elevation from sea level to 4,200 meters (m) (13,800 feet (ft)) (Dept. of Geography 1983). The regional geological setting is a mid-oceanic volcanic island archipelago set in a roughly northwest to southeast line, with younger islands to the southeast. The youngest island, Hawaii, is volcanically active. The older islands are increasingly eroded, so that the

basaltic portions of many of the northwesternmost islands (such as Laysan, Necker, and Nihoa) are entirely submerged, and coralline atolls and shoals are often all that remain above sea level (Macdonald *et al.* 1986). The topography of the Hawaiian Islands is extremely diverse. On the younger islands, Hawaii and Maui, gently sloping unweathered shield volcanoes with very poor soil development are juxtaposed with older, heavily weathered valleys with steep walls, well-developed streams, and gently sloped flood plains. The older islands to the northwest (i.e., Niihau, Kauai, Oahu, and Molokai) are generally more weathered. On a typical older island, sea cliffs and large amphitheater-headed valleys on the windward (northeast) side contrast with erosionally younger, dissected slopes on the leeward

(southwest) side (Dept. of Geography 1983).

The climate of the Hawaiian Islands reflects the tropical setting buffered by the surrounding ocean (Dept. of Geography 1983). The prevailing winds are northeast trades with some seasonal fluctuation in strength. There are also winter storm systems and occasional hurricanes. Temperatures vary over the year on an average of 5° Celsius (C) (11° Fahrenheit (F)) or less, with daily variation usually exceeding seasonal variation in temperature. Temperature varies with elevation and ranges from a maximum recorded temperature of 37.7° C (99.9° F), measured at 265 m (870 ft) elevation, to a minimum of minus 12.7° C (9.1° F) recorded at 4,205 m (13,795 ft) elevation. Annual rainfall varies greatly by location, with marked windward to leeward gradients over short distances. Minimum average

annual rainfall is less than 250 millimeters (mm) (10 inches (in)); the maximum average precipitation is well in excess of 11,000 mm (450 in) per year. Precipitation is greatest during the months of October through April. A dry season is apparent in leeward settings, while windward settings generally receive tradewind-driven rainfall throughout the year (Dept. of Geography 1933).

The native-dominated vegetation of the Hawaiian Islands varies greatly according to elevation, moisture regime, and substrate. The most recent classification of Hawaiian natural communities recognizes nearly 100 native vegetation types (Gagne and Cuddihy 1990). Within these types are numerous island-specific or region-specific associations, comprising an extremely rich array of vegetation types within a very limited geographic area. Major vegetation formations include forests, woodlands, shrublands, grasslands, herblands, and pioneer associations on lava and cinder substrates.

There are lowland, montane, and subalpine forest types in Hawaii, extending from sea level to above 3,000 m (9,800 ft) in elevation. Coastal and lowland forests are generally dry or mesic and may be open- or closed-canopied. The stature of lowland forests is generally under 10 m (30 ft). Eleven species included in this ruling (*Adenophorus periens*, *Bonamia menziesii*, *Diellia erecta*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Mariscus pennatiformis*, *Neraudia sericea*, *Plantago princeps*, *Solanum incompletum*, *Spermolepis hawaiiensis*, and *Vigna o-wahuensis*) have been reported from lowland forest habitat. Montane forests, occupying elevations between 1,000 and 2,000 m (3,000 and 6,500 ft), are dry to mesic on the leeward slopes of the islands of Kauai, Maui, and Hawaii. On those islands, as well as on Oahu, Molokai, and Lanai, mesic to wet montane forests occur on the windward slopes and summits. The dry and mesic forests may be open- to closed-canopied, and may exceed 20 m (65 ft) in stature. Of the species in this ruling, four (*Diellia erecta*, *Plantago princeps*, *Solanum incompletum*, and *Vigna o-wahuensis*) have been reported from montane mesic and dry forest habitats. Montane wet forests are usually dominated by several species of native trees and tree ferns. Three species (*Adenophorus periens*, *Mariscus pennatiformis*, and *Plantago princeps*) have been reported from montane wet forest habitat. At high montane and subalpine elevations, at and above 2,000 m (6,500 ft) elevation, are subalpine

forests, usually open-canopied and forming a mosaic with surrounding grasslands and shrublands. Subalpine forests are known only from Haleakala on East Maui and from Hualalai, Mauna Kea, and Mauna Loa on Hawaii.

Solanum incompletum has been reported from subalpine forest habitat.

Hawaiian shrublands are also found from coastal to alpine elevations. The majority of Hawaiian shrubland types are in dry and mesic settings, or on cliffs and slopes too steep to support trees. Wet montane shrublands are typically dominated by *Metrosideros* ('ohi'a). Taxa reported from native shrublands include *Bonamia menziesii*, *Hibiscus brackenridgei*, and *Sesbania tomentosa*. Hawaiian grassland types are found from coastal to subalpine settings. Coastal and lowland grasslands are known from the Northwestern Hawaiian Islands, Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. Both *Hibiscus brackenridgei* and *Vigna o-wahuensis* have been reported from native grasslands.

The land that supports these 12 plant species is owned by various private parties, the City and County of Honolulu, the County of Maui, the State of Hawaii (including State parks, forest reserves, natural area reserves, and Hawaiian Home Lands), and the Federal government (including national parks, national wildlife refuges, national historic sites, and property under the jurisdiction of the Department of Defense).

Discussion of the 12 Plant Taxa Included in This Final Rule

Adenophorus periens (pendant kibi fern) was first collected by Captain Fredrick William Beechey in the 1820s or 1830s. It was not formally described until 1974, when L. Earl Bishop published the name *Adenophorus periens*. Prior to its description, the names *Polypodium adenophorus* and *Adenophorus pinnatifidus* had been erroneously applied to the species represented by Beechey's specimen (Bishop 1974).

Adenophorus periens, a member of the grammitis family (Grammitidaceae), is a small, pendant, epiphytic (not rooted on the ground) fern. The rhizome (prostrate stem) is covered with small dark, stiff scales 2 to 4 centimeters (cm) (0.8 to 1.6 in) long. Its yellowish green fronds are usually between 10 and 40 cm (4 and 16 in) long and covered with hairs. The fronds have slightly hairy stalks less than 1 cm (0.4 in) long. Each frond is comprised of oblong or narrowly triangular pinnae (divisions or leaflets) 5 to 15 mm (0.2 to 0.6 in) long with margins that are smooth or toothed

and lined with sparse hairs. The pinnae are situated perpendicular to the axis of the midrib, with each pinna twisted such that its upper surface faces upward. Round sori (groups of spore-producing bodies) usually develop in the central portion of the fertile frond, forming two regular rows on each pinna. This species differs from other species in this endemic Hawaiian genus by having hairs along the pinna margins, pinnae at right angles to the midrib axis, by the placement of the sori, and the degree of dissection of each pinna (Bishop 1970, 1974; Hillebrand 1888; Linney 1989).

Historically, *Adenophorus periens* was known from the following general areas: Halemanu on Kauai, the Koolau Mountains of Oahu, the summit of Lanai, Kula Pipeline on East Maui, and Hilo and Waimea on the island of Hawaii (Hawaii Heritage Program (HHP) 1992a1 to 1992a6, 1992a10 to 1992a13). Currently, *Adenophorus periens* is known from several locations on three islands. On Kauai, one population is known from the boundary of Hono O Na Pali Natural Area Reserve (NAR) and Na Pali Coast State Park on State land, one from Waioli on State land, and four are clustered in the Wahiawa area over a distance of 2 sq km (0.8 sq mi) on private land (HHP 1992a15 to 1992a17; Hawaii Plant Conservation Center (HPCC) 1991b, 1991c, 1992; Lorence and Flynn 1991). On Molokai, there is a single population of three plants on private land at Kamakou Preserve (HHP 1992a7). On the island of Hawaii, four populations are found at Olaa Tract, Kane Nui o Hamo Crater, Kahaualea NAR, and 2.4 km (1.5 mi) northwest of Puu Kaua on private, State, and Federal land (L. Cuddihy, National Park Service, *in litt.*, 1983, 1988; HHP 1992a8, 1992a9, 1992a14). The population at Kane Nui o Hamo has recently been affected by volcanic eruptions and drought and its status is uncertain (Hugo Huntzinger, National Park Service, *in litt.*, 1993). The statewide total of 11 current populations comprises approximately 1,280 individuals of this species; on Kauai, there are about 63 individuals; on Molokai, there are 3; and on Hawaii, there are approximately 1,215 (L. Cuddihy, *in litt.*, 1983, 1988; HHP 1992a7 to 1992a9, 1992a14 to 1992a17; HPCC 1991a to 1991c; Lorence and Flynn 1991).

Adenophorus periens is found in *Metrosideros polymorpha* ('Ohia')/ *Cibotium glaucum* (Hapu'u) Lowland Wet Forest between 470 and 1,270 m (1,540 and 4,140 ft) in elevation (HHP 1992a7, 1992a8, 1992a14 to 1992a16). Associated species include *Broussaisia*

arguta (kanawao ke'oke'o), *Cheirodendron trigynum* ('olapa), *Dicranopteris linearis* (uluhe), *Freycinetia arborea* ('ie'ie), and *Psychotria hawaiiensis* (kopiko) (HHP 1992a7, 1992a8, 1992a15, 1992a16). The primary threats to *Adenophorus periens* are habitat degradation by pigs (*Sus scrofa*); competition for light, space, nutrients, and water with alien plant species; and habitat destruction by fires.

Asa Gray gave the name *Bonamia menziesii* (NCN) to a plant from the Sandwich Islands (Hawaii) in honor of its collector, Archibald Menzies (Gray 1862). Wilhelm Hillebrand (1888) placed the species into the segregate genus *Breweria*. Otto Degener (1932a, 1932b) described a new genus, *Perispermum*, and placed *Bonamia menziesii* in it. He also described another species of *Perispermum*, *P. albiflorum*. T. Myint and D.B. Ward (1968) recognized only one Hawaiian species and placed it in the genus *Bonamia*. They recognized two varieties: variety *menziesii* and a new variety, *rockii*. The current treatment (Austin 1990) recognizes only one species with no subspecific taxa.

Bonamia menziesii, a member of the morning-glory family (Convolvulaceae), is a vine with twining branches up to 10 m (33 ft) long that are fuzzy when young. The leathery, oblong to oval leaves measure 3 to 9 cm (1.2 to 3.5 in) in length and 1 to 4 cm (0.4 to 1.6 in) wide. The upper leaf surface is usually hairless or covered with sparse hairs and the lower surface is covered with dense fuzzy hairs. The white to greenish funnel-shaped flowers, each 2 to 2.5 mm (0.08 to 0.1 in) long, are produced singly or in clusters of three on stalks 1 to 2 cm (0.4 to 0.8 in) long with tiny bracts (modified leaves) at the base of each stalk. Stamens usually have glandular hairs at their bases. The flower has two styles that are separate or partly fused. The fruits are tan or yellowish brown capsules 1 to 1.5 cm (0.4 to 0.6 in) long that contain one or two oval seeds imbedded in black pulp. This species is the only member of the genus that is endemic to the Hawaiian Islands and differs from other genera in the family by its two styles, longer stems and petioles, and rounder leaves (Austin 1990).

Historically, *Bonamia menziesii* was known from the following general areas: scattered locations on Kauai, the Waianae Mountains of Oahu, scattered locations on Molokai, and the eastern sides of Maui and Hawaii (HHP 1992b3, 1992b4, 1992b10, 1992b11, 1992b13, 1992b15 to 1992b17, 1992b28, 1992b35). Currently, *Bonamia menziesii* is known from 28 populations on 5

islands. On Kauai, five populations are known from Kalalau, Paaiki Valley, Mount Kahili (all on State land), and Wahiawa drainage on private land (HHP 1992b25 to 1992b27, Lorence and Flynn 1991). On Oahu, *Bonamia menziesii* is known from both the Waianae and the Koolau Mountains. In the Waianae Mountains between Kuaokala and Nanakuli, 10 populations are spread over a distance of 24 km (15 mi) on Federal, private, and State land; 8 of these populations are clustered in the northernmost section over a distance of 8 km (5 mi) (HHP 1992b6, 1992b8, 1992b9, 1992b12, 1992b19, 1992b20, 1992b22, 1992b23, 1992b30, 1992b34). In the southeastern part of the Koolau Mountains, five populations are found over an area of 6 sq km (2.5 sq mi) on private and State land (HHP 1992b5, 1992b14, 1992b18, 1992b21, 1992b31). On Lanai, *Bonamia menziesii* is known from four scattered locations from Kanepuu to Puhielelu on private land (Garnett 1991; HHP 1992b1, 1992b2, 1992b32; HPCC 1991d). On Maui, one population is known from the western slopes of West Maui on private land and two populations are located on East Maui on private and State land (HHP 1992b24, 1992b29, 1992b33). On the island of Hawaii, a single population is located at Kaupulehu on private land (HHP 1992b7). The total current populations throughout the State consist of approximately 200 individuals, with the largest populations occurring on Oahu (HHP 1992b14, 1992b21, 1992b23, 1992b30). On Kauai, there are approximately 28 plants; on Oahu no more than 150; on Lanai approximately 9; on Maui a total of 10; and on the island of Hawaii at least 1 specimen has been collected (HHP 1992b1, 1992b2, 1992b5 to 1992b12, 1992b14, 1992b18 to 1992b27, 1992b29 to 1992b34; Lorence and Flynn 1991).

Bonamia menziesii is found on steep slopes in dry to mesic forest and sometimes in wet forest between the elevation of 150 and 625 m (492 and 2,051 ft) (Austin 1990). Associated species include 'ohi'a, *Canthium odoratum* (alahe'e), *Nestegis sandwicense* (olopua), *Pisonia* sp. (papala kepau), and *Sapindus oahuensis* (lonomea) (HHP 1992b1, 1992b2, 1992b4, 1992b7 to 1992b9, 1992b18 to 1992b20, 1992b22, 1992b23, 1992b25, 1992b27, 1992b30, 1992b31, 1992b33). The primary threats to *Bonamia menziesii* are habitat degradation and possible predation by wild and feral ungulates (pigs, goats (*Capra hircus*), axis deer (*Axis axis*), black-tailed deer (*Odocoileus hemionus*), and cattle (*Bos*

taurus), competition with a variety of alien plant species, and fire.

