



TECHNICAL NOTE

USDA

NATURAL RESOURCES CONSERVATION SERVICE

HAWAII

Biology Technical Note - No. 12

CRITICAL HABITAT INFORMATION

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EXCEL Spreadsheet Attached CD

Also available online at:

<ftp://ftp-fc.sc.egov.usda.gov/HI/pub/technotes/biology/>

PART 1. GENERAL INFORMATION

I. Purpose of Worksheet

This technical note provides information about critical habitat in Hawaii. For NRCS field personnel, knowledge of critical habitat is required to:

- conduct a thorough resource inventory for our clients;
- determine, based on the inventory and analysis of habitat, if there are wildlife (plants & animals) funding opportunities for landowners interested in participating in Farm Bill programs; and
- comply with the Interagency Cooperation Section of the Endangered Species Act (ESA) of 1973, as amended:
 1. Section 7 (a)(1) states that all federal agencies shall utilize their authorities to further the Endangered Species Act by carrying out programs for the conservation of threatened or endangered species.
 2. Section 7 (a)(2) requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or adversely modify designated critical habitat.

Part 2 of this technical note includes general critical habitat summaries by animal species or cluster of plant species. Part 3 of this technical note is the Endangered Species in Hawaii matrix which includes all threatened and endangered plants and animals in the State including detailed information on species with designated critical habitat. A CD with the matrix on it is attached to this technical note. A paper copy of the matrix is not attached to this technical note because it is too large. The matrix is also available online at:

<ftp://ftp-fc.sc.egov.usda.gov/HI/pub/technotes/biology/>. The following table summarizes the information in the matrix for those species with critical habitat:

Field Name	Comments
Scientific Name	e.g. <i>Argyroxiphium kauense</i>
Common Name	e.g. Mauna Loa Silversword NCN = No Common Name
Phylum	Plant, Mollusk, Bird, Arthropod, Reptile
Status	(T) Threatened, (E) Endangered
Proposed critical habitat	(x) indicates critical habitat was proposed on selected island
Designated critical habitat	(Y) Yes, critical habitat was designated (N) No, critical habitat was not designated
CH Status	Designated, not proposed, nondesignated
Island Distribution	Species distribution throughout major islands (C) Current; (R) Reported; (H) Historic
Landform / Forest Type*	e.g. Moist, open forest; subalpine mesic shrubland; bogs; and weathered, old pahoehoe or aa lava with well developed pockets of soil
Plant Community*	associated native plant species
Elevation*	Elevation range in feet
Map (Unit)*	Critical habitat map and unit number

* Please Note: The selected (*) fields are specific for each island on which a species has critical habitat. For example, the coastal plant *Ischaemum byrone* is provided with critical habitat on four islands (Molokai, Maui, Kauai, Big Island) and the specific landform, plant community, elevation, and map units are different for each island.

II. Explanation of Critical Habitat

Under the Endangered Species Act, the Secretary of the Interior shall designate critical habitat for federally threatened and endangered species whenever it is determined to be prudent and determinable. Critical habitat designation has been delegated to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service. **Critical habitat is the term used to define those areas of habitat containing physical and biological features that are essential for an endangered or threatened species to recover and that require special management or protection.** Critical habitat determinations are based on the best scientific and commercial data available and consider those biological and physical features that are essential to the conservation of the species. These features are termed “primary constituent elements” and include: space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, or rearing offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

These elements are important to consider when project boundaries are within or nearby designated critical habitat. These elements can and should be analyzed to determine restoration alternatives for landowners, and to determine the effect of a proposed action on the plant or animal under the ESA.

Nationwide, most listed species are not provided with critical habitat. In fact, only 475 of the 1264 listed species in the U.S. have designated critical habitat, 244 of which are in Hawaii. The following table summarizes the general statistics for threatened & endangered species in the nation and in the State of Hawaii.

Threatened & Endangered Species in the U.S.A. and Hawaii¹		
	T & E Species	T & E Species with Critical Habitat
Total – All 50 States	1,264	475
(Animals)	(518)	(164)
(Plants)	(746)	(311)
Hawaii Total	317	244
(Animals)	(44)	(5)
(Plants)	(273)	(239)

Hawaii differs from most other states not only in the large number of listed species (317), but also in the large number of species with designated critical habitat. Additionally, Hawaii has the largest number of plant species with critical habitat in the nation. Many Hawaiian species have critical habitat on more than one island, taking into account both the current and/or historical range.

¹ As of 03/03/05 and not including the Northwestern Hawaiian Islands

Critical Habitat Distribution Throughout the Hawaiian Islands	
Island	Number of Species ²
Hawaii	47 species (plants + moth)
Maui & Kahoolawe	60 species (plants + moth)
Lanai	3 species (plants)
Molokai	41 species (plants + moth)
Oahu	100 species (plants + elepaio)
Kauai & Niihau	86 species (plants + cave animals + snail)

On the main Hawaiian Islands, only five animal species have designated critical habitat: the Oahu elepaio, Kauai cave spider, Kauai cave amphipod, Blackburn’s sphinx moth, and Newcomb’s snail. The Hawaiian monk seal has critical habitat in the Northwestern Hawaiian Islands.

The USFWS may exclude an area from critical habitat when the benefits of exclusion outweigh the benefits of including the area within critical habitat, provided the exclusion will not result in extinction of the species. For some species, such as certain endangered *Pritchardia* palms, critical habitat has not been designated because publishing maps of their habitat may result in vandalism, theft, or over-collection. Critical habitat has not been designated for some species because such action would be redundant to the other conservation mechanisms currently in place for them. For example, on the island of Lanai, critical habitat was initially proposed on 20,000 acres for 37 plant species. However, critical habitat for only 3 species on 789 acres was included in the final designation. The USFWS determined that the lands excluded from final critical habitat designation were being managed under several voluntary partnerships and agreements for the conservation of 34 of the 37 species.

Critical habitat designation does not affect activities on state or private lands unless there is a federal nexus such as a requirement of a federal permit, license, or federal funding is being provided for a proposed project, such as USDA benefits or programs. State or private landholder activities such as farming, grazing, hunting, and other recreational uses are generally not affected by a critical habitat designation even if the landowner’s property is within the geographical boundaries of the critical habitat.

By law, NRCS and other federal agencies are required to ensure that any activity they fund, carry out, or authorize is not likely to jeopardize the survival of a listed species or destroy or adversely modify its critical habitat. By consulting (i.e. under section 7 of the ESA) with USFWS, NRCS can usually minimize or avoid any potential conflicts and the proposed project can be undertaken. Safe Harbor Agreements, Habitat Conservation Plans, or Candidate Conservation Agreements can also be undertaken to give private landholders regulatory relief from additional restrictions under the ESA when their efforts lead to enhancement or restoration of critical habitat or habitat for T&E or candidate species.

² The sum of species on all islands exceeds the total number of species with critical habitat because many species have critical habitat on more than one island.

