COMMONWEALTH of VIRGINIA

A Survey of the Macro-moths (Lepidoptera) of the Bull Run Mountains Natural Area Preserve, Virginia

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A SURVEY OF THE MACRO-MOTHS (LEPIDOPTERA) OF THE BULL RUN MOUNTAINS NATURAL AREA PRESERVE, VIRGINIA

Final Report

Project Period: April 2005 to September 2007

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ABSTRACT

Four sites at Bull Run Mountains Natural Area Preserve were regularly sampled for macro-moths during the spring and summer months of 2005, 2006, and 2007. A total of 3,798 specimens representing 394 species in 13 families are documented thus far. No species are state or federally listed as threatened or endangered. Five species are included on the Virginia list of rare, threatened, and endangered animals. One species of notodontid is a probable new state record. A list of all identified macro-moth species is presented, along with a discussion of possible impacts of gypsy moth suppression efforts on the macro-moth fauna of Bull Run Mountains Natural Area Preserve.

INTRODUCTION

The moth fauna of Virginia consists of more than 2400 species, of which approximately 1200 are macro-moths. The term "macro-moth" is an informal designation of species in thirteen families of the order Lepidoptera, including: Arctiidae, Bombycidae, Drepaniidae, Geometridae, Lasiocampidae, Lymantriidae, Mimallonidae, Noctuidae, Nolidae, Notodontidae, Saturniidae, Sphingidae, and Uraniidae.

During the past two decades, the staff of the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH) have mounted an intensive state-wide inventory to document the entire macro-moth fauna of Virginia. Distributional and seasonal data gathered from both literature and specimen records are analyzed to identify rare, threatened, and endangered species and determine the conservation needs. As a result, DCR-DNH has built an extensive reference collection and detailed data base. Complimenting these ongoing inventory efforts are additional surveys of macro-moths, all of which were undertaken within the last ten years (see Ludwig, 2000, 2001, 2002; Steury et al., 2007; Evans, submitted)

For three consecutive seasons (April 2005 through September 2007) the zoology inventory staff at DCR-DNH conducted fieldwork in the Bull Run Mountains. They provided equipment, supplies, and expertise to the Bull Run Mountains Conservancy (BRMC) to assist their efforts to conduct a survey of macro-moths within the Bull Run Mountains Natural Area Preserve (BRMNAP).

Purpose of study
Moths were surveyed in the BRMNAP in order to:

- obtain a species list of the macro-moth fauna
- detect the presence of rare species
- provide information on non-target species impacted by gypsy moth control efforts

Study area
The following brief narrative is a distillation of Fleming's (2002) excellent description of the physiography and hydrology of the Bull Run Mountains. For a historical perspective of the region, the reader is directed to the informative works of Allard and Leonard (1943, 1944a, 1944b, 1952) for detailed descriptions of the Bull Run Mountains in the 1930's and 1940's.

The Bull Run Mountains are located about 35 miles (56 kilometers) west of Washington, DC on the Inner Piedmont of northern Virginia and straddle Fauquier, Prince William, and Loudoun counties. They consist of a complex of distinct ridges separated by narrow valleys that extend 15 miles (24 kilometers) southward from Aldie in Loudoun County to New Baltimore in Fauquier County. The complex ranges vary in width from 0.9 to 2.2 miles (1.5 to 3.5 kilometers). The ridges are interrupted by three major gaps. From north to south these are Cold Spring Gap, located at the headwaters of Bull Run; Hopewell Gap, cut by the headwaters of Little Bull Run; and Thoroughfare Gap, which is traversed by Bull Run and bisected by Interstate 66. All of the waters flowing out of the Bull Run Mountains, including the abundant seepages and spring-fed brooks originating in its interior valleys ultimately drain into the Potomac River via Goose Creek and the Occoquan River.

The northern (Aldie to Hopewell Gap) and southern (New Baltimore to Thoroughfare Gap) sections of the Bull Run Mountains are both comprised of low knobs and short ridges. It is the central portion of the complex, located between Hopewell and Thoroughfare Gaps, where the Bull Run Mountains reach their maximum width. The highest elevations are encountered along the ridges between Cold Spring and Thoroughfare Gaps, ranging from 1,200 to 1,369 feet (366-417 meters) above sea level.

