Doryopteris angelica

(No common name)

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: *Doryopteris angelica* (No common name)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional Office:
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Lead Field Office:
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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 in June 2016. The review was based on the final rule listing this species; the final critical habitat designation; the recovery outline; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawaii, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Gregory Koob, Conservation and Restoration Team Manager.

1.3 Background:

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

[USFWS] U.S. Fish and Wildlife Service. 2015. Endangered and threatened wildlife and plants; 5-year status reviews of 133 species in Hawaii, Oregon, Idaho, and Washington. Federal Register 80(30): 8100–8103.

1.3.2 Listing history:

Original Listing
FR notice: USFWS. 2010a. Endangered and threatened wildlife and plants; determination of endangered status for 48 species on Kauai and designation of critical habitat, final rule. Federal Register 75(70): 18960–19165.
Date listed: April 13, 2010
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:

N/A

1.3.4 Review History:

This is the first 5-year review for this species. *Doryopteris angelica* is a fern that was listed as endangered, with designation of critical habitat, on April 13, 2010 (USFWS 2010a). The recovery outline for *D. angelica* is included in the recovery outline for the Kauai Ecosystem, published in 2010 (USFWS 2010b). A draft recovery plan is in preparation.

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

At the start of the 5-year review, the Recovery Priority Number proposed for *Doryopteris angelica* is 5 (using the USFWS scale of 1 to 18), based on the high degree of threat, a high potential for recovery with some threats that are well understood and easily alleviated and others that are currently difficult to alleviate, and its status as a full species (USFWS 2010b).

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: USFWS. 2010b. Recovery outline for the Kauai ecosystem. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pages.
Date issued: June 17, 2010
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***

___ ***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***

___ ***No***

2.2 Recovery Criteria

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

___ ***Yes***

_X_ ***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?

_____ ***Yes***

_____ ***No***

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

_____ ***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 (Factors A, B, C, D, and E) affecting this species is presented in section 2.3.2.

The recovery plan is currently being drafted. However, the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so USFWS also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, USFWS has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. A species with a narrow extant range is one currently known from one or two adjacent gulches or ridges within the same mountain range. Some species have historically been known from only one population. For these species, given the limited information known of their habitat requirements, the number of mature individuals needed to prevent extinction was doubled within the known population rather than expanding the known range of the species for preventing extinction and the interim stage. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

To prevent extinction of *Doryopteris angelica*, a short-lived obligate outcrosser with a narrow range, the species needs a minimum of three populations consisting of 100 mature individuals per population. In addition to achieving the numbers of reproducing individuals, all major threats must be controlled in the immediate vicinity of the populations, each population must show evidence of some stage of natural reproduction (*i.e.*, viable seeds or seedlings), and 50 mature individuals from each population, or less if fewer than 50 remain, must be represented in an *ex situ* collection that is secure and well managed.

This recovery objective has not been met (see Table 1).

Interim Stage

To meet the interim stage of recovery of *Doryopteris angelica*, 600 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of sporelings and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant *et al.* 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria

In addition to achieving 5 to10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions

must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

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:

Little is known about the life history of *Doryopteris angelica* other than it is a fern with two life stages, gametophyte and sporophyte. Its reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown (USFWS 2010a).

Doryopteris angelica is a large, terrestrial fern (Pteridaceae family) with fronds up to 60 centimeters (cm) (2 feet (ft)) long, stipes (stalks) that are 2 to 4 times longer than blades, and up to 2 to 4 millimeters (0.08 to 0.2 inches) in diameter, adaxially (on the same side as the axis) flattened, with conspicuous wings on both sides of the flat area on the upper surface. Scales are sparse at the base, with black center and lateral white stripes, tapering to hair-like tips. Blades are deltate (triangular), up to 30 by 30 cm (1 by 1 ft). This species is similar to *D. decipiens* but much larger with thick large fronds and predominantly winged stipes (Palmer 2003).

