

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Kokia kauaiensis* (kokio)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

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

Lead Region/Field Office:

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

Name of Reviewer(s):

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

Methodology used to complete this 5-year review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on April 29, 2008. The review was based on the final critical habitat designation for *Kokia kauaiensis* and other species from the island of Kauai (USFWS 2003), as well as a review of current, available information. The National Tropical Botanical Garden provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Samuel Aruch, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Assistant Field Supervisor for Endangered Species and Deputy Field Supervisor before submission to the Field Supervisor for approval.

Background:

For information regarding the species listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (http://ecos.fws.gov/tess_public).

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

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designation for *Kokia kauaiensis* published in the Federal Register on February 27, 2003 (USFWS 2003) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats and no significant new information regarding the species' biological status have

come to light since listing to warrant a change in the Federal listing status of *K. kauaiensis*.

When listed in 1996, *Kokia kauaiensis* was estimated to have a total of 145 to 170 individuals, in six scattered populations in northwestern Kauai, with only five of these populations having been seen since 1990. The five locations known in 1996 were Paaiki Valley; the Mahanaloa-Kuia Valley junction within or on the boundary of Kuia Natural Area Reserve; the western side of Kalalau Valley, and Pohakuao Valley, both within Na Pali Coast State Park; and the Koaie Stream branch of Waimea Canyon. The three largest populations contained between 30 and 70 individuals each, with the others each numbering fewer than 10 individuals (USFWS 1996). In 1993, two individuals were seen in Hipalau Valley but have not been reported since (Perlman 2008), and one four-meter (13 foot) tall individual noted in Pohakuao at 482 meters (1,580 feet) elevation in 1992 and 1999 has also not been seen again (National Tropical Botanical Garden 2008a; Perlman 2008). The Pohakuao individual was visited numerous times since 1999. It was doing well, yet has not been observed flowering or fruiting. Overall, current populations and numbers of individuals have declined to an estimated 45 to 50 individuals in five populations.

Fossil seed capsules of *Kokia kauaiensis* have been identified in Holocene fossil deposits at Makauwahi Cave, on Kauai's south shore (Burney *et al.* 2001). This suggests that this now rare and geographically restricted species was widespread a millennium ago. This notion is also supported by the high survival and rapid growth of outplanted *K. kauaiensis* at Makauwahi Cave (D. Burney, National Tropical Botanical Garden, pers. comm. 2008; Burney *et al.* 2001). Botanists from the National Tropical Botanical Garden have been monitoring various occurrences of *K. kauaiensis* for over thirty years (National Tropical Botanical Garden 2008a). Field data from those years indicated varying number of individuals at all locations known to USFWS in 1996. While observations of individual plants were frequent, occurrences as reported in the past are difficult to correlate prior to the consistent use of geographical positioning technology.

In 1996, 5 individuals of *Kokia kauaiensis* were known in Kalalau Valley, below Kahuamaa Flat from 427 to 609 meters (1,400 to 2,000 feet) (National Tropical Botanical Garden 2008a), and in 1999 six individuals and a few seedlings were seen in the enclosure in Kalalau (Wood 2000). In 2001, seven individuals were seen in Kalalau (Hawaii Biodiversity and Mapping Program 2008; Wood 2000), and in December 2005, two mature individuals and two seedlings were seen on the eastern side of Kalalau, plus four mature individuals and two seedlings on the western side. A month prior, another botanist saw two mature and five immature individuals, perhaps indicating that regeneration is not necessarily resulting in survivorship (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a; Tangalin 2005). As of 2008, only four individuals remain in Kalalau (M. Clark, National Tropical Botanical Garden, pers. comm. 2008).

In Koaie Canyon and along the Koaie Stream, a number of *Kokia kauaiensis* individuals have been observed over the years. In 1987, 50 individuals were noted at 609 to 792

meters (2,000 to 2,600 feet) elevation (Hawaii Biodiversity and Mapping Program 2008). In 1990, seven individuals were seen in a gulch near the *Aleurites moluccana* (kukui) forest at Beaver Valley (Piwa) at 625 meters (2,050 feet) elevation, and another tree was sighted further upstream at the same elevation. Another two individuals were seen along the stream and gulch. By 2000, there was only one tree, on the south side of stream, and the tree along the stream was gone (National Tropical Botanical Garden 2008a; Perlman 2008). In September 2000, three individuals were collected from Kawaiiki, a side valley of Koaie Canyon (Wood 2000), and from 2001 to 2004, three additional individuals were noted along the stream at 700 meters (2,300 feet) elevation. In 2004, botanists reported an additional tree at 625 meters (2,050 feet) elevation on a slope (National Tropical Botanical Garden 2008a; Tangalin 2005), and one in Koaie at 700 meters (2,300 feet) elevation (National Tropical Botanical Garden 2008a).