Based on data collected at nearby Manassas 13 miles (21 kilometers) SE of the Bull Run Mountains from 1950 to 1985, the average minimum temperature is 44.0°F (6.7°C), while the mean maximum temperature is 67.2°F (19.6°C). The coldest month (January) had a mean minimum temperature of 24.1°F (-4.4°C),

while the warmest month (July) had a mean maximum temperature of 88.3°F (31.3°C). The highest amounts of precipitation fell as rain between the months of May and August and averaged 35.59 inches (904 millimeters) annually. It must be noted that the study years 2005-2007 were drought years and that climatological data for this time period is not currently available.

Since the American chestnut (Castanea dentata) succumbed to the introduced fungal blight (Cryphonectria parasitica) in the early twentieth century, the natural vegetation of the region is now broadly characterized as a mixed oak forest (Quercus spp.), with various species of pine (Pinus spp.) on the dry ridges and in mixed mesophytic forests located in coves, ravines, and along stream bottoms (Fleming, 2002). Today, exotic diseases and pests continue to threaten the trees of the region, including dogwood anthracnose (Discula destructiva), hemlock woolly adelgid (Adelges tsugae), and the gypsy moth (Lymantria dispar) (Fleming, 2002).

Collecting sites

Light trapping sites located in two counties were selected primarily to sample moth populations in areas known to be infested with gypsy moths and subject to the gypsy moth suppression program in BRMNAP (fide M. Kieffer). Both Fauquier and Prince William counties are located within the gypsy moth quarantine area and the ridges within the BRMNAP are regularly defoliated.

The trapping station sites include:

Fauquier County:

High Point (N38.85172 W077.71530; table mountain pine-oak-heath woodland)

midslope, plot 979 (N38.86032 W077.70956; basic oak-hickory forest)

Prince William County:

1.52km SW Antioch/Thunder Oaks, Old Cabin site, plot 965 (N38.84873 W077.69944; pine-oak-heath woodland)

300m N Mountain House (N38.82682 W077.70687; chestnut-oak forest)

MATERIALS AND METHODS

The primary method used to attract and capture moths was a BioQuip® Universal black light trap. Each of the four traps consisted of a 3.5 gallon propylene bucket, aluminum funnel and lid, 12-watt "U-shaped" BL blacklight tube, and powered by a 12-volt sealed wheelchair battery. With the aid of photoswitches, traps came on at dusk and switched off at dawn.

To sample as many different species of moths as possible, each trap was operated twice a month (April through November 2005-2006, April-September 2007) for a total of 84 trap nights.

All captured moths were either field-pinned by BRMC staff and volunteers, or brought back to the DCR-DNH Zoology Lab for sorting, preparation, and identification. Authoritative identifications were provided by DCR-DNH staff with the aid of the agency's extensive synoptic collection of Virginia moths and reference library that includes the works of Covell (2005), Ferguson (1971, 1972, 1985), Franclemont (1973), and Hodges, (1971).

To date, 3,798 moths from the inventory have been identified and entered into the DCR-DNH Virginia Moth Data Base. A synoptic set of moth species collected was assembled and sent to the BRMC, while the vast majority of prepared and identified specimens will be deposited in the Virginia Museum of Natural History (Martinsville, VA), the National Museum of Natural History, Smithsonian Institution (Washington, DC), and other institutions. Large numbers of duplicates for the most common species were discarded. A small amount of material still awaits identification.

RESULTS AND DISCUSSION

Summary of the macro-moth inventory of the BRMNAP. Three hundred ninety-four species in 13 families have been identified from 3,798 specimens thus far. The number of species sampled per family is as follows: Arctiidae (28), Bombycidae (2), Drepaniidae (4), Geometridae (84), Lasiocampidae (85), Lymantriidae (9), Mimallonidae (1), Noctuidae (198), Nolidae (4), Notodontidae (29), Saturniidae (9), Sphingidae (10), and Uraniidae (1) (see Appendix, Table 1 for a list of species).

None of the moth species sampled during the inventory are considered by state or federal authorities as threatened or endangered (see Roble, 2006). However, five species appear on the list of watchlisted moths (Roble, 2006), including the geometrids Caripeta angustiorata Wlk. and Euchlaena marginaria (Minot) and the noctuids Acronicta haesitata (Grote), A. spinigera Gn., and Eutelia pulcherimma (Grote). The elegant prominent [Odontosia elegans (Strecker)], a notodontid, is a probable new state record.