III. How to Use This Technical Note

This technical note can be used in the following three ways:

a. **General Inventory** information is useful to the planner and the client. The critical habitat summaries provide an overview of critical habitat on each island. They include descriptions of the habitat, threats to the survival of the species, and recommended actions (conservation practices) that will affect recovery of the species. The large number of plant species included within each plant cluster necessitates that the summaries for plant clusters be very general. The planner should consult the Endangered Species Matrix for species specific information on the habitat requirements of T&E plants. Because critical habitat has been designated for only 5 animal species on the main Hawaiian Islands, we were able to provide detailed information about these animal species within this Tech Note.

b. **Project Oriented** information is of use when working on a proposed Farm Bill project. If endangered species, threatened species, or critical habitat is located within the project area, this technical note provides general information about those species to the planner or client. Information summarizing threats and recommended actions offers the planner ideas for restoration or preservation.

The Endangered Species in Hawaii matrix provides the primary constituent elements which can also be used in conservation planning. The primary constituent elements fall into three categories: **landform/plant community**, **associated species**, and **elevation range**. As an example, consider the Pendent Kihī Fern (*Adenophorus periensis*). This fern has critical habitat on Kauai, Oahu, Molokai, and Hawaii. On Oahu, its primary constituent elements are as follows:

Landform/Plant Community	Trees in <i>Metrosideros polymorpha</i> or <i>Metrosideros rugosa</i> wet forests
Associated Species	<i>Cheirodendron</i> spp., <i>Cibotium</i> sp., <i>Dicranopteris linearis</i> , <i>Hedyotis terminalis</i> , <i>Machaerina angustifolia</i> , <i>Syzygium sandwicensis</i>
Elevation Range	1,014 – 2,844 feet

Additionally, the matrix provides information about the species' distribution throughout the Hawaiian archipelago by designating whether its presence is (C) current, (H) historic, or merely (R) reported.

c. **Species Specific** information is included in the general descriptions. Using the matrix, the planner can find information about a listed species by searching for scientific name (e.g. *Adenophorus periensis*) or common name³ (e.g. Pendent Kihī Fern). The matrix will indicate whether or not critical habitat exists for that species. For those species with critical habitat, the matrix provides the location (Map and Map Unit) which can be viewed using ArcView and Toolkit.

³ Many Hawaiian plants have the same common name for multiple related species, so this search strategy won't work for all species.

PART 2. CRITICAL HABITAT SUMMARIES

I. Island of Hawaii: Plants

(41 species)



A total of approximately 84,200 hectares (208,063 acres) on the island of Hawaii fall within the boundaries of the 99 critical habitat units designated for these 41 species (see attached matrix for complete list of plant species). Critical habitat was not designated for two species that are not extant in the wild or in cultivation, for two species of *Pritchardia*, the native palm or Loulu, because of the threat of collection or vandalism, and for two species for which habitat could not be identified or habitat was excluded because current habitat management provides a conservation benefit to the species.

THREATS

Threats to the survival of the 41 plant species include deforestation, clearing, or other habitat disturbances such as increasing or initiation of grazing activity by feral or domestic animals; selective cutting of native trees for fences; competition with non-native plants; pipelines, or roads; genetic inbreeding; and random environmental events and catastrophes, such as landslides, wildfires, hurricanes, or tsunamis, which could destroy a large percentage of a species at any one time.

RECOVERY

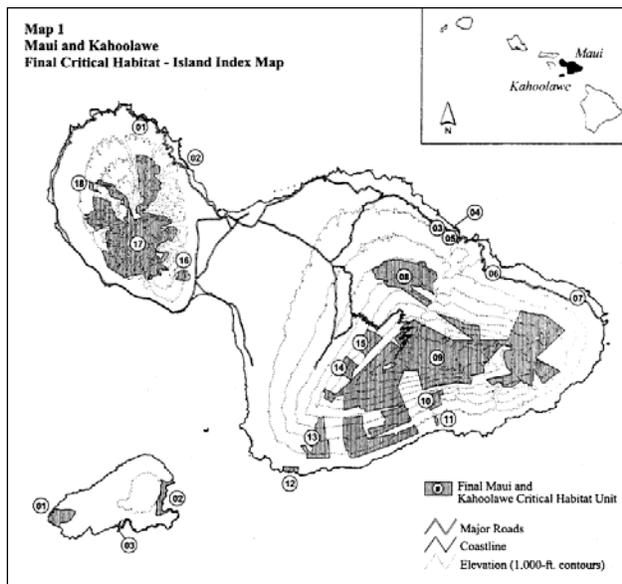
The recovery strategy outlined in the recovery plans include: (1) Stabilization of existing wild populations (2) protection and management of habitat, (3) enhancement of existing small populations and reestablishment of new populations within historic ranges, and (4) research on species biology and ecology.

In general, the recovery objectives for each plant species include the establishment of a total of 8 to 10 populations on islands within the species' known range with a minimum of:

- 100 mature, reproducing individuals per population for long-lived perennials;
- 300 mature, reproducing individuals per population for short-lived perennials; and
- 500 mature, reproducing individuals per population for annuals.

Each population should persist at this level for a minimum of five consecutive years.

The GIS shapefile for the Big Island plant cluster can be located at <Geodata\Endangered Habitat\bi-indvspec-final-30may2003-nad83.shp>



II. Islands of Maui and Kahoolawe: Plants

(60 species)

A total of approximately 37,717 hectares (93,200 acres) on the island of Maui and 1,180 hectares (2,915 acres) on the island of Kahoolawe fall within the boundaries of the 139 critical habitat units designated for the 60 plant species (see attached matrix for complete list of plant species).

Eighteen of these species are endemic⁴ to the islands of Maui and Kahoolawe, while 42 species are reported from one or more other islands, as well as Maui and/or Kahoolawe. Several species are known from only a single

occurrence. Additionally, some species exist on other Hawaiian islands but are currently not known from Maui or Kahoolawe. Critical habitat was designated on Maui and/or Kahoolawe because these two islands are part of the species' historic ranges.

TREATS

Threats to these 60 species include: 1) lack of pollinators, including those lost to nonnative insect species such as the black twig borer, yellow jacket, Argentine ant, or Chinese rose beetle; 2) competition from nonnative plant species; 3) collection by humans; 4) destruction by off-road vehicles; 5) predation and trampling by cattle, goats, and axis deer; 6) habitat degradation by feral pigs; 7) predation by rats and slugs; 8) random environmental events (flood, fire, landslides, rockslides, etc.) that could cause extinction due to the small number of existing individuals and; 9) reduced reproductive vigor due to the small number of existing individuals.

RECOVERY

Needed recovery actions include: control of feral ungulates, rodents, and slugs; construction of enclosures to protect plants from feral ungulates; control of non-native invasive vegetation; control of non-native insects; re-establishment of plant populations via out-planting or seed dispersal; fire prevention activities; and maintenance of genetic stock.

