

5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Kokia drynarioides* (koki‘o)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

Lead Region/Field Office:

Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

Name of Reviewer:

Cheryl Phillipson, Biologist, PIFWO

Lauren Weisenberger, Plant Recovery Coordinator, PIFWO

Megan Laut, Conservation & Restoration Team Manager, PIFWO

Methodology used to complete this 5-year review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office (PIFWO) of the U.S. Fish and Wildlife Service (Service) beginning in October 2019. The review was based on a review of current, available information since the last 5-year review for *Kokia drynarioides* (USFWS 2015). The evaluation by Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

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).

Review Analysis:

Please refer to the previous 5-year reviews for *Kokia drynarioides* published in the Federal Register on July 21, 2009 and August 25, 2015 (available at https://ecos.fws.gov/docs/five_year_review/doc2476.pdf and https://ecos.fws.gov/docs/five_year_review/doc4591.pdf) for a complete review of the species’ status, threats, management efforts, and references cited. We are not aware of any significant new information regarding the species’ biological status since listing to warrant a change in the Federal listing status of *K. drynarioides*.

This long-lived perennial tree in the Malvaceae (mallow) family is endangered. The status and trends for *Kokia drynarioides* are provided in the tables below.

New Status Information:

- In 2014, there were two populations, totaling two to five mature, three immature, and 21 seedlings within Pu‘uwa‘awa‘a (PEPP 2014). Currently, there are two mature trees at Koena (Ka‘ūpūlehu). These individuals are naturally recruiting as there are reports of gathering six seedlings from the area (Hawaii Forest Industry Association (HFIA) 2016, 2017) and hundreds of seeds have been collected from these individuals (Maui Nui Botanical Garden (MNBG) 2019; Volcano Rare Plant Facility (VRPF) 2019). Uncertainty remains if some trees at Pu‘uwa‘awa‘a are wild or previous reintroductions (PEPP 2014).

New Threats:

- Climate change loss or degradation of habitat—Climate change may pose a threat to this species. Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Kokia drynarioides* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.73 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

New Management Actions:

- Captive propagation for genetic storage and reintroduction—
 - Previously, Lyon Arboretum Seed Conservation Laboratory reported thousands of seeds in storage. Currently, there are 455 seeds collected and stored representing four founders from Pu‘uwa‘awa‘a (Lyon Arboretum 2019).
 - In 2016 and 2017, twenty seeds were propagated from collections from a wild plants within Koena. The rare plant nursery for Ka‘ūpūlehu reported 63 seeds in storage representing one or more plants located at the National Tropical Botanical Garden (NTBG) preserve at Māulukua, and one wild plant within Koena. Five seedlings were collected from within an enclosure as these individuals were growing close to a trail (Ka‘ūpūlehu Dryland Forest Preserve (KDFP) 2019).
 - Hawaii Volcanoes National Park (HVNP) reported one plant in storage sourced from an outplanting at Kīpuka Nēnē in 2014 and one plant representing one wild individual (HVNP 2019).
 - Maui Nui Botanical Garden (MNBG) reported hundreds of seeds and 15 plants in storage sourced from collections at the Olinda Rare Plant Facility (ORPF) (MNBG 2019).
 - The rare plant nursery at Pu‘uwa‘awa‘a reported 193 seeds in storage representing one founder from the Koki‘o enclosure. In 2018, 12 plants were propagated (Pu‘uwa‘awa‘a 2018).