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:

In 1994, three individuals of *Doryopteris angelica* were discovered on a ridge of Mahanaloa Valley on Kauai, and it was estimated there could be a total of 10 individuals in the area (Wood and Wagner 1999). In 1998, 30 individuals were observed on the north facing slopes below Kakio Keokeo picnic area in Makaha Valley (HBMP 2010; NTBG 1998). In 2007, twenty individuals were observed in Makaha Valley on the north-facing slopes of the southeast branch, three individuals were observed at Awaawapuhi, 10 to 20 individuals were noted at Kuia, six individuals at

Mahanaloa, and four to five individuals at Paaiki (Wood 2007). In 2009, on the south facing slope accessed from Nualolo Trail, there were seven individuals noted (NTBG 2009b). There are records of this species from six locations: Awaawapuhi (three individuals), Nualolo (ca. 10 individuals), Mahanaloa (six individuals), Makaha (10 to 50 individuals), Kuia (at least 10 to 50 individuals), and Paaiki (50 individuals) (HBMP 2010; NTBG 1997, 1999, 2000a-b, 2004a-b, 2007, 2009a-b, 2011a-b, 2013, 2014a-c, 2015a-i, 2016; PEPP 2010, 2015). The recent IUCN status assessment for this species in 2015 is the most thorough review for this species and estimates there are eight subpopulations (considered as populations by USFWS) totaling a maximum estimate of 250 individuals, though population numbers and habitat are in decline (Edmonds and Walsh 2015).

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:

Doryopteris angelica was discovered in 1994 by Ken Wood and named in 1999 for the prominent wings on its stipes (Palmer 2003; Wood and Wagner 1999).

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 for spatial distribution of the species.

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

Doryopteris angelica is found on Kauai in *Acacia koa (koa)–Metrosideros polymorpha* (ohia) lowland mesic forest between 671 and 975 m (2,200 and 3,200 ft) elevation (HBMP 2010; Palmer 2003; TNCH 2007).

In Makaha, *Doryopteris angelica* typically occurs in *Metrosideros polymorpha –Acacia* koa montane mesic forest with associated native plant species including *Alphitonia ponderosa* (kauila), *Alyxia stellata* (maile), *Coprosma* spp. (pilo), *Dianella sandwicensis* (ukiuki), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Doodia* sp. (no common name (NCN)), *Doryopteris decipiens* (kumuniu), *Dryopteris unidentata* (akole), *Euphorbia atrococca* (akoko), *E. haeleeleana* (spurge),

Isodendrion laurifolium (aupaka), *Leptecophylla tameiameiae* (pukiawe), *Liparis hawaiensis* (awapuhikanaloa), *Myrsine* spp. (kolea), *Neraudia melastomifolia* (maaloa), *Psychotria mariniana* (kopiko), *Pteralyxia kauaiensis* (kaulu), and *Zanthoxylum dipetalum* (ae) (HBMP 2010; NTBG 1996, 2015a; Wood 2007).

In Kuia, *Doryopteris angelica* typically occurs in *Metrosideros polymorpha –Acacia koa* montane mesic forest with associated native plant species including *Alphitonia ponderosa*, *Bobea brevipes* (ahakea lau lii), *Carex meyenii* (NCN), *Cheirodendron* spp. (olapa), *Dianella sandwicensis* (ukiuki), *Dodonaea viscosa*, *Eragrostis variabilis* (kawelu), *Leptecophylla tameiameiae*, *Melicope barbigera* (uahiapele), *M. ovata* (alani),*Microlepia strigosa* (palapalai), *Panicum nephelophilum* (konakona), *Planchonella sandwicensis*. (alaa), *Polyscias kavaiensis* (oheohe), *Psychotria greenwelliae* (kopiko), *Remya kauaiensis* (NCN), *Scaevola procera* (naupaka kuahiwi), *Wikstroemia furcata* (akia), and *Wilkesia gymnoxiphium* (iliau) (HBMP 2010; Wood 2007).

At Mahanaloa, *Doryopteris angelica* typically occurs in *Metrosideros polymorpha–Acacia koa* lowland mesic forest with associated native plant species including *Coprosma waimeae* (olena), *Cryptocarya mannii* (holio), *Diplazium sandwicianum* (hoio), *Doodia* sp., *Dryopteris glabra* (kilau), *D. unidentata*, *Leptecophylla tameiameiae*, *Melicope barbigera*, *M. ovata*, and *Psychotria hobdyi* (kopiko) (Wood 2007).