In Kuia Valley, about 40 individuals were seen in 1993 at 689 meters (2,260 feet) elevation. By 1999, only 22 to 23 individuals were known (Wood 2000). In 2004, 22 mature individuals and two seedlings were counted (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a). In September 2005, two individuals were seen at the confluence of the Kuia and Mahanaloa Valleys and these were in poor condition, with predation by mites (Perlman 2008).

In Mahanaloa Valley, about 50 to 75 individual trees were known in 1990 and 1993, with a few located within a fenced enclosure (National Tropical Botanical Garden 2008a). In 1999, eight individuals were seen at 594 to 649 meters (1,950 to 2,130 feet) elevation (Wood 2000) near the *Pteralyxia* enclosure. In 2004, botanists from the National Tropical Botanical Garden saw six individuals on ledges near *Delissea kauaiensis* at 524 meters (1,720 feet) elevation. In 2005, three individuals were sighted in the same area (Perlman 2008; Tangalin 2005).

In Paaiki Valley, 50 individuals were known in 1990 (National Tropical Botanical Garden 2008a) and in 1993 about 75 individuals were estimated at 628 meters (2,060 feet) elevation (Perlman 2008). In 1994, about 50 individuals were seen on the south side of the valley at 579 meters (1,900 feet) elevation (National Tropical Botanical Garden 2008a). In 1999, botanists counted 18 mature individuals, 6 immature individuals, and 32 seedlings inside the enclosure and 20 individuals at least 3 meters (9 feet) tall outside the enclosure (Wood 2000). In December 2005, ten mature and five immature individuals were observed outside the enclosure and two mature individuals were observed inside the enclosure (National Tropical Botanical Garden 2008a; Tangalin 2005)

Vegetation in the Kalalau habitat is *Diospyros sandwicensis* (lama) -*Metrosideros polymorpha* (ohia) lowland mesic forest. The canopy is composed of 40 percent *Diospyros sandwicensis*, ten percent *Antidesma platyphyllum* var. *hillebrandii* (hame), ten percent *Metrosideros polymorpha* var. *glaberrima*, (ohia), ten percent *Psychotria mariniana* and *P. greenwelliae* (kopiko), five percent *Pouteria sandwicensis* (alaa), and one percent *Pleomele aurea* (hala pepe). Understory tree cover is 40 percent *Psydrax odoratum* (alahee), 2 to 4 meters (6 to 10 feet) tall. Other associated species include:

Alectryon macrococcus var. *macrococcus* (mahoe), *Bobea elatior* (ahakea lau nui), *Carex meyenii* (no common name [NCN]), *Charpentiera elliptica* (papala), *Diospyros hillebrandii* (lama), *Diplazium sandwichianum* (hoio), *Doodia kunthiana* (okupukupu), *Elaeocarpus bifidus* (kalia), *Eugenia reinwardtiana* (nioi), *Flueggea neowawraea* (mehamehame), *Freycinetia arborea* (ie ie), *Kadua affinis* (manono), *Leptecophylla tameiameiae* (pukiawe), *Melicope feddei* (alani), *Myrsine lanaiensis* (kolea), *Nephrolepis exaltata* (kupukupu), *Pisonia brunoniana* (papala kepau), *P. sandwicensis* (aulu), *Pritchardia minor* (loulu), *Pteralyxia kauaiensis* (kaulu), *Rauvolfia sandwicensis* (hao), *Santalum freycinetianum* var. *pyrularium* (iliahi), *Syzygium sandwicensis* (ohia ha), and *Tetraplasandra kavaiensis* (ohe ohe) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a; Wood 2000). During the winter months when the sun is further in the southern sky, this forest, below the towering cliffs in the southeast, remains cool and shaded throughout the day. This has likely been extremely beneficial to the native forest species by allowing them to retain more moisture than other more exposed regions in the valley (National Tropical Botanical Garden 2008a).