It is likely that further intensive survey efforts will reveal more species and several years will be required to develop a "complete" list for the region. However, the number of additional species is likely to decline in relation to sustained or increased effort.

Impacts of gypsy moth suppression at BRMNAP. The European gypsy moth, Lymantria dispar, is one of the most destructive insect pests ever to gain a foothold on the North American continent. It was introduced into Medford, Massachusetts in 1868 or 1869 by an amateur entomologist as a possible source of silk (Liebhold et al., 1992).

Dispersal of this species is relatively slow because the females are flightless. Still, new populations are frequently introduced into new areas as a result of inadvertent movement of egg masses attached to vehicles, lawn furniture, etc. (Talerico, 1981). However, the primary means of dispersal is by the passive movement of first instar larvae carried on the wind (Mason & Mc Manus, 1981).

Although gypsy moth caterpillars are usually associated with oaks (Quercus spp.), they are highly polyphagous and will eat the leaves of a broad range of deciduous hardwoods. Localized population outbreaks are common and the resultant defoliation can have substantial environmental and economic impacts.

Liebhold & McManus (1999, fide Rieske & Buss, 2001) note that there are three basic methods of gypsy moth control:

- No control, a "hands-off" approach that allows defoliation by the gypsy moth caterpillars to run its course
- Application of diflubenzuron (Dimlin®)
- Application of Btk (Bacillus thuringiensis var. kurstaki)

No control. Not applying any controls to suppress gypsy moth larvae carries the risk of habitat instability due to an increase in temperature and a drop in humidity as a result of loss of vegetation, as well as increased erosion. Reduced biodiversity due to displacement of arthropods as a direct result of competition with gypsy moths can also produce changes in the composition of primary producers and grazers affecting bottom-up structuring in forest arthropod communities (see citations in Rieske & Buss, 2001).

Scriber (2004) concludes that the hands-off approach may cause just as much or more harm to non-target species of Lepidoptera as Btk, reinforcing the concept that all pest management programs have some risk of negative non-target impacts. The magnitude and relative importance of these impacts remain critical deciding factors when weighing environmental impacts against pest management methods.

Application of diflubenzuron. Marketed as Dimlin®, diflubenzuron is a chitin-inhibiting insect growth regulator that disrupts the formation of cuticle of the exoskeleton during molting. It is used to control forest defoliating insects and is most effective when applied against larval insects, especially caterpillars; it is generally not lethal to adult insects (Sample et al., 1993).

Applications of Dimlin® are known to kill some insect eggs directly or through contact with gravid females. The negative effects of this material on non-target species in aquatic communities, as well as soil and canopy fauna, including parasites of gypsy moths is well-documented (see citations in Rieske & Buss, 2001). Sample et al. (1993) found little effect of treatments on beetles (Coleoptera), flies (Diptera), and wasps (Hymenoptera), but note that these results could be skewed as a result of biased sampling techniques (e.g. uv light traps). Another self-acknowledged limitation of this study was that only moths were identified to species; all other orders were identified to family only. Dimlin® is degraded by soil microbes,

but lethal residues have been detected in soils up to seven weeks after application (Sample et al., 1993).

Application of Btk. A spore-forming bacterial insect pathogen, Btk specifically attacks insects of the order Lepidoptera (butterflies, moths, skippers). It acts by disrupting the epithelial layer of the insect midgut. The long- and short-term effects of Btk on non-target organisms are not well documented. Its impact varies among affected species with some studies showing that native arthropod biodiversity actually increases in areas treated with Btk (see citations in Rieske & Buss, 2001).

The unintended consequences of applying Btk to kill gypsy moth caterpillars are of serious concern to land managers. The pathogen is usually applied shortly after tree buds crack open, thus affecting all early season caterpillars. A study of non-target species of Lepidoptera in west central Virginia, including the treatment year (one application of Btk) and two subsequent recovery years, showed only modest and mostly insignificant reductions in caterpillar populations in non-target species (Wagner et al., 1996).

The negative effects of Btk applications on microlepidopterans are mixed. Since the larvae of many species feed inside rolled up leaves or inside plant tissues, the caterpillars minimize or completely avoid contact with the lethal bacterium. In some sampled species, small declines were noted but not considered significant (Wagner et al., 1996).

