Recovery Outline for
Bog Buck Moth
(*Hemileuca maia menyanthevora, = H. iroquois*)

April 2023

Photo of a male bog buck moth (center) by J. Jaycox, NYNHP and instar larvae (top right) by K. Sime.

Introduction

This document outlines a preliminary course of action for the recovery of the bog buck moth (*Hemileuca maia menyanthevora, = H. iroquois*) until a comprehensive recovery plan for the species is approved. The bog buck moth is a large-bodied, day-flying moth limited in occurrence to a few locations near Lake Ontario in New York, United States (U.S.), and in two locations in Ontario, Canada. This species is found in open, calcareous, low shrub wetlands, called fens, that contain large amounts of a host plant, buckbean (*Menyanthes trifoliata)*. The bog buck moth was listed as an endangered species on April 14, 2023 (88 FR 15921). The current status of the bog buck moth is poor, with two known potentially healthy populations in Ontario, and one known extant population in poor condition in New York.

Listing Status: Endangered throughout its range; April 14, 2023
Species Range: New York, U.S. and Ontario, Canada
Recovery Priority Number: 6
Lead Region: Northeast
Lead Field Office: New York Field Office
Lead Contact: Sandra Doran, sandra_doran@fws.gov

Background

Type and Quality of Available Information to Date

The species status assessment (SSA; Service 2021) that informed the bog buck moth endangered species listing also provided the basis for the recommendations in this recovery outline. Key uncertainties and assumptions include:

- We do not fully understand the causes of bog buck moth boom and bust cycles, but we assume the causes are similar to those affecting other buck moths. These include disease, parasitoids, predation and pesticides. Egg parasitoids are known in New York bog buck moth populations, and it is likely that larval and pupal parasitoids are present. We have no information about disease, predation or pesticides impacting bog buck moth populations.

- The vulnerability of the species' habitat to stressors is unknown. If parts of a large wetland are impacted by a stressor, such as parasitoids or flooding, there may be some suitable habitat remaining. However, if all areas of a large wetland are equally vulnerable to a stressor, then smaller, scattered wetlands are a better defense affording the species additional redundancy and resiliency.

- We do not know whether bog buck moths use the strategy of overwintering as pupae if fall conditions are not appropriate for adult flights. This is a possibility given that closely related species have been documented using this strategy and would afford the species some additional resiliency.

- We do not know the extent to which interacting changes in temperature and precipitation may influence flooding or drying out of bog buck moth sites. There may be compounding effects on bog buck moths from changes in temperature associated with shifts in phenology or reduced snowpack.

- We have no long-term trend information for the Canadian subpopulations. Four subpopulations were considered extant in 2009. Only two of the four subpopulations were reconfirmed as extant in 2011 (Ministry of the Environment, Conservation and Parks 2020).

Brief Life History

The bog buck moth is a fairly large-bodied, day-flying moth limited in occurrence to a few locations near Lake Ontario in New York and in Ontario, Canada. The life cycle of the bog buck moth is similar to that of other *Hemileuca* species and generally completed within 1 year. Nonfeeding adults emerge in the fall. After mating, female buck moths lay one large cluster of eggs on sturdy stems of a variety of plant species, in the vicinity of bog buckbean plants. The eggs overwinter until the following spring when they hatch into larvae that rely primarily on the host plant. Pupation occurs by mid-July and takes place below the surface of the peat mat. The pupal stage lasts about 2 months, but the pupae may be capable of remaining dormant until the following fall or possibly the fall after that (Cryan and Dirig 1977; Tuskes *et al.* 1996).

Limiting Life History Characteristics

- Bog buck moths are limited to highly specific habitat of open, calcareous, low shrub fens containing large amounts of buckbean (COSEWIC 2009). While there are additional fens meeting these conditions in Ontario and New York, none have signs of bog buck moth use.

- Bog buck moths depend on shifting mosaics of early successional fen habitat created by regular disturbance (such as periodic flooding) (Cryan and Dirig 2020). Without disturbances, vegetation succession will occur; in fens with intact hydrology, this succession occurs very slowly. Succession may be sped up with nutrient inputs or changes to hydrology.

