

Blackburn's Sphinx Moth
(*Manduca blackburni*)

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: Blackburn's Sphinx Moth (*Manduca blackburni*)

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5-YEAR REVIEW
Blackburn's Sphinx Moth/ *Manduca blackburni*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia,
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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 (PIFWO) of the U.S. Fish and Wildlife Service (USFWS) beginning on March 8, 2007. The final recovery plan was the primary source of information for this five-year review. However, updates on the status and biology of the species and its threats were also obtained from other sources. The evaluation of the status of the species was prepared by the lead PIFWO biologist. The document was then reviewed by the Recovery Program Leader and acting Assistant Field Supervisor for Endangered Species, and Deputy Field Supervisor, before submission to the Field Supervisor for approval.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

USFWS. 2007a. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 71 species in Oregon, Hawaii, Commonwealth of the Northern Mariana Islands, and Territory of Guam. Federal Register 72(45):10547-10550.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 2000. Endangered and threatened wildlife and plants; determination of endangered status for Blackburn's sphinx moth from Hawaii. Federal Register 65:4770-4779.

Date listed: February 1, 2000

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:

USFWS. 2003a. Endangered and threatened wildlife and plants; designation of critical habitat for Blackburn's sphinx moth; final rule. Federal Register 68:34710-34766.

1.3.4 Review History:

Species status (FY 2008 Recovery Data Call [September 2008]):
Stable

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

2C

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: USFWS. 2005. Recovery plan for the Blackburn's sphinx moth (*Manduca blackburni*). Portland, OR. 125 pages.

Date issued: August 26, 2005

Dates of previous revisions, if applicable: NA

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

☒ 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*

☐ *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:

The threats affecting this species (Factors A, B, C, D and E) are discussed in detail in section 2.3.2.

Due to the limited information available on the species, the recovery plan provides interim downlisting and delisting criteria. For downlisting the recovery plan calls for one Blackburn's sphinx moth population within one management unit, as defined in the recovery plan, on Hawaii, Kahoolawe, and Maui. Each of these populations must be well-distributed, naturally reproducing, and stable or increasing in size through one to two El Niño events or for at least five consecutive years before downlisting is considered (Factors A, B, C, D, and E). The recovery plan defines stable Blackburn's sphinx moth populations as those in which observed population declines are followed by population increase to pre-decline levels.

For delisting the recovery plan calls for the following criteria: (1) one moth population within one management unit must be naturally reproducing and stable or increasing in size, through one to two El Niño events or a minimum of five consecutive years within the Kauai-Oahu Management Unit (Factors A, B, C, D, and E); (2) four moth populations within four management units must be naturally reproducing and stable or increasing in size, through one to two El Niño events or a minimum of five consecutive years on three different islands within the Maui Nui Management Unit (of those four, one within windward and one within leeward Maui Island) (Factors A, B, C, D, and E); and (3) two moth populations with two management units must be naturally reproducing and stable or increasing in size, through one to two El Niño events or a minimum of five consecutive years within the Big Island (Hawaii Island) Management Unit (Factors A, B, C, D, and E).

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:

The largest populations of Blackburn's sphinx moth, on Maui and Hawaii, are all associated with native trees in the genus *Nothocestrum* (Van Gelder and Conant 1998). *Nothocestrum latifolium* (aiea) and *N. breviflorum* (aiea) are both known larval host plants for the species (Riotte 1986). Other host plants include non-native *Nicotiana tabacum* (commercial tobacco), *Nicotiana glauca* (tree tobacco), *Solanum melongena* (eggplant), *Lycopersicon esculentum* (tomato), and possibly *Datura stramonium* (Jimson weed) (Riotte 1986). Recent work on moth captive propagation indicates that tomato may be a suboptimal larval host plant (Rubinoff 2007).

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:

Currently Blackburn's sphinx moth is known only from populations on Maui, Kahoolawe, and Hawaii. However, no reasonably accurate estimate of population size has been determined due to the adult moths' wide-ranging behavior and overall rarity. Therefore, trends and abundance estimates are not available at this time.