Diellia erecta (NCN) was described by William Dunlop Brackenridge based on a specimen collected during the Wilkes Expedition in 1840 (Brackenridge 1854). He also described *Diellia pumila*, which subsequently has been considered a depauperate form of *D. erecta*. *Davallia alexandri* was published by Hillebrand in 1873. It has subsequently been considered a form of *Diellia erecta* with finely dissected fronds. *Diellia erecta* and *Davallia alexandri* had been placed in the genus *Lindsaya* by certain early authors, and *Diellia erecta* into the genus *Schizoloma*. Degener and Amy B. Greenwell (1950) published the new combination *Diellia erecta* var. *falcata* for a taxon originally described by Brackenridge as *Diellia falcata*. However, further study has established that *Diellia falcata* is best considered a separate species. *Diellia erecta* is now considered to be a species with no subspecific taxa (Wagner 1952, Wagner and Wagner 1992).

Diellia erecta, a member of the spleenwort family (Aspleniaceae), is a fern that grows in tufts of three to nine lance-shaped fronds, each 20 to 70 cm (8 to 28 in) long. The fronds emerge from a 1 to 2.5 cm (0.4 to 1 in) long rhizome covered with brown to dark gray scales. The frond stalks are reddish brown to black and smooth and glossy, 2 to 21 cm (0.8 to 8.3 in) long, and have a few stiff scales at their bases. Each frond has 15 to 50 lance-shaped pinnae arranged oppositely along the midrib. The pinnae are usually between 2 and 4 cm (0.8 and 1.6 in) long and 4 to 8 mm (0.2 to 0.3 in) wide. Ten to 20 sori, which may be separate or fused, are borne on each margin of the pinna. Each sorus is covered by an indusium (protective membrane) that falls short of the edge of the frond and runs parallel to the edge of each pinna. This species differs from other members of the genus in having brown or dark gray scales usually more than 2 cm (0.8 in) in length, fused or separate sori along both margins, shiny black midribs that have a hardened surface, and veins that do not usually encircle the sori (Degener and Greenwell 1950, Hillebrand 1888, Robinson 1912, Smith 1934, Wagner 1952).

Historically, *Diellia erecta* was known from the Kokee area on Kauai; the Koolau Mountains on Oahu; Pukoo, Pelekunu Valley, and Kaunakakai Gulch on Molokai; Mahana Valley and Hauola Gulch on Lanai; scattered locations on West Maui; and various locations on the island of Hawaii (HHP 1992c1 to 1992c3, 1992c6, 1992c8 to 1992c11, 1992c16, 1992c18 to 1992c26).

Currently, *Diellia erecta* is only known from Molokai, Maui, and Hawaii. On Molokai, there are four locations with an unknown number of individuals at Halawa Valley, Kahuaawi Gulch, Makolelau, and Puu Kolekole on private land (HHP 1992c12, 1992c14, 1992c15; Robert Hobdy, Hawaii State Division of Forestry and Wildlife (DOFAW), pers. comm., 1991). On Maui, there is a total of at least 38 individuals at 7 locations: 4 populations on West Maui at Iao Valley on private land, and Kanaha Stream, Manawainui Plant Sanctuary, and Papalaua Gulch on State land; and 3 populations on East Maui at Olinda, Waipoi Gulch, and near Makawao on State and private land (HHP 1992c4, 1992c5, 1992c7, 1992c13, 1992c17; HPCC 1990a; Joel Lau, HHP, and R. Hobdy, pers. comm., 1992). On the island of Hawaii, there are 2 populations on State land: 1 at Honomalino with over 20 plants, and 1 at Manuka NAR with at least 1 plant (J. Lau, pers. comm., 1992). Statewide, this species has a total of 13 populations and approximately 63 known individuals.

Diellia erecta is found in *Diospyros sandwicensis* (Lama)/'Ohi'a Lowland Mesic Forest between 210 and 1,590 m (700 and 5,200 ft) in elevation (HHP 1992c21; HPCC 1990a; R. Hobdy, pers. comm., 1992). Other associated plant species include *Dodonaea viscosa* ('a'ali'i), *Dryopteris unidentata*, *Pleomele auwahiensis* (halapepe), *Syzygium sandwicensis* ('ohi'a ha), and *Wikstroemia* sp. ('akia) (HPCC 1990a). The major threats to *Diellia erecta* are habitat degradation by pigs, goats, and cattle; competition with alien plant species; and stochastic extinction due to the small number of existing individuals.

In 1912, Joseph F. Rock collected the first specimens of *Flueggea neowawraea* (mehamehame) from Kapua on the island of Hawaii (Rock 1913). Based on his specimens, he established the monotypic genus *Neowawraea*, named for Dr. Heinrich W. Wawra, a colleague of Rock's. He named the species *Neowawraea phyllanthoides* because of its apparent resemblance to *Phyllanthus*, a member of the same family (Euphorbiaceae). Earl Edward Sherff (1939) later transferred the taxon to the genus *Drypetes*. W. John Hayden (1987), upon further investigation, placed the species in the genus *Flueggea*. Because retention of the specific epithet would result in a later homonym, Hayden chose to maintain the tribute to Wawra in the new epithet, *neowawraea*.

Flueggea neowawraea, a member of the spurge family (Euphorbiaceae), is a large tree up to 30 m (100 ft) tall and

2 m (7 ft) in diameter with white oblong pores covering its scaly, pale brown bark. The thin, papery, oval leaves, 4 to 14 cm (1.5 to 5.5 in) long and 2 to 9 cm (0.8 to 3.5 in) wide, are green on the upper surface and pale green on the lower surface. Plants are usually dioecious (having separate male and female plants) with unisexual flowers lacking petals. Male flowers, on stalks less than 4 mm (0.2 in) long, have five green sepals with brownish tips. The female flowers, on stalks 1 to 2.5 mm (0.04 to 0.1 in) long, have sepals of unequal length with irregular margins. The two-lobed stigma is positioned atop a 2.5 to 3 mm (0.1 in) long, round ovary with a nectary disk. The fleshy, round fruits, about 5 mm (0.2 in) in diameter, are reddish brown to black and contain two slightly curved seeds about 3 mm (0.1 in) long that are somewhat triangular in cross section. This species is the only member of the genus found in Hawaii and can be distinguished from other species in the genus by its large size; scaly bark; the shape, size, and color of the leaves; flowers clustered along the branches; and the size and shape of the fruits (Hayden 1990, Linney 1982, Neal 1965).

Historically, *Flueggea neowawraea* was known from Waii near Kapuna on Molokai, but is now presumed extinct on that island (HHP 1992d25, Hayden 1990). This species was also known from Kealia Trail, Kahanahai Valley, and Pohakea Gulch in the Waianae Mountains of Oahu (HHP 1992d5, 1992d10, 1992d33). Currently, *Flueggea neowawraea* is known on Kauai from Limahuli Valley, Kalalau, Pohakuao, and from the Koaie and Poomau branches of Waimea Canyon (HHP 1992d17, 1992d18, 1992d30 to 1992d32; HPCC 1990b; J. Lau, pers. comm., 1992). Also, three individuals (some of which may be dead) are known from the two adjacent valleys of Mahanaloa and Paai, near Makaha Point, on State-owned land (HHP 1992d9, 1992d13). Only one unhealthy individual is known from Limahuli Valley on privately owned land (HHP 1992d17). One tree is known from Kalalau and 10 from Pohakuao on State-owned land (J. Lau, pers. comm., 1992). Sixteen trees are known from the Poomau branch of Waimea Canyon, and 40 to 80 individuals are known from 4 scattered populations along the Koaie branch of Waimea Canyon on State-owned land (HHP 1992d18, 1992d30, 1992d31; HPCC 1990b; J. Lau, pers. comm., 1992). On Oahu, *Flueggea neowawraea* is currently known from 15 locations with approximately 33 individuals in the Waianae Mountains. The populations

are spread from East Kapuahikahi Gulch to Puumaialau Gulch over a distance of about 15.5 km (9.6 mi) on Federal, State, County, and private land (HHP 1992d1 to 1992d4, 1992d6 to 1992d8, 1992d11, 1992d12, 1992d14 to 1992d16, 1992d19, 1992d20, 1992d24, 1992d26, 1992d29; J. Lau, pers. comm., 1992). On East Maui, one or two individuals are known from Auwahi on the southwest slope of Haleakala at approximately 850 m (2,800 ft) elevation on privately owned land (HHP 1992d23). Five populations are known from the island of Hawaii in South Kona and Kau, extending over an area of about 10 by 5 km (6 by 3 mi) from Papa to Manuka, and numbering approximately 20 individuals, on State and private land (HHP 1992d21, 1992d22, 1992d27, 1992d28, 1992d34, 1992d35; J. Lau, pers. comm., 1990). A Hawaii Island population on private land at Huehue Ranch in North Kona consists of an unknown number of individuals (Hayden 1990). Statewide, the species totals 28 populations containing approximately 127 to 167 known individuals.

Flueggea neowawraea occurs in dry to mesic forest at 250 to 1,000 m (820 to 3,280 ft) elevation (Hayden 1990). Associated plant species include alaha'e, lama, *Aleurites moluccana* (kukui), *Antidesma pulvinatum* (hame), and *Streblus pendulina* ('a'ia'i) (HHP 1992d3, 1992d7, 1992d9, 1992d12 to 1992d19, 1992d30, 1992d31, 1992d34). The primary threat to the continued existence of *Flueggea neowawraea* is the black twig borer (*Xylosandrus compactus*), that has affected all known *Flueggea neowawraea* plants. Other major threats include habitat degradation by feral and wild ungulates (pigs, goats, deer, and cattle), competition with alien plant species, and fire. The small number of individuals within any population and the scattered distribution of populations, compounded by a requirement for cross-pollination because the species is dioecious, must be considered a serious threat.

In 1838, Asa Gray described *Hibiscus brackenridgei* (ma'ou hau hele) from a specimen collected on West Maui (Roe 1961). Then, in 1930, Edward Leonard Caum published two varieties, *molokaiana* and *kauaiana*, based upon type specimens from the islands of Molokai and Kauai (Caum 1930). An additional variety, var. *mokuleiana*, was named by Sister Margaret James Roe in 1961. In 1990, David Bates recognized two subspecific taxa: ssp. *mokuleianus* and ssp. *brackenridgei* (including var. *molokaiana*). He placed *Hibiscus brackenridgei* var. *kauaiana* in

synonymy with a non-Hawaiian species of *Hibiscus*, *H. calyphyllus*.

Hibiscus brackenridgei, a member of the mallow family (Malvaceae), is a sprawling to erect shrub or small tree up to 5 m (16 ft) tall. Most plant parts (young branches, leaves, and some flower parts) vary in the degree of hairiness. The leaves, about 5 to 15 cm (2 to 6 in) long and equally wide, have three to seven lobes but are generally heart-shaped in outline. Beneath each leaf stalk is a pair of very thin stipules (leaf-like appendages), 5 to 15 mm (0.2 to 0.6 in) long, that fall off early in development, leaving an elliptic scar. Flowers are borne singly or in small clusters. The petals, between 3.5 and 8 cm (1.4 and 3.1 in) long, are yellow, usually with a maroon spot in the center of the flower. Each triangular calyx lobe is reddish to yellow, and usually has a raised, elongated gland on the midrib. Seven to 10 bracts are attached below the calyx. The staminal column, which has anthers attached to the upper three-fourths or nearly to the base, extends beyond the petals. The fruits are somewhat round or oval capsules 1.1 to 2 cm (0.4 to 0.8 in) long that have a beak-like appendage at one end. This species differs from other members of the genus in having the following combination of characteristics: yellow petals, a calyx comprised of triangular lobes with raised veins and a single midrib often bearing a prominent elongated gland, 7 to 10 bracts attached below the calyx, and thin stipules 5 to 15 mm (0.2 to 0.6 in) long that fall off, leaving an elliptic scar (Bates 1990).

Hibiscus brackenridgei is currently known from Oahu, Lanai, Maui, and Hawaii; it may possibly occur on Kauai. Twelve populations are known to exist, containing approximately 60 individuals. The two recognized subspecies are discussed separately below. *Hibiscus brackenridgei* ssp. *brackenridgei* was known historically from Laau Point on Molokai (HHP 1992e7), from scattered locations on Lanai, and from Pohakea Gulch south to near McGregor Point on West Maui (HHP 1992e4, 1992e5, 1992e10 to 1992e13, 1992e15). *Hibiscus brackenridgei* was also collected from an unspecified site on Kahoolawe (HHP 1992e17). However, the specimen is unavailable, and the subspecies was not determined (Bates 1990). Currently, *Hibiscus brackenridgei* ssp. *brackenridgei* consists of about 7 populations containing probably fewer than 60 individuals on State and private land on the islands of Lanai, Maui, and Hawaii (HHP 1992e1 to 1992e3, 1992e6, 1992e9, 1992e14, 1992e16; HPCC 1990c, 1991e; J. Lau, pers. comm., 1992). On

Lanai, only five or six plants remain near Keomuku Road at 275 m (900 ft) elevation on privately owned land (HHP 1992e14, HPCC 1991e). On West Maui, *Hibiscus brackenridgei* ssp. *brackenridgei* is known from two populations occurring at Kaunohua Gulch and the West Maui NAR (HHP 1992e2, 1992e3; J. Lau, pers. comm., 1992). The Kaunohua Gulch population, numbering approximately eight individuals, is found within a fenced area of 5 to 10 sq m (55 to 110 sq ft) on privately owned land (HHP 1992e3). The West Maui NAR population, consisting of 14 individuals, is located in the Lihau section at about 400 m (1,300 ft) elevation in lowland dry forest on State-owned land (HHP 1992e2; J. Lau, pers. comm., 1992). On East Maui, the known populations, which extend over a 6.25 sq km (2.4 sq mi) area, number no more than 20 individuals (HHP 1992e1, 1992e8; HPCC 1990c). These populations are near Puu o Kali between 249 and 440 m (800 and 1,450 ft) in elevation on State-owned land (HHP 1992e1, 1992e8). On the island of Hawaii, *Hibiscus brackenridgei* ssp. *brackenridgei* is known from two populations on State and private land: at Puu Anahulu Homesteads and Puu Huluhulu, approximately 3.5 km (2 mi) apart. These two populations contain no more than five individuals (HHP 1992e6, 1992e16; P. Q. Tomich, *in litt.*, 1991; K. Wallis, *in litt.*, 1993).