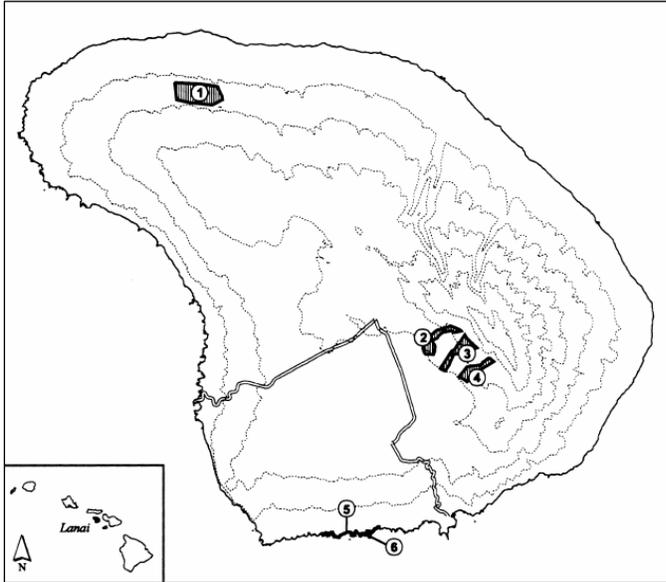
In general, the recovery objectives for each plant species include the establishment of a total of 8 to 10 populations on islands within the species' known range with a minimum of:

- 100 mature, reproducing individuals per population for long-lived perennials;
- 300 mature, reproducing individuals per population for short-lived perennials; and
- 500 mature, reproducing individuals per population for annuals.

Each population should persist at this level for a minimum of five consecutive years.

The GIS shapefile for the Maui plant cluster can be located at [Geodata\Endangered Habitat\mau-indv-final-nad83-06jun2003.shp](#)
 The GIS shapefile for the Kahoolawe plant cluster can be located at [Geodata\Endangered Habitat\kaho-final-nad83.shp](#)

⁴ "Endemic" species are found only in a certain geographic area.



III. Island of Lanai: Plants

(3 plant species)

Thirty-seven listed plant species are known historically from the island of Lanai. Seven of these species are endemic to the island of Lanai, while 30 species are reported from one or more other islands, in addition to Lanai. The final critical habitat designation includes critical habitat for 3 of the 37 plant species. These species are: *Bidens microantha* ssp. *kalealaha* (kookoolau), *Tetramolopium remyi* (no common name), and *Portulaca sclerocarpa* (poe)

A total of approximately 320 hectares (789 acres) on Lanai fall within the boundaries of the six critical habitat units designated for the three species.

THREATS

The primary threats to *Tetramolopium remyi* (**Critical Habit Unit 1**) include sheet erosion, grazing by Axis Deer and Mouflon Sheep, and competition from non-native plants, primarily broomsedge (*Andropogon virginicus*) and guinea grass (*Panicum makimum*).

The primary threats to *Bidens microantha* ssp. *kalealaha* (**Critical Habitat Units 2, 3, 4**) include habitat destruction by axis deer and mouflon sheep; competition from a variety of nonnative plant species include Swamp Mahogany (*Eucalyptus robustus*); depressed reproductive vigor due to a limited local gene pool; and fire.

The major threats to *Portulaca sclerocarpa* (**Critical Habitat Units 5 & 6**) are herbivory by the larvae of a nonnative sphinx moth (*Hyles lineata*); competition from nonnative plants; and fire.

RECOVERY⁵

Recovery efforts should include 1) exclusion of ungulates from endangered plant habitat; 2) development and support of feral herbivore (axis deer and mouflon sheep) removal programs; 3) reducing the threat of fire through removal of grass cover and other dense weeds; 4) removal of nonnative plant competitors; 5) protection from hikers, vehicles, and other possibilities of direct human disturbance; 6) implementation of expansion plans; and 7) reestablish wild populations within the historic range.

In general, the recovery objectives for each plant species include the establishment of a total of 8 to 10 populations on islands within the species' known range with a minimum of:

- 100 mature, reproducing individuals per population for long-lived perennials;
- 300 mature, reproducing individuals per population for short-lived perennials; and
- 500 mature, reproducing individuals per population for annuals.

Each population should persist at this level for a minimum of five consecutive years.

The GIS shapefile for the Lanai plant cluster can be located at [Geodata\Endangered Habitat\lan-indvspec-final-nad83.shp](#)

⁵ Lanai Plant Cluster Recovery Plan

The majority of parcels in the critical habitat are owned by the federal government, the State of Hawaii, and the City and County of Honolulu. Privately held land within the critical habitat totals 10,762 hectares (26,594 acres). Of the lands designated as CH for the Oahu elepaio, 99.6% are zoned for conservation. Additionally, most of the CH lands are in mountainous areas where access is difficult due to the steep terrain, and these lands are not suited to development or agriculture.

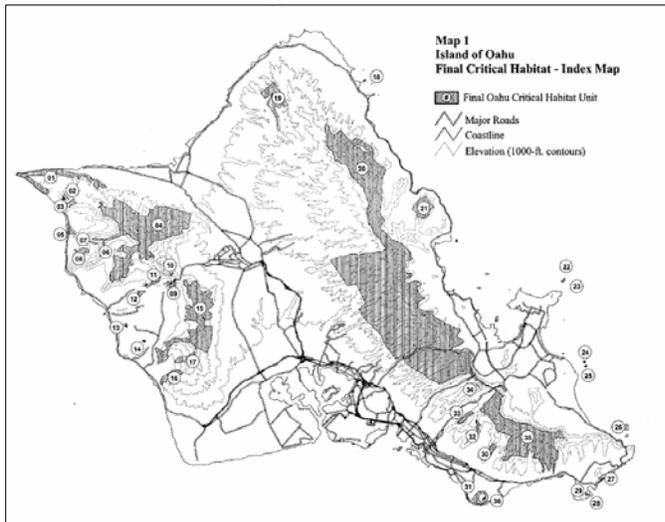
THREATS

The primary threats are habitat loss as well as nest predation by alien rats (Black Rat (*Rattus rattus*), and Norway Rat (*Rattus norvegicus*)) and alien diseases, particularly avian pox and avian malaria, which are carried by the alien Southern House Mosquito (*Culex quinquefasciatus*). Threats to habitat include alien plant invasions, fire, and human disturbances.

RECOVERY

Key recovery activities to the Oahu Elepaio include 1) rat and mosquito control programs; 2) native forest restoration of full canopy; 3) and installation of fire breaks or other fire control measures.

The GIS shapefile for the Oahu Elepaio can be located at
[Geodata\Endangered Habitat\ele-utm4nad83-04apr02.shp](#)



IV.b. Island of Oahu: Plants

(99 plant species)

A total of 22,274 hectares (55,040 acres) on Oahu has been designated as critical habitat for 99 plant species (see attached matrix for complete list of plant species). The critical habitat is composed of 303 units. Critical habitat was proposed but was not designated for *Cyrtandra crenata* (haiwale) and *Pritchardia kaalae* (loulou).