- Between 2013 and 2019, the Volcano Rare Plant Facility (VRPF) reported representation of 25 founders (either wild or reintroduced) in collections. In total, there are 478 seeds representing seven individuals and 30 plants in inventory representing 12 individuals (VRPF 2019).
- Waimea Valley Arboretum reported 10 seeds in storage representing one individual in 2018 (Waimea Arboretum 2018). In 2014, there were two plants in refugia representing two wild individuals; however, their current status is not reported.
- In 2014, the Plant Extinction Prevention Program (PEPP) collected more than 300 seeds representing two wild individuals within the Koki‘o exclosures and sent them to the VRPF for storage (PEPP 2014).
- Reintroduction—
 - The rare plant nursery for Ka‘ūpūlehu Dryland Forest Preserve (KDFP) reported reintroduction of 22 plants at three sites within the Preserve in 2017 (KDFP 2019).
 - HVNP reported reintroduction of one plant propagated from the individuals at Kīpuka Nēnē back to the same area (HVNP 2019).
 - Future Forests Nursery reintroduced 72 individuals of *Kokia drynarioides* within exclosures at Palamanui between 2014 and 2019. Currently, 67 survive (Future Forests Nursery 2019).
 - Pu‘uwa‘awa‘a Forest Reserve reported reintroduction of a total of 1,386 individuals of *Kokia drynarioides*: two plants at the Aiea unit, 886 plants within the Hauaina Reservoir Paddock, 409 plants reintroduced within ‘Owē‘owē, and one plant at Pāpala, 86 plants at Uhiuhi I/Wiliwili, and two plants not within a management unit (Pu‘uwa‘awa‘a 2018; Adkins 2020, in litt.).
 - The VRPF reports reintroduction of 147 plants (representing 18 founders) between 2013 and 2019 at Pu‘uwa‘awa‘a and Ka‘ūpūlehu, and one individual at Hilani Pali within HVNP (VRPF 2019).
 - In 2019, PEPP summarized the total number of individuals reintroduced at six sites at Pu‘uwa‘awa‘a (more than 1,200 plants), these include augmentation of the *Kokia* exclosures populations with four mature, three immature, and 41 seedlings; 505 immature plants reintroduced at Hauaina Reservoir Paddock; 515 immature plants reintroduced at Kukui Paddock; 86 immature plants reintroduced by the State’s Natural Area Reserves staff at the Uhiuhi exclosure; 71 immature plants reintroduced at the Oweowe exclosure; and 63 immature plants reintroduced at Pu‘uwa‘awa‘a Cone exclosure (PEPP 2019).
- Population research and biology—
 - Sherwood and Morden (2014) conducted a study to determine the genetic variation of *Kokia kauaiensis* as compared to *K. cookei* and *K. drynarioides*, and to determine if the three species were genetically distinct (Sherwood and Morden, p. 538). They found that populations of *K. kauaiensis* contained substantial genetic diversity, and that *K. drynarioides* had a greater genetic variation, likely because *K.*

drynarioides occurs in more widely separated locations (Sherwood and Morden, pp. 537, 543).

- A previous study by Morden and Ching Harbin (2013) postulated that the dispersal of the African ancestor of *Hesperomannia* occurred via a stepping-stone colonization across Southeast Asia, with intermediate species going extinct. Following this report, Morden and Yorkston (2018) proposed that a similar colonization scenario could have occurred for *Kokia drynarioides* as its closest ancestor, *Gossypioides kirkii*, is also of African origin (Morden and Yorkston 2018, p. 210). The study demonstrated that *Kokia* species' relationships are consistent with this stepping-stone model of dispersal in the Hawaiian Islands (Morden and Yorkston 2018, p. 220).

Table 1. Status and trends of *Kokia drynarioides* from listing through current 5-year review.

Date	No. wild individuals	No. outplanted	Downlisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
1984 (listing and critical habitat)	15	Unknown	Greatly reduce major threats (ungulates, fire, fountain grass)	No
			Natural regeneration adequate to replace individuals lost from population and preserve genetic diversity	No
			Recovery proceeds for the time needed (ca 13 years) to provide demographic data to be used in population viability analysis	No
			Determine the minimum habitat area needed for survival over the next 200 years	No
			Current habitat secured in perpetuity	No
			Implement management practices to maintain protected habitats	No

			Results of PVA for number and densities of species (minimum of 100 individuals in each of 3 populations in North Kona)	No
1994 (recovery plan)	4	21	Greatly reduce major threats (ungulates, fire, fountain grass)	Partially
			Natural regeneration adequate to replace individuals lost from population and preserve genetic diversity	No
			Recovery proceeds for the time needed (ca 13 years) to provide demographic data to be used in population viability analysis	No
			Determine the minimum habitat area needed for survival over the next 200 years	No
			Current habitat secured in perpetuity	No
			Implement management practices to maintain protected habitats	No
			Results of PVA for number and densities of species (minimum of 100 individuals in each of 3 populations in North Kona)	No
2009 (5-year review)	2	98	Greatly reduce major threats (ungulates, fire, fountain grass)	Partially
			Natural regeneration adequate to replace individuals lost from population and preserve genetic diversity	No

			Recovery proceeds for the time needed (ca 13 years) to provide demographic data to be used in population viability analysis	No
			Determine the minimum habitat area needed for survival over the next 200 years	No
			Current habitat secured in perpetuity	No
			Implement management practices to maintain protected habitats	Partially
			Results of PVA for number and densities of species (minimum of 100 individuals in each of 3 populations in North Kona)	No
2015 (5-year review)		ca 166	Greatly reduce major threats (ungulates, fire, fountain grass)	Partially
			Natural regeneration adequate to replace individuals lost from population and preserve genetic diversity	No
			Recovery proceeds for the time needed (ca 13 years) to provide demographic data to be used in population viability analysis	No
			Determine the minimum habitat area needed for survival over the next 200 years	No

			Current habitat secured in perpetuity	No
			Implement management practices to maintain protected habitats	Partially
			Results of PVA for number and densities of species (minimum of 100 individuals in each of 3 populations in North Kona)	No
Date	No. wild individuals	No. outplanted	*Preventing Extinction Criteria identified by HPPRCC	*Preventing Extinction Criteria Completed?
2020 (5-year review)	6	Unknown (at least 67; ~1,300 planted)	All threats managed in all 3 populations	Partially, reintroductions in exclosures
			Complete genetic storage	Yes
			Reproduction (i.e. viable seeds, seedlings) at all 3 populations	Partially, recruitment at one location
			3 populations with 25 mature individuals each	No

* The Preventing Extinction Stage was established in 2011. Prior to 2011, the Interim Stabilization Stage was the first stage towards recovery (now it is the second stage after Preventing Extinction).