The feeding habits of many macro-moth larvae leave them exposed to the residue of Btk applications. As with the microlepidopterans, declines in populations were not significant and most moths and butterflies studied and rebounded quickly after the single application (Wagner et al., 1996). The larval numbers of these species rebounded after the first recovery year with four exceptions: forest tent caterpillar moth (Malacosoma disstria), ruby quaker (Orthosia rubescens), common oak moth (Phoberia atomaris), and banded hairstreak (Satyrium calanus). Of these, both the M. disstria and S. calanus continued to exhibit reduced abundance in the second recovery year.

Wagner and Miller (1995) also reported a U.S. Forest service study on six native species of butterflies found to be highly susceptible to Btk, all of which occur or are likely to occur in the BRMNAP: eastern tiger swallowtail (Papilio glaucus), spring azure (Celastrina ladon), Diana fritillary(Speyeria diana), red-

spotted purple (Limenitis arthemis astyanax),and tawny emperor (Asterocampa clyton).

Because of the early season application of Btk, the species most likely to be negatively impacted are those that are exposed and actively feeding during the application, particularly those species that produce only a single generation annually. Because Btk is short-lived in the environment, later emerging caterpillars, such as giant silk moths (Saturniidae) are less likely to be affected. Wagner et al. (1996) suggest that gypsy moth control with Btk might even be beneficial to giant silk moth caterpillars by eliminating competition and early season leaf damage.

Sample et al. (1996) note the reduction of Lepidoptera populations due to Btk application and defoliations. They also suggest the possibility that fluctuations in insect populations before, during, and after Btk applications are due primarily to environmental conditions, such as weather.

The application of both Btk and diflubenzuron are known to negatively affect some ground-dwelling and leaf litter arthropods, even one year after application. The results are not clear due to a lack of understanding of the normally widely fluctuating populations of the taxa studied (Rieske & Buss, 2001).

Introduction of parasitoids. Another biological control agent used to combat gypsy moth caterpillars is the tachinid fly, Compsilura concinnata. This parasitoid was introduced several times in the Northeast throughout much of the last century to combat 13 species of pests, but most releases were targeted at gypsy moths. Like gypsy moth caterpillars, the larvae of giant silk moth are also suitable hosts for the tachinid fly's larvae.

The study of Boettner et al. (2000) on populations of the giant silk moths Hyalophora cecropia and Callosamia promethia in Massachusetts suggests that the reported declines of these and other saturniid moth populations in New England may be caused by C. concinnata. During this study, they discovered a population of a state-listed (threatened) saturniid Hemileuca maia maia (Dru.) for which C. concinnata was responsible for 36% of the mortality in third instar larvae.

This tachinid fly produces three to four generations every year, while gypsy moths produce only one. In the absence of gypsy moth caterpillars, C. concinnata must parasitize other insect larvae

in order to survive and is currently known to parasitize more than 200 other species of moths, beetles, and sawflies (Wagner et al., 1996).

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Anne Chazal and Steve Roble reviewed an earlier draft of this report and made numerous suggestions to improve its quality and accuracy.

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APPENDIX

Table 1. Three hundred ninety-four species of macro-moths were collected and identified from the Bull Run Mountains Natural Area Preserve during 2005-2007. Species with an '*' are not indigenous to North America; '**' indicates probable new state record.