- Expected dispersal distances for adult males are just a few kilometers. Females fly little compared to males and dispersal between fens is unlikely. Any new bog buck moth colonies (or recolonization of extirpated sites) will require wind-aided dispersal or human-aided relocation of gravid females.

- Bog buck moth populations undergo considerable fluctuations. When they are at the smaller end (crash or bust) of the cycle, small population size puts sites at greater risk of extirpation from stochastic events (e.g., periodic flooding, summer drought).

- Low genetic diversity is documented within the bog buck moth (Dupuis *et al.* 2020). Genetic drift[1] is more likely to negatively affect populations that have a smaller effective population size[2] and populations with low gene flow that are geographically spread and isolated from one another.

[1] The variation in the relative frequency of different genotypes in a small population, owing to the chance disappearance of particular genes as individuals die or do not reproduce.
[2] The number of individuals in a population who contribute offspring to the next generation.

Primary Threats

All extant populations are experiencing some degree of habitat alteration from invasive plant species, habitat succession, and flooding. Prolonged flooding may drown various life stages of bog buck moths or reduce suitable habitat either by directly making it unavailable (under water) or reducing survival and growth of bog buckbean, the principal food source for the bog buck moth larvae. Flooding has increased at one New York population over the past several years due to increased winter and spring precipitation (projected to increase due to climate change) and high Great Lakes water levels. Water level management has altered or has the potential to alter several bog buck moth sites. Bog buck moths exhibit attributes associated with high sensitivity to climate change (Foden *et al*., 2018) including specialized habitat requirements, dependence on appropriate climatic conditions for various life stages, dependence upon a specific host plant, rarity of populations, and existing exposure to other threats.

Current Biological Status of the Species

The current status of the bog buck moth in New York is poor. The only confirmed extant New York population is in poor condition, one population is extirpated, and one population is presumed extirpated. Most sites in New York are owned and managed by the New York State Department of Environmental Conservation (NYSDEC). In Ontario, there are two potentially healthy populations (table 1), both located on private land.

Table 1: Protection status, ownership, and condition status of bog buck moth populations and subpopulations in the United States and Canada.

Country	Population/Subpopulation	Ownership	Protection Status	Condition Status
U.S.	**Jefferson County Population**	NYSDEC	Protected/Public	Extirpated
U.S.	**Oswego Inland Site Population**	Central New York Land Trust	Protected/Private	Presumed Extirpated
U.S.	**Lakeside Subpopulations**			
	Lakeside 1	The Nature Conservancy	Protected/Public	Presumed Extirpated
	Lakeside 2	The Nature Conservancy	Protected/Public	Presumed Extirpated
	Lakeside 3	NYSDEC	Protected/Public	Poor
	Lakeside 4	NYSDEC	Protected/Public	Poor
	Lakeside 5	NYSDEC	Protected/Public	Poor
Canada	**White Lake Subpopulations**			
	White Lake North	Private	Unprotected	Unknown/Likely Good based on rebound of adult numbers in 2020.
	White Lake South	Private	Unprotected	Unknown. No surveys in recent years
Canada	**Richmond Fen Subpopulations**			
	Richmond Fen North	Private	Unprotected	Unknown. No surveys in recent years
	Richmond Fen South	Private	Unprotected	Unknown/Likely Good based on instar larval counts in 2020.

Conservation Actions to Date

Canada

Listing

The bog buck moth[3] was listed as endangered by COSEWIC in 2009 (COSEWIC 2009, entire). It was listed as endangered under the Ontario Endangered Species Act[4] (OESA) in 2010. The bog buck moth was listed as endangered on Schedule 1 of the Species at Risk Act in 2012, which protects the bog buck moth from being killed, harmed, harassed, captured, or taken in Canada. Populations of the bog buck moth are located within provincially significant wetlands and Areas of Natural or Scientific Interest and receive some protection under the OESA.