Hibiscus brackenridgei ssp. *mokuleianus* is currently known from five populations, possibly containing as few as six to eight individuals. Undocumented observations of this taxon have been reported from Lihue and Olokele Canyon on Kauai (Bates 1990). On Oahu, *Hibiscus brackenridgei* ssp. *mokuleianus* was known historically from scattered locations in the Waianae Mountains (HHP 1992e18, 1992e21, 1992e22, 1992e24). Within a 12 by 5 km (7.5 by 3 mi) area extending from Puu Pane to Kealia-Kawaihapai are three current populations (1992e19, 1992e20, 1992e23, 1992e25; HPCC 1990d). The northernmost population, consisting of three individuals and occupying an area of 10 to 100 sq m (110 to 1,080 sq ft), is in the mountains south of the Dillingham Military Reservation at an elevation of 170 m (560 ft) on privately owned land (HHP 1992e25, HPCC 1990d). Another population is known from two adjacent gulches between the Dupont Trail and Puu Iki at elevations between 120 and 240 m (400 and 800 ft) (HHP 1992e19, 1992e23). This population on privately owned land consists of three to five individuals in an area measuring not

more than 0.25 sq km (0.1 sq mi) (HHP 1992e19, 1992e23). A population of *Hibiscus brackenridgei* ssp. *mokuleianus* reported from the Puu Pane area has not been seen for more than 40 years (HHP 1992e20).

Hibiscus brackenridgei occurs in lowland dry to mesic forest and shrubland from 130 to 800 m (425 to 2,625 ft) in elevation (Geesink *et al.* 1990; HHP 1992e1, 1992e4, 1992e5, 1992e8, 1992e14, 1992e19, 1992e25). Associated plant species include 'a'ali'i, alahe'e, *Erythrina sandwicensis* (wiliwili), *Reynoldsia sandwicensis* ('ohe), and *Sida fallax* ('ilima) (HHP 1992e1 to 1992e3, 1992e6, 1992e8, 1992e20, 1992e23, 1992e25). The primary threats to this species are habitat degradation and possible predation by pigs, goats, axis deer, and cattle; competition with alien plant species; road construction; and stochastic extinction and/or reduced reproductive vigor due to the small number of existing individuals.

In 1931, the name *Cyperus pennatifolius* was published by Georg Kukenthal based on a specimen collected from Hana on Maui (Christophersen and Caum 1931). He also described a variety of the species, variety *bryanii*, for plants collected from the Northwestern Hawaiian Island of Laysan. Tetsuo Koyama recombined the species under the genus *Mariscus* and maintained the two subspecific taxa as subspecies (Wagner *et al.* 1989).

Mariscus pennatifolius (NCN), a member of the sedge family (Cyperaceae), is a perennial plant with a woody root system covered with brown scales. The stout, smooth, three-angled stems are between 0.4 and 1.2 m (1.3 and 4 ft) long, slightly concave and 3 to 7 mm (0.1 to 0.3 in) in diameter in the lower part. The three to five linear, somewhat leathery leaves are 8 to 17 mm (0.3 to 0.7 in) wide and at least as long as the stem. Each flower cluster, umbrella-shaped and moderately dense, is 4 to 15 cm (1.5 to 6 in) long and 5 to 25 cm (2 to 10 in) wide. About 5 to 18 spikes, comprised of numerous spikelets, form each cluster. Each spikelet, measuring about 8 to 14 mm (0.3 to 0.6 in) in length, is yellowish brown or grayish brown and is comprised of 8 to 25 densely arranged flowers. The glumes (bracts beneath each flower), which are less than twice as long as wide, are spreading and overlap tightly. The lowest glume does not overlap the base of the uppermost glume. This species differs from other members of the genus by its three-sided, slightly concave, smooth stems; the length and number of spikelets; the leaf width; and the length and diameter of

stems. The two subspecies are distinguished primarily by larger and more numerous spikelets, larger achenes (dry, one-seeded fruits), and more overlapping and yellowish glumes in ssp. *pennatiformis* as compared with ssp. *bryanii* (Koyama 1990).

Historically, *Mariscus pennatiformis* ssp. *pennatiformis* was known from six populations, located on Kauai at Halemanu in Kokee State Park, on Oahu in the Waianae Mountains on a ridge above Makaha Valley, on East Maui at Keanae Valley and Hana, and on the island of Hawaii at an unspecified location (HHP 1992f3 to 1992f6). *Mariscus pennatiformis* ssp. *pennatiformis* also exists in cultivation at the Maui Zoological and Botanical Gardens. The cultivated plants were originally from Nahiku, East Maui (J. Davis and R. Silva, Maui Zoological and Botanical Gardens, *in litt.*, 1978). It is not known whether the Nahiku population is still extant. The five current populations, with an unknown number of individuals, are at open sites in mesic forests and low elevation grasslands from sea level to 1,200 m (3,940 ft) in elevation. No historical locations are known for *Mariscus pennatiformis* ssp. *bryanii*. It is currently known only from federally managed Laysan Island. This subspecies is found on the southeast end of the central lagoon, and the west and northeast sides of the island (HHP 1992f1, 1992f2; Koyama 1990). These 3 locations are on sandy substrate at 5 m (16 ft) in elevation and contain approximately 30 individuals (HHP 1992f1, 1992f2; Koyama 1990). Associated species include *Cyperus laevigatus* (makaloa), *Eragrostis variabilis* (kawelu), and *Ipomoea* sp. (HHP 1992f1, Koyama 1990). The small number of individuals and fewer than six known populations of *Mariscus pennatiformis* make the species vulnerable to stochastic extinction and/or reduced reproductive vigor.

Neraudia sericea (ma'aloa) was published by Gaudichaud in 1851 (Cowan 1949). In 1888, Hillebrand reduced it to a variety of *N. melastomaefolia* (*N. melastomaefolia* var. *sericea*). He also described a new species, *N. kahoolawensis*, named for a specimen collected by J.M. Lydgate on the island of Kahoolawe. In the most current treatment (Wagner *et al.* 1990), the reduction of *N. sericea* to a variety of *N. melastomaefolia* is not accepted and *N. kahoolawensis* is considered a Kahoolawe population of *N. sericea*.

Neraudia sericea, a member of the nettle family (Urticaceae), is a 3 to 5 m (10 to 16 ft) tall shrub with densely hairy branches. The elliptic or oval

leaves are between 4.3 and 13 cm (1.7 and 5.1 in) long and have smooth margins or slightly toothed margins on young leaves. The upper leaf surface is moderately hairy and the lower leaf surface is densely covered with irregularly curved, silky gray to white hairs up to 1 mm (0.04 in) long along the veins. The male flowers may be stalkless or have short stalks. The female flowers are stalkless and have a densely hairy calyx that is either toothed, collar-like, or divided into narrow unequal segments. The fruits are 1 mm (0.04 in) long achenes with the apical section separated from the basal portion by a deep constriction. Seeds are oval with a constriction across the upper half. *Neraudia sericea* differs from the other four closely related species of this endemic Hawaiian genus by the density, length, color, and posture of the hairs on the lower leaf surface and by its mostly entire leaf margins (Wagner *et al.* 1990).

Neraudia sericea was known historically from Kamalo and near Waianui on Molokai, from Kaiholena on central Lanai, Olowalu Valley on West Maui, the southern slopes of Haleakala on East Maui, and from an unspecified site on Kahoolawe (HHP 1992g1, 1992g3, 1992g4, 1992g6 to 1992g10). Currently, two populations of this species are known, from the slopes below Puu Kolekole on Molokai, specifically along the bottom and lower slopes of Makolelau Gulch, and from Pohakea Gulch on West Maui (HHP 1992g2, 1992g5, 1992g11). Both populations are on privately owned land. The Makolelau population contains an estimated 50 to 100 individuals growing in 'Ohi'a/'A'ali'i/*Styphelia tameiameia* (Pukiawe) Lowland Dry Shrubland in an area of over 100 sq m (1,080 sq ft) (HHP 1992g11). The population size of the Pohakea population is undetermined (HHP 1992g2). *Neraudia sericea* generally occurs in lowland dry to mesic shrubland or forest between 670 and 1,370 m (2,200 and 4,500 ft) in elevation (HHP 1992g3, 1992g10, 1992g11; Wagner *et al.* 1990). Other associated plant species include 'ilima, lama, *Bobea* ('ahakea), *Coprosma* (pilo), and *Hedyotis* (HHP 1992g11). The primary threats to *Neraudia sericea* are habitat degradation by feral pigs and goats; competition with the alien plant, *Melinis minutiflora* (molasses grass); and stochastic extinction and/or reduced reproductive vigor due to the small number of existing populations and individuals.

In 1826, Louis Charles Adelbert von Chamisso and D.F.L. Schlechtendal described the species *Plantago princeps*

(ale) (Rock 1920a). In 1829, *P. queleniana* was described by Gaudichaud. An additional species, *P. fauriei*, was described by H. Leveille (1911) from a specimen collected by Abbe Urbain Jean Faurie from Hanapepe Falls on Kauai. Several varieties and forms of *P. princeps* have also been described. The currently accepted classification places *P. queleniana* and *P. fauriei* in synonymy with *P. princeps* and recognizes only four varieties: *anomala*, *laxifolia*, *longibracteata*, and *princeps* (Gaudichaud 1829, Gray 1862, Hillebrand 1888, Mann 1867, Rock 1920a, Wagner *et al.* 1990, Wawra 1874).

Plantago princeps, a member of the plantain family (Plantaginaceae), is a small shrub or robust perennial herb. Its erect or ascending stems are hollow, about 2 to 250 cm (1 to 100 in) long, and often branched with young internodes that are more or less woolly with reddish brown hairs. The oblong to elliptic, thick, leathery leaves are between 6 and 30 cm (2.4 and 12 in) long and up to 5 cm (2 in) wide and are tufted near the ends of stems. The leaves have smooth or minutely toothed margins, a pointed tip, and primary veins that converge at the base of the leaves. Numerous stalkless flowers are densely arranged in a cluster 11 to 28 cm (4.3 to 11 in) long with each cluster on a stalk 10 to 50 cm (4 to 20 in) long. Each flower spreads at an angle of nearly 90 degrees to the axis of the stalk or grows upright. The sepals are somewhat distinct and elliptic in shape. The fruits are capsules that contain three or four tiny black seeds; the surface of the seeds is apparently covered with a sticky membrane. This species differs from other native members of the genus in Hawaii by its large branched stems, flowers at nearly right angles to the axis of the flower cluster, and fruits that break open at a point two-thirds from the base. The four varieties (*anomala*, *laxiflora*, *longibracteata*, and *princeps*) are distinguished by the branching and pubescence of the stems; the size, pubescence, and venation of the leaves; the density of the inflorescence; and the orientation of the flowers (Wagner *et al.* 1990).

The four varieties of *Plantago princeps* were historically found on five islands, and now occur on Kauai, Oahu, Molokai, and Maui. A total of 18 populations containing approximately 300 to 1,200 individuals is currently known. The four varieties are discussed separately below. Historically, *Plantago princeps* var. *anomala* was known from Makaleha in the Waianae Mountains on Oahu, and a ridge west of Hanapepe

River on Kauai (HHP 1992i1, 1992i4). Currently on Kauai, 4 populations with 45 individuals are known from the south rim and upper reaches of Kalalau Valley on State land (HHP 1992i2; HPCC 1990e, 1990g, 1991g).

Historically, *Plantago princeps* var. *laxiflora* was known from Waikolu, Olokui, Kamakou, and Pelekunu on the east side of Molokai; in back of Lahaina on West Maui; and Hamakua and Kohala on the island of Hawaii (HHP 1992i6, 1992i8 to 1992i11, 1992i16, 1992i17). Currently on Molokai, *Plantago princeps* var. *laxiflora* is known from one population with five individuals at Kawela Gulch on private land (HHP 1992i5). On Maui, it is known from 2 locations in Iao Valley on West Maui, and 4 locations within Haleakala National Park and adjacent Waikamoi Preserve on East Maui on Federal and private land, totalling about 100 plants on that island (HHP 1992i7, 1992i12 to 1992i15, 1992i18; HPCC 1990h to 1990j, 1991h, 1991i).

Plantago princeps var. *longibracteata* was historically known from Hanalei, the Wahiawa Mountains, and Hanapepe Falls on Kauai, and from Kaala and the Koolauloa Mountains on Oahu (HHP 1992i19, 1992i21, 1992i23, 1992i24, 1992i26). Currently, 2 populations are known from Kauai at Waioli Valley and Waialeale on State land; they are estimated to contain between 130 and more than 1,000 individuals (HHP 1992i25, 1992i27). On Oahu, two populations approximately 3.5 km (2.2 mi) apart are known from the Poamoho area on private and State land; the number of individuals is not known (HHP 1992i20, 1992i22). Historically, *Plantago princeps* var. *princeps* was known from Nuuanu Pali and Kalihi in the Koolau Mountains of Oahu (HHP 1992i28 to 1992i30). Three current populations of this taxon are known from Mount Tantalus in the Koolau Mountains and from North Palawai and Ekahanui gulches in the Waianae Mountains of Oahu. Between 16 and 20 individuals are known from the Waianae Mountains. The number of individuals at the Koolau site is not known, as it was last observed in 1948 (HHP 1992i3, 1992i28 to 1992i31; HPCC 1990f; J. Lau, pers. comm., 1992).