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:

No new information.

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.):

No new information.

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

Ungulate exclosures of various sizes have been constructed in Management Units on Kauai Lanai, Molokai, Maui, and Hawaii, and, in some cases, ungulate removal has also been undertaken (Williams 2000; Medeiros 2006; Hawaii Department of Land and Natural Resources 2007; D. Ball, USFWS, pers. comm. 2008; M. Clark, USFWS, pers. comm. 2008; J. Higashino, USFWS, pers. comm. 2008). Forest restoration, including outplanting of *Nothocestrum* species, has been undertaken in Management Units on Kauai, Maui and Hawaii (Allen 2000; Medeiros 2006; D. Ball, USFWS, pers. comm. 2008; M. Clark, USFWS, pers. comm. 2008; J. Higashino, USFWS, pers. comm. 2008). In addition, ungulates were removed from Kahoolawe in the 1990s and restoration of the island is ongoing (J. Higashino, USFWS, pers. comm. 2008). However, additional management is needed in all of the management units to help achieve recovery of the species.

2.3.1.7 Other:

Rubinoff (2007) undertook efforts to develop captive propagation techniques for the Blackburn's sphinx moth in 2005. Eight eggs were collected and two female Blackburn's sphinx moth females were raised

successfully. Additional work was proposed in 2007 but was not carried out due to insufficient funding (D. Rubinoff, University of Hawaii, 2008).

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:

Blackburn's sphinx moths are found in dry to mesic forest habitats. Its habitats have been severely degraded due to past and present land management practices including ranching, the impacts of introduced plants and animals, wildfire, and agricultural development (Cuddihy and Stone 1990). Due to these factors, *Nothocestrum peltatum* on Kauai, *N. breviflorum* on Hawaii, and *N. latifolium* on Kauai, Lanai, Maui, Molokai, and Oahu, all of which are potential native host plants for Blackburn's sphinx moth, are now either federally listed as endangered species or are candidates for listing (USFWS 1994a, 1994b, 2006). *Nothocestrum peltatum* is known from seven populations totaling 23 individuals on Kauai while *N. breviflorum* is known from 171 individuals on the island of Hawaii (USFWS 2003b, 2007b). *Nothocestrum latifolium* is known from 19 populations totaling fewer than 1,100 individuals. Specifically, known numbers consist of 1 population of 1 individual on Kauai, 4 populations of 9 individuals on Lanai, 3 populations of over 1,000 individuals on Maui, 5 populations of 45 to 50 individuals on Molokai, and 6 populations totaling 10 individuals on Oahu (Hawaii Biodiversity and Mapping Program 2006; W. Moses, The Nature Conservancy of Hawaii, pers. comm. 2006; F. Starr, U.S. Geological Survey, Biological Resources Discipline, pers. comm. 2006; H. Oppenheimer, pers. comm. 2006). A fourth species, *Nothocestrum longifolium*, is found primarily in wet forest and occasionally in mesic forests on all of the main islands except Kahoolawe and Niihau (Wagner *et al.* 1999). This species is not federally listed or a candidate for listing at this time and information on the number of individuals and populations is not available.

Efforts to outplant *Nothocestrum* species have been undertaken in Management Units on Maui and Hawaii (Allen 2000, Medeiros 2006). In addition, ungulate exclosures and, in some cases, ungulate control has been undertaken in Management Units on Kauai, Lanai, Molokai, Maui, and Hawaii (Williams 2000; Medeiros 2006; Hawaii Department of Land and Natural Resources 2007; J. Higashino, USFWS, pers. comm. 2008). However, additional management is needed in these management units to help achieve the recovery of the species.

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

Sphinx moths, in general, are sought by collectors and as early as the

1950s there was a standing reward for specimens of another rare Hawaiian sphinx moth (*Tinostoma smargditis*) (Zimmerman 1958). Unrestricted collecting and handling for scientific purposes are also known to impact populations of other species of rare Lepidoptera (Murphy 1988). Collection for scientific purposes is now monitored and permitted, if appropriate, under Section 10 of the Endangered Species Act. No information is available on the level of illegal collection.