FAMILY	SPECIES	G-RANK	S-RANK
Arctiidae	Apantesis carlotta Fgn.	G4	S5
	Apantesis nais (Dru.)	G5	S4S5
	Apantesis phalerata (Harr.)	G5	S5
	Apantesis vittata (F.)	G5	S4S5
	Cisseps fulvicollis (Hbn.)	G5	S5
	Cisthene packardii (Grt.)	G5	S5
	Cisthene plumbea Stretch	G5	S5
	Clemensia albata Pack.	G5	S5
	Crambidia pallida Pack.	G5	S5
	Crambidia uniformis Dyar		S5
	Cycnia tenera Hbn.	G5	S5
	Euchaetes egle (Dru.)	G5	S4S5
	Grammia anna (Grt.)	G5	S5
	Grammia parthenice intermedia (Stretch)	G5	S5
	Grammia virgo (L.)	G5	S5
	Halysidota tessellaris (J.E.Sm.)	G5	S5
	Haploa clymene (Brown)	G5	S5
	Holomelina aurantiaca (Hbn.)	G5	S5
	Holomelina opella (Grt.)	G5	S5
	Hypercompe scribonia (Stoll)	G5	S5
	Hyphantria cunea (Dru.)	G5	S5
	Hypoprepia fucosa Hbn.	G5	S5
	Hypoprepia miniata (Kby.)	G5	S5
	Lophocampa caryae Harris		S5
	Pyrrharctia isabella (J.E.Sm.)	G5	S5
	Spilosoma congrua Wlk.	G5	S5
	Spilosoma latipennis Stretch	G4	S3S4
	Spilosoma virginica (F.)	G5	S5
Bombycidae	Apatelodes torrefacta (J.E.Sm.)	G5	S5
	Olceclostera angelica (Grt.)	G5	S5
Drepanidae	Drepana arcuata Wlk.	G5	S5
	Euthyatira pudens (Gn.)	G5	S5
	Oreta rosea (Wlk.)	G?	S5
	Pseudothyatira cymatophoroides (Gn.)	G5	S5
Geometridae	Anavitrinelia pampinaria (Gn.)	G5	S5
	Antepione thisoaria (Gn.)	G5	S5
	Besma endropiaria (Grt.& Rob.)		S4S5
	Besma quercivoraria (Gn.)	G5	S5
	Biston betularia cognataria (Gn.)	G5	S5
	Cabera erythemaria Gn.		S3S5
	Campaea perlata (Gn.)	G5	S5

Geometridae	Caripeta angustiorata Wlk.		S1S3
	Caripeta aretaria (Wlk.)	G4	S4
	Cladara anguilineata (Grt.& Rob.)		S2S4
	Costaconvexa centrostrigaria (Woll.)	G5	S5
	Cyclophora myrtaria (Gn.)	G5	S4
	Cyclophora pendulinaria (Gn.)	G?	S5
	Digrammia continuata (Wlk.)	G5	S5
	Dyspteris abortivaria (H.-S.)	G5	S4S5
	Epimecis hortaria (F.)	G5	S5
	Eubaphe mendica (Wlk.)	G5	S5
	Euchlaena amoenaria (Gn.)	G5	S5
	Euchlaena astylusaria (Wlk.)		S3S5
	Euchlaena irraria (B. & McD.)	G?	S5
	Euchlaena marginaria (Minot)		S1S3
	Euchlaena obtusaria (Hbn.)	G4	S4
	Euchlaena pectinaria (D. & S.)	G?	S5
	Eulithis diversilineata (Hbn.)	G5	S5
	Eulithis gracilineata (Gn.)		S3S5
	Eupithecia matheri Rindge		S3S5
	Eupithecia miserulata Grt.	G5	S4S5
	Eusarca confusaria Hbn.	G5	S5
	Eutrapela clemataria (J.E.Sm.)	G5	S5
	Heliomata cycladata Grt. & Rob.	G5	S5
	Heterophleps triguttaria H.-S.	G5	S5
	Hethemia pistasciaria (Gn.)		S4S5
	Hypagyrtis esther (Barnes)	G5	S5
	Hypagyrtis unipunctata (Haw.)	G5	S5
	Hypomecis gnopharia (Gn.)		S4S5
	Hypomecis umbrosaria (Hbn.)	G5	S5
	Idaea obfusaria (Wlk.)	G4G5	S5
	Iridopsis defectaria (Gn.)	G4	S4
	Iridopsis humaria (Gn.)		S4S5
	Iridopsis larvaria (Gn.)	G5	S5
	Itame pustularia (Gn.)	G5	S5
	Lambdina athasaria (Wlk.) complex		S5
	Lambdina fiscellaria (Gn.) complex	G5	S2S5
	Lambdina pellucidaria (Grt.& Rob.)		S5
	Lomographa semiclarata (Wlk.)	G5	S3S5
	Lomographa vestaliata (Gn.)	G5	S4S5
	Lytrosis sinuosa Rindge	G4	S4
	Lytrosis unitaria (H.-S.)	G5	S5
	Macaria aemulataria Wlk.		S5
	Macaria granitata (Gn.)	G4	S4
	Macaria promiscuata (Fgn.)	G4	S4
	Melanolophia canadaria (Gn.)	G?	S5
	Metarranthis amyrisaria (Wlk.)	G4	S4
	Metarranthis angularia B.& McD. complex	G?	S5
	Metarranthis homuraria (Grt.& Rob.)	G?	S5
	Metarranthis hypochraria (H.-S.)		S5
	Metarranthis obfirmaria (Hbn.)		S5