Plantago princeps is typically found on steep slopes, rock walls, or at bases of waterfalls from 480 to about 1,100 m (1,580 to 3,600 ft) in elevation (Wagner *et al.* 1990). Associated plant species include 'a'ali'i, kopiko, 'ohi'a, uluhe, and *Dubautia plantaginea* (HHP 1992i28; HPCC 1990e to 1990i, 1990k, 1991g to 1991i). The primary threats to *Plantago princeps* are habitat degradation by ungulates (pigs and

goats) and competition with various alien plant species.

Sesbania tomentosa ('ohai) was first described by W.J. Hooker and G.A.W. Arnott in 1836 from collections from Oahu (Degener 1937); it was named for its silvery hairs. In 1920, Joseph F. Rock described an arborescent form of the species (*S. tomentosa* f. *arborea*) based on a Molokai specimen. Degener and Sherff (Sherff 1949) published a new variety, var. *molokaiensis*, based on plants from West Molokai. Nearly 30 years later, Otto and Isa Degener elevated that variety to the specific level (Degener and Degener 1978). At that time, the Degeners also described two new species, *S. hawaiiensis* and *S. hobydi*. In the currently accepted classification by Geesink and others (1990), *S. arborea*, *S. hawaiiensis*, *S. hobydi*, and *S. molokaiensis* are synonymized with *S. tomentosa*. However, they note that the arborescent form of the species found on the island of Molokai probably merits formal taxonomic recognition.

Sesbania tomentosa, a member of the pea family (Fabaceae), is typically a sprawling shrub with branches up to 14 m (45 ft) long but may also be a small tree up to 6 m (20 ft) in height. Each compound leaf is comprised of 18 to 38 oblong to elliptic leaflets, each 15 to 38 mm (0.6 to 1.5 in) long and 5 to 18 mm (0.2 to 0.7 in) wide, and is usually sparsely to densely covered with silky hairs. The flowers, in clusters of two to nine, are salmon tinged with yellow, orange-red, or rarely pure yellow. The petals are between 23 and 45 mm (0.9 and 1.8 in) long, the upper pair sometimes of a lighter color than the other petals. The calyx is about 7 to 12 mm (0.3 to 0.5 in) long. Fruits are slightly flattened pods 7 to 23 cm (2.8 to 9 in) long and about 5 mm (0.2 in) wide that contain about 6 to 27 olive to pale or dark brown, oblong seeds. *Sesbania tomentosa* is the only endemic Hawaiian species in the genus, differing from the naturalized *S. sesban* by the color of the flowers, the longer petals and calyx, and the number of seeds per pod (Geesink *et al.* 1990).

On Molokai, *Sesbania tomentosa* was known historically from Mahana on Mauna Loa, in the vicinity of the coast near Waiahewahewa Gulch, and on Molokai's west coast at Laau and Ilio Points (HHP 1992j16, 1992j18, 1992j23, 1992j26, 1992j37). On Oahu, *Sesbania tomentosa* was known historically from eastern Oahu at Ulupau Crater, and on the islets of Kaohikaipu and Mokulua (HHP 1992j3, 1992j6, 1992j34). This taxon was also known historically from western Oahu at an unspecified location along the Waianae coast (HHP 1992j10).

On Lanai, *Sesbania tomentosa* was known historically from scattered locations on the south half of the island and on the east slope of the island at Kahinahina (HHP 1992j5, 1992j19 to 1992j22, 1992j42). *Sesbania tomentosa* was also known historically from an unspecified location on Kahoolawe (HHP 1992j24).

Currently, there are two populations of *Sesbania tomentosa* in the Northwestern Hawaiian Islands (HHP 1992j35, 1992j36). One population is on the island of Nihoa, which comprises 0.8 sq km (0.3 sq mi) and is under U.S. Fish and Wildlife Service management (Depart. of Geography 1983, HHP 1992j35). The Nihoa plants have been described as relatively common in some areas, with several thousand individuals known (HHP 1992j35). Another population is known from Necker Island, which is only 0.2 sq km (0.1 sq mi) in area, and like Nihoa is managed by the U.S. Fish and Wildlife Service (HHP 1992j36). Although there are no population estimates for Necker Island, *Sesbania tomentosa* is known to occur from 45 m (150 ft) elevation to the summit, growing on the tops of all hills of the main island with a few individuals found on the Northwest Cape (HHP 1992j36). On the privately owned island of Nihoa, *Sesbania tomentosa* is known from the south tip of the island at the headland west of Kaumuhonu Bay. The size of this population has not been determined; in 1947 at least one collection was made at an elevation of 50 m (160 ft) (HHP 1992j14).

On Kauai, *Sesbania tomentosa* is found between Mana town and Mana Point and at Polihale State Park (HHP 1992j15, 1992j33; HPCC 1991L). The population on State-owned land at Polihale State Park consists of about 30 individuals growing in a lithified dune area at approximately 12 m (40 ft) elevation in an area of approximately 10 to 50 sq m (110 to 540 sq ft) (HHP 1992j33). The second population is approximately 6 km (4 mi) southwest of the Polihale State Park population, growing alongside a pond owned by the State (HHP 1992j15). The size of the population has not been determined. On Oahu, *Sesbania tomentosa* is currently known from 1 population of 50 to 100 individuals on State-owned land at Kaena Point (HHP 1992j1, 1992j2). This population is primarily within the Kaena Point NAR, growing in sand dunes in a Naupaka kahakai Mixed Coastal Dry Shrubland (HHP 1992j1, 1992j2; HPCC 1990o). However, scattered individuals are also located to the east for about 3.5 km (2.25 mi) along

the north coast (HHP 1992j1, 1992j2; Woodward *et al.* 1991).

On Molokai, *Sesbania tomentosa* is known from the south slopes of central Molokai from Kamiloloa to Makolelau and along Molokai's northwest coast from Moomomi to east of Hinanaulua. The 4 populations on private and State-owned land from Kamiloloa to Makolelau total fewer than 2,000 individuals and grow in a 7 by 3 km (4.5 by 2 mi) area (HHP 1992j11, 1992j13, 1992j25, 1992j27; HPCC 1990m, 1990n). The 3 populations from Moomomi to east of Hinanaulua consist of about 100 to 150 plants growing on State and private land from sea level to 60 m (200 ft) elevation in a 5 by 1 km (3 by 0.5 mi) area (HHP 1992j12, 1992j28, 1992j49; HPCC 1990L). On Lanai, *Sesbania tomentosa* is now restricted to the northern slopes of the island. This cluster of 3 populations between Paomai and Maunalei is on privately owned land and includes at least 12 individuals growing on arid slopes (HHP 1992j17, 1992j38, 1992j39).

On Maui, *Sesbania tomentosa* is only known from two areas on West Maui and two areas on East Maui. On West Maui, one plant is on State-owned land below Lihau Peak (HHP 1992j30). *Sesbania tomentosa* also occurs on a 6 km (4 mi) stretch of the northeast coast of West Maui, from the lighthouse near Nakalele Point to Puu Kahulianapa (HHP 1992j31, 1992j32, 1992j43, 1992j48; HPCC 1991m). This cluster of 4 populations contains an estimated 50 to 75 individuals on land owned by the State, the County of Maui, and private individuals (HHP 1992j31, 1992j32, 1992j43, 1992j48; R. Hoby, pers. comm., 1992). On East Maui, two trees exist on privately owned land in Kamaole, but they appear to have been planted (Winona Char, Char & Associates, *in litt.*, 1993). *Sesbania tomentosa* also occurs on the southeastern slopes of Pimoe cinder cone between 450 and 500 m (1480 to 1640 ft) elevation. This population consists of 13 plants located on the Hawaii National Guard Kanaio Training Area (Sam Gon, The Nature Conservancy, *in litt.*, 1993). Off the south central coast of Kahoolawe, approximately 25 to 30 individuals of *Sesbania tomentosa* are found on the sparsely vegetated islet of Puu Koae, which is a State-owned seabird sanctuary (HHP 1992j29).

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 km (10 mi) of coastline between Ka Lae and Kaalela. This cluster of populations on

State-owned land contains an estimated 260 individuals growing between sea level and 25 m (80 ft) elevation, with some populations occurring in 'Ilima Coastal Dry Shrubland (HHP 1992j7, 1992j9, 1992j44, 1992j45, 1992j50; HPCC 1991j, 1991k; W. Char, *in litt.*, 1993). The second cluster is in Hawaii Volcanoes National Park and consists of scattered populations within a 19 by 8 km (12 by 5 mi) area from above Kukalauula Pali to Kahue, at elevations between 10 and 850 m (30 and 2,800 ft). This cluster of populations on federally owned land contains at least 50 individuals (HHP 1992j4, 1992j8, 1992j40, 1992j41, 1992j46, 1992j47; H. Huntzinger, *in litt.*, 1993). On the northwestern coast, a single plant occurs at 30 m (100 ft) elevation on private land at Kaupulehua (W. Char, *in litt.*, 1993). The other northwest coast population is also on private land at Waiakailio, and consists of eight plants with several seedlings at 300 m (1000 ft) elevation (W. Char, *in litt.*, 1993). The total currently known populations of *Sesbania tomentosa* on the 8 main Hawaiian islands (Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii) contain an estimated 2,000 to 3,000 individuals. In the Northwestern Hawaiian Islands, the largest population occurs on Nihoa and consists of several thousand individuals (HHP 1992j35).

Sesbania tomentosa is found on sandy beaches, dunes, soil pockets on lava, and along pond margins (Geesink *et al.* 1990). It commonly occurs in coastal dry shrublands and grasslands, but is also known from open 'ohi'a forests and Mixed Coastal Dry Cliffs (HHP 1992j2, 1992j4, 1992j5, 1992j7, 1992j14, 1992j27, 1992j28, 1992j35, 1992j49). Associated plant species include 'ilima, naupaka kahakai, *Heteropogon contortus* (pili), *Myoporum sandwicense* (naio), and *Sporobolus virginicus* ('aki'aki) (HHP 1992j1, 1992j2, 1992j7, 1992j8, 1992j12, 1992j13, 1992j25, 1992j28, 1992j31, 1992j33, 1992j40, 1992j45, 1992j49, 1992j50). The primary threats to *Sesbania tomentosa* are habitat degradation caused by axis deer and cattle, competition with various alien plant species, fire, and destruction by off-road vehicles.

A specimen collected by David Nelson in 1779 from the island of Hawaii was described and named *Solanum incompletum* (thorny popolo) by Dunal (1852). In 1888, Hillebrand described two varieties of the species: var. *glabratum* and var. *mauiense*. In 1969, Harold St. John described the species *S. haleakalaense* based on a specimen collected by Hillebrand on the south slope of Haleakala on Maui (St.

John 1969). In the latest treatment, *S. haleakalaense* was synonymized with *S. incompletum* and no subspecific taxa of *S. incompletum* were recognized (Symon 1990).

Solanum incompletum, a member of the nightshade family (Solanaceae), is a woody shrub up to 3 m (10 ft) tall. Its stems and lower leaf surfaces are covered with prominent reddish prickles about 4 mm (0.2 in) long or sometimes with yellow fuzzy hairs on young plant parts and lower leaf surfaces. The oval to elliptic leaves, 10 to 15 cm (4 to 6 in) long and about 7 cm (2.8 in) wide, have prominent veins on the lower surface, and are on stalks up to 7 cm (2.8 in) long. The leaf margins are lobed with one to four lobes on each side. Numerous flowers grow in loose branching clusters with each flower on a stalk about 9 mm (0.4 in) long. The calyx and flowers generally lack prickles. The white petals form a star-shaped corolla about 2 cm (0.8 in) in diameter. The curved anthers, about 2 mm (0.08 in) long, top short filaments that do not extend beyond the petals. Fruits are round berries about 1.5 cm (0.6 in) in diameter that mature from yellow-orange to black. This species differs from others in the genus by being generally prickly and having loosely clustered white flowers, curved anthers about 2 mm (0.08 in) long, and berries 1 to 2 cm (0.4 to 0.8 in) in diameter (Symon 1990).

Historically, *Solanum incompletum* was known from central and northeastern Lanai and from scattered locations on Maui (HHP 1992k1, 1992k2, 1992k4, 1992k10 to 1992k13; Symon 1990). According to David Symon (1990), the known distribution of *Solanum incompletum* also extends to the islands of Kauai and Molokai. On the island of Hawaii, *Solanum incompletum* was known historically from the Kohala Mountains, Kona, Puu Waawaa, Puu Ikaaka Crater, and Omaokoili (HHP 1992k3, 1992k5, 1992k7 to 1992k9). The single remaining known population is from the island of Hawaii; it has not been seen for more than 40 years. This population is on State land at Puu Huluhulu and consists of perhaps two individuals at an approximate elevation of 2,040 m (6,700 ft) (HHP 1992k6). Associated species include naio, *Acacia koa* (koa), and *Sophora chrysophylla* (mamane) in dry mesic forest, diverse mesic forest, and subalpine forest at elevations from 300 to 2,040 m (1,000 to 6,700 ft) (HHP 1992k1, 1992k6; Symon 1990; J. Lau, pers. comm., 1992). The primary threats to the last remaining individuals of *Solanum incompletum* are stochastic extinction and reduced reproductive

vigor due to the extremely small number of existing plants, and competition with the alien plant, *Senecio mikanioides* (German ivy).

Spermolepis hawaiiensis (NCN) was first described by H. Wolff in 1921. In the past, this Hawaiian species had been confused with the European plants, *Apium echinatum* and *Caucalis daucooides* (Constance and Affolter 1990, Wolff 1921).

Spermolepis hawaiiensis, a member of the parsley family (Apiaceae), is a slender annual herb with few branches that grows to a height of 5 to 20 cm (2 to 8 in). Its leaves, dissected into narrow, lance-shaped divisions, are oblong to somewhat oval in outline and grow on stalks about 2.5 cm (1 in) long. Flowers are arranged in a loose, compound umbrella-shaped inflorescence arising from the stem, opposite the leaves. Each cluster consists of two to six flowers, with each flower on a stalk between 2 and 6 mm (0.08 and 0.2 in) long. The calyx is lacking in this species, but one to five bracts grow below the clusters of flowers. The fruits are oval and laterally compressed and constricted at the line where the two halves of the fruit meet. The fruits are 4 mm (0.2 in) long and 3 mm (0.1 in) wide, covered with curved bristles, and contain seeds that are marked with longitudinal grooves beneath oil tubes that are characteristic of the parsley family. *Spermolepis hawaiiensis* is the only member of the genus native to Hawaii. It is distinguished from other native members of the family by being a non-succulent annual with an umbrella-shaped inflorescence (Constance and Affolter 1990).