2.3.2.3 Disease or predation:

Alien arthropods, whether purposefully or accidentally introduced, pose a serious threat to Blackburn's sphinx moth through direct predation, parasitism, and competition for food or space (Howarth and Medeiros 1989, Howarth and Ramsay 1991). In addition, introduced vertebrates, like the Japanese white-eye (*Zosterops japonicus*), can prey upon, and compete for resources with, the Blackburn's sphinx moth.

No new Blackburn's sphinx moth predators, parasites, or competitors have been reported since the publication of the recovery plan (2005). However, populations of known and potential predators of the species still persist throughout its known range. Efforts to develop control measures for some potential predators, like the big-headed ant (*Pheidole megacephala*) and Argentine ant (*Linepithema humile*), have met with some success (Peck *et al.* 2007, Snook *et al.* 2008). However, additional work is needed on the control and eradication of predators, parasites, and predators to recover the species.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Alien predatory and parasitic insects are significant factors contributing to the reduction in Blackburn's sphinx moth abundance, and may be the most serious current, direct threat to its continued existence. Some of these alien species were intentionally introduced by the State of Hawaii Department of Agriculture or other agricultural agencies (Funasaki *et al.* 1988) and importations and augmentations of lepidopteran parasitoids is still a potential threat. Federal regulations for the introductions of biological control agents have not adequately protected this species (Lockwood 1993). There are no Federal statutes requiring review of biological control agents before their introduction, and the limited Federal review process requires consideration of potential harm only to economically important species (Miller and Aplet 1993). Although the State of Hawaii requires pre-release review of new introductions (Hawaii Division of Forestry and Wildlife, Hawaii Revised Statutes Chapter 150A), post-release biology and host range cannot be predicted from laboratory studies (Gonzalez and Gilstrap 1992; Roderick 1992) and the purposeful release or augmentation of any lepidopteran predator or parasitoid is a potential threat to the Blackburn's sphinx moth (Gagné and Howarth 1985; Simberloff 1992).

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Blackburn's sphinx moths are also susceptible to seasonal variations and weather fluctuations affecting their quality and quantity of available habitat and food. For example, during times of drought, it is expected that nectar availability for adult moths will decrease. No new information is available on changes in the quality and quantity of habitat and food available due to weather fluctuations. However, climatic changes associated with global warming could severely impact the distribution and availability of Blackburn's sphinx moth habitat.

2.4 Synthesis

The Blackburn's sphinx moth is endemic to the Hawaiian Islands and is currently found on the islands of Hawaii, Maui, and Kahoolawe. The current population of the species is unknown and trends in population status have not been determined due to difficulties in estimating population densities. Loss and degradation of habitat for the species continues due to overgrazing by introduced ungulates. Alien arthropods continue to impact the species through predation, competition, and parasitism. In addition, the accidental or intentional release of alien predators and competitors continues to threaten the species. Long-term changes in climatic conditions due to global warming are also expected to impact the distribution and abundance of available habitat for the species. However, the extent of these impacts on the Blackburn's sphinx moth's populations remains unknown.

Because Blackburn's sphinx moth populations are not known to be stable or increasing in management units on Hawaii, Maui, and Kahoolawe the interim downlisting criteria of the species have not been met. Therefore, Blackburn's sphinx moth meets the definition of endangered as it remains in danger of extinction throughout all of its range.

3.0 RESULTS

3.1 Recommended Classification:

☐ **Downlist to Threatened**

☐ **Uplist to Endangered**

☐ **Delist**

☐ *Extinction*

☐ *Recovery*

☐ *Original data for classification in error*

☒ **No change is needed**

3.2 New Recovery Priority Number: N/A

Brief Rationale:

3.3 Listing and Reclassification Priority Number: N/A

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

- Develop and implement a long-term monitoring program for the species.
- Continue efforts to develop and refine captive propagation techniques for the species.
- Identify primary predators, competitors, and parasites of Blackburn's sphinx moth and develop and implement appropriate control measures.
- Remove ungulates and restore habitat in management units.
- Address issue of tree tobacco removal.
- Revise downlisting and delisting criteria when sufficient information is available.