Koae Canyon habitat is *Diospyros sandwicensis* or diverse lowland mesic forest with associated species *Acacia koa* (koa), *Alectryon macrococcus* var. *macrococcus*, *Antidesma platyphyllum*, *Asplenium* spp., *Bidens sandwicensis* subsp. *sandwicensis* (kookoolau), *Bobea timonioides* (ahakea), *Boehmeria grandis* (akolea), *Canavalia kauaiensis* (awikiwiki), *Chamaesyce celastroides* var. *hanapepensis* (akoko), *Claoxylon sandwicense* (laukea), *Cyrtomium caryotideum* (kaapeape), *Diellia pallida* (NCN), *Doodia kunthiana*, *Diospyros sandwicensis*, *Dodonaea viscosa* (aalii), *Doryopteris decora* (NCN), *Eragrostis variabilis* (kawelu), *Flueggea neowawraea*, *Gahnia beecheyi* (NCN), *Hibiscus waimeae* subsp. *waimeae* (kokio keokeo), *Kadua affinis*, *Leptecophylla tameiameiae*, *Melanthera fauriei* (nehe), *Metrosideros polymorpha*, *Microlepia strigosa* (palapalai), *Myrsine* spp., *Nestegis sandwicensis* (olopua), *Nototrichium sandwicensis* (kului), *Sphenomeris chinensis* (palaa), *Polypodium pellucidum* (ae lau nui), *Peperomia* spp. (ala ala wai nui), *Pipturus kauaiensis* (mamake), *Pisonia sandwicensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psychotria greenwelliae*, *P. mariniana*, *Psydrax odorata*, *Pteridium aquilinum* var. *decompositum* (kilau), *Pteris irregularis* (mana), *Rauvolfia sandwicensis*, *Santalum freycinetianum* var. *pyrularium*, *Sida fallax* (ilima), *Tetraplasandra kavaiensis*, and *Xylosma hawaiiense* (ae) (National Tropical Botanical Garden 2008a; Perlman 2008; Wood 2000). This area was described by botanist Joel Lau as severely eroded in 1987 (Hawaii Biodiversity and Mapping Program 2008).

Kuia Valley and the Mahanaloa fenced enclosure in the Kuia Natural Area Reserve are in diverse mesic forest. Associated native species include *Metrosideros polymorpha* var. *glaberrima*, *Acacia koa*, *Alyxia stellata* (maile), *Antidesma platyphyllum* var. *hillebrandii*, *Coprosma waimeae* (olena), *Delissea kauaiensis* (NCN), *Diospyros* sp., *Dryopteris unidentata* (akole), *Elaeocarpus bifidus*, *Euphorbia haeleleana* (NCN), *Kadua affinis*, *K. knudsenii* (NCN), *Isodendron laurifolium* (aupaka), *Nesoluma polynesianum* (keahi), *Pipturus albidus* (mamake), *P. kauaiensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psydrax odorata*, *Psychotria greenwelliae*, *P. mariniana*, *Syzygium sandwicensis*, *Tetraplasandra waimeae* (he kikoola), *Xylosma hawaiiense*, and

Zanthoxylum dipetalum (kawau) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a; Wood 2000).

The Paaiki enclosure is in *Metrosideros polymorpha* – *Acacia koa* mixed mesic forest with associated species including *Carex meyenii*, *Carex wahuensis* (NCN), *Charpentiera elliptica*, *Cyrtomium caryotideum*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Doodia kunthiana*, *Dryopteris unidentata*, *Hibiscus waimeae*, *Nestegis sandwicensis*, *Nototrichium sandwicense*, *Psydrax odorata*, *Pisonia sandwicensis*, *Pittosporum kauaiensis* (hoawa), *Pouteria sandwicensis*, and *Streblus pendulinus* (aiai). Native snails in the family Tortellinidae were observed on *Kokia kauaiensis* plants within the enclosure (National Tropical Botanical Garden 2008a; Wood 2000).

Pohakuao has relictual diverse mesic forest with a secondary succession of invasive introduced plant species. The associated native species include *Bidens sandwicensis* subsp. *sandwicensis*, *Boehmeria grandis*, *Lipochaeta connata* subsp. *acris* (nehe), *Nesoluma polynesianum*, *Pouteria sandwicensis*, *Pritchardia napaliensis* (loulou), *Psychotria mariniana*, *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Santalum freycinetianum* var. *pyrularium*, and *Wilkesia gymnoxiphium* (iliau) (National Tropical Botanical Garden 2008a). The habitat at Poopooiki has *Pteralyxia* mixed mesic lowland forest with *Euphorbia haeleleana* and *Rauvolfia sandwicensis* (National Tropical Botanical Garden 2008a),