At Awaawapuhi and Nualolo, *Doryopteris angelica* typically occurs in *Metrosideros polymorpha–Acacia koa* montane mesic forest with associated native plant species including *Claoxylon sandwicense* (laukea), *Dianella sandwicensis*, *Dodonaea viscosa*, *Melicope anisata*, *M. barbigera*, *Planchonella sandwicensis*, *Polyscias kavaiensis*, *Pritchardia minor* (loulu), *Psychotria mariniana*, and *Wilkesia gymnoxiphium* (HBMP 2010; Wood 2007).

At Paaiki, *Doryopteris angelica* typically occurs in *Metrosideros polymorpha–Acacia koa* forest with associated native plant species including *Carex meyenii*, *C. wahuensis* (NCN), *Charpentiera elliptica* (papala), *Cyrtomium caryotideum* (ka ape ape), *Diospyros sandwicensis*, *Doodia kunthiana* (NCN), *Dryopteris unidentata*, *Pisonia sandwicensis* (kaulu), *Pittosporum kauaiensis* (hoawa), *Planchonella sandwicensis*, *Psydrax odorata* (alahee), and *Streblus pendulinus* (aiai) (HBMP 2010; Wood 2007).

2.3.1.7 Other:

N/A

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 (Factor A):

Ungulate degradation of habitat—Feral pigs (*Sus scrofa*), goats (*Capra hircus*), black-tailed (mule) deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). These ungulates and evidence of their activities have been observed at all known occurrences of *Doryopteris angelica* (HBMP 2010; NTBG 1994, 1995, 1996, 1997, 1998, 1999, 2000a-b, 2004a-b, 2007, 2009a-b, 2011a-b, 2013, 2014a, cc, 2015a-i, 2016; PEPP 2014, 2015).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive nonnative plants impacting *Doryopteris angelica* include *Adiantum hispidulum* (rough maidenhair fern), *Blechnum appendiculatum* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Grevillea robusta* (silk oak), *Hedychium gardnerianum* (kahili ginger), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Morella faya* (firetree), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Setaria parviflora* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2000a-b, 2009a, 2011a, 2013, 2014a, 2015a, g, 2016; Wood 2007).

Fire destruction or degradation of habitat—Fire can destroy spores as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison *et al*. 2002). Fire is noted as a threat to *Doryopteris angelica* at the Kuia and Makaha occurrences (NTBG 2007, 2009b, 2014a, 2015a, c-i, 2016).

Hurricanes—Loss and degradation of habitat—In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger

1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel *et al.* 2008; Yu *et al.* 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year

Climate change loss or degradation of habitat—Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii 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 *Doryopteris angelica* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.825 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):

Not a threat.

2.3.2.3 Disease or predation (Factor C):

Ungulate predation or herbivory—Herbivory by feral pigs, goats, and black-tailed deer is reported to be a threat to *Doryopteris angelica* at all known occurrences (HBMP 2010; NTBG 1994, 1995, 1996, 1997, 1998, 1999, 2000a-b, 2004a-b, 2007, 2009a-b, 2011a-b, 2013b, 2014a, c, 2015a-i, 2016; PEPP 2014, 2015).

Rodent predation or herbivory—Herbivory by rats is noted as a threat to populations of *Doryopteris angelica* at Awaawapuhi, Nualolo, Kuia, and Makaha (HBMP 2010; NTBG 1996, 1999, 2000a-b, 2009b, 2011a-b, 2013b, 2014a, 2015a, c-i, 2016). Rats eat virtually every part of plants at every stage (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment.

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):

Lack of adequate hunting regulations—All populations of *Doryopteris angelica* occur or occurred within in state hunting areas. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. One population is fenced; however, habitat modification and destruction, and herbivory, by feral ungulates have been noted as a threat to the species. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010).

Lack of adequate biosecurity legislation—Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Doryopteris angelica.* The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma *et al.* 2002).

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):

Invasive species—Established invasive plant species competition—Nonnative plant species including *Adiantum hispidulum*, *Blechnum appendiculatum*, and *Kalanchoe pinnata*, compete with *Doryopteris angelica* for water, light, and nutrients (Wood 2007).

Stochastic events—Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Currently, there are approximately 250 individuals of *Doryopteris angelica* at eight locations.