Recovery Planning and Implementation

The Ontario Ministry of Natural Resources and Forestry (OMNRF) published a recovery strategy for the bog buck moth on December 7, 2011 (Gradish and Tonge 2011, entire). The recovery strategy includes protecting known sites and working with landowners to preserve habitat. Environment Canada published a recovery strategy (Environment Canada, 2015) with population and distribution objectives and goals: sustain current populations at extant sites; expand populations to suitable, unoccupied sites within the current range; and maintain abundance through habitat restoration and invasive species management. Other actions include conducting inventory and monitoring to determine distribution and abundance, assessing of risks of invasive species and insecticides, evaluating hydrology of wetland habitat, and securing habitat and supporting research (OMNRF 2022). The Ontario government is committed to working on and funding recovery actions with other organizations; however, available resources (funding limitations) and other priorities may preclude work on recovery actions[5].

New York

State Listing

The bog buck moth was listed as Endangered[6] by the State of New York in 1999 and is protected by Environmental Conservation Law (ECL) section 11-0535 and the New York Code of Rules and Regulations (6 NYCRR Part 182). An incidental take permit is required for any proposed project that may result in a take of bog buck moths, including, but not limited to, actions that may kill or harm individual animals or result in the adverse modification, degradation, or destruction of habitat occupied by the bog buck moth.

The bog buck moth was included as a Species of Greatest Conservation Need (SGCN) in the New York State Department of Environmental Conservation (NYSDEC)

[3] Called Bogbean Buckmoth in Canadian reports

[4] https://www.ontario.ca/laws/statute/07e06. Accessed 7/13/2020.

[5] https://www.ontario.ca/page/bogbean-buckmoth-government-response-statement

[6]https://govt.westlaw.com/nycrr/Document/I21eb7aa2c22211ddb7c8fb397c5bd26b?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1. Accessed 7.13.2020

Comprehensive Wildlife Conservation Strategy (CWCS)(NYSDEC 2005, Appendix 5, pp. 14-17) and as a high priority SGCN in the 2015 update (NYSDEC 2015, not numbered). The CWCS (NYSDEC 2005, Appendix 5, pp. 15-16) includes multiple recommendations for the bog buck moth.

The NYSDEC has a draft recovery plan for the bog buck moth for New York State (Bonanno and White 2011, entire) that has not been finalized. Recovery actions outlined include research, habitat management, and monitoring. The primary recovery action implemented in New York to date has been assessing the status of the species through fall moth surveys. Habitat management has also been conducted at a few sites. For example, annual manual removal of cattail (*Phragmites australis*) since 2016 at the Oswego Inland Site has pushed back cattail encroachment (Service 2021).

Habitat Protection

All known populations are in conservation ownership and are protected from direct impacts (e.g., wetland fill associated with roads or development) (table 1). Central New York Land Trust has periodically conducted invasive species management to restore native habitat and is working with adjacent landowners to reduce nutrient inputs and pesticide and herbicide use.

The NYSDEC Freshwater Wetlands Act[7] (ECL Article 24) provides protection for wetlands greater than 12.4 acres in size or of unusual local importance. Regulated activities within the wetland or adjacent buffer require permits from the NYSDEC. In addition, in accordance with section 404 of the Clean Water Act, the U.S. Army Corps of Engineers has the authority to regulate discharge of dredged or fill material into waters of the United States, including wetlands. In New York, placing fill into bogs and fens is not authorized under the Nationwide Permit Program[8].

Recovery Priority Number: 6

The recovery priority number is 6, reflecting a subspecies with a high degree of threat and low recovery potential. Threats from hydrological changes (prolonged flooding), habitat succession, and invasive species are high, while threats from predation, disease, parasitism, and pesticides are unknown. Biological and ecological limiting factors are poorly understood, and the species' characteristics make it highly vulnerable to climate change. None of the populations in New York are in good condition.

[7]https://www.dec.ny.gov/docs/wildlife_pdf/wetart24a.pdf. Accessed 4.13.2023.
[8] https://www.nan.usace.army.mil/Portals/45/docs/regulatory/NWP/LRB-NAN_Final_2017_RCs_NY.pdf?ver=2017-03-22-110955-210. Accessed 2.13.2023.

Interim Recovery Program

Interim Recovery Strategy

In New York. maintain and improve conditions for all remaining subpopulations at the Lakeside sites and restore the Oswego Inland Site population through surveys, assessments, and habitat management. Determine viability of subpopulations. Initiate propagation of bog buck moth and augment extant populations or reintroduce them to extirpated sites. Assess and protect adjacent sites with suitable habitat. Conduct research and create a long-term monitoring program. In Canada, collaborate with OMNRF and Canadian experts on recovery actions for the four subpopulations at the Richmond Fen and White Lake sites to help protect, maintain, and improve conditions for bog buck moth.

