5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Flueggea neowawraea* (Mehamehame)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2007. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 71 species in Oregon, Hawaii, Commonwealth of the Northern Mariana Islands, and territory of Guam. Federal Register 72(45):10547-10550.

Lead Region/Field Office:

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

Name of Reviewer(s):

Annie Marshall, Pacific Islands Fish and Wildlife Office, Fish and Wildlife Biologist
Marie Bruegmann, Pacific Islands Fish and Wildlife Office, Plant Recovery Coordinator
Marilet A. Zablan, Pacific Islands Fish and Wildlife Office, Recovery Program Leader and acting Assistant Field Supervisor for Endangered Species

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 March 7, 2008. The review was based on the final critical habitat designation for *Flueggea neowawraea* and other species from the islands of Kauai and Niihau, as well as a review of current, available information (USFWS 2003). The Bernice P. Bishop Museum provided an initial draft of portions of the 5-year review and they also provided recommendations for conservation actions needed prior to the next five-year review. The evaluation of the status of the species was prepared by our lead PIFWO biologist and reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and acting Assistant Field Supervisor for Endangered Species 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 *Flueggea neowawrea* 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 *Flueggea neowawraea*.

SUMMARY

Historically, *Flueggea neowawraea* was recorded on Hawaii, Maui, Molokai, Oahu, and Kauai. When this species was listed in 1994, there were about 28 occurrences totaling 127 to 167 individuals State-wide (USFWS 1994). *Flueggea neowawraea* still exists throughout its recorded range except on Molokai, where the single known tree died before 1939. More than 15 populations are currently known, totaling 108 to 128 wild individuals (USFWS 2008). No one of populations consists of 25 mature reproducing individuals. *Flueggea neowawraea* is now considered to be in the family Phyllanthaceae (Wurdack *et al*. 2004).

On Oahu, *Flueggea neowawraea* grows in gulches of the northern Waianae Mountains. Wild individuals of the taxon are declining in number over time, with 108 individuals in 10 populations currently found on Oahu, consisting of Kahanaiki/Kapuna (seven mature wild; augmented with 72 immature individuals); Ohikilolo (one wild), West Makaleha (six wild), Central and East Makaleha (five wild), Halona (two wild), Kauhiuhi (one wild), Mikilua (one wild), Mt. Kaala (three wild), Nanakuli (one wild), and Makaha (nine wild). On Oahu, about 40 percent of *F. neowawraea* individuals are mature plants, and 60 percent are immature plants that were augmented into the wild population. Viable seed has been collected from only two trees, both located in the West Makaleha population, the only location where male and female trees are near each other (U.S. Army 2007).

Flueggea neowawraea is most common on Kauai, with 28 wild trees estimated to be known, but surveys have not been recently undertaken (USFWS 2008). The largest population occurs within Pohakuao Valley. A survey of the South Falls region in 1999 reported around 30 living trees and approximately 100 standing or fallen dead individuals; however, during surveys in 2001 only seven of the 30 trees were found still living (Wood 2006; Wood and LeGrande 2002). An additional four healthy individual plants were mapped during an inventory of the North Falls region in January 2002, and a single individual is known to occur on the forested slope below the North Falls cliff region, giving a total of 12 *Flueggea neowawraea* in Pohakuao. A population of eight individuals was discovered in Koaie Canyon in 2004, three are found at Kalalau, and five individuals in Poomau (Wood and LeGrande 2002).

Only two trees are known to persist on the southern flank of Haleakala, East Maui (USFWS 2008), with perhaps another three to four trees in the area (H. Oppenheimer, Plant Extinction Prevention Program, pers. comm. 2008).

Nine trees are known on the island of Hawaii in five populations at Manuka, Honomolino, Hualalai Ranch, and Hoomau (Plant Extinction Prevention Program 2007). At Manuka, the fenced population consists of three male trees, treated with systemic pesticides to control the introduced invasive black twig borer (beetle). Over 105

outplants at Manuka were killed by black twig borer. The unfenced Honomolino and Hoomau individuals consist of at least one female producing seed. The Hualalai Ranch individual, a male, is not in good condition.

In total, *Flueggea neowawraea* is known from 108 to 128 individuals in 22 populations. No wild seedlings or immature individuals are reported in any of the populations (Plant Extinction Prevention Program 2007; U.S. Army 2007, 2006), and the taxon continues to decline. Few trees have been observed in flower or fruit; individual trees are usually isolated and far from trees of the opposite gender, and most are unhealthy due to black twig borer damage. Many of the remaining live trees are partially dead, with crowns that have died back but that retain some relatively healthy live branches. Little is known about the male to female ratio of plants left in the wild nor about the genetic diversity that remains in the living populations. Currently the sex of 43 percent of Kauai's population of *Flueggea* has been assessed; seven female trees, five males, and 16 of unknown gender have been identified (Wood 2006; Wood and LeGrande 2002). Preliminary genetic data indicates that individuals from Kauai are the most genetically variable from other island populations (Oahu, Maui, and Hawaii). Some trees appear to have a greater resistance than others to the effects of the black twig borer (*Xylosandra compactus*), and it is suggested that these individuals be monitored more vigorously than others for seed collection.