Historically, *Spermolepis hawaiiensis* was known from Waimea on Kauai, Koko Head on Oahu, Paomai and Kahinahina on Lanai, and Kipuka Kahali' on Hawaii (HHP 1992L3 to 1992L5, 1992L8, 1992L9; H. Huntzinger, *in litt.*, 1993). Currently, six populations are known on Oahu, Molokai, Lanai, and West Maui; one additional population may exist on Hawaii. On Oahu, on State land at Diamond Head (land leased to the Department of Defense at the Diamond Head Reservation), 10 plants were observed in 1992 during the dry season. In 1988, when the site was first visited, thousands of plants were seen over an area less than 50 sq m (several hundred sq ft) (Wayne Takeuchi, DOFAW, pers. comm., 1992). The population fluctuations probably reflect seasonal changes in precipitation. On Molokai, about 600 plants were reported from Kamalo on private land within an area of less than 400 sq m (0.1 ac) (HHP

1992L6). On Lanai, 2 populations of *S. hawaiiensis* are known on private land: 1 at Kapoho with 100 individuals and 1 west of Puu Manu with 50 to 100 individuals covering an area of about 0.1 ha (0.25 ac) (HHP 1992L7; R. Hobdy, pers. comm., 1992). On West Maui, 3 populations are known on State land: 1 in the Lihau section of the West Maui NAR, with 60 to 100 individuals within an area of about 0.4 ha (1 ac); 1 further east in the Lihau section of the West Maui NAR, with several hundred plants scattered over a distance of 0.7 km (0.4 mi); and 1 above Lahainaluna School, with several hundred individuals spread over an area of about 0.4 ha (1 ac) (HHP 1992L1, 1992L2; HPCC 1991n). On the island of Hawaii, a collection of *Spermolepis hawaiiensis* was made at an unspecified location in 1943; it is not known whether this population still exists (HHP 1992L9).

Spermolepis hawaiiensis is known from various vegetation types, including 'ohi'a forests, 'A'ali'i Lowland Dry Shrubland, cultivated fields, and pastures between about 300 and 600 m (1,000 and 2,000 ft) in elevation (HHP 1992L2, 1992L8, 1992L9; HPCC 1991n). Associated plant species include 'ilima, *Doryopteris* sp., *Gouania hillebrandii*, and the alien plant, *Leucaena leucocephala* (koa haole) (HHP 1992L1). The primary threats to *Spermolepis hawaiiensis* are habitat degradation by axis deer and competition with the alien plant, koa haole.

Vigna o-wahuensis (Oahu vigna) was described by T. Vogel in 1836 from a specimen from the Waianae Mountains of Oahu (Gray 1854). In 1854, Gray described another species, *Vigna sandwicensis*, for which Rock later designated two varieties: var. *heterophylla* and var. *sandwicensis* (Rock 1920b). The currently accepted treatment places *V. sandwicensis* in synonymy under *V. o-wahuensis* (Geesink *et al.* 1990).

Vigna o-wahuensis, a member of the pea family, is a slender twining annual or perennial herb with fuzzy stems that grows to 0.4 m (1.3 ft) in length. Each leaf is made up of three leaflets that vary in shape from round to linear, are 1.2 to 8 cm (0.5 to 3 in) long and 0.1 to 2.5 cm (0.04 to 1 in) wide, and are sparsely or moderately covered with coarse hairs. Flowers, in clusters of one to four, have thin, translucent, pale yellow or greenish yellow petals about 2 to 2.5 cm (0.8 to 1 in) long. The two lowermost petals are fused and appear distinctly beaked. The sparsely hairy calyx is 4 to 8 mm (0.2 to 0.3 in) long with asymmetrical lobes that measure about 3 mm (0.1 in) long. The fruits are long slender pods 4 to 9 cm (1.6 to 3.5 in)

long and about 5 mm (0.2 in) wide, that may or may not be slightly inflated and contain 7 to 15 gray to black seeds less than 6 mm (0.2 in) long. This species differs from others in the genus by its thin yellowish petals, sparsely hairy calyx, and thin pods which may or may not be slightly inflated (Geesink *et al.* 1990).

Historically, *Vigna o-wahuensis* was known from Niihau and from an unspecified location on Kauai (HHP 1992m10, 1992m16). On Oahu, this taxon was known from between Waimanalo and Makapuu Point, the Mokulua Islets, and the Waianae Mountains (HHP 1992m13 to 1992m15, 1992m20). On Maui, *Vigna o-wahuensis* was known from an unspecified site on West Maui and from Makawao, Waiakoa, and Haleakala on East Maui (HHP 1992m2 to 1992m4, 1992m25). There are no currently known populations on Niihau, Kauai, Oahu, or Maui. On Molokai, *Vigna o-wahuensis* was known historically from the western end of the island in the vicinity of Ilio Point (HHP 1992m18). On Lanai, this species occurred historically at scattered locations across the island's southern half (HHP 1992m5, 1992m6, 1992m8, 1992m9, 1992m17). On the island of Hawaii, this taxon was known from Mauna Loa and Kau at unspecified sites (HHP 1992m1, 1992m19, 1992m24).

Currently, a total of fewer than 100 individuals of *Vigna o-wahuensis* is known from 7 populations on the islands of Molokai, Lanai, Kahoolawe, and Hawaii (HHP 1992m11, 1992m12, 1992m21 to 1992m23; HPCC 1991; J. Lau, pers. comm., 1992). On Molokai, there are two populations separated by a distance of 4 km (2.5 mi). One population, south of Onini Gulch at about 850 m (2,800 ft) elevation on privately owned land, covers an area of 18 sq m (200 sq ft) in a forestry planting of *Fraxinus uhdei* (tropical ash) and *Pinus* (pine) (HHP 1992m11). The other Molokai population of about 10 individuals is on privately owned land at Makolelau (J. Lau, pers. comm., 1992). On Lanai, at least one individual of *Vigna o-wahuensis* is known from the arid windward slopes northeast of Kanepuu above Lapaiki at about 370 m (1,200 ft) elevation on privately owned land (HHP 1992m7, 1992m23). On the State-owned island of Kahoolawe, *Vigna o-wahuensis* grows between Makaalae and Lua Kealialalo at 140 m (460 ft) elevation, near the summit at about 400 m (1,300 ft) elevation, and about 0.8 km (0.5 mi) south of Hanakanaea near "Sailor's Hat" (HHP 1992m21, 1992m23; J. Lau, pers. comm., 1992). Only one individual is known from the

population between Makaalae and Lua Kealialalo in pili grassland (J. Lau, pers. comm., 1992). Near the summit, about 20 plants grow in a 9 sq m (100 sq ft) area with a few more plants scattered nearby (HHP 1992m22). The size of the population south of Hanakanaea has not been determined, but at least one collection has been made recently (HHP 1992m21). On the island of Hawaii, *Vigna o-wahuensis* is known only from Nohonaohae Cinder Cone on privately owned land. Ten plants are known from 'A'ali'i Lowland Dry Shrubland within an enclosure containing pasture grass (HHP 1992m12, HPCC 1991o).

Vigna o-wahuensis occurs in dry to mesic grassland and shrubland from 10 to 1,370 m (30 to 4,500 ft) in elevation (Geesink et al. 1990; HHP 1992m1 to 1992m3, 1992m5, 1992m11, 1992m12, 1992m15, 1992m22, 1992m24). Other associated plant species include 'ilima, *Chenopodium* ('aheahea), *Dubautia menziesii*, and *Osteomeles anthyllidifolia* (ulei) (HHP 1992m11, 1992m12, 1992m23; HPCC 1991o). The primary threats to *Vigna o-wahuensis* are habitat degradation by ungulates (pigs and axis deer), competition with various alien plant species, fire, and stochastic extinction and/or reduced reproductive vigor due to the small number of existing populations and individuals.

Previous Federal Action

Federal action on these plants began as a result of section 12 of the Act, which directed the Secretary of the Smithsonian Institution to prepare a report on plants considered to be endangered, threatened, or extinct in the United States. This report, designated as House Document No. 94-51, was presented to Congress on January 9, 1975. In that document, *Adenophorus periens*, *Bonamia menziesii*, *Flueggea neowawraea* (as *Drypetes phyllanthoides*), *Hibiscus brackenridgei* (as *H. b.* var. *brackenridgei*, var. *mokuleianus*, and var. "from Hawaii"), *Neraudia sericea*, *Plantago princeps* (as *P. p.* var. *elata*, var. *laxifolia*, and var. *princeps*), *Sesbania tomentosa* (as *S. t.* var. *tomentosa*), *Solanum incompletum* (as *S. i.* var. *glabratum*, var. *incompletum*, and var. *mauiensis*), *Vigna o-wahuensis* (also as *V. sandwicensis* var. *heterophylla* and *V. s.* var. *sandwicensis*) were considered to be endangered. *Diellia erecta* and *Plantago princeps* (as *P. p.* var. *acaulis*, var. *denticulata*, and var. *queleniana*) were considered to be threatened, and *Neraudia sericea* (as *N. kahoolawensis*) and *Solanum incompletum* (as *S. haleakalense*) were considered to be extinct.

On July 1, 1975, the Service published a notice in the **Federal Register** (40 FR 27823) of its acceptance of the Smithsonian report as a petition within the context of section 4(C)(2) (now section 4(b)(3)) of the Act, and giving notice of its intention to review the status of the plant taxa named therein. As a result of that review, on June 16, 1976, the Service published a proposed rule in the **Federal Register** (41 FR 24523) to determine endangered status pursuant to section 4 of the Act for approximately 1,700 vascular plant species, including all of the above taxa considered to be endangered or thought to be extinct, plus *Diellia erecta* (considered threatened). The list of 1,700 plant taxa was assembled on the basis of comments and data received by the Smithsonian Institution and the Service in response to House Document No. 94-51 and the July 1, 1975, **Federal Register** publication.

General comments received in response to the 1976 proposal are summarized in an April 26, 1978, **Federal Register** publication (43 FR 17909). In 1978, amendments to the Act required that all proposals over 2 years old be withdrawn. A 1-year grace period was given to proposals already over 2 years old. On December 10, 1979, the Service published a notice in the **Federal Register** (44 FR 70796) withdrawing the portion of the June 16, 1976, proposal that had not been made final, including the above taxa, along with four other proposals that had expired. The Service published updated notices of review for plants on December 15, 1980 (45 FR 82479), September 27, 1985 (50 FR 39525), and February 21, 1990 (55 FR 6183). In these notices, 11 of the taxa (including synonymous taxa) that had been in the 1976 proposed rule were treated as category 1 candidates for Federal listing. Category 1 taxa are those for which the Service has on file substantial information on biological vulnerability and threats to support preparation of listing proposals. Other than *Mariscus pennatiformis*, *Neraudia sericea* (as *N. kahoolawensis*), *Plantago princeps* (as *P. p.* var. *acaulis* and var. *queleniana*), *Sesbania tomentosa* (as *S. hobbyi*), *Solanum incompletum* (as *S. haleakalense*), and *Spermolepis hawaiiensis*, all the aforementioned taxa that were proposed as endangered in the June 16, 1976, proposed rule were considered category 1 candidates on all three notices of review. *Flueggea neowawraea* appeared as *Neowawraea phyllanthoides* in the 1980 and 1985 notices. In the 1980 and 1985 notices, *Sesbania tomentosa* (as *S. hobbyi*) and

Solanum incompletum (as *S. haleakalense*) were considered category 1* species. Category 1* species are those that are possibly extinct. *Plantago princeps* (as *P. p.* var. *acaulis* and var. *queleniana*) appeared as a category 2 taxon and *Neraudia sericea* (as *N. kahoolawensis*) as a category 3A species in the 1980 and 1985 notices. Category 2 taxa are those for which there is some evidence of vulnerability, but for which there are not enough data to support listing proposals at the time. Category 3A taxa are those for which the Service has persuasive evidence of extinction. Through taxonomic revisions, each of the category 1*, 2, and 3A taxa were synonymized under category 1 taxa on the 1990 list. *Mariscus pennatiformis* (as *Cyperus p.* var. *bryanii*) first appeared on the 1985 notice of review as a category 1 taxon. *Spermolepis hawaiiensis* first appeared on the 1990 notice of review as a category 1 species after it was rediscovered in 1986.

Section 4(b)(3)(B) of the Act requires the Secretary to make findings on petitions that present substantial information indicating that the petitioned action may be warranted within 12 months of their receipt. Section 2(b)(1) of the 1982 amendments further requires all petitions pending on October 13, 1982, be treated as having been newly submitted on that date. On October 13, 1983, the Service found that the petitioned listing of these species was warranted, but precluded by other pending listing actions, in accordance with section 4(b)(3)(B)(iii) of the Act; notification of this finding was published on January 20, 1984 (49 FR 2485). Such a finding requires the Service to consider the petition as having been resubmitted, pursuant to section 4(b)(3)(C)(i) of the Act. The findings were reviewed in October of 1984, 1985, 1986, 1987, 1988, 1989, 1990, and 1991. The proposed rule published on September 14, 1993 (58 FR 48012) to list 12 species of plants from the Hawaiian Islands as endangered species constituted the final 1-year finding that was required for these species.

Based on comments and recommendations received in response to the proposal (see Comments and Recommendations, below), the Service now determines these 12 plant species to be endangered with the publication of this final rule.

Summary of Comments and Recommendations

In the September 14, 1993, proposed rule and associated notifications, all interested parties were requested to submit factual reports or information

that might contribute to the development of a final rule. The public comment period ended on November 15, 1993. Appropriate State agencies, county governments, Federal agencies, scientific organizations, and other interested parties were contacted and requested to comment. Newspaper notices inviting public comment were published in "The Maui News" on October 7, 1993, the "Hawaii Tribune-Herald" on October 8, 1993, and the "Honolulu Advertiser" on October 7, 1993.