Recovery Actions

New York

- Enhance protection at extant sites by establishing buffers areas around sites.
- Investigate potential new sites in New York State by assessing medium fens for habitat suitability to support bog buck moth and for possible introduction of bog buck moth.
- Assess the status of the species at extant sites by conducting fall moth surveys and egg counts.
- Conduct site-specific management actions to maintain and improve conditions of extant subpopulations at the Lakeside site, including restoring habitat, addressing succession, managing invasive species, and managing water levels.
- Conduct habitat restoration to increase the size of suitable habitats that provide food source and host plants and address succession and invasive species at the Lakeside sites in coordination with NYSDEC and The Nature Conservancy in New York.
- Continue developing research plans with academic institutions (i.e., State University of New York, College of Environmental Science and Forestry) (ESF) and others to investigate the cause of extirpation at the Oswego Inland site; assess impacts from pesticides, flooding, and parasitoids; the effects of egg and larvae parasitism on population dynamics; pupation habitat; immigration to and emigrations from population sites; and long-term populations dynamics.
- Develop a long-term monitoring plan to survey all sites to assess progress toward recovery over time.
- Initiate captive management with academic institutions (ESF) to determine how best to raise sufficient numbers of bog buck moth, augment extant sites, reintroduce bog buck moth to extirpated sites in Oswego County, and possibly introduce bog buck moth to other suitable sites in New York.
- Determine population viability parameters for bog buck moth populations.

Canada

- Coordinate with the Ontario Ministry of Natural Resources regarding the status of the sites and recovery efforts.
- Enhance protection at extant sites, buffer areas around sites, and investigate potential new sites with suitable habitat in Canada.
- Conduct management actions to maintain and improve conditions of extant subpopulations at the White Lake and Richmond Fen sites.
- Work with landowners on protection measures, initiate or reinitiate population surveys, work on recovery actions, and identify research needs for the White Lake and Richmond Fen sites.
- Develop a long-term monitoring plan to survey all sites and assess progress toward recovery over time.

Preliminary Steps for Recovery Planning

The New York Field Office will lead the recovery effort in New York and coordinate recovery efforts with the OMNRF and others for the Ontario populations. We will prepare a single species recovery plan for the bog buck moth that is informed by the best available science (i.e., Species Status Assessment, scientific literature, site surveys, and habitat assessments). The recovery plan will include objective and measurable criteria that, when met, will ensure the conservation of the species. During the recovery planning process, we will seek input and review from stakeholders in New York and Ontario, as well as other species experts, as appropriate. Stakeholder groups include state and Federal agencies, research institutions, and conservation organizations. The draft recovery plan should be completed by September 24, 2024, and the final Recovery Plan should be completed by September 25, 2025. These timeframes may be affected by available resources and regional priorities.

Approved: KYLA HASTIE Digitally signed by KYLA HASTIE Date: 2023.05.03 01:26:39 -04'00'

Kyla Hastie
Acting Regional Director
Northeast Region

Literature Cited

Bonanno, S.E., and E.L. White. 2011. Draft: Bog buckmoth (*Hemileuca sp. 1*) recovery plan for New York State. New York Natural Heritage Program, Albany, NY.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. COSEWIC assessment and status report on the Bogbean Buckmoth *Hemileuca sp.* In Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 29 pp.

Cryan, J.F., and R. Dirig. 1977. The Moths of Autumn. Pine Bush Historic Preservation Project, Inc., Albany, NY.

Cryan, J.F., and R. Dirig. 2020. Moths of the Past: Eastern North American buck moths (*Hemileuca*, Saturniidae), with notes on their origin, evolution, and biogeography. Pine Bush Historic Preservation Project Occasional Publication No. 2. 44 pp.