THREATS

Threats to the survival of the 99 plant species include deforestation, clearing, or other habitat disturbance (e.g. from feral ungulates); unrestricted collecting for scientific or horticultural purposes; increasing or initiation of grazing activity by feral or domestic animals; competition from nonnative plants; wildfire; predation by rats; selective cutting of native trees for fences, pipelines, or roads; tissue damage inflicted by insects such as the black twig borer (*Xylosandrus compactus*) and the two-spotted leafhopper (*Sophonia rufofascia*); genetic inbreeding; and random environmental events and catastrophes such as landslides, fires, hurricanes, or tsunamis, which could destroy a large percentage (or cause extinction) of a species at any one time.

According to the Draft Recovery Plan for Oahu Plants (1997), one of the greatest threats is competition with alien plants. The most significant alien plants include: Christmas berry (*Schinus terebinthifolius*), strawberry guava (*Psidium cattleianum*), molasses grass (*Melinis minutiflora*), Koster's curse (*Clidemia hirta*), lantana (*Lantana camara*), koa haole (*Leucaena leucocephala*), prickly Florida blackberry (*Rubus argutus*), silk oak (*Grevillea robusta*), daisy fleabane (*Erigeron karvinskianus*), firetree (*Myrica faya*), Hilo grass (*Paspalum conjugatum*), common ironwood (*Casuarina equisetifolia*), huehue haole (*Passiflora suberosa*), Maui pamakani (*Ageratina adenophora*), Hamakua pamakani (*Ageratina riparia*), air plant (*Kalanchoe pinnata*), a relative of Koster's curse (*Tibouchina herbacea*), and shoebutton ardisia (*Ardisia elliptica*).

RECOVERY

Needed recovery actions include: (1) Stabilization of existing wild populations (2) protection and management of habitat, (3) enhancement of existing small populations and reestablishment of new populations within historic ranges, (4) research on biology and ecology (5) control of nonnative invasive vegetation, and (6) control of feral ungulates.

In general, the recovery objectives for each plant species include the establishment of a total of 8 to 10 populations on islands within the species' known range with a minimum of:

- 100 mature, reproducing individuals per population for long-lived perennials;
- 300 mature, reproducing individuals per population for short-lived perennials; and
- 500 mature, reproducing individuals per population for annuals.

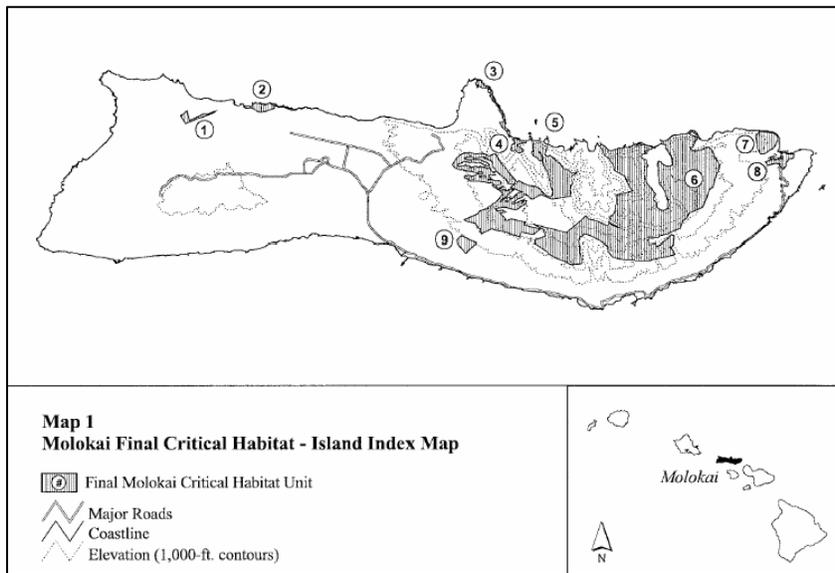
Each population should persist at this level for a minimum of five consecutive years.

The GIS shapefile for the Oahu plant cluster can be located at <Geodata\Endangered Habitat\oahu-indvspec-final-nad83-20030617.shp>

V. Island of Molokai: Plants

(41 plant species)

The USFWS designated critical habitat for 41 species on the island of Molokai (see attached matrix for complete list of plant species). A total of approximately 9,843 hectares (24,333 acres) of land in 88 units fall within the critical habitat boundaries.



Some of the critical habitat designated for a given species is currently not known to be occupied by one or more of these species. These unoccupied critical habitat units will provide habitat for one or more populations, either through natural recruitment or managed reintroductions.

THREATS

Due to the reduced size of suitable habitat areas for these Hawaiian plant species, they are susceptible to catastrophic events and weather fluctuations affecting quality and quantity of available habitat, as well as direct pressure from nonnative plants and animals. Habitat destruction by feral animals (e.g. goats, pigs, and axis deer) and wildfire also threaten some of these species.

RECOVERY

Needed recovery actions include: (1) Stabilization of existing wild populations (2) protection and management of habitat, (3) enhancement of existing small populations and reestablishment of new populations within historic ranges, (4) research on biology and ecology (5) control of nonnative invasive vegetation, and (6) control of feral ungulates.

In general, the recovery objectives for each plant species include the establishment of a total of 8 to 10 populations on islands within the species' known range with a minimum of:

- 100 mature, reproducing individuals per population for long-lived perennials;
- 300 mature, reproducing individuals per population for short-lived perennials; and
- 500 mature, reproducing individuals per population for annuals.

Each population should persist at this level for a minimum of five consecutive years.

The GIS shapefile for the Molokai plant cluster can be found at [Geodata\Endangered Habitat\mol-indv-final-nad83.shp](#)

VI.a. Island of Kauai: Cave Wolf Spider and Cave Amphipod



Kauai Cave Wolf Spider: *Adelocosa anops* is the world's only eyeless wolf spider. Adults are about 12.7 to 19.0 mm (0.5 to 0.75 in) in total body length with a reddish brown carapace, pale to silvery abdomen, and beige to pale orange legs. It is a predator, and although blind, can detect the presence of potential food items through chemo-tactile sensory organs and actively stalks its prey. This spider reproduces at a very slow rate relative to terrestrial-dwelling wolf spiders.

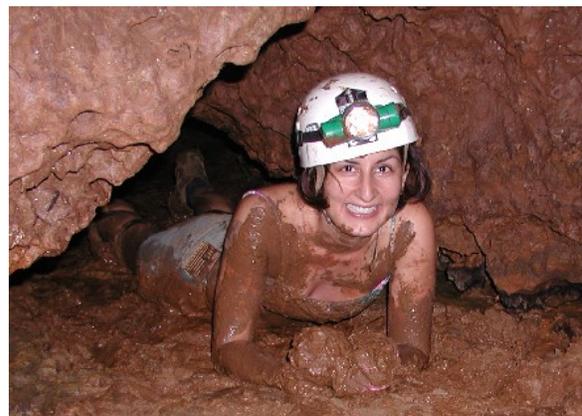


Kauai Cave Amphipod: *Spelaeorchestia koloana* lacks eye facets and pigmentation. Adult cave amphipods are 7 to 10 mm in length with a slender laterally compressed body that appears shiny and translucent. The amphipod is a detritivore and has been observed feeding on plant material washed into the caves, as well as the fecal material of other arthropods. This amphipod serves as the primary food source of the Kauai Cave Wolf Spider

Both the Kauai cave wolf spider and the Kauai cave amphipod are found only in the Koloa area of Kauai. While they occur in small, subterranean spaces, voids, and cracks in relatively young lava flows as well as consolidated calcium carbonate deposits, these two species are only known from four and six caves respectively.