Comments were received from three parties: One from an individual in support of the listing of *Spermolepis hawaiiensis*, but offering no additional information; one from an individual in

support of the listing of *Spermolepis hawaiiensis*, *Adenophorus periens* and *Sesbania tomentosa*, and providing information on the possible extirpation of the population of *Adenophorus periens* at Kane Nui o Hamo by volcanic activity and drought, and indicating that the actual number of plants of *Sesbania tomentosa* in Hawaii Volcanoes National Park is more than 50; the third respondent provided information on three previously unknown populations of *Sesbania tomentosa*, one from the south coast of East Maui and two from the northwest coast of the island of Hawaii. The information provided by these respondents has been incorporated into this final rule. The

information received does not indicate that any of these species are under less threat than previously thought.

Summary of Factors Affecting the Species

Section 4 of the Endangered Species Act (16 U.S.C. 1533) and regulations (50 CFR part 424) promulgated to implement the Act set forth the procedures for adding species to the Federal lists of endangered and threatened species. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1). The threats facing these 12 species are summarized in Table 2.

TABLE 2.—SUMMARY OF THREATS

Species	Feral animal activity				Alien plants	Fire	Human impacts	Insects	Limited numbers*
	Pigs	Goats	Deer	Cattle					
<i>Adenophorus periens</i>	X	.....	.....	.....	X	X	.....	.....
<i>Bonamia menziesii</i>	X	X	X	X	X	X	.....	.....
<i>Diellia erecta</i>	X	X	.....	X	X	.....	.....	.....	X ¹
<i>Flueggea neowawraea</i>	X	X	X	X	X	X	.....	X	
<i>Hibiscus brackenridgei</i>	X	X	X	X	X	.....	X	.....	X ¹
<i>Mariscus pennatifolius</i> .....	.....	.....	.....	.....	.....	.....	.....	.....	X ¹
<i>Neraudia sericea</i>	X	X	.....	.....	X	.....	.....	.....	X ^{1,2}
<i>Plantago princeps</i>	X	X	.....	.....	X	.....	.....	.....
<i>Sesbania tomentosa</i> .....	.....	.....	X	X	X	X	X	.....
<i>Solanum incompletum</i> .....	.....	.....	.....	.....	X	.....	.....	.....	X ^{2,3}
<i>Spermolepis hawaiiensis</i> .....	.....	.....	X	.....	X	.....	.....	.....
<i>Vigna o-wahuensis</i>	X	.....	X	.....	X	X	.....	.....	X ¹

* No more than 100 individuals and/or fewer than five populations.

¹ No more than 100 individuals.

² Fewer than five populations.

³ No more than 10 individuals.

These factors and their application to *Adenophorus periens* L.E. Bishop (pendant kihi fern), *Bonamia menziesii* A. Gray (no common name (NCN)), *Diellia erecta* Brack. (NCN), *Flueggea neowawraea* W. Hayden (mehamehame), *Hibiscus brackenridgei* A. Gray (ma'o hau hele), *Mariscus pennatifolius* (Kekunth.) T. Koyama (NCN), *Neraudia sericea* Gaud. (ma'aloa), *Plantago princeps* Cham. and Schlechtend. (ale), *Sesbania tomentosa* Hook. and Arnott ('ohai), *Solanum incompletum* Dunal (thorny popolo), *Spermolepis hawaiiensis* Wolff (NCN), and *Vigna o-wahuensis* Vogel (Oahu vigna) are as follows:

A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range

Native vegetation on all of the main Hawaiian Islands has undergone extreme alteration because of past and present land management practices including ranching, deliberate alien animal and plant introductions, and

agricultural development (Cuddihy and Stone 1990, Wagner *et al.* 1985). The Northwestern Hawaiian Islands have undergone similar alteration, but to a lesser degree. The primary threats facing the 12 plant species included in this ruling are ongoing and threatened destruction and adverse modification of habitat by feral animals and competition with alien plants.

Eleven of the 12 species in this ruling are variously threatened by feral animals. (See Table 2.) Animals such as pigs, goats, axis deer, black-tailed deer, and cattle were introduced either by the early Hawaiians (pigs) or more recently by European settlers (all ungulate species) for food and/or commercial ranching activities. Over the 200 years following their introduction, their numbers increased and the adverse impacts of feral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect of trampling and grazing native plants, feral ungulates have contributed significantly to the heavy erosion still

taking place on most of the main Hawaiian islands.

Pigs (*Sus scrofa*), originally native to Europe, Africa, and Asia, were introduced to Hawaii by the Polynesian ancestors of Hawaiians, and later by western immigrants. The pigs escaped domestication and invaded primarily wet and mesic forests and grasslands of Kauai, Oahu, Molokai, Maui, and Hawaii. They presently threaten the existence of at least eight of the taxa in those habitats. While foraging, pigs root and trample the forest floor, encouraging the establishment of alien plants in the newly disturbed soil. Pigs also disseminate alien plant seeds through their feces and on their bodies, accelerating the spread of alien plants through native forest (Cuddihy and Stone 1990, Stone 1985). On Kauai, three populations each of *Adenophorus periens* and *Flueggea neowawraea* and a single population each of *Plantago princeps* var. *anomala* and *P. p.* var. *longibracteata* have sustained loss of individual plants and/or habitat as a

result of feral pig activities (HHP 1992d18, 1992i2; J. Lau, pers. comm., 1992). The following numbers of populations of the plants on Oahu are threatened by pigs: 4 populations of *Bonamia menziesii*, 15 of *Flueggea neowawraea*, 1 of *Hibiscus brackenridgei* ssp. *mokuleianus*, and 2 populations each of *Plantago princeps* var. *longibracteata* and *P. p. var. princeps*. On Molokai, one population each of *Diellia erecta*, *Plantago princeps* var. *laxiflora*, and *Vigna o-wahuensis*, and two populations of *Neraudia sericea* are also threatened by pigs. On East Maui, pigs are destroying the habitat of three populations of *Plantago princeps* var. *laxiflora* (HHP 1992i12; J. Lau, pers. comm., 1992). On the island of Hawaii, feral pigs are a major threat to species at the following locations: in Kahaualea NAR, Olaa Tract, and 2.4 km (1.5 mi) northwest of Puu Kauka, where at least three populations of *Adenophorus periens* occur; and in the regions of Manuka and Honomalino in the South Kona District, where one or more populations of *Diellia erecta* and *Flueggea neowawraea* remain (J. Lau, pers. comm., 1992).

Goats (*Capra hircus*), native to the Middle East and India, were first successfully introduced to the Hawaiian Islands in 1792. Feral goats now occupy a wide variety of habitats from lowland dry forests to montane grasslands on Kauai, Oahu, Molokai, Maui, and Hawaii, where they consume native vegetation, trample roots and seedlings, accelerate erosion, and promote the invasion of alien plants (Stone 1985, van Riper and van Riper 1982). Goats are significantly degrading the habitat of at least five species in this rule. On Kauai, goats contribute to the substantial decline of one population of *Bonamia menziesii*, four populations of *Flueggea neowawraea*, and one population of *Plantago princeps* var. *anomala* (HHP 1992d18, 1992d30, 1992d31, 1992i2; J. Lau, pers. comm., 1992). On Oahu, encroaching urbanization and hunting pressure tend to concentrate the goat population in the dry upper slopes of the Waianae Mountains, where one population of *Bonamia menziesii* and two populations of *Flueggea neowawraea* exist (HHP 1992d15; J. Lau, pers. comm., 1992). The goat population in the Waianae area is apparently increasing, becoming an even greater threat to the rare plants that grow there. On Molokai, two populations of *Diellia erecta* in Halawa Valley and Puu Kolekole and one population of *Neraudia sericea* at Makolelau are presently threatened by goats (HHP 1992c12, 1992c13; J. Lau,

pers. comm., 1992). Until a few years ago, feral goats were a major threat to rare plants in Haleakala National Park on East Maui, but because of an active ungulate control program, the goat population was reduced to 100 by 1988. While they are no longer a significant threat, the future ingress and reestablishment of goats are still a possibility (Lloyd Loope, National Park Service (NPS), pers. comm., 1992) and could potentially affect the three populations of *Plantago princeps* var. *laxiflora* found in the park (J. Lau, pers. comm., 1992).

Eight individuals of axis deer (*Axis axis*), introduced to the island of Molokai in 1868, increased to thousands of animals within about 30 years (Tomich 1986). By the turn of the century, the herds so damaged the vegetation of Molokai that professional hunters were hired to control their numbers (Tomich 1986). By then, the native vegetation had suffered irreparable damage from overgrazing by axis deer. They degrade the habitat by trampling and overgrazing vegetation, which removes ground cover and exposes the soil to erosion (J. Lau, pers. comm., 1992). Activity of deer on Molokai has resulted in loss of habitat and/or individuals of at least six of the species. In the absence of a protective fence, axis deer continue to invade the unfenced areas and threaten to trample the plants. On both Molokai and Lanai, the axis deer populations are presently actively managed for recreational hunting by the Hawaii State Department of Land and Natural Resources. Extensive red erosional scars caused by decades of deer activity are evident on Lanai. The habitat of three Lanai populations of *Bonamia menziesii* and one population of *Hibiscus brackenridgei* ssp. *brackenridgei* on that island is negatively affected by axis deer (HHP 1992e1; J. Lau, pers. comm., 1992). Two populations of *Sesbania tomentosa* at Paomai and Mahana on Lanai were last seen in the mid-1950s (HHP 1992j17, 1992j38). Those areas have long supported axis deer, which probably pose the primary threat to those two *Sesbania* populations. Elsewhere on Lanai, one population of *Vigna o-wahuensis* above Lapaiki and one population of *Spermolepis hawaiiensis* at Kapoho are threatened by axis deer (HHP 1992L7, 1992m23). To control deer in what remains of Lanai's dry forests, The Nature Conservancy of Hawaii (TNCH) is presently erecting fenced enclosures to protect populations of rare taxa (including two populations of *Bonamia menziesii*) that occur within Kanepuu Preserve (Heidi Bornhorst,

TNCH, and J. Lau, pers. comms., 1992). Although the fence is high enough to normally inhibit entry by deer, human pressure can force the deer to jump over the fence. On Maui, deer damaged plants of two populations of *Hibiscus brackenridgei* ssp. *brackenridgei* at Puu O Kali by stripping the bark and breaking limbs (HHP 1992e1, 1992e8).

Black-tailed deer (*Odocoileus hemionus*) were first introduced to Kauai in 1961 for the purpose of sport hunting and today probably number well over 500 animals. The deer are presently confined to the western side of the island, where they feed on a variety of native and alien plants (van Riper and van Riper 1982). On Kauai, one population of *Bonamia menziesii* in Paaiki Valley and the population of *Flueggea neowawraea* in Paaiki and Mahanaloa valleys are threatened by black-tailed deer (J. Lau, pers. comm., 1992).

Large-scale ranching of cattle (*Bos taurus*) in the Hawaiian Islands began in the middle of the 19th century on the islands of Kauai, Oahu, Maui, and Hawaii. Large ranches, tens of thousands of acres in size, developed on East Maui and Hawaii (Cuddihy and Stone 1990) where most of the State's large ranches still exist today. Degradation of native forests used for ranching activities became evident soon after full-scale ranching began. The negative impact of cattle on Hawaii's ecosystem is similar to that described for goats and deer (Cuddihy and Stone 1990, Stone 1985). Cattle grazing continues in several lowland regions in the northern portion of the Waianae Mountains of Oahu: in Lualualei, where one population of *Bonamia menziesii* exists, and in Kaumoku Gulch, where one population of *Hibiscus brackenridgei* ssp. *mokuleianus* remains (HHP 1992b30; J. Lau, pers. comm., 1992). On Molokai, cattle ranching is slowly recovering from setbacks caused by recent herd reductions enforced in an effort to eliminate bovine tuberculosis from domestic and feral stock. As cattle ranching becomes reestablished on Molokai and the number of cattle increases, the threat to the rare plant species that remain in those ranching areas will also likely increase. One population of *Sesbania tomentosa* located east of Moomomi Preserve grows in a grazing area. On Maui, cattle ranching is the primary agricultural activity on the west and southwest slopes of East Maui and in lowland regions of West Maui. On both East and West Maui, one or more populations of *Bonamia menziesii*, *Diellia erecta*, and *Hibiscus brackenridgei* ssp. *brackenridgei* and the only Maui

population of *Flueggea neowawraea* continue to be threatened by grazing cattle (HHP 1992c13; J. Lau, pers. comm., 1992). The *Flueggea neowawraea* population and one of the *Bonamia menziesii* populations grow within a fenced enclosure. Although probably minimal, the possibility of cattle entering the enclosure poses a potential threat. In the Kamaoa-Puueo and South Point regions of the island of Hawaii, cattle continue to graze in habitat currently occupied by most of the populations of *Sesbania tomentosa* on that island (J. Lau, pers. comm., 1992). In addition, one population of *Hibiscus brackenridgei* ssp. *brackenridgei* and the only known population of *Bonamia menziesii* on that island grow in regions currently used for cattle ranching (J. Lau, pers. comm., 1992).

Habitat disturbance caused by human activities threatens two of the taxa. On West Maui, all-terrain vehicles have driven over *Sesbania tomentosa* plants growing west of Nakalele Point lighthouse (HHP 1992j43). Continued off-road activity threatens to destroy a significant portion of that population. On the island of Hawaii, a dirt road runs through a population of *Sesbania tomentosa* located in the Kamaoa-Puueo region (HHP 1992j50). Off-road activity could damage a significant portion of that population as well. In the Puu Anahulu region on that island, a ranch road was bulldozed close to a plant of *Hibiscus brackenridgei* ssp. *brackenridgei* in 1989 (HHP 1992e6). Continued road development threatens to destroy the only known population of that taxon in the area.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization is not known to be a factor, but unrestricted collecting for scientific or horticultural purposes would seriously impact the six species whose low numbers make them especially vulnerable to disturbances (*Diellia erecta*, *Hibiscus brackenridgei*, *Mariscus pennatifolius*, *Neraudia sericea*, *Solanum incompletum*, and *Vigna o-wahuensis*).