Most trees are found in degraded unprotected habitat threatened with high levels of ungulates [cattle (*Bos taurus*), goats (*Capra hircus*), and pigs (*Sus scrofa*)] and invasive introduced plant species. On Oahu, a little more than half of the critical habitat for *Flueggea neowawraea* is located in forest habitat with greater than 50 percent native plant cover (USFWS 2007). This species is threatened by military-related wildfire in action areas for Makua, Schofield Barracks Military Reservation, and Lualualei Naval Magazine, Oahu (USFWS 2007). Approximately 64 individuals are located in the low fire-risk zone and nine individuals occur in the very low fire-risk zone. On Hawaii, the habitat at Manuka is more than 50 percent native dry forest, Honomalino is very degraded *Metrosideros* (ohia) forest, and Hualalai Ranch is pasture with the invasive introduced species *Grevillea robusta* (silk oak) (Plant Extinction Prevention Program 2007). Pigs threaten the population at Honomalino, Hawaii (Plant Extinction Prevention Program 2007), and goats were observed browsing suckers growing at the base of the tree at Ohikilolo (U.S. Army 2006). The population at Koaie Canyon, Kauai is subject to habitat degradation and destruction by feral goats and pigs, and non-native plant species such as *Lantana camara* (lantana), *Grevillea robusta* (silk oak), *Melia azedarach* (chinaberry), *Synedrella nodiflora* (nodeweed), *Centaurium erythraea* (bitterherb), *Lythrum maritimum* (loosestrife), *Oxalis corniculata* (yellow wood sorrel), *Passiflora edulis* (passion fruit), *Vulpia bromoide*s (brome fescue), *Abutilon grandifolium* (hairy abutilon), *Hyptis pectinata* (comb hyptis), and *Triumfetta semitriloba* (Sacramento bur), some of which possess the ability to spread rapidly and cover effectively large areas in the forest understory (K. Wood, National Tropical Botanical Garden, pers. comm., 2008). The primary threat to the continued existence of *Flueggea neowawraea* is the black twig borer (*Xylosandrus compactus*), which has affected the vigor of all known individuals by causing slight to severe defoliation (Plant Extinction Prevention Program 2007; USFWS

2007). It is a small beetle that attacks over 100 species of trees and shrubs by burrowing into woody branches, where it lays its eggs and introduces a pathogenic fungus (*Fusarium solani*) as food for its larvae. The fungus is responsible for the decline or death of twigs, branches, and entire plants. Stress from black twig borer damage may limit or prevent flowering by killing vascular tissue (U.S. Army 2007). Fruits produced on nursery trees are taken by birds before they mature. Black twig borer *(Xylosandrus compactus)* is very damaging to this species, and research is being conducted to find better control methods (U.S. Army 2006).

The Chinese rose beetle (*Adoretus sinicus*) also causes partial defoliation in *Flueggea neowawraea*. Defoliation together with other stresses, compounded by senescence, could result in death of the entire tree. Seedlings are also attacked by black twig borers and Chinese rose beetles (Lilleeng-Rosenberger 2005), inhibiting photosynthesis and the growth of individuals. Predation of fruits by rats is another possible threat to the taxon (K. Wood, pers. comm., 2008; USFWS 1999, 2008).

The need for cross-pollination constrains this species' recovery, given its low numbers, isolation of mature trees, and separation of male and female trees (USFWS 2007). Reductions in population size and reproduction could result in expression of inbreeding depression among any progeny that result, including reduced reproductive vigor.

Catastrophic extinction through environmental events, possible land slides, human disturbance, fire, and for the rare species, reduced reproductive vigor as the result of limited numbers of existing individuals, are additional threats to the species (K. Wood, pers. comm., 2008).

The U.S. Army is focusing on collecting cuttings and air layers from all known *Flueggea neowawraea* trees, collecting and storing pollen for hand pollination of greenhouse plants, propagating seed, and securing habitat with fences. Outplanting sites in Kahanahaiki Gulch at Leeward Community College, and Waimea Audubon Center have fared well and the U.S. Army will continue to establish clones of all known trees in botanical gardens and other *inter situ* (sites of similar habitat to wild individuals but not within historical range) sites (U.S. Army 2007). The 841 seeds are stored at the National Tropical Botanical Garden (2008). The U.S. Army has 67 plants in nurseries, 525 seeds in genetic storage, and has reintroduced 64 immature individuals (U.S. Army 2007). Pahole Rare Plant Facility has three plants in genetic storage (Pahole Rare Plant Facility 2008). The University of Hawaii's Harold L. Lyon Arboretum (2008) has six individuals represented in micropropagation. Pollen is also being stored for future pollination events in nursery collections (U.S. Army 2006). Pollen has been held frozen at 20 percent relative humidity for as long as six months and used to produce viable seed, and fresh mature seed can be stored dried and frozen for five years with no decrease in viability (U.S. Army 2007).