Not all caves in the Koloa area contain these unique animals. Not only must the cave contain a woody debris food source for the amphipod and other generalist feeders, the proper cave environment must be present. These animals require conditions at or approaching 100% relative humidity. If the caves, cracks, or voids are drafty or exposed to drying conditions, the cave animals will attempt to retreat to more suitable habitats.

The Kauai cave wolf spider and Kauai cave amphipod are generally restricted to dark and stagnant air zones, or other subterranean habitats such as cracks, voids, and other microclimate conditions similar to those zones. However, both the cave wolf spider and amphipod may be found in sub-optimal cave habitats (e.g. cave transition zone) when conditions are appropriate (elevated humidity during periods of increased rainfall). All of the caves where the cave amphipod has been located contain penetrating plant roots and/or other decomposing plant material which serves as a food source for this detritivore. Plant material upon which the amphipods feed need not be from native plants, although nonnative toxic or indigestible plants may be inappropriate or damaging for amphipod foraging. The Kauai cave wolf



NRCS Soil Conservationist, Michelle Clark, assisting USFWS with quarterly cave animal surveys in the Makauwahi Cave on Kauai

spider can be found in caves where the cave amphipod does not occur; other nonnative arthropods (e.g. cockroaches, wood lice, small spiders) can be used as food for this generalist predator.

Roots from surface plants are the primary means by which Hawaiian caves receive nutrient input. Therefore, protection and restoration of surface plant communities is an extremely important consideration for cave conservation in Hawaii. Factors or activities that impact or modify surface vegetation over caves (e.g. fire, replacement of native or other perennial vegetation with grasses or some nonnative plants) can damage or destroy the underlying cave community.

Other threats include the alien terrestrial nemertine worm (*Argonemertes dendyi*) which is thought to be able to feed on invertebrates such as the amphipod and spider. Human impact from curiosity seekers is also of concern. Human visitation may result in the intentional or unintentional trampling of cave inhabitants.

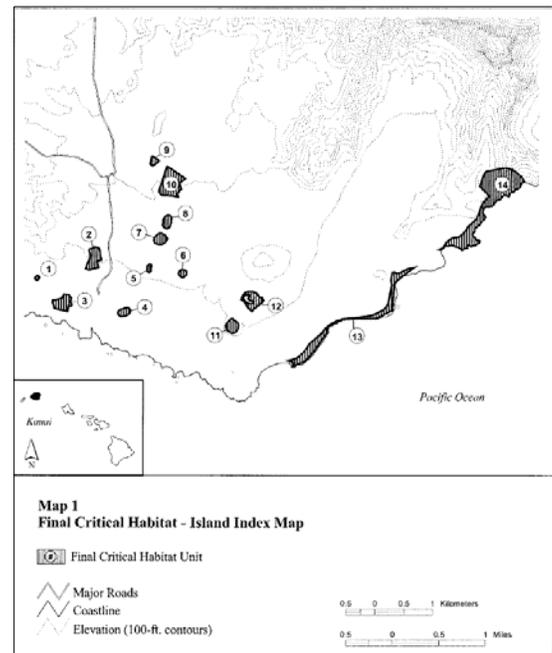
Cigarettes introduce harmful nicotine into the environment via smoke or discarded butts. Wood fire smoke may be equally damaging since far more smoke is produced and detrital food reserves may be burned. Finally, human activity in caves frequently results in the importation of garbage, which encourages the invasion of caves by potential competitors and predators such as cockroaches.

Primary Constituent Elements

The presence of subterranean spaces from 5 mm to 25 cm at their narrowest point (collectively called “mesocaverns”) and/or cave passages greater than 25 cm, dark and/or stagnant air zones that maintain relative humidity at saturation levels and the presence of roots from living, nontoxic plants such as, but not limited to, ohia (*Metrosideros polymorpha*), maiapilo (*Capparis sandwichiana*), and aalii (*Dodonaea viscosa*) in these mesocaverns and caves.

Threats: General threats to cave ecosystems include alteration of food and water inputs through changes in land use, alteration of airflow and microclimate in caves by disturbance of the surface, waste disposal and pollution, invasions of alien species, direct and indirect disturbance of the habitat by human visitors. Specifically, the major threats affecting cave resources and cave fauna are overlying alien weeds, alien animals (e.g. brown violin spider, little brown scorpion, centipedes, or large cockroaches), alien microorganisms, human use, construction, fire, pollution.

Recovery: Recovery actions include 1) securing gates on cave openings to prohibit human access; 2) providing additional non-toxic woody food sources for amphipods; 3) restoring the cave climate (humidity and temperature) by reducing outside air influence; 4) planting native vegetation and/or removing non-native appropriate vegetation overlying caves; and 5) preventing, reducing, or eliminating the presence of non-native predators and competitors.



Cave Animal GIS shapefile can be found at [Geodata\Endangered Habitat\cave-final-nad83.shp](#)

VI.b. Island of Kauai: Newcomb's Snail



The U.S. Fish and Wildlife Service designated critical habitat for the Newcomb's Snail (*Erinna newcombi*) consisting of eight stream segments and associated tributaries, springs and seeps, and adjacent riparian areas on the island of Kauai, totaling 19.76 kilometers (12.28 miles) of stream channel and 1,812 hectares (4,479 acres).

The Newcomb's snail is very small. It has a smooth, black shell formed by a single, oval whorl, 6 mm long (0.25 in.) and 3 mm (0.12 in) wide. The snail is restricted to freshwater. While the details of its ecology are not well known, Newcomb's snail probably has a life history similar to other members of the Lymnaeidae family. There are four species of Lymnaeidae snails that are native to Hawaii. These snails generally feed on algae and vegetation growing on submerged rocks. Eggs are attached to submerged rocks or vegetation and there are no widely dispersing larval stages; the entire life cycle is tied to the stream system in which the adults live.

The specific habitat requirements of the Newcomb's snail include fast-flowing springs, seeps, and vertical-to-overhanging waterfalls. Surveys of main stream channels of many of the perennial stream channels indicate that the snail is found only in protected areas within the main stream channels. Suitable habitat is generally associated with overhanging waterfalls located in the main channel of perennial streams supported by stable ground water input, or with small, spring-fed tributaries. Another common element among sites harboring snail populations is that the water source appears to be consistent and permanent, even during severe drought.