C. Disease and Predation.

Black twig borer (*Xylosandrus compactus*) has been cited as an immediate threat to all extant populations of *Flueggea neowawraea* (J. Lau, pers. comm., 1992). The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely and often killing branches or whole plants (Howarth 1985). All known plants of *Flueggea*

neowawraea suffer slight to severe defoliation and reduced vigor due to infestations of this alien insect.

Evidence of predation on two of the taxa by ungulates (cattle, deer, goats) is documented on Oahu, Lanai, and Maui. On Oahu, plants of *Bonamia menziesii* at Lualualei grow over native vegetation and drape well below the browse line of cattle, indicating the potential for cattle to feed on the plants (HHP 1992b30). On Lanai, axis deer are known to feed on this species, especially at Kanepuu. Depredation of *Hibiscus brackenridgei* ssp. *brackenridgei* by goats has been observed on Lanai and Maui. Goats are known to eat the branch tips and strip the bark of the plants (HHP 1992e14). While there is no evidence of predation on the other 11 species, none of them are known to be unpalatable to cattle, deer, or goats. Predation is therefore a probable threat to species growing at sites where those animals have been reported (*Diellia erecta*, *Flueggea neowawraea*, *Neraudia sericea*, *Plantago princeps*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, and *Vigna o-wahuensis*) (See Factor A.).

D. The Inadequacy of Existing Regulatory Mechanisms

Of the 12 species in this ruling, a total of 10 have populations located on private land, 2 on County land, 10 on State land, and 7 on Federal land. With the exception of *Neraudia sericea* which is restricted to private land, all of the other species occur in more than one of those ownership categories. The known populations of these species located on Federal lands are inadequate to ensure their long-term survival.

There are no State laws or existing regulatory mechanisms at the present time to protect or prevent further decline of these plants on private or State land. However, Federal listing would automatically invoke listing and associated protection under Hawaii State law.

E. Other Natural or Manmade Factors Affecting Their Continued Existence

Eleven of the 12 species are threatened by competition with one or more alien plant species. (See Table 2). The most significant of these appear to be *Schinus terebinthifolius* (Christmasberry), *Psidium cattleianum* (strawberry guava), *Melinis minutiflora* (molasses grass), *Pennisetum setaceum* (fountain grass), *Clidemia hirta* (Koster's curse), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Prosopis pallida* (kiawe), *Toona ciliata* (Australian red cedar), *Cenchrus ciliaris* (buffelgrass), *Rubus argutus* (prickly Florida blackberry), *Passiflora*

mollissima (banana poka), and *Rubus ellipticus* (Himalayan raspberry).

Many noxious alien plants such as Christmasberry have invaded the dry to mesic lowland regions of the Hawaiian Islands. Introduced to Hawaii before 1911, Christmasberry forms dense thickets that shade out and displace other plants (Cuddihy and Stone 1990). This fast-growing species is found in lowland areas of the major Hawaiian Islands (Smith 1985) and is currently expanding its range. Christmasberry is a major component of the mesic forests of the Waianae and Koolau Mountains of Oahu. For example, over half of the populations of *Bonamia menziesii*, 2 of the populations of *Plantago princeps* var. *princeps*, and all 15 populations of *Flueggea neowawraea* that occur on Oahu are negatively affected by this invasive plant (HHP 1992b18, 1992b22, 1992b31, 1992d3, 1992d15, 1992d16; J. Lau, pers. comm., 1992). In addition, one population of *Diellia erecta* at Halawa Valley on Molokai and one population of *Bonamia menziesii* on Lanai are also affected (J. Lau, pers. comm., 1992). On Maui, Christmasberry is spreading in Iao Valley and on the south slope of East Maui (Haleakala Volcano) and is one of the primary alien plant threats to one or more populations of *Bonamia menziesii*, *Diellia erecta*, and *Plantago princeps* var. *laxiflora* that exist there (J. Lau, pers. comm., 1992). On the island of Hawaii, Christmasberry continues to threaten at least two populations of *Diellia erecta* and *Flueggea neowawraea* in the regions of Manuka and Honomalino in the South Kona District (HHP 1992d34; J. Lau, pers. comm., 1992).

Strawberry guava, an invasive shrub or small tree native to tropical America, has become naturalized on all of the main Hawaiian islands. Like Christmasberry, strawberry guava is capable of forming dense stands that exclude other plant species (Cuddihy and Stone 1990) and is dispersed mainly by feral pigs and fruit-eating birds (Smith 1985). This alien plant grows primarily in mesic and wet habitats and provides food for several alien animal species, including feral pigs and game birds, which disperse the plant's seeds through the forest (Smith 1985, Wagner et al. 1985). Strawberry guava is considered one of the greatest alien plant threats to Hawaii's rain forests and is known to pose a direct threat to at least one population of *Adenophorus periens* and *Bonamia menziesii* on the island of Kauai (HHP 1992a16; J. Lau, pers. comm., 1992). Strawberry guava is a major invader of forests in the Waianae and Koolau Mountains of Oahu, where it often

forms single-species stands. It poses an immediate threat to 6 populations of *Bonamia menziesii*, 10 populations of *Flueggea neowawraea*, and 1 population of *Plantago princeps* var. *princeps* on that island (HHP 1992b5, 1992b14, 1992b18, 1992b21; J. Lau, pers. comm., 1992). On Molokai, the habitat of the Halawa Valley population of *Diellia erecta* is currently being invaded by strawberry guava (HHP 1992c12). On Maui, strawberry guava is beginning to invade the habitat of one population each of *Bonamia menziesii* and *Plantago princeps* var. *laxiflora* on West Maui and at least one population each of *Diellia erecta* and *Plantago princeps* var. *laxiflora* on East Maui (J. Lau, pers. comm., 1992). It is also a major threat to the habitat of *Adenophorus periens* in Kahaualea NAR on the island of Hawaii (HHP 1992a8).

First introduced to the Hawaiian Islands as cattle fodder, molasses grass was later planted for erosion control (Cuddihy and Stone 1990). This alien grass quickly spread to dry and mesic forests previously disturbed by ungulates. Molasses grass produces a dense mat capable of smothering plants (Smith 1985), essentially preventing seedling growth and native plant reproduction (Cuddihy and Stone 1990). Because it burns readily and often grows at the border of forests, molasses grass tends to carry fire into areas with woody native plants (Cuddihy and Stone 1990, Smith 1985). It is able to spread prolifically after a fire and effectively compete with less fire-adapted native plant species, ultimately creating a stand of alien grass where forest once stood. Molasses grass is becoming a major threat to seven of the species on four islands. In the Waianae Mountains of Oahu, three populations of *Bonamia menziesii* and one population of *Plantago princeps* var. *princeps* are immediately threatened by this grass. On Molokai, at least one population each of *Diellia erecta*, *Plantago princeps* var. *laxiflora*, and *Neraudia sericea* and all populations of *Vigna o-wahuensis* on the island are also negatively affected. Molasses grass is quickly spreading throughout the dry regions of West Maui, threatening two populations of *Diellia erecta* there. On Hawaii Island, a population of *Sesbania tomentosa* in Hawaii Volcanoes National Park is located in an area invaded by molasses grass (J. Lau, pers. comm., 1992).

Like molasses grass, fountain grass has greatly increased fire risk in some regions, especially on the dry slopes of Hualalai, Kilauea, and Mauna Loa volcanoes on the island of Hawaii. The effects of fountain grass invasion are similar to those discussed above for

molasses grass. Fountain grass threatens the native vegetation on the leeward slopes of Hualalai in a region where at least one population of *Hibiscus brackenridgei* ssp. *brackenridgei* and the only known Hawaii Island populations of *Bonamia menziesii* and *Vigna o-wahuensis* exist (HHP 1992m12; J. Lau, pers. comm., 1992).

Koster's curse, a noxious shrub native to tropical America, was first reported on Oahu in 1941. It had spread through much of the Koolau Mountains by the early 1960s, and spread to the Waianae Mountains by 1970 (Cuddihy and Stone 1990). It poses a serious threat to two populations of *Plantago princeps* var. *longibracteata* in the Koolau Mountains. Koster's curse is widespread in Honouliuli and threatens two populations of *Flueggea neowawraea* that occur in that area of the Waianae Mountains. This prolific alien plant has recently spread to five other islands, including Kauai, where there are at least five small infestations totaling about 40 ha (100 ac) (Cuddihy and Stone 1990); one of these poses an immediate threat to one population of *Adenophorus periens* in Waioli Valley (J. Lau, pers. comm., 1992).

Lantana, a native of the West Indies, became naturalized in dry to mesic forests and shrublands of the Hawaiian Islands before 1871 (Cuddihy and Stone 1990). This shrub often forms thick cover and produces chemicals that inhibit the growth of other plant species (Smith 1985). On Kauai, lantana is a major component of the vegetation at Paaiki Valley and Waimea Canyon and is rapidly becoming established in Pohakua. It poses a threat to populations of *Flueggea neowawraea* in those areas (HHP 1992d13, 1992d17, 1992d18, 1992d30, 1992d31). One population of *Bonamia menziesii* on Lanai and one on Maui are also negatively affected by this invasive plant (HHP 1992b1, 1992b24).

Koa haole, a shrub naturalized and often dominant in low elevation, dry, disturbed areas on all of the main Hawaiian Islands, threatens to degrade the habitat of six of the species. Koa haole is one of the major weeds found at Polihale on the island of Kauai, growing in the vicinity of a population of *Sesbania tomentosa* (HHP 1992j33; J. Lau, pers. comm., 1992). In the Waianae Mountains of Oahu, koa haole is one of the primary weed threats to half of the *Bonamia menziesii* populations and all of the *Hibiscus brackenridgei* ssp. *mokuleianus* populations found in the area (HHP 1992b12, 1992b19, 1992e23; J. Lau, pers. comm., 1992). Most of the Molokai populations of *Sesbania tomentosa* and one of the Kahoolawe

populations of *Vigna o-wahuensis* are also negatively affected by koa haole (HHP 1992j13; J. Lau, pers. comm., 1992). On Maui, koa haole poses a threat to *Hibiscus brackenridgei* ssp. *brackenridgei* and *Spermolepis hawaiiensis* in the Lihau section of the West Maui NAR, and is probably also a threat to *Hibiscus brackenridgei* ssp. *brackenridgei* and *Sesbania tomentosa* elsewhere on West Maui (HHP 1992e3; J. Lau, pers. comm., 1992).

Kiawe, a deciduous thorny tree that can grow to 20 m (65 ft) in height, overshadows other plants and competes with associated vegetation for available water and space. At Polihale, on the island of Kauai, it is the primary alien plant threat to *Sesbania tomentosa*. Two Molokai populations of *Sesbania tomentosa* compete with kiawe for water and space on Moomomi's beaches. The primary alien plant threat to *Vigna o-wahuensis* on the island of Kahoolawe is kiawe (HHP 1992m21).

Australian red cedar is a fast-growing tree that was probably introduced to Hawaii for lumber. It is now found in many of Hawaii's extensively planted lowland forests and has become naturalized in mesic to wet forests (Wagner et al. 1990). Today, this tree is a definite threat to at least one population of *Bonamia menziesii* and most of the plants of *Flueggea neowawraea* in the Waianae Mountains of Oahu (J. Lau, pers. comm., 1992).

Buffelgrass forms continuous cover in dry habitats and provides excellent fuel for fire, from which it recovers quickly. Its seeds are easily dispersed by wind (Smith 1985). Buffelgrass threatens the habitat of two populations of *Sesbania tomentosa* on Molokai, and at least one population of *Vigna o-wahuensis* on Kahoolawe (J. Lau, pers. comm., 1992).

Prickly Florida blackberry was introduced to the Hawaiian Islands in the late 1800s (Haselwood and Motter 1983). The fruits are easily spread by birds to open areas where this plant can form dense, impenetrable thickets (Smith 1985). The Kauai population of *Adenophorus periens*, which is located at the boundary of Hono O Na Pali NAR and Na Pali Coast State Park, is threatened by this noxious weed (J. Lau, pers. comm., 1992).

A vine in the passionflower family, banana poka was introduced to the islands in the 1920s, probably as an ornamental. This vine is extremely detrimental to certain wet forest habitats of Kauai, Maui, and Hawaii. Heavy growth of this vine can cause damage or death to the native trees by overloading branches, causing breakage, or by forming a dense canopy cover, intercepting sunlight and shading out

native plants below. An infestation of this vine is located at Olaa Tract on the island of Hawaii, the site of one population of *Adenophorus periens* (J. Lau, pers. comm., 1992).

A recent introduction to the Hawaiian Islands, yellow Himalayan raspberry is rapidly becoming a major weed pest in wet forests, pastures, and other open areas on the island of Hawaii. It forms large thorny thickets and displaces native plants. Its ability to invade the understory of wet forests enables it to fill a niche presently unoccupied by any other major wet forest weed in Hawaii. This has resulted in an extremely rapid population expansion of this alien plant in recent years. One population of *Adenophorus periens* grows in Olaa Tract within Hawaii Volcanoes National Park in a region where yellow Himalayan raspberry is found in increasing numbers (J. Lau, pers. comm., 1992).

There are a number of other alien plant species that pose a significant threat to populations of the plants in this ruling. *Cynodon dactylon* (Bermuda grass) is a major threat to at least one population of *Sesbania tomentosa* at Moomomi on Molokai. *Senecio mikanioides* (German ivy), a noxious, wind-dispersed vine that forms localized mats of vegetation, is a threat to the only currently known population of *Solanum incompletum* on the island of Hawaii (J. Lau, pers. comm., 1992). This *Solanum incompletum* population is fenced and protected from ungulates; however, it is not protected from German ivy. *Syzygium cumini* (Java plum), a large evergreen tree, is an aggressive invader of undisturbed forests (Smith 1985). It threatens to shade out the only known populations of *Hibiscus brackenridgei* ssp. *mokuleianus* on Oahu (J. Lau, pers. comm., 1992). *Melia azedarach* (pride of India), a fast-growing deciduous tree that forms deep shade, grows in open dry habitats. A major infestation of this large tree in Waimea Canyon on Kauai poses an immediate threat to individuals of *Flueggea neowawraea* (HHP 1992d18, 1992d31).

