Santalum freycinetianum var. *lanaiense*
Lanai sandalwood (‘iliahi)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

5-YEAR REVIEW

Species reviewed: *Santalum freycinetianum* var. *lanaiense* / Lanai sandalwood ('iliahi)

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5-YEAR REVIEW
Santalum freycinetianum var. *lanaiense* (Lanai sandalwood [ʻiliahi])

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:
Region 1, Endangered Species Program, Division of Recovery, Jesse D`Elia, (503) 231-2071

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

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on March 16, 2009. The review was based on 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 Recovery Program Lead and the Assistant Field Supervisor for Endangered Species before submission to the Deputy Field Supervisor for approval.

1.3 Background:

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

[USFWS] U.S. Fish and Wildlife Service. 2009. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 103 species in Hawaii. Federal Register 74(49):11130-11133.

1.3.2 Listing history

Original Listing
FR notice: USFWS. 1986. Endangered and threatened wildlife and plants; determination of threatened or endangered status for *Santalum freycinetianum* var. *lanaiense* (Lanai Sandalwood or iliahi). Federal Register 51(10):3182-3185.
Date listed: January 24, 1986
Entity listed: Species
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings:

No critical habitat has been designated for *Santalum freycinetianum* var. *lanaiense*.

1.3.4 Review History:

Species status review [FY 2010 Recovery Data Call (September 2010)]: Declining

Recovery achieved:
1 (0-25%) (FY 2007 Recovery Data Call – most recent year reported)

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

3

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: U.S. Fish and Wildlife Service. 1995. Lanai plant cluster recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 138 pages.
Date issued: September 29, 1995.
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

____ ***Yes***
__X_ ***No***

2.1.2 Is the species under review listed as a DPS?

____ ***Yes***
__X_ ***No***

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes***
____ ***No***

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ ***Yes***
____ ***No***

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ ***Yes***
____ ***No***

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ ***Yes***
__X_ ***No***

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

__X_ ***Yes***
____ ***No***

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

__X_ ***Yes***

____ ***No***

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

__X__ ***Yes***
____ ***No***

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

A synthesis of the threats (Listing Factors A, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

Stabilizing, downlisting, and delisting objectives are provided in the Lanai plant cluster recovery plan (USFWS 1995), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Santalum freycinetianum* var. *lanaiense* 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, weeding, etc.) and be represented in an *ex situ* (off-site) collection. In addition, a minimum of three populations should be documented on Lanai, and if possible, at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

Only 1 of 40 known populations contains more than 25 individuals and all threats are not being managed. This recovery objective has not been met.

For downlisting, a total of five to seven populations of *Santalum freycinetianum* var. *lanaiense* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

This recovery objective has not been met.

For delisting, a total of eight to ten populations of *Santalum freycinetianum* var. *lanaiense* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 100 mature individuals per population for long-lived perennials. Each population should persist at this level for a minimum of five consecutive years before delisting is considered.

This recovery objective has not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

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

Santalum trees are root-parasitic, which means they have special root extensions that capture water and nutrients from roots of other plants. The plants that donate nutrients to *Santalum* are called hosts, and *Santalum* does not grow well without them (Merlin *et al*. 2006).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Santalum freycinetianum var. *lanaiense* has been reported from Lanai, East and West Maui, and East Molokai. On West Maui, *Santalum freycinetianum* var. *lanaiense* was seen at Papalaua Gulch, in the Hanaula area, near Ukumehame Rim in 2004 (National Tropical Botanical Garden 2009). Three trees were seen there in 1997 at 924 meters (3,030 feet) elevation (Wood 2010). In 1995, at Hanaulaiki Gulch, a gulch west of Papalaua, in West Maui, a single tree was observed between 853 to 914 meters (2,800 to 3,000 feet) elevation (Wood 2010). Between 2006 and 2009, Hank Oppenheimer of the Plant Extinction Prevention Program observed 8 individuals at Hahakea, 7 individuals at Puehuehunui, 10 at Honokowai, 3 at the head of Hanaula Gulch, 12 at or near the head of Pohakea Gulch, 9 on the north side of Kauaula, and 4 from Mahinahina to Kaulalewelewe (Oppenheimer 2010).