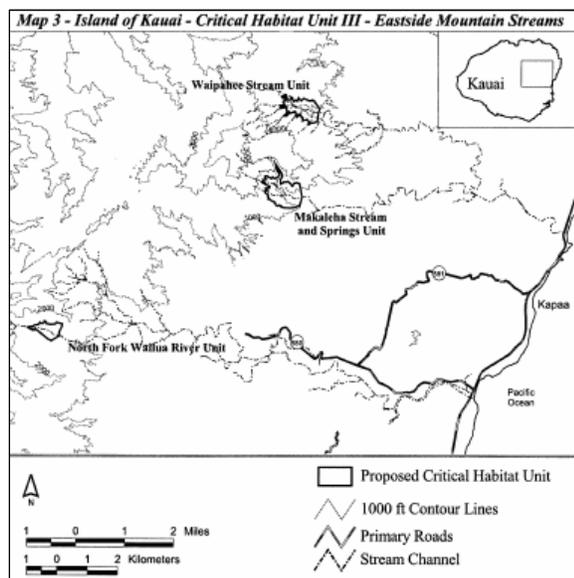
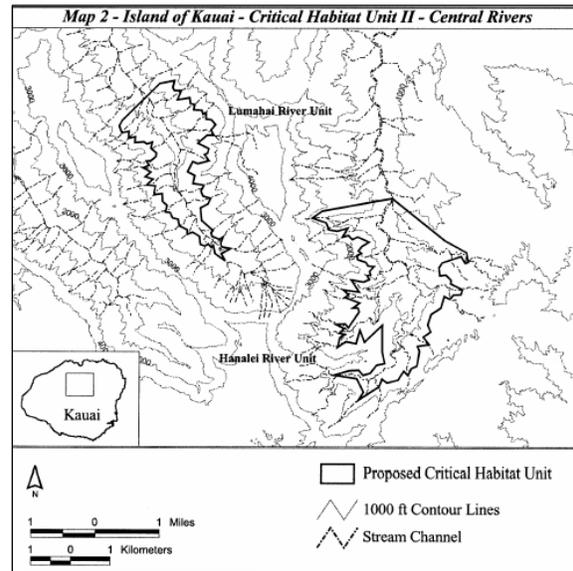
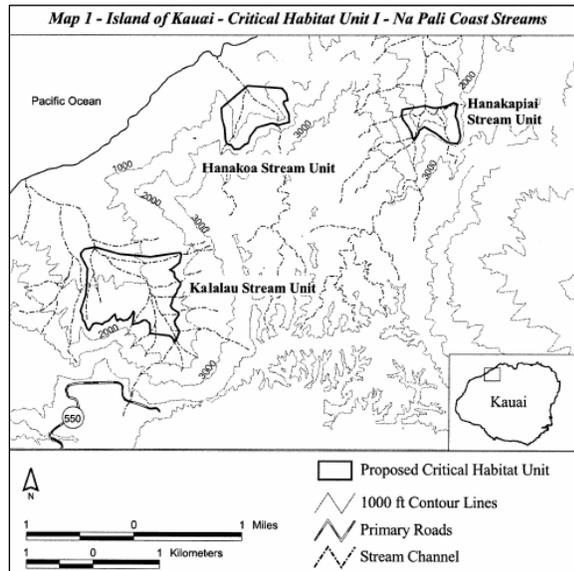
The current known range of Newcomb's snail is limited to very small sites located within six stream systems in north- and east-facing drainages on Kauai. They are: Kalalau Stream; Lumahai River; Hanalei River (four subpopulations); Waipahee Stream (a tributary to Kealia Stream); two subpopulations in Makaleha Stream (a tributary to Kapaa Stream); and the North Fork Wailua River (two subpopulations). A few individual snails have been observed in Limahuli Stream, but if a viable population occurs there, it has not been located.

Critical habitat stream complex unit	Critical habitat sub-units	Ownership	Lower boundary elevation	Upper boundary elevation	Stream segment length*
I. Na Pali Coast Streams ...	(a) Kalalau Stream	State—Na Pali Coast State Park.	183 m (600 ft)	488 m (1,600 ft)	1.38 km (0.86 mi)
	(b) Hanakoa Stream	State—Na Pali Coast State Park.	122 m (400 ft)	457 m (1,500 ft)	0.80 km (0.50 mi)
	(c) Hanakapiai Stream	State—Na Pali Coast State Park.	183 m (600 ft)	457 m (1,500 ft)	0.56 km (0.35 mi)
II. Central Rivers	(a) Lumahai River	Private—Kamehameha Schools.	183 m (600 ft)	457 m (1,500 ft)	5.0 km (3.11 mi)
	(b) Hanalei River	State—Halela Forest Reserve.	122 m (400 ft)	457 m (1,500 ft)	7.58 km (4.71 mi)
III. Eastside Mountain Streams.	(a) Waipahee Stream	Private—Cornerstone Hawaii Holdings, LLC.	262 m (880 ft)	366 m (1,200 ft)	1.73 km (1.08 mi)
	(b) Makaleha Stream	State—Kealia Forest Reserve.	183 m (600 ft)	457 m (1,500 ft)	1.59 km (0.99 mi)
	(c) North Fork Wailua River.	State—Lihue-Koloa Forest Reserve.	335 m (1,100 ft)	427 m (1,400 ft)	1.12 km (0.7 mi)
Total	19.76 km (12.28 mi)

* Length of main stream channel, does not include tributaries or springs.

Critical Habitat Units for the Newcomb's Snail by Lower and Upper Boundary Elevations in meters (m) and feet (ft) and the length of the Stream Segments in kilometers (km) and miles (mi).

It is estimated that the six known populations of snail have a total of approximately 6,000 to 7,000 individuals. The great majority of these snails, perhaps over 90 percent, are located in the populations found in Kalalau Stream (**Map 1**) and the Lumahai River (**Map 2**).



Primary Constituent Elements: All designated critical habitat areas contain the primary constituent elements for the Newcomb's snail. The primary constituent elements are: cool, clean, moderate-to-fast-flowing water in streams, springs, and seeps; their adjacent riparian areas and hydrogeologic features that capture and direct water flow to these spring and stream systems; a perennial flow of water throughout even the most severe drought conditions; and stream channel morphology that provides protection from channel scour by having overhanging waterfalls, protected tributaries or similar areas.

No agricultural lands are included in the designation of critical habitat for Newcomb's snail. Also, no operating water diversion structures that remove water from stream channels for agricultural use are included in the designation.