5.0 REFERENCES

Allen, W. 2000. Restoring Hawaii's dry forests. *Bioscience* 50:1037-1041.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of the native Hawaiian vegetation; effects of humans, their activities and introductions. Cooperative National Park Resource Study Unit, Hawaii. 138 pp.

Funasaki, G.Y., P.L. Lai, L.M. Nakahara, J.W. Beardsley, and A.K. Ota. 1988. A review of biological introductions in Hawaii: 1890 to 1985. *Proceedings of the Hawaiian Entomological Society* 28:105-160.

Gagné, W.C. and F.G. Howarth. 1985. Conservation status of endemic Hawaiian Lepidoptera. Pages 74-84 in *Proceedings of the 3rd Congress of European Lepidopterists*. Cambridge. 1982. Societas Europaea Lepidopterologica, Karluhe.

Gonzalez, D. and F.E. Gilstrap. 1992. Foreign exploration: assessing and prioritizing natural enemies and consequences of pre-introduction studies. Pages 53-70 in Kauffman, W. C. and J. E. Nechols (eds). *Selection Criteria and Ecological Consequences of Importing Natural Enemies*. Thomas Say Publications in Entomology: Proceedings. Entomological Society of America, Lanham, Maryland.

- Hawaii Biodiversity and Mapping Program. 2006. *Nothocestrum latifolium*.
<http://hbmp.hawaii.edu/printpage.asp?spp=PDSOL0P020>, downloaded on April 14, 2007.
- Hawaii Department of Land and Natural Resources. 2007. Conservation management within hunting units, July 1, 2004 – June 30, 2008. Performance report for USFWS grant agreement 122004G018. Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, Kauai. 9 pp.
- Howarth, F.G. and A. Medeiros. 1989. Non-native invertebrates. Pages 82-87 in Stone, C. P. and D. B. Stone (eds), Conservation Biology in Hawaii. University of Hawaii Cooperative National Park Resources Unit, Honolulu, Hawaii.
- Howarth, F.G. and G.W. Ramsay. 1991. The conservation of island insects and their habitats. Pages 71-107 in Collins, N. M. and J. A. Thomas (eds), The Conservation of Insects and Their Habitats. Academic Press, London.
- Lockwood, J.A. 1993. Environmental issues involved in biological control of rangeland grasshoppers (Orthoptera: Acrididae) with exotic agents. Environmental Entomology 22:503-518.
- Medeiros, A.C. 2006. Restoration of native Hawaiian dryland forest at Auwahi, Maui. U.S. Geological Survey Factsheet 2006-3035; March 2006. U.S. Department of Interior, U.S. Geological Survey. 4 pages.
- Miller, M. and G. Aplet. 1993. Biological control: a little knowledge is a dangerous thing. Rutgers Law Review 45:285-334.
- Murphy, D.D. 1988. Are we studying our endangered butterflies to death? Journal of Research Lepidopterists 26:236-239.
- Peck, R., P. Banko, J. Cappadonna, and M. Euaparadorn. 2007. Developing tools for invasive ants in Hawaii Volcanoes National Park [abstract]. Page 91 in 2007 Hawaii Conservation Conference Meeting Program; 2007 July 25-27; Honolulu, Hawaii.
- Riotte, J.C.E. 1986. Re-evaluation of *Manduca blackburni* (Lepidoptera: Sphingidae). Proceedings of the Hawaiian Entomological Society 27:79-90.
- Roderick, G. 1992. Post-colonization evolution of natural enemies. Pages 53-70 in Kauffman, W.C. and J.E. Nechols (eds). Selection Criteria and Ecological Consequences of Importing Natural Enemies. Thomas Say Publications in Entomology: Proceedings. Entomological Society of America, Lanham, Maryland.
- Rubinoff, D. 2007. *Manduca blackburni* reintroduction project. Draft Report to Environmental Defense. 8 pages.