On East Maui, it was observed in Auwahi in 1994, with approximately 50 individuals in varying degrees of health reported between 792 to 1,219 meters (2,600 and 4,000 feet) elevation (Hawaii Biodiversity and Mapping Program 2009). Between 2006 and 2008, Oppenheimer identified four sites in Auwahi where *Santalum freycinetianum* var. *lanaiense* still occurred (Oppenheimer 2010).

On Lanai, *Santalum freycinetianum* var. *lanaiense* occurs in the Kanepuu Preserve (State of Hawaii Department of Land and Natural Resources 2009). Four mature trees were seen there in 1994, and 5 in 1997, with 15 immature individuals that may be root sprouts or outplantings (Hawaii Biodiversity and Mapping Program 2009; Oppenheimer 2010). At Waiopae Gulch on Lanai, in the central branch of headwaters via Haalelepaakai, three individuals of *S. freycinetianum* var. *lanaiense* were observed in 2006 at 950 meters (3,117 feet) elevation (National Tropical Botanical Garden 2009). A single tree was seen on the windward side of Hauola on the upper side of Waiopae Gulch in 1994 at 884 to 1,006 meters (2,900 to 3,300 feet) elevation (Wood 2010). In 2008, three individual trees of *S. freycinetianum* var. *lanaiense* were observed in a drainage to the north of Puhielelu Ridge in the headwaters of Lopa Gulch at 930 meters (3,051 feet) elevation (Wood 2010). From 2006 to 2008, Oppenheimer observed 21 individuals in 15 locations around Lanaihale, probably including the Puhielelu and Waiopae locations. In addition, he observed a single wild and three reintroduced individuals in Kanepuu, and additional individuals at four locations in the mountains east of Lanai City (Oppenheimer 2010).

On East Molokai between 2007 and 2009, Oppenheimer observed over a dozen individuals of *Santalum freycinetianum* var. *lanaiense* in four locations; Kikiakala, Kamoku Flats, Waiakuilani Gulch-Puu Kokekole, and Kumueli Gulch, with the largest concentration at Kumueli (Oppenheimer 2010).

The current population estimates for *Santalum freycinetianum* var. *lanaiense* is at least 110 individuals located in 40 locations on three islands, however, experts estimate there may be more than 2,000 individuals (Harbaugh *et al.* 2010).

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

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Santalum freycinetianum has been divided taxonomically into three varieties: var. *freycinetianum*, var. *lanaiense*, and var. *pyrularium*. At the time of listing, *Santalum freycinetianum* var. *lanaiense* was known only from the island of Lanai (USFWS 1986). In the recovery plan for this species, published in 1995, the range for this species included west Maui, as well as Lanai (USFWS 1995). In her revision of the Hawaiian species of *Santalum*, Harbaugh *et al*. (2010) moved the plants previously recognized as *S. freycinetianum* var. *lanaiense* to *S. haleakalae* var. *lanaiense*. For the remainder of this review, *S. freycinetianum* var. *lanaiense* will now be referred to as *S. haleakalae* var. *lanaiense* (Harbough *et al.* 2010). In addition, the range of *S. haleakalae* var. *lanaiense* now includes Molokai, Lanai, and east and west Maui (Harbaugh *et al.* 2010).

The new revision of *Santalum,* which moves the variety to *S. haleakalae* var. *lanaiense,* indicates this variety also occurs on Molokai in several locations: Kikiakala, Makakupaia, Puu Hoi Ridge, the upper part of Pelekunu Valley, east of Kua Gulch, and Kawela Gulch, the ridge between east forks of Kawela Gulch. The total estimated number of individuals for the variety as newly designated is 2,000 (Harbaugh *et al.* 2010).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.):

See section 2.3.1.2 above.