Geometridae	Nematocampa resistaria (H.-S.)		S5
	Nemoria bistriaria bistriaria Hbn.	G5	S5
	Nemoria lixaria (Gn.)	G5	S5
	Nemoria mimosaria (Gn.)		S2S4
	Nemoria rubrifrontaria (Pack.)		S5
	Nepytia sp. near pellucidaria (Pack.)	G4	S4
	Patalene olyzonaria puber (Grt.& Rob.)		S5
	Pero ancetaria (Hbn.)	G?	S5
	Pero morrisonaria (Hy. Edw.)	G5	S4S5
	Phaeoura quernaria (J.E.Sm.)	G?	S5
	Plagodis alcoolaria (Gn.)	G5	S5
	Plagodis fervidaria (H.-S.)	G5	S5
	Plagodis phlogosaria (Gn.)	G?	S4S5
	Probole alienaria H.-S.	G?	S5
	Probole amicaria (H.-S.)	G5	S5
	Probole nepiasaria (Wlk.)		S2S4
	Prochoerodes lineola (Goeze)	G5	S5
	Protoboarmia porcelaria (Gn.)		S5
	Rheumaptera prunivorata (Fgn.)	G5	S5
	Scopula limboundata (Haw.)	G5	S5
	Selenia kentaria (Grt. & Rob.)	G?	S5
	Synchlora aerata (F.)		S4S5
	Tetracis cachexiata Gn.	G5	S5
	Tetracis crocallata Gn.	G5	S5
	Thysanopyga intractata (Wlk.)	G5	S5
	Xanthotype sospeta (Drury)		S4S5
	Xanthotype urticaria Swett	G5	S4S5
Lasiocampidae	Artace cribraria (Ljungh)	G5	S5
	Malacosoma americanum (F.)	G5	S5
	Malacosoma disstria Hbn.	G5	S5
	Phyllodesma americana (Harr.)	G5	S3S4
	Tolype velleda (Stoll)	G5	S5
Lymantriidae	Dasychira basiflava (Pack.)	G5	S5
	Dasychira dorsipennata (B.& McD.)		S2S4
	Dasychira manto (Stkr.)	G5	S5
	Dasychira meridionalis (B.& McD.)	G4G5	S2S5
	Dasychira obliquata (Grt.& Rob.)	G4	S5
	Dasychira tephra Hbn.	G5	S5
	Lymantria dispar (L.)	G5	SE
	Orgyia definita Pack.	G5	S5
	Orgyia leucostigma (J.E.Sm.)	G5	S5
Mimallonidae	Lacosoma chiridota Grt.	G5	S5
Noctuidae	Abagrotis alternata (Grt.)	G5	S5
	Acontia aprica (Hbn.)	G4G5	S2S4
	Acronicta afflicta Grt.	G5	S5
	Acronicta americana (Harr.)	G5	S5
	Acronicta clarescens Gn.	G5	S2S4
	Acronicta funeralis (Grt.& Rob.)	G4G5	S4
	Acronicta haesitata (Grt.)	G5	S1S4
	Acronicta hamamelis Gn.	G4?	S3