Current management actions:

- Captive propagation for genetic storage and reintroduction—
    - The NTBG has planted 84 plants in their gardens (NTBG 2017). The DOFAW Kauai district has 11 plants from Makaha Ridge growing in their nursery and has reintroduced 17 plants to the fenced exclosure at Paaiki (DOFAW 2011; PEPP 2010).
    - PEPP has collected spores from the Makaha and Kuia individuals and propagation is conducted at Lyon Arboretum and the Pahole Rare Plant Facility, where there are two plants in the nursery (Lyon Arboretum 2017; PEPP 2016). NTBG collects spores and reported 505 spores in storage in the seed bank (NTBG 2017).
    - Population viability monitoring and analysis is ongoing (PEPP 2010, 2014, 2015, 2016).

Table 1. Status and trends of *Doryopteris angelica* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2010 (listing and critical habitat)	29–54	0	All threats managed in all three populations	No
			Complete genetic storage	Partially
			Three populations with 100 mature individuals each	No
2016 (5-year review)	250	17	All threats managed in all three populations	No
			Reproduction (*i.e.*, viable spores, sporophytes) at all three populations	Unknown
			Complete genetic storage	Partially
			Three populations with 100 mature individuals each	No

Table 2. Threats to *Doryopteris angelica* and conservation efforts.

Threat	Listing	Current	Conservation/

	factor	Status	Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partially–Individuals provided some protection within fenced exclosure
Established ecosystem-altering invasive plant modification and degradation of habitat	A	Ongoing	Partially–Nonnative plant control within fenced exclosure
Hurricane destruction and degradation of habitat	A	Ongoing	None
Climate change loss or degradation of habitat	A	Ongoing	None
Ungulate predation or herbivory	C	Ongoing	Partially– Individuals provided some protection within fenced exclosure
Rodent predation or herbivory	C	Ongoing	None
Inadequacy of existing regulatory mechanisms—Lack of adequate hunting regulations	D	Ongoing	None
Inadequacy of existing regulatory mechanisms—Lack of adequate biosecurity legislation	D	Ongoing	None
Invasive species—Established invasive plant species competition	E	Ongoing	Partially–Nonnative plant control within fenced exclosure
Stochastic events—Reduced viability due to low numbers	E	Ongoing	Partially–Spore collection, propagation, and outplanting

2.4 Synthesis

Currently, fewer than 250 individuals of *Doryopteris angelica* persist at eight locations. A new population of five individuals was discovered at Makaha (PEPP 2015). Spore collecting and propagation efforts are ongoing, and 17 individuals have been outplanted in a fenced exclosure at Paaiki.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and have 50 individuals from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or seed bank) collection. In addition, a minimum of three populations should be documented on Kauai where they now occur or occurred historically. Each of these

populations must be naturally reproducing (demonstrate some reproduction, i.e., viable spores, sporelings) with a minimum of 100 mature individuals per population.

The preventing extinction goals for this species have not been met, as currently no populations of 100 mature individuals exists, genetic storage collections are incomplete (Table 1) and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Doryopteris angelica* meets the definition of endangered as it remains in danger of extinction throughout its range.

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

- Surveys and inventories—Survey suitable habitat within historic range for additional individuals.
- Ungulate monitoring and control—Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Protect all occurrences against browsing and disturbances from feral ungulates.
- Invasive plant monitoring and control—
  - Control established ecosystem-altering nonnative invasive plant species around all populations.
  - Control invasive nonnative plant species around all populations that compete with the species.
- Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations.

- Predator and herbivore monitoring and control—Implement effective measures to control rodents around all known populations.
- Captive propagation for genetic storage and reintroduction—Continue spore collection with complete representation of remaining individuals and establish secure *ex situ* stocks.
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Genetic research—Map genetic diversity in the surviving populations to guide future reintroduction and augmentation efforts and survey *ex-situ* holdings and conduct molecular fingerprinting.
- Population biology research—Study *Doryopteris angelica* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
- Based on the recovery criteria above, consider development of a recovery plan.

5.0 REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of *Doryopteris angelica* (No common name)

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:_____

For **Field Supervisor, Pacific Islands Fish and Wildlife Office**

GREGORY KOOB

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