Dupuis, J.R., S.M. Geib, C. Schmidt, and D. Rubinoff. 2020. Genomic-wide sequencing reveals remarkable connection between widely disjunct populations of the internationally threatened bog buck moth. Insect Conservation and Diversity 13:495-500. Website accessed March 31, 2023: https://doi.org/10.1111/icad.12432

Environment Canada. 2015. Recovery Strategy for the Bogbean Buckmoth (Hemileuca sp.) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. 20 pp. + Annexes.

Foden, W.B., B.E. Young, H.R. Akcakaya, R.A. Garcia, A.A. Hoffmann, B.A. Stein, C.D. Thomas, C.J. Wheatley, D. Bickfod, J.A. Carr, D.G. Hole, T. G. Martin, M. Pacifici, J.W. Pearce-Higgins, P.J. Platts, P.Cisconti, J.E.M. Watson, and B. Huntley. 2018. Climate change vulnerability assessment of species. WIREs Climate Change 10(e551):1-36. *https://doi.org/10.1002/wcc.551*

Gradish, A. and M. Tonge. 2011. Recovery Strategy for the Bogbean Buckmoth (*Hemileuca* sp.) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 19 pp.

Ministry of the Environment, Conservation and Parks. 2020. Bogbean Buckmoth Five-year review of progress towards the protection and recovery of Ontario's species at risk. 2017. Website accessed March 31, 2023: *https://www.ontario.ca/document/five-year-review-progress-towards-protection-and-recovery-ontarios-species-risk-2017/bogbean-buckmoth#section-8. Updated August 18, 2020.*

New York State Department of Environmental Conservation (NYSDEC). 2005. A Strategy for Conserving New York's Fish and Wildlife Resources Appendix A5: Comprehensive Wildlife Conservation Strategy Species Group Reports for Insects.

New York State Department of Environmental Conservation (NYSDEC). 2015 New York Wildlife Action Plan. Website accessed March 31, 2023: *https://www.dec.ny.gov/animals/7179.html*

New York State Department of Environmental Conservation (NYSDEC). Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits 6 NYCRR Part 182. Website accessed: March 31, 2023: *https://govt.westlaw.com/nycrr/Browse/Home/NewYork/NewYorkCodesRulesandRegulations?guid=Ia8d30760b5a011dda0a4e17826ebc834&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default).*

New York State Department of Environmental Conservation (NYSDEC) Department of Fish, Wildlife and Marine Resources, Article 24 Freshwater Wetlands, Title 23 of Article 71 of the Environmental Conservation Law. Website accessed April 13.2023: *https://www.dec.ny.gov/docs/wildlife_pdf/wetart24a.pdf*

Ontario Ministry of Natural Resources and Forestry (OMNRF). 2022. Bogbean buckmoth government response statement. Website accessed March 28, 2023: *https://www.ontario.ca/page/bogbean-buckmoth-government-response-statement#section-1.*

Tuskes, P.M., J.P. Tuttle, and M.M. Collins. 1996. The Wild Silk Moths of North America. Cornell University Press, Ithaca, NY. 250 pp.

U.S. Army Corps of Engineers 2017. Final 2017 Nationwide Permit Regional Conditions and Designated Critical Resource Waters in the Buffalo (LRB) and New York (NAN) Districts for New York State. Website accessed: 4.13.2023: *https://www.nan.usace.army.mil/Portals/45/docs/regulatory/NWP/LRB-NAN_Final_2017_RCs_NY.pdf?ver=2017-03-22-110955-210*

U.S. Fish and Wildlife Service (Service). Biological Review of the Bog Buckmoth **(**Saturniidae**:** *Hemileuca nevadensis***)**. Sime, K. 2017.

U.S. Fish and Wildlife Service (Service). 2021. Species status assessment report for the bog buck moth (*Hemileuca maia menyanthevora)(= H. iroquois*). Version 1.1. New York Field Office, U.S. Fish and Wildlife Service, Cortland New York. February 2021. Cortland, NY. 94 pp + Appendices.

U.S. Fish and Wildlife Service (Service). 2023. Federal Register Notice (FR 88 FR 15921. Website accessed: March 31, 2023: *https://www.federalregister.gov/documents/2023/03/15/2023-05012/endangered-and-threatened-wildlife-and-plants-endangered-species-status-for-bog-buck-moth Accessed March 31, 2023.*