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

On West Maui at Papalaua Gulch, *Santalum haleakalae* var. *lanaiense* occurs in *Metrosideros polymorpha* (ohia) – *Dodonaea viscosa* (aalii) – *Diospyros sandwicensis* (lama) mesic forest with *Coprosma foliosa* (pilo), *Doodia kunthiana* (okupukupu), *Leptecophylla tameiameiae* (pukiawe), *Lysimachia remyi* (no common name[NCN]), *Melicope volcanica* (alani), *Microlepia strigosa* (palapalai), *Nestegis sandwicensis* (olopua), *Pittosporum* sp. (hoawa), *Pleomele* sp. (hala pepe), *Psychotria* sp. (kopiko), *Remya mauiensis* (NCN), and *Wikstroemia* sp. (akia) (National Tropical Botanical Garden 2009; Wood 2010). West of Papalaua at Hanaulaiki Gulch on West Maui, *Santalum freycinetianum* var. *lanaiense* occurs in *Metrosideros polymorpha – Leptecophylla tameiameiae* mixed mesic shrubland with *Asplenium* spp. (iwa or kuau), *Carex* spp. (NCN), *Charpentiera* sp., *Eragrostis* sp., *Cyperus* sp. (ahu awa), *Panicum nephelophilum* (kona kona), and *Trisetum inaequale* (NCN) (Wood 2010). On East Maui, the habitat includes associated native species *Euphorbia* sp. (akoko), *Charpentiera* sp. (papala), *Dodonaea viscosa*, *Metrosideros polymorpha*, *Myrsine* sp. (kolea), *Nestegis sandwicensis*, *Pleomele* sp., *Pouteria sandwicensis* (alaa), *Streblus pendulinus* (aiai) *Tetraplasandra* sp. (ohe), and *Xylosma* sp. (ae) (Hawaii Biodiversity and Mapping Program 2009).

On Lanai at Waiopae Gulch, *Santalum haleakalae* var. *lanaiense* occurs in *Metrosideros polymorpha – Dicranopteris linearis* (uluhe) – *Diplopterygium pinnatum* (uluhe lau nui) wet forest with *Broussaisia arguta* (kanawao), *Cheirodendron trigynum* (olapa), *Cyrtandra grayana* (keokeo haiwale), *Dubautia laxa* (naenae lua melemele), *Kadua affinis* (manono), *Pipturus albidus* (mamake), *Pittosporum confertiflorum* (hoawa), *Pneumatopteris sandwicensis* (hoio kula), and *Scaevola chamissoniana* (naupaka kuahiwi) (Wood 2010). In Kanepuu, on Lanai, the habitat is dry *Nestegis sandwicensis –Diospyros sandwicensis* forest with *Bonamia menziesii* (NCN), *Gardenia brighamii* (nanu), *Hibiscus brackenridgei* (mao hau hele), *Myoporum sandwicense* (naio), *Nesoluma polynesicum* (keahi), and *Pouteria sandwicensis* (Hawaii Biodiversity and Mapping Program 2009; State of Hawaii Department of Land and Natural Resources 2009).

On Lanai at Puhielelu Ridge *Santalum haleakalae* var. *lanaiense* occurs in closed to open *Metrosideros polymorpha* mesic forest and riparian vegetation with matting ferns of *Dicranopteris* sp.

and *Diplopterygium* sp. with *Antidesma platyphyllum* (hame), *Cheirodendron trigynum, Dubautia plantaginea* (naenae), *Freycinetia arborea* (ie ie), *Kadua acuminata* (manono), *K.affinis* (manono), *Labordia* sp. (kamakahala), *Melicope volcanica, Nestegis sandwicensis, Perrottetia sandwicensis* (olomea), *Pleomele* sp., *Pouteria* sp., *Psychotria mariniana* (kopiko), *Tetraplasandra oahuensis* (ohe mauka), and *Xylosma hawaiiense* (Perlman 2010; Wood 2010).