A major threat affecting the regeneration and survival of *Kokia kauaiensis* is competition and habitat degradation by invasive introduced plant species, including *Adiantum hispidulum* (rough maidenhair fern), *Aleurites moluccana* (kukui), *Andropogon glomeratus* (beardgrass), *Bryophyllum pinnata* (air plant), *Christella dentata* (downy wood fern), *Commelina diffusa* (dayflower, holoholo), *Cordyline fruticosa* (ti), *Erigeron karvinskianus* (daisy fleabane), *Furcraea foetida* (Mauritius hemp), *Gastridium ventricosum* (nitgrass), *Grevillea robusta* (silk oak), *Hyptis pectinata* (comb hyptis), *Lantana camara* (lantana), *Ludwigia octovalvis* (primrose willow), *Mangifera indica* (mango), *Melia azedarach* (pride-of-India), *Paspalum urvillei* (vasey grass), *Passiflora edulis* (passion fruit), *P. ligularis* (sweet granadilla), *Pluchea carolinensis* (sourbush), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Rubus argutus* (blackberry), *R. rosifolius* (thimbleberry), *Stachytarpheta jamaicensis* (vervain, snake weed), *Syzygium cumini* (Java plum), and *Triumfetta semitriloba* (Sacramento bur) (Factor E). Other threats include substrate loss, due to habitat degradation by feral goats (*Capra hircus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*) (Factors A and C) (National Tropical Botanical Garden 2008a; USFWS 1996; Wood 2000); fire (Factor E); hurricanes (Factor E) (Perlman 2008), and landslides and falling rocks (Factor E) (Wood 2000). Seed predation by rats (*Rattus* sp.) and insects, including mites (species unknown), leaf hopper (species unknown), and coffee twig borer (*Xylosandrus compactus*) have all been observed on *K. kauaiensis* (Factor C) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a; Perlman 2008; Tangalin 2005; USFWS 1996). Climate change may also pose a threat to *K. kauaiensis* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species.

In addition to all of the other threats, species like *Kokia kauaiensis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks (Factor E). The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (Factor E) (USFWS 1998).

Conservation measures that have been taken include fencing of some wild individuals, monitoring, seed collection, propagation, and outplanting, both to augment at least one wild population and *ex situ*. To safeguard existing genetic material, propagation for genetic storage and reintroduction is occurring at the National Tropical Botanical Garden. Currently there are 345 seeds in storage and 304 plants have been propagated (National Tropical Botanical Garden 2009). *Kokia kauaiensis* has been extensively out planted by the National Tropical Botanical Garden. More than 200 individuals, from different parent populations, have been planted at the Lawai McBryde and Haena Limahuli Gardens, and at the Makauwahi Cave Reserve (National Tropical Botanical Garden 2008b).

Hawaii Division of Forestry and Wildlife has outplanted *Kokia kauaiensis*, with 20 individuals surviving at the Kalalau Rim enclosure, from two different parents. Thirteen of these are immature individuals that were grown at the National Tropical Botanical Garden. Most are less than one meter (three feet) tall with moderate to poor vigor. The remaining seven individuals are older outplantings, between one and a half to three meters (five to ten feet) tall. The population of *K. kauaiensis* in Paaiki Valley has been fenced by the Hawaii Division of Forestry and Wildlife (USFWS 1998) and fifteen mature individuals over three and a half meters (ten feet) tall survive in their Piwa Valley Enclosure. One individual is in their Lapa Enclosure, which is mature and about three and a half meters (ten feet) tall (Perlman 2008; M. Wyson, Hawaii Division of Forestry and Wildlife, pers. comm. 2008).

Fencing seems to make a significant contribution to survival. After a year of drought, one botanist noted that *Kokia kauaiensis* seedling survivorship in the Paaiki Enclosure was extraordinary over the year 2004. This was attributed to ungulate exclusion. The presence of native snails on *Kokia* leaves was another indication of a healthier population (National Tropical Botanical Garden 2008a).

Stabilizing, downlisting, and delisting objectives are provided in the addendum to the Kauai recovery plan (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Kokia kauaiensis* is a long-lived perennial, and to be considered stable, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on the island of Kauai. Each of these populations

must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

The interim stabilization goals for this species have not been met (see Table 1), as no population has more than 25 mature individuals and all threats are not being managed. Therefore, *Kokia kauaiensis* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Continue to collect seeds for full genetic storage and for use in reintroduction efforts.
- Survey Koaie and Kawaiiki area for additional individuals.
- Develop a standard monitoring protocol, using tagging and GIS coordinates, to determine reintroduction needs for the species.
- Monitor growth and survival rates for both wild and reintroduced individuals.
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

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Personal communications:

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Table 1. Status of *Kokia kauaiensis* from listing through 5-year review.

Date	No. wild indivs.	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1996 (listing)	145-170	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	Yes
1998 (recovery plan)	105-150	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	Yes
2003 (critical habitat)	166-171	Unknown	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	Yes
2009 (5-year review)	45-50	>200	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Kokia kauaiensis* (kokio)

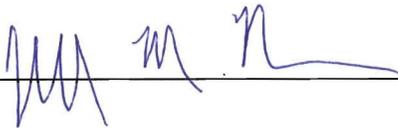
Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year review:

- Delisting
- Reclassify from Endangered to Threatened status
- Reclassify from Threatened to Endangered status
- No Change in listing status

Field Supervisor, Pacific Islands Fish and Wildlife Office

for



Date AUG 27 2010