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for plants from the Multi-Island plants (USFWS 1999), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Flueggea neowawraea* is a long-lived perennial, and to be considered stabilized, which is

the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (off-site) collection. In addition, a minimum of three populations should be documented on islands where they now occur or occurred historically. For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

The stabilization and recovery goals for this species have not been met as only one population has 25 mature individuals, no reproduction is occurring in the wild, and, not all threats are being managed. Therefore, *Flueggea neowawraea* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Continue to collect fruit from all wild and any reintroduced individuals that set viable seed to add to the genetic diversity of the *ex situ* material.
- Control introduced invasive plant species around wild and outplanted plants.
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates.
- Continue reintroducing individuals into protected suitable habitat within historical range.
- Investigate techniques to improve natural recruitment, including development and implementation of methods to control black twig borer.
- Assess genetic variability within extant population.
- Study *Flueggea neowawraea* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.

References:

Harold L. Lyon Arboretum Micropropagation Laboratory. 2007. Micropropagation database. University of Hawaii at Manoa. Unpublished.

Lilleeng-Rosenberger, K. E. 2005. Growing Hawaii's Native Plants. Mutual Publishing, Honolulu, HI.

National Tropical Botanical Garden. 2008. Report on controlled propagation of listed and candidate species, as designated under the U.S. Endangered Species Act. Unpublished.

Plant Extinction Prevention Program. 2008. Section 6 annual performance report for endangered plant restoration and enhancement - Plant Extinction Prevention (formerly Genetic Safety Net), Fiscal Year 2008 (July 1, 2007 – June 30, 2008). Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife. 113 pages. Unpublished.

U.S. Army. 2006. 2006 Status Reports for the Makua Implementation Plan and the Draft Oahu Implementation Plan. United States Army Garrison, Directorate of Public Works, Environmental Division, Schofield Barracks, Hawaii.

U.S. Army. 2007. 2007 Status Reports for the Makua Implementation Plan and the Draft Oahu Implementation Plan. United States Army Garrison, Directorate of Public Works, Environmental Division, Schofield Barracks, Hawaii.

[USFWS] U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; endangered status for 12 plants from the Hawaiian Islands. Federal Register 59:56333–56351.

[USFWS] U.S. Fish and Wildlife Service. 1999. Recovery plan for the multi-island plants. U.S. Fish and Wildlife Service, Portland.

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

[USFWS] U.S. Fish and Wildlife Service. 2007. Reinitiation of the 1999 Biological Opinion of the U.S. Fish and Wildlife Service for U.S. Army military training at Makua Military Reservation, island of Oahu.

[USFWS] U.S. Fish and Wildlife Service. 2008. Rare plant tracking database. Pacific Islands Fish and Wildlife Office, Honolulu, HI. Accessed on April 28, 2008. Unpublished.

Wood, K. R. 2006. Further Investigations into the Distribution and Abundance of *Flueggea neowawraea* (Euphorbiaceae) on Kauai, Hawaii. Page 14, Botanical report prepared for the Department of Land and Natural Resources, Division of Forestry and Wildlife, and the U.S. Fish and Wildlife Service.

Wood, K. R., and M. K. LeGrande. 2002. Biological Inventory of Upper Pohakuao Valley, North and South Falls Region, Na Pali Coast State Park, Kauai, Hawaii; with information concerning the distribution and abundance of *Flueggea neowawraea* (Euphorbiaceae) and *Oceanodroma castro* (Hydrobatidae). Page 40, Special Report Prepared for The Department of Land and Natural Resources, Division of State Parks, Technical Report.

Wurdack, K. J., P. Hoffmann, R. Samuel, A. De Bruijn, M. Vn Der Bank, and M. W. Chase. 2004. Molecular phylogenetic analysis of Phyllanthaceae (Phyllanthoideae pro parte, Euphorbiaceae sensu lato) using plastid *rbcl* DNA sequences. American Journal of Botany 91:1882-1900.

Table 1. Status of *Flueggea neowawraea* from listing through 5-year review.

Date	**No. wild indivs**	**No. outplanted**	**Stability Criteria identified in Recovery Plan**	**Stability Criteria Completed?**
1994 (listing)	127-167	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1998 (recovery plan)	124-195	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No*
2003 (critical habitat)	62-100+	0	All threats managed in all 3 populations	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2008 (5-yr review)	108-128	72	All threats managed	No
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No

* Although one or two population units may number 25 or more mature individuals, individual trees are often isolated and not reproducing

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Flueggea neowawraea*

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

Recommendation resulting from the 5-year review:

_____ Delisting
_____ Reclassify from Endangered to Threatened status
_____ Reclassify from Threatened to Endangered status
_X_ No Change in listing status

Field Supervisor, Pacific Islands Fish and Wildlife Office

Patrick Leonard

Date 4/7/09