THREATS

- 1) Habitat degradation resulting from hydromodifications such as diversion of surface and/or groundwater
- 2) Degradation of stream water quality from deforestation, feral ungulates, or erosion along forest trails
- 3) The Newcomb's snail may also be susceptible to predation from the rosy wolf snail (*Euglandina rosea*), introduced to Hawaii in 1955. This species has demonstrated the ability to submerge itself underwater to eat aquatic snails. Additionally, this predator has had a serious impact on native snail species on Samoa, Tahiti and many islands throughout the Pacific. In Hawaii, predation by the rosy wolf snail on the Newcomb's snail has only been observed under laboratory conditions and has not been documented in the wild. Additional alien predators include the Green Swordtail fish (*Xiphophorus helleri*), the American bullfrog (*Rana catesbeiana*), and the Wrinkled Frog (*Rana rugosa*).
- 4) Parasitism by two species of marsh fly introduced to control an alien snail

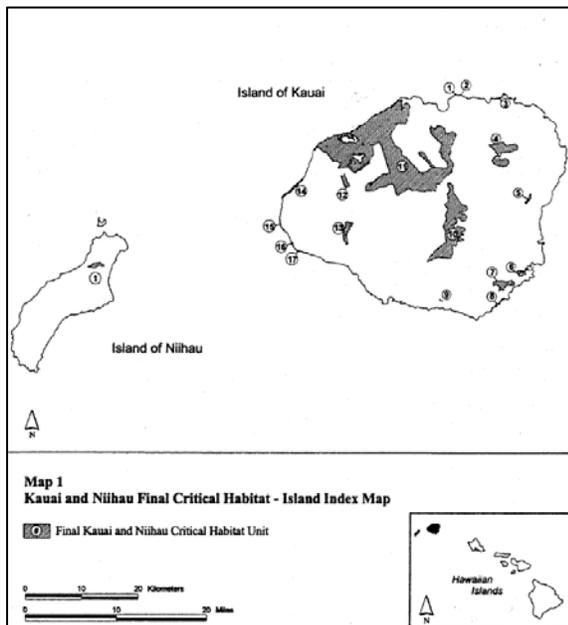
RECOVERY

Recovery will require restoration of Newcomb's snails to areas of historically occupied habitat either through natural dispersal or translocation. Mere stabilization of Newcomb's snail populations within its currently occupied habitat will not provide long-term conservation of the species.

Recovery actions should include 1) protection and preservation of water quality via conservation forestry and control of invasive species; 2) management of hunting and hiking trails so that they have the least amount of adverse impact upon adjacent streams or riverine habitats; and 3) monitoring Newcomb's snail habitat for the presence of the rosy wolf snail or other alien predators.

The GIS shapefile for the Newcomb's Snail critical habitat can be located at [Geodata\Endangered Habitat\snail_final_nad83.shp](#)

VII. Islands of Kauai and Niihau: Plants (83 plant species)



The U.S. Fish and Wildlife Service has designated a total of approximately 21,266 hectares (52,549 acres) of land on the island of Kauai and 144 hectares (357 acres) of land on the island of Niihau for 83 species of plant (see attached matrix for complete list of plant species).

Because of its age and relative isolation, Kauai has levels of floristic diversity and endemism that are higher than on any other island in the Hawaiian archipelago. However, the vegetation on Kauai has undergone extreme alterations because of past and present land use. Land with rich soils was altered by early Hawaiians and more recently, converted to agricultural use, human development, or pasture. Intentional or inadvertent introduction of nonnative plant and animal species has also contributed to the

reduction of native vegetation on Kauai. Native forests are now limited to the upper elevation mesic and wet regions. The land that supports the habitat essential to the conservation of the 83 plant taxa is owned by various private parties, the State of Hawaii, and the federal government.

Niihau's relative isolation and severe environmental conditions have produced few endemic species. The only plant with designated critical habitat on Niihau is olulu (*Brighamia insignis*).

THREATS

Threats to the 83 plant species include: 1) habitat degradation and destruction by feral ungulates (pigs, goats, deer); 2) competition with invasive nonnative plants; 3) fire; 4) predation by rats; 5) catastrophic environmental events (landslides, flood, hurricanes) that could cause extinction due to the small number of existing populations and/or individuals; 6) reduced reproductive vigor due to the small number of individuals and; 7) changes in hydrology from diversions.

RECOVERY⁶

Recovery activities should ensure long-term protection of habitat; develop threat management plans for each protected area; control feral ungulates; conduct essential alien plant control; provide necessary fire protection; control other introduced animals including rodents, slugs, insects, and red jungle fowl; control disease; ensure availability of pollination vectors; protect areas from direct threats from humans; prevent introduction of new alien species to Hawaii; expand existing populations and ; design and implement a public education program.

The GIS shapefile for the Kauai plant cluster can be located at <Geodata\Endangered Habitat\kau-final-indv-nad83.shp>

The GIS shapefile for the Niihau plant species can be located at <Geodata\Endangered Habitat\nii-final-nad83.shp>

⁶ Taken from the Recovery Plan for the Kauai Plant Cluster

VIII. Multi Island (Hawaii, Kahoolawe, Maui, Molokai): Blackburn's Sphinx Moth

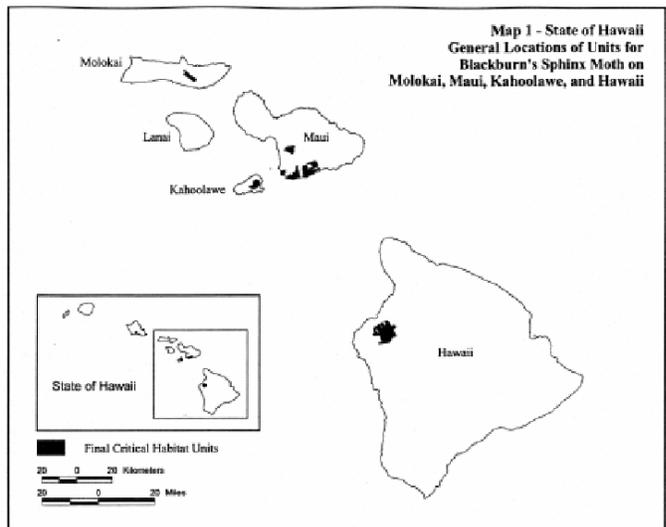


The USFWS designated a total of approximately 22,440 hectares (55,451 acres) on the islands of Hawaii, Kahoolawe, Maui and Molokai for the Blackburn's sphinx moth (*Manduca blackburni*).

Blackburn's sphinx moth is Hawaii's largest native insect, with a wing span of up to 5 inches (12 centimeters). The large caterpillars occur in two color morphs, bright green or gray with scattered white speckles throughout the back and a horizontal white stripe on the side margin of each segment.

Like other sphinx moths, it has long, narrow forewings and a thick, spindle shaped body tapered at both ends. It is grayish brown in color with black bands across the top margins of the hindwings and five orange spots along each side of the abdomen.

Blackburn's sphinx moth larvae feed on plants in the nightshade family (Solanaceae). The natural host plants are native trees within the genus *Nothoecstrum* (aiea), on which the larvae consume leaves, stems, flowers, and buds. However, many of the plants consumed by this species are not native to the Hawaiian Islands, and include *Nicotiana tabacum* (commercial tobacco), *Nicotiana glauca* (tree tobacco), *Solanum melongena* (eggplant), *Lycopersicon esculentum* (tomato), and possibly *Datura stramonium* (Jimson weed).