Fire threatens six plant species growing in dry to mesic grassland, shrubland, and forests on five islands. On Oahu, fire is a potential threat to three populations of *Bonamia menziesii* and two populations of *Flueggea neowawraea* located adjacent to Makua Military Reservation, where current ordnance training exercises could unintentionally ignite fires (HHP 1992b12, 1992b19, 1992b20, 1992d12; J. Lau, pers. comm., 1992). The area has had a history of fires that may have burned through at least one of the

populations of *Bonamia menziesii*, and burned to within a few tens of meters of another (HHP 1992b19, 1992b20). Fire is also a threat to the following populations: one population each of *Bonamia menziesii* and *Flueggea neowawraea* on Oahu, one population of *Bonamia menziesii* on Lanai, two populations of *Sesbania tomentosa* and one population of *Vigna o-wahuensis* on Molokai, all known populations of *Vigna o-wahuensis* on Kahoolawe, and at least one population each of *Bonamia menziesii* and *Sesbania tomentosa* on the island of Hawaii (HHP 1992d12; J. Lau, pers. comm., 1992). Of note is a population of *Adenophorus periens* in Kahaulea NAR on the island of Hawaii (HHP 1992a8). Tephra fallout and lava flows from Kilauea Volcano have affected the NAR over the past several years. Wildfires ignited by volcanic activity have destroyed some of the NAR's mesic and wet forests. In addition, tephra fallout and noxious volcanic gasses have caused extensive damage to surrounding native forests. Such catastrophic natural events threaten to destroy the region's largest population of *Adenophorus periens*.

The small number of populations and of individual plants of six of these species (*Diellia erecta*, *Hibiscus brackenridgei*, *Mariscus pennatiformis*, *Neraudia sericea*, *Solanum incompletum*, and *Vigna o-wahuensis*) increases the potential for extinction from stochastic events. The limited gene pool may depress reproductive vigor, or a single human-caused or natural environmental disturbance could destroy a significant percentage of the individuals or the only known extant population. For example, *Solanum incompletum* is known from a single population on the island of Hawaii and numbers only two individuals. Two of the species have fewer than 5 populations and 6 of the species are estimated to number no more than 100 individuals (See Table 2). All of the species in this ruling except *Sesbania tomentosa* either number fewer than 20 populations or total fewer than 200 individuals. The reproductive system of *Flueggea neowawraea* further exacerbates the problem of limited numbers. Since each tree bears only male or female flowers, they must be cross-pollinated from a different tree (Hayden 1990). If only a few trees flower at the same time, or if flowering trees are too widely separated for pollination by insects, no seed will be set. The survival of small, isolated populations, which probably are already experiencing depressed reproductive vigor, is therefore further threatened.

The Service has carefully assessed the best scientific and commercial information available regarding the past, present, and future threats faced by these species in determining to make this rule final. Based on this evaluation, this rulemaking will list these 12 species as endangered: *Adenophorus periens*, *Bonamia menziesii*, *Diellia erecta*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Mariscus pennatiformis*, *Neraudia sericea*, *Plantago princeps*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, and *Vigna o-wahuensis*. These 12 species are threatened by one or more of the following: habitat degradation and/or predation by pigs, goats, deer, and cattle; competition for space, light, water, and nutrients by alien plants; habitat loss from fires; human impacts from recreational activities; and insect infestations. Six of the 12 species either number no more than about 100 individuals or are known from fewer than 5 populations. Small population size and limited distribution make all of these species particularly vulnerable to extinction from reduced reproductive vigor or from stochastic events. Because these 12 species are in danger of extinction throughout all or a significant portion of their ranges, they fit the definition of endangered as defined in the Act. Therefore, the determination of endangered status for these 12 species is warranted.

Critical habitat is not being proposed for the 12 species included in this rule, for reasons discussed in the "Critical Habitat" section of this rule.

Critical Habitat

Section 4(a)(3) of the Act, as amended, requires that, to the maximum extent prudent and determinable, the Secretary designate critical habitat at the time the species are determined to be endangered or threatened. The Service finds that designation of critical habitat is not presently prudent for these species. Such a determination would result in no known benefit to the species. The species have low total populations and/or numbers of individuals and face anthropogenic threats. The publication of precise maps and descriptions of critical habitat in the **Federal Register**, as required for the designation of critical habitat, would increase the degree of threat to these plants from take or vandalism and could contribute to their decline. The listing of these species under the Act publicizes the rarity of the plants and, thus, can make these plants attractive to researchers, curiosity seekers, or collectors of rare plants. All involved parties and the major landowners have

been notified. Protection of the habitat of the species will be addressed through the recovery process and through the section 7 consultation process.

Therefore, the Service finds that designation of critical habitat for these species is not prudent at this time, because such designation would increase the degree of threat from vandalism, collecting, or other human activities and because it is unlikely to aid in the conservation of these species.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Endangered Species Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain activities. Listing can encourage and result in conservation actions by Federal, State, and local agencies, and private organizations and individuals. The Endangered Species Act provides for possible land acquisition and cooperation with the State and requires that recovery plans be developed for listed species. The requirements for Federal agencies and the prohibitions against certain activities involving listed plants are discussed, in part, below.

Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is being designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(2) requires Federal agencies to insure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

Two taxa are located on Federal land in a national wildlife refuge on three Northwestern Hawaiian Islands: *Mariscus pennatiformis* ssp. *bryanii* grows only on the island of Laysan and *Sesbania tomentosa* grows on Necker and Nihoa. The national wildlife refuge is under the jurisdiction of the U.S. Fish and Wildlife Service. On the island of Hawaii, two species (*Adenophorus periens* and *Sesbania tomentosa*) are located in Hawaii Volcanoes National Park. Three populations of *Plantago princeps* var. *laxiflora* are located in Haleakala National Park on Maui. The two national parks on Maui and Hawaii are under the jurisdiction of the

National Park Service. Federal laws protect all plants on the national wildlife refuges, national parks, and national historic sites from damage or removal.

Five of the species in this rule occur on land owned or leased by the U.S. Department of Defense. Populations of *Bonamia menziesii* and *Flueggea neowawraea* are located in the mountains of the Lualualei Naval Reservation. No military activities currently affect those populations. On the island of Oahu, *Flueggea neowawraea* is known to grow on lands owned by the U.S. Army in Schofield Barracks Military Reservation. One population of *Hibiscus brackenridgei* ssp. *mokuleianus* may possibly occur at Schofield Barracks as well. Three of the species are located on State-owned land currently leased to the U.S. military: On Oahu, *Bonamia menziesii* and *Flueggea neowawraea* are located within Makua Military Reservation and *Spermolepis hawaiiensis* is located in Diamond Head Reservation, leased by the Department of Defense. Portions of Makua Military Reservation are used by the Army and other branches of the military for ordnance training. The two species are not located inside the impact areas or adjacent buffer zones and, thus, are not directly affected by military activities. The Army has constructed firebreaks on the Makua Military Reservation to minimize damage from unintentional fires that occasionally result from the use of ordnance (Herve Messier, U.S. Army, Ft. Shafter, pers. comm., 1990). Plants of *Spermolepis hawaiiensis* are restricted to the outer slope of Diamond Head and are not in an area affected by military activities. One species, *Vigna owahuensis*, grows on the previously federally owned island of Kahoolawe where the Federal government is involved with ordnance disposal. Although periodic detonation of ordnance is required on the island, the populations of this species found there are at sites too remote to sustain impacts from such detonation (J. Lau, pers. comm., 1992). There are no other known Federal activities that occur within the presently known habitat of these 12 plant species.

The Act and implementing regulations at 50 CFR 17.61, 17.62, and 17.63 set forth a series of general prohibitions and exceptions that apply to all endangered plant species. With respect to the 12 plant species subject to this final rule, all prohibitions of section 9(a)(2) of the Act, implemented by 50 CFR 17.61 apply. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to import or export any

endangered plant species to/from the United States; transport such species in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale such species in interstate or foreign commerce; remove and reduce to possession any such species from areas under Federal jurisdiction; maliciously damage or destroy any such species on any area under Federal jurisdiction; or remove, cut, dig up, damage, or destroy any such species on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law. Certain exceptions apply to agents of the Service and State conservation agencies. Section 10 of the Act and 50 CFR 17.62 provide for the issuance of permits under certain circumstances to carry out activities involving endangered plants that are otherwise prohibited by section 9.

It is the policy of the Service (59 FR 34272) to identify to the maximum extent practicable at the time a species is listed those activities that would or would not be likely to constitute a violation of section 9 of the Act. Such information is intended to clarify the potential impacts of a species' listing on proposed and ongoing activities within the species' range. Seven of the twelve species in this rule are known to occur on lands under the jurisdiction of the Fish and Wildlife Service, National Park Service or Department of Defense. Collection, damage or destruction of these species on these lands is prohibited without a Federal endangered species permit. Such activities on non-Federal lands would constitute a violation of section 9 if conducted in knowing violation of Hawaii State law or regulations or in violation of State criminal trespass law (see Hawaii State Law section below).

Two of the listed species are of horticultural interest and both are currently in commercial trade. *Hibiscus brackenridgei* is a very attractive member of a genus known for its immense horticultural popularity and is the official State flower of Hawaii. *Sesbania tomentosa* also is an exceptionally attractive species that grows well in low elevation urban areas. Intrastate commerce (commerce within a State) is not prohibited under the Act. However, interstate and foreign commerce (sale or offering for sale across State or international boundaries), will require a Federal endangered species permit. (Endangered species may be advertised for sale provided the advertisement contains a statement that no sale may be consummated until a permit has been

obtained from the Service.) Other than possible interstate commerce, the Service is not aware of any other activities being conducted by the public that will be affected by this listing and result in a violation of section 9. Questions regarding whether specific activities will constitute a violation of section 9 should be directed to the Field Supervisor of the Service's Pacific Islands Office (see ADDRESSES section). Requests for copies of the regulations concerning listed plants and general inquiries regarding prohibitions and permits may be addressed to the U.S. Fish and Wildlife Service, Ecological Services, Endangered Species Permits, 911 N.E. 11th Avenue, Portland, Oregon 97232-4181 (503/231-2063; FAX 503/231-6243).

Hawaii State Law

Federal listing would automatically invoke listing under Hawaii State law. Hawaii's Endangered Species Act (HRS, Sect. 195D-4(a)) states, "Any species of aquatic life, wildlife, or land plant that has been determined to be an endangered species pursuant to the [Federal] Endangered Species Act shall be deemed to be an endangered species under the provisions of this chapter and any indigenous species of aquatic life, wildlife, or land plant that has been determined to be a threatened species pursuant to the [Federal] Endangered

Species Act shall be deemed to be a threatened species under the provisions of this chapter." The State law prohibits cutting, collecting, uprooting, destroying, injuring, or possessing any listed species of plant, or attempting to engage in any such conduct. The State law also encourages conservation by State agencies and triggers other State regulations to protect the species (HRS, sect. 195-4 and 5). The State may enter into agreements with Federal agencies to administer and manage any area required for the conservation, management, enhancement, or protection of endangered species (HRS, Sect. 195D-5(c)).

National Environmental Policy Act

The Fish and Wildlife Service has determined that an Environmental Assessment or Environmental Impact Statement, as defined under the authority of the National Environmental Policy Act of 1969, need not be prepared in connection with regulations adopted pursuant to section 4(a) of the Endangered Species Act of 1973, as amended. A notice outlining the Service's reasons for this determination was published in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of all references cited herein is available upon request from

the Pacific Islands Office (see ADDRESSES above).

Authors

The authors of this final rule are Joan E. Canfield, Derral R. Herbst, and Adam Asquith of the Pacific Islands Office (see ADDRESSES section) (808/541-3441).

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, and Transportation.

Regulation Promulgation

Accordingly, part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, is amended as set forth below:

PART 17—[AMENDED]

1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361-1407; 16 U.S.C. 1531-1544; 16 U.S.C. 4201-4245; Pub. L. 99-625, 100 Stat. 3500; unless otherwise noted.

2. Section 17.12(h) is amended by adding the following, in alphabetical order under the plant families indicated, to the List of Endangered and Threatened Plants:

§ 17.12 Endangered and threatened plants.
 * * * * *
 (h) * * *

Species		Historic range	Family name	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
Flowering Plants							
Spermolepis hawaiiensis.	None	U.S.A. (HI)	Apiaceae	E	559	NA	NA
Diellia erecta	Asplenium-leaved diellia.	U.S.A. (HI)	Aspleniaceae	E	559	NA	NA
Bonamia menziesii	None	U.S.A. (HI)	Convolvulaceae	E	559	NA	NA
Mariscus pennatiformis.	None	U.S.A. (HI)	Cyperaceae	E	559	NA	NA
Flueggea neowawraea.	Mehamehame	U.S.A. (HI)	Euphorbiaceae	E	559	NA	NA
Sesbania tomentosa	'Ohai	U.S.A. (HI)	Fabaceae	E	559	NA	NA
Vigna o-wahuensis	None	U.S.A. (HI)	Fabaceae	E	559	NA	NA
Adenophorus periens	Pendant kahi fern	U.S.A. (HI)	Grammitidaceae	E	559	NA	NA

Species		Historic range	Family name	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
Hibiscus brackenridgei.	Ma'o hau hele	U.S.A. (HI)	Malvaceae	E	559	NA	NA
Plantago princeps	Laukahi kuahiwi	U.S.A. (HI)	Plantaginaceae	E	559	NA	NA
Solanum incompletum.	Popolo ku mai	U.S.A. (HI)	Solanaceae	E	559	NA	NA
Neraudia sericea	None	U.S.A. (HI)	Urticaceae	E	559	NA	NA

Dated: September 12, 1994.

Mollie H. Beattie,

Director, Fish and Wildlife Service.

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