- Simberloff, D. 1992. Conservation of pristine habitats and unintended effects of biological control. Pages 103-117 in Kauffman, W.C. and J.E. Nechols (eds). Selection Criteria and Ecological Consequences of Importing Natural Enemies. Thomas Say Publications in Entomology: Proceedings. Entomological Society of America, Lanham, Maryland.
- Snook, K., R. Peck, P. Banko, J. Cappadonna, and M. Euaparadorn. 2008. Efficacy of baits to control the big-headed ant (*Pheidole megacephala*) in Hawaii Volcanoes National Park [abstract]. Page 56 in 2008 Hawaii Conservation Conference Meeting Program; 2008 July 29-31; Honolulu, Hawaii.
- U.S. Fish and Wildlife Service. 1994a. Endangered and threatened wildlife and plants: determination of endangered or threatened status for 24 plants from the Island of Kauai, Hawaii. Federal Register 59:9304-9329.
- U.S. Fish and Wildlife Service. 1994b. Endangered and threatened wildlife and plants: determination of endangered or threatened status for 21 plants from the Island of Hawaii, State of Hawaii. Federal Register 59:10305-10325.
- U.S. Fish and Wildlife Service. 2000. Endangered and threatened wildlife and plants; determination of endangered status for Blackburn's sphinx moth from Hawaii. Federal Register 65:4770-4779.
- U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; designation of critical habitat for Blackburn's sphinx moth; final rule. Federal Register 68:34710-34766.
- U.S. Fish and Wildlife Service. 2003b. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii; final rule. Federal Register 68:39624-39722.
- U.S. Fish and Wildlife Service. 2005. Recovery plan for the Blackburn's sphinx moth (*Manduca blackburni*). Portland, Oregon. 125 pp.
- U.S. Fish and Wildlife Service. 2007a. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 71 species in Oregon, Hawaii, Commonwealth of the Northern Mariana Islands, and Territory of Guam; Notice of Review. Federal Register 72:10547-10550.
- U.S. Fish and Wildlife Service. 2007b. *Nothocestrum peltatum* (aiea), 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 6 pages.
- Van Gelder, E. and S. Conant. 1998. Biology and conservation of *Manduca blackburni*. Report to U.S. Fish and Wildlife Service, Honolulu, Hawaii. 52 pages.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawaii. University of Hawaii Press and Bishop Museum Press, Honolulu, Hawaii. Bishop Museum Special Publications 83:1-1,853

Zimmerman, E.C. 1958. Macrolepidoptera. Insects of Hawaii. Volume 7. University of Hawaii Press, Honolulu, Hawaii. Pages 429, and 442-444.

Personal Communications

Ball, D., U.S. Fish and Wildlife Service. Response to request for information on Maui Nui projects in Blackburn's Sphinx Moth Management Units, October 17, 2008.

Clark, M., U.S. Fish and Wildlife Service. Response to request for information on Kauai projects in the Blackburn's Sphinx Moth Management Unit, October 20, 2008.

Higashino, J., U.S. Fish and Wildlife Service. Response to request for information on Maui Nui projects in Blackburn's Sphinx Moth Management Units, October 17, 2008.

Moses, W., The Nature Conservancy. Response to request for candidate plant species information, September 15, 2006.

Oppenheimer, H., Plant Extinction Prevention Program. Telephone interview regarding plant candidate species information updates, September 15, 2006.

Rubinoff, D., University of Hawaii. Response to request for information on results of captive rearing program, October 15, 2008.

Starr, F., U.S. Geological Survey, Biological Resources Division. Response to request for candidate plant species information, 2006.

Approved: Olivia M. J. S. Date 31 July 2009
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