Table 2. Threats to *Kokia drynarioides* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Agriculture and urban development	A	Ongoing	None
Ungulate destruction and degradation of habitat and herbivory	A, C, D	Ongoing	Partial, all reintroductions within exclosures

Established ecosystem altering invasive plant species degradation of habitat and competition	A, E	Ongoing	Partial, nonnative plant control within exclosures
Degradation and destruction by fire	A	Ongoing	Partial, Pu‘uwa‘awa‘a fire management approach
Climate change degradation or loss of habitat, including drought	A	Ongoing	Partial, secondary reintroduction sites at HVNP
Predation and herbivory by rodents	C	Ongoing	None
Predation by invertebrates—ants and aphids	C	Ongoing	None
Loss of vigor due to low numbers	E	Ongoing	Partial, collection, propagation, and reintroduction

Synthesis:

Currently, there are 2 to 6 wild individuals of *Kokia drynarioides* at one or two locations on the island of Hawai‘i. Fortini *et al.* conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections and their analysis showed that *K. drynarioides* is highly vulnerable to the effects of climate change. Genetic representation of the wild individuals is complete, and collection of seeds from wild and reintroduced plants is ongoing, with more than 1,400 seeds added to storage since 2015 and 86 plants currently in an *ex situ* living collection. More than 1,300 individuals have been reintroduced at 7 locations; however, current survivorship of 93 percent is reported only for those at Palamanui, and no data is available for the other locations. Observations of naturally recruiting seedlings was last reported in 2015. Wild and reintroduced individuals are fenced; however, there must be continuous monitoring for ungulate ingress. Some nonnative plant control is ongoing.

Stabilizing (interim), downlisting, and delisting objectives were provided in the Recovery Plan for *Caesalpinia kavaiensis* and *Kokia drynarioides* (USFWS 1994), and have been updated according to the draft revised recovery objective guidelines developed by the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC 2011). The HPPRCC identifies an additional initial objective, the Preventing Extinction Stage, in addition to the Interim Stabilization, Delisting, and Downlisting objectives. Furthermore, life history traits such as breeding system, population size fluctuation or decline, and reproduction type (sexual or vegetative), have been included in the calculation of goals for the number of populations and reproducing individuals for each stage. The goals for each stage remain grouped by life span defined as annual, short-lived perennial (fewer than 10 years), or long-lived perennial.

Kokia drynarioides is a long-lived perennial tree. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three populations should be documented on the island of Hawai‘i where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, saplings) with a minimum of 25 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met. There are between four and six wild individuals remaining, and, although there were more than 1,300 reintroduced individuals (mostly at Pu‘uwa‘awa‘a), survivorship is unknown, and recruitment has been reported at only one site (Table 1). There is complete genetic representation of the last known wild individuals (Table 1); however, not all threats are being managed (Table 1, Table 2). Therefore, *Kokia drynarioides* meets the definition of Endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

No new threats and no other significant new information is reported regarding the species’ biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020.

- Surveys and inventories—Continue to conduct surveys for additional occurrences of *Kokia drynarioides* and monitor reintroductions for a current assessment of the species’ status.
- Ungulate exclosures—Maintain existing exclosures and monitor for incursions by feral ungulates.
- Ecosystem-altering invasive plant species control—Control invasive nonnative plants at all wild and reintroduced populations of *K. drynarioides*
- Fire monitoring and control—Develop and implement a fire management plan for all reintroduction sites.
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery.
- Predation and herbivory control—
 - Implement effective control measures for rodents at all reintroduction sites
 - Research effects of damage caused by ants and aphids and effective control measures if determined to be necessary.
- Captive propagation for genetic storage and reintroduction—
 - Continue collection of material for genetic storage and propagation for reintroduction into protected suitable habitat.
 - Evaluate genetic resources currently in storage to determine the need for additional long-term storage due to this species’ vulnerability to climate change.

- Reintroduction and translocation—Continue augmentation of wild populations and establishment of new populations through reintroduction into suitable protected habitat. Assess success of reintroductions and monitor recruitment.
- Alliance and partnership development—Continue to contribute to implementation of ecosystem-level restoration and management to benefit this species.

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Kokia drynarioides*
(koki'o)

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

Recommendation resulting from the 5-year review:

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

For Field Supervisor, Pacific Islands Fish and Wildlife Office

Date _____