In Hauola Gulch, Waialala – Kunoa Gulch, above Maunalei Gulch and between Kehewai and Kahinahina Gulches on Lanai, *Santalum haleakalae* var. *lanaiense* occurs in *Diospyros sandwicensis – Metrosideros polymorpha* mesic forest with *Alyxia stellata* (maile), *Antidesma platyphyllum, Bobea sandwicensis* (akahea), *Charpentiera* sp., *Cheirodendron trigynum, Cibotium* sp. (hapuu), *Clermontia grandiflora* (oha wai), *Cyrtandra* sp. (keokeo haiwale), *Dicranopteris linearis, Freycinetia arborea, Ilex anomala* (kawau), *Leptecophylla tameiameiae, Myrsine lanaiense* (kolea), *Nestegis sandwicensis, Pouteria sandwicensis, Pleomele* sp., *Psychotria mariniana, Tetraplasandra kauaiensis* (ohe ohe), *Wikstroemia* sp., and *Xylosma hawaiiense* (Perlman 2010).

2.3.1.7 Other:

No new information.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Threats that modify habitat on Lanai include feral deer (*Axis axis*) and mouflon sheep (*Ovis musimon*) (Merlin *et al*. 2006). On Lanai it is also threatened by invasive introduced plants species including in Waiopae: *Leptospermum scoparium* (tea tree), *Melinis minutiflora* (molasses grass), *Morella faya* (fire tree), *Phaius tankarvilleae* (nun's orchid), *Psidium cattleianum* (strawberry guava), and *Schinus terebinthifolius* (Christmas berry) (Hawaii Biodiversity and Mapping Program 2009). At Puhielelu these invasive introduced plant species include *Eucalyptus robusta* (swamp mahogany), *Morella faya, Psidium cattleianum, Rubus rosifolius* (thimbleberry), and *Leptospermum*

scoparium (tea tree) (Oppenheimer 2010; Wood 2010). At Kanepuu, invasive introduced species include *Lantana camara*, *Leucaena leucocephala* (haole koa), *Melinis minutiflora*, and *Schinus terebinthifolius* (Christmasberry) (Oppenheimer 2010; Perlman 2010). In addition, pollinator disruption and potentially inbreeding depression are threats to *S. haleakalae* var. *lanaiense* on Lanai (Wood 2010).

At Hanaulaiki Gulch on West Maui, threats from invasive introduced plant species include *Erigeron karvinskianus*, *Lantana camara*, and *Melinis minutiflora* (Wood 2010).

On West Maui, invasive introduced plants include *Buddleia* sp. (butterfly bush), *Lantana camara*, *Melinis minutiflora*, and *Tibouchina herbacea* (Wood 2010). In Papalaua on West Maui, these invasive introduced plant species include *Erigeron karvinskianus* (daisy fleabane), *Lantana camara* (lantana), *Melinis minutiflora*, and *Melinis repens* (natal grass) (Wood 2010). On East Maui, introduced invasive plants include *Acacia mearnsii* (black wattle), *Bocconia frutescens* (NCN), *Pennisetum clandestinum* (Kikuyu grass), and *Schinus terebinthifolius* (Hawaii Biodiversity and Mapping Program 2009; Oppenheimer 2010).

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

There are anecdotal reports of illegal harvesting of *Santalum* species (sandalwood) for their fragrant heartwood (Oppenheimer 2010).

2.3.2.3 Disease or predation:

Feral axis deer and mouflon sheep browse this species (Merlin *et al*. 2006). A native parasitic vine, *Cassytha filiformis* was observed parasitizing seedlings and saplings in Kanepuu, but the direct impacts to this species is unknown. Two-spotted leaf hopper (*Sophonia rufofascia*) and black twig borer (*Xylosandrus compactus*) have been implicated in the destruction of this species (Hawaii Biodiversity and Mapping Program 2009). Rats (*Rattus* spp.) and mice (*Mus* spp.) are seed predators (Oppenheimer 2010; Perlman 2010).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

No new information.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

The introduced invasive plant species discussed in section 2.3.2.1 above are also a threat to *Santalum haleakalae* var. *lanaiense* because they compete with the species for water, light, and nutrients.

Fire is a serious threat to all populations (Oppenheimer 2010).

Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

Santalum haleakalae obtains vital nutrients from other woody species such as koa (*Acacia koa*), an endemic forest tree which, when available, is reportedly the main host. As the habitats where *S. haleakalae* occurs become degraded by activities of feral ungulates and congested with invasive introduced plant species, compatible host plants which are required by *S. haleakalae* become scarce. Unless restoration is done in these areas with this factor in mind, *S. haleakalae* may continue to decline (Merlin *et al*. 2006).