Noctuidae	Acronicta hasta Gn.	G5	S5
	Acronicta impleta Wlk.	G5	S5
	Acronicta inclara Sm. complex	G5	S5
	Acronicta interrupta Gn.	G5	S5
	Acronicta laetifica Sm.	G5	S5
	Acronicta lithospila Grt.	G5	S5
	Acronicta modica Wlk.	G4	S5
	Acronicta morula Grt.& Rob.	G5	S4S5
	Acronicta ovata Grt.	G5	S5
	Acronicta radcliffei (Harv.)	G5	S2S4
	Acronicta spinigera Gn.	G4	S1S3
	Acronicta tritona (Hbn.)	G5	S3S5
	Acronicta vinnula (Grt.)	G5	S5
	Agriopodes fallax (H.-S.)	G5	S5
	Agrochola bicolorago (Gn.)	G5	S5
	Agrotis ipsilon (Hufn.)	G5	S5
	Allagrapha aerea (Hbn.)	G5	S5
	Allotria elonympha (Hbn.)	G5	S5
	Amolita fessa Grt.	G5	S5
	Amphipoea velata (Wlk.)	G5	S5
	Amphipyra pyramidoides Gn.	G5	S5
	Anagrapha falcifera (Kby.)	G5	S5
	Anathix ralla (Grt.& Rob.)	G5	S5
	Anicla illapsa (Wlk.)	G5	S5
	Anicla infecta (Ochs.)	G5	S5
	Archanara oblonga (Grt.)	G5	S3S4
	Arugisa latiorella (Wlk.)	G5	S5
	Autographa precationis (Gn.)	G5	S5
	Azenia obtusa (H.-S.)	G4G5	S5
	Basilodes pepita Gn.	G4	S5
	Bleptina caradrinalis Gn.	G5	S5
	Caenurgina crassiuscula (Haw.)	G5	S5
	Caenurgina erechtea (Cram.)	G5	S5
	Callopistria cordata (Ljungh)	G5	S4S5
	Catocala amica (Hbn.)	G5	S5
	Catocala andromedae Gn.	G5	S5
	Catocala coccinata Grt.	G5	S5
	Catocala connubialis Gn.	G5	S4
	Catocala dejecta Stkr.	G4	S2S4
	Catocala epione (Dru.)	G5	S5
	Catocala flebilis Grt.	G5	S5
	Catocala gracilis Edw.	G5	S4S5
	Catocala ilia (Cram.)	G5	S5
	Catocala lacrymosa Gn.	G5	S5
	Catocala nebulosa Edw.	G5	S2S5
	Catocala palaeogama Gn.	G5	S5
	Catocala piatrix Grt.	G5	S5
	Catocala retecta Grt.	G5	S5
	Catocala ultronia (Hbn.)	G5	S5
	Catocala vidua (J.E.Sm.)	G5	S5

Noctuidae	Cerastis tenebrifera (Wlk.)	G?	S4S5
	Cerma cerintha (Tr.)	G?	S5
	Chaetaglaea sericea (Morr.)	G5	S4S5
	Charadra deridens (Gn.)	G5	S5
	Chrysanympha formosa (Grt.)	G5	S5
	Chytolita morbidalis (Gn.)	G5	S5
	Chytonix palliatricula (Gn.)	G?	S5
	Colocasia flavicornis (Sm.)	G5	S5
	Colocasia propinquilinea (Grt.)	G5	S4S5
	Condica mobilis (Wlk.)		SA
	Copivaleria grotei (Morr.)	G5	S4S5
	Cosmia calami (Harv.)	G?	S5
	Crocigrapha normani (Grt.)		S5
	Egira alternans (Wlk.)	G5	S4S5
	Elaphria alapallida Pogue & Sullivan		S5
	Elaphria georgei (Moore & Rob.)	G4	S2S4
	Elaphria grata Hbn.	G5	S5
	Elaphria versicolor (Grt.)	G?	S5
	Eudryas grata (F.)	G5	S5
	Euparthenos nubilis (Hbn.)	G5	S5
	Euplexia benesimilis McD.	G?	S5
	Eupsilia morrisoni (Grt.)		S2S5
	Eupsilia sp. near cirripalea Franc.		S4S5
	Eutelia pulcherrima (Grt.)	G5	S1S4
	Faronta diffusa (Wlk.)	G5	SA?
	Feltia herilis (Grt.)	G5	S5
	Feltia subgothica (Haw.)	G5	S2S5
	Galgula partita Gn.	G?	S5
	Helicoverpa zea (Boddie)	G5	S5
	Homohadena infixa (Wlk.)	G4	S4S5
	Homophoberia apicosa (Haw.)	G5	S5
	Homorthodes furfurata (Grt.)	G5	S3S5
	Homorthodes lindseyi (Benj.)		S5
	Hypena abalienalis Wlk.		S4S5
	Hypena baltimoralis Gn.	G5	S5
	Hypena bijugalis Wlk.		S4S5
	Hypena madefactalis Gn.		S4S5
	Hypena manalis Wlk.	G5	S5
	Hypena palparia (Wlk.)	G5	S5
	Hypena scabra (F.)	G5	S5
	Hypena sordidula Grt.	G4?	S2S4
	Hypsoropha hormos Hbn.	G5	S5
	Idia aemula Hbn.	G5	S5
	Idia americalis (Gn.)	G5	S5
	Idia lubricalis (Gey.)	G5	S5
	Lacinipolia anguina (Grt.)	G5	S5
	Lacinipolia implicata McD.	G4G5	S5
	Lacinipolia laudabilis (Gn.)	G5	S4S5
	Lacinipolia renigera (Steph.)	G5	S5
	Lacinipolia teligera (Morr.)		S5