Habitat & Behavior: Historical records of this species are mostly from coastal, lowland, and dryland forests in areas receiving less than 50 inches (120 centimeters) of rainfall, though they have been collected from sea level to 2,500 feet (760 meters). It was most common historically on Maui. Larvae of Blackburn's Sphinx Moth feed on native `aiea trees (consuming leaves, stems, flowers, and buds) and other plants in the nightshade family. However, many of the host plants recorded for the species are not native to the Hawaiian Islands and include tree tobacco, commercial tobacco, and tomato plants.

Development from egg to adult can take as little as 56 days, but pupae may aestivate (dormancy during a period when conditions are hot and dry) in the soil for as long as a year. Adult moths can be found year round but seem to be most active during two periods, January to April and September to November. Adult moths are strong fliers.

Distribution: Once found on six Hawaiian Islands, the moth now exists only on Maui, Kahoolawe, and the island of Hawaii. They were believed extinct until 1984 when a small population was rediscovered in a lowland dry forest on the south coast of East Maui (Kanaio area).

The largest populations of Blackburn's sphinx moths, on Maui and Hawaii, are associated with trees in the genus *Nothocestrum*. For example, the large stand of *Nothocestrum* trees within Maui's Na niao Natural Area Reserve is likely the largest in the State, and this fact may explain why the moth occurs with such regularity in the Kanaio area.

Additional small isolated populations are now known from other parts of Maui. Populations were recently discovered on Kahoolawe (the first record of this species on this island) in 1997 and in 1998 in North Kona on the island of Hawaii.

The one unoccupied area designated as critical habitat is located on the island of Molokai. Although currently unoccupied by the moth, the area contains both larval stage and adult moth native host plants. The area is close enough in proximity to the Maui moth population that it is feasible that the area may be repopulated by the moth on its own. Furthermore, because Molokai is the closest island to Oahu, such an area on Molokai may provide for a flight corridor for moths eventually dispersing to the island of Oahu, which is also part of its historical range.



The large caterpillars occur in two color morphs, bright green or gray with scattered white speckles throughout the back and a horizontal white stripe on the side margin of each segment. (photos by Betsy Gagne)

THREATS

The Blackburn's Sphinx Moth is threatened by introduced ants and parasitic wasps that prey on the eggs and caterpillars, and the loss of its native host plant, `aiea, which is a dryland forest tree. Ants are not a natural component of Hawaii's arthropod fauna and they are particularly destructive due to their high densities, aggressiveness, and broad range of diet. The native host plant is found in endangered ecosystems, dry and mesic forests, and has been adversely affected by feral animals, alien plant invasions, and habitat conversions associated with development. In addition, the moth is also susceptible to overcollection by individuals for their personal collections or for trade. Because the remaining populations are small and restricted, the potential for extinction from a chance event, such a fire or a hurricane, is greatly increased.

RECOVERY

Recovery efforts should include conserving and restoring populations in multiple locations, reducing or eliminating the presence of non-native predatory and parasitic insects, planting native *Nothocestrum latifolium*, and reducing wildfire and feral ungulate pressure on the moth's habitat.

GIS shapefile for Sphinx Moth critical habitat (**Molokai & Maui & Kahoolawe**)
[Geodata\Endangered Habitat\moth-notbi-final-nad83-20030610.shp](#)

GIS shapefile for Sphinx Moth critical habitat (**Big Island**)
[Geodata\Endangered Habitat\moth-bi-final-nad83.shp](#)

IX. References

1. FEDERAL REGISTER

Island of Hawaii - Plants

50 CFR Part 17 / Vol. 68, No. 127 / Wednesday, July 2, 2003 / Rules and Regulations

Islands of Maui and Kahoolawe - Plants

50 CFR Part 17 / Vol. 68, No. 93 / Wednesday, May 14, 2003 / Rules and Regulations

Island of Lanai - Plants

50 CFR Part 17 / Vol. 68, No. 6 / Thursday, January 9, 2003 / Rules and Regulations

Island of Oahu – Oahu Elepaio

50 CFR Part 17 / Vol. 66, No. 237 / Monday, December 10, 2001 / Rules and Regulations

Island of Oahu – Plants

50 CFR Part 17 / Vol. 68, No. 116 / Tuesday, June 17, 2003 / Rules and Regulations

Island of Molokai – Plants

50 CFR Part 17 / Vol. 68, No. 52 / Tuesday, March 18, 2003 / Rules and Regulations

Island of Kauai & Niihau – Plants

50 CFR Part 17 / Vol. 68, No. 39 / Thursday, February 27, 2003 / Rules and Regulations

Island of Kauai – Kauai Cave Wolf Spider and Kauai Cave Amphipod

50 CFR Part 17 / Vol. 68, No. 68 / Wednesday, April 9, 2003 / Rules and Regulations

Island of Kauai – Newcomb's Snail

50 CFR Part 17 / Vol. 67, No. 161 / Tuesday, August 20, 2002 / Rules and Regulations

Multi Islands – Blackburn's Sphinx Moth

50 CFR Part 17 / Vol. 68, No. 111 / Tuesday, June 10, 2003

2. U.S. Fish & Wildlife Service, Pacific Islands / Endangered Species
<http://pacificislands.fws.gov/wesa/endspindex.html#Hawaiian>
3. *An Assessment of the Biological Importance and Recommendations for Management of Caves within the Kukui'Ula Property, Koloa, Kauai*, Final Report, Hawaii Biological Survey, March 2003
4. U.S. Fish and Wildlife Service. 2004. Draft Recovery Plan for the Kauai Cave Arthropods: the Kauai Cave Wolf Spider (*Adelocosa anops*) and the Kauai Cave Amphipod (*Spelaeorchestia koloana*). U.S. Fish and Wildlife Service. Portland, Oregon. 55pp.
Available at: <http://pacific.fws.gov/ecoservices/endangered/recovery/default.htm>
6. U.S. Fish and Wildlife Service. 1995. Recovery Plan for the Kauai Plant Cluster. U.S. Fish and Wildlife Service. Portland, Oregon. 270pp.
7. U.S. Fish and Wildlife Service. 1994. Lanai Plant Cluster Recovery Plan: *Abutilon eremitopetalum*, *Abutilon menziesii*, *Cyanea macrostegia* ssp. *gibsonii*, *Cyrtandra munroi*, *Gahnia lanaiensis*, *Phyllostegia glabra* var. *lanaiensis*, *Santalum freycinetianum* var. *lanaiense*, *Tetramolopium remyi*, and *Viola lanaiensis*. U.S. Fish and Wildlife Service, Portland, OR. 138pp.
8. U.S. Fish and Wildlife Service. 1997. Draft Recovery Plan for the Oahu Plant. U.S. Fish and Wildlife Service, Portland, Oregon. 229 pp., plus Appendices.

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Cave Amphipod: William Mull

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Sphinx Moth: Betsy Gagne, Hawaii Natural Area Reserves System