One of the largest *Santalum haleakalae* var. *lanaiense* trees recorded on East Maui was fenced in a small enclosure by the Native Hawaiian Plant Society in the 1980s. Weed control was conducted regularly within the enclosure until 2008 (Oppenheimer 2010).

In 2009, one million dollars in funds from the federal Department of Interior's Cooperative Endangered Species Conservation Fund was designated to be used on Molokai, to help acquire a perpetual conservation easement over 248 hectares (614 acres) of strategic watershed on the eastern end of the island. The property has several federally listed threatened or endangered species as well as critical habitat in and around

the proposed easement area. Federally listed species that will benefit from this protection are *Cyanea mannii* (haha), *Canavalia molokaiensis* (awikiwiki), *Hibiscus arnottianus* ssp. *immaculatus* (kokio keokeo), *Brighamia rockii* (puaala), *Cyanea dunbariae* (haha), *Gardenia brighamii* (nanu), *Pritchardia munroi* (loulu), and *Phyllostegia hispida* (USFWS 2009; C. Rowland, USFWS, pers. comm. 2010). These activities may benefit populations of *Santalum haleakalae* var. *lanaiense* on Molokai.

2.4 Synthesis

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Lanai plant cluster (USFWS 1995), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Santalum haleakalae* var. *lanaiense* 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 interim stabilization goals for this species have not been met as there is only a single known population consisting of more than 25 individuals (Table 1) and all threats have not been managed (Table 2). Therefore, *Santalum haleakalae* var. *lanaiense* meets the definition of endangered as it remains in danger of extinction throughout its range.

Table 1. Status of *Santalum haleakalae* var. *lanaiense* (updated nomenclature) from listing through 5-year review.

Date	No. wild indivs	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1986 (listing)	39	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1995 (recovery plan)	>275	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2010 (5-year review)	110	0	All threats managed in all 3 populations	Partially (Table 2)
			Complete genetic storage	No
			3 populations with 25 mature individuals each	Partially: only Auwahi population with greater than 25 individuals

Table 2. Threats to *Santalum haleakalae* var. *lanaiense*(updated nomenclature).

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – habitat modification and herbivory	A, C, D	Ongoing	Partially: one individual on East Maui and Kanepuu individuals fenced but fence not maintained
Rats – seed predation	C	Ongoing	No
Mice – seed predation	C	Ongoing	No
Two spotted leaf hopper - herbivory	C	Ongoing	No
Black twig borer - predation	C	Ongoing	No
Fire	E	Ongoing	No
Invasive introduced plants	A, E	Ongoing	Partially: weed control around one East Maui individual
Climate change	A, E	Increasing	No

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X_ No change is needed

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Fence existing populations to provide protection from the negative impacts of feral ungulates.
- Control invasive introduced species around known populations.
- Develop and implement methods to control the two-spotted leaf hopper and black twig borer.
- Control rats in the vicinity of these populations.
- Develop and implement methods to control mice.
- Propagate to augment the existing populations.
- Establish additional populations within protected suitable habitat.
- Develop and implement a wildfire management plan.
- Survey areas where *Santalum haleakalae* var. *lanaiense* has been reported to determine if the variety warrants delisting under the new taxonomic treatment.
- Work with Hawaii Division of Forestry and Wildlife, The Nature Conservancy of Hawaii, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

5.0 REFERENCES

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Personal Communications:

Rowland, Craig. 2010. Conservation Partnerships Program Coordinator, U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office. E-mail to Marie Bruegmann, U.S Fish and Wildlife Service, dated April 16, 2010. Subject: Additional information on status of Molokai easement.

Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Santalum freycinetianum* var. *lanaiense* (Lanai sandalwood ['iliahi])

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

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Chelsie Javar, Fish and Wildlife Biologist
Marie Bruegmann, Plant Recovery Coordinator
Jess Newton, Recovery Program Lead
Assistant Field Supervisor for Endangered Species

Field Supervisor, Pacific Islands Fish and Wildlife Office

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