Noctuidae	Lascoria ambigualis Wlk.	G5	S5
	Lesmone detrahens (Wlk.)	G5	S5
	Leucania linda Franc.	G?	S5
	Leucania pseudargyria Gn.	G5	S4S5
	Leucania scirpicola Gn.	G5	SA?
	Leucania ursula (Fbs.)	G5	S5
	Lithacodia muscosula (Gn.)	G5	S5
	Lithophane antennata (Wlk.)	G5	S4S5
	Macrochilo hypocritalis Fgn.	G4	S3S4
	Marathyssa basalis Wlk.	G5	S5
	Metaxaglaea semitaria Franc.	G5	S2S5
	Metaxaglea inulta (Grt.)		S4S5
	Mocis texana (Morr.)	G5	S5
	Morrisonia confusa (Hbn.)	G5	S5
	Morrisonia evicta (Grt.)	G5	S4S5
	Morrisonia latex (Gn.)	G5	S5
	Mythimna unipuncta (Haw.)	G5	S5
	Nedra ramosula (Gn.)	G5	S5
	Nephelodes minians Gn.	G5	S5
	Nigetia formosalis Wlk.	G4	S5
	*Noctua pronuba (L.)		SE
	Ochropleura implecta Laf.	G5	S5
	Ogdoconta cinereola (Gn.)	G5	S5
	Oligia modica (Gn.)	G5	S4S5
	Orthodes cynica Gn.	G5	S5
	Orthodes majuscula H.-S.	G5	S5
	Orthosia garmani (Grt.)		S4S5
	Orthosia rubescens (Wlk.)	G5	S5
	Paectes oculatrix (Gn.)	G5	S5
	Palthis angulalis (Hbn.)	G5	S5
	Pangrapta decoralis Hbn.	G5	S5
	Panopoda carneicosta Gn.	G5	S5
	Panopoda rufimargo (Hbn.)	G5	S5
	Panthea sp. near furcilla (Pack.)	G5	S4
	Papaipema arctivorens Hamp.	G5	S3S5
	Papaipema baptisiae (Bird)	G4G5	S5
	Papaipema inquaesita (Grt.& Rob.)	G5	S3S5
	Parallelia bistriaris Hbn.	G5	S5
	Peridroma saucia (Hbn.)	G5	S5
	Perigea xanthioides Gn.	G5	S5
	Phalaenophana pyramusalis (Wlk.)	G5	S5
	Phalaenostola larentioides Grt.	G5	S5
	Phlogophora periculosa Gn.	G5	S5
	Phosphila miselioides (Gn.)	G5	S5
	Phyprosopus callitrichoides Grt.	G5	S5
	Polia detracta (Wlk.)	G5	S5
	Polygrammate hebraeicum Hbn.	G5	S5
	Protolampra brunneicollis (Grt.)	G5	S5
	Psaphida resumens Wlk.		S4S5
	Pseudeustrotia carneola (Gn.)	G5	S5

Noctuidae	Pseudohermonassa bicarnea (Gn.)	G5	S5
	Pseudoplusia includens (Wlk.)	G?	S5
	Pseudorthodes vecors (Gn.)	G5	S5
	Renia discoloralis Gn.	G5	S5
	Renia factiosalis (Wlk.)		S4S5
	Rivula propinqualis Gn.	G5	S5
	Schinia rivulosa (Gn.)		S4S5
	Schinia trifascia Hbn.		S4S5
	Scolecocampa liburna (Gey.)	G5	S5
	Spargaloma sexpunctata Grt.	G5	S4S5
	Spiloloma lunilinea Grt.	G4	S4S5
	Spodoptera ornithogalli (Gn.)	G5	S5
	Spragueia leo (Gn.)	G5	S5
	Tarachidia candefacta (Hbn.)	G5	S4S5
	Tetanolita floridana (Sm.)		S5
	Tetanolita mynesalis (Wlk.)		S5
	Thioptera nigrofimbria (Gn.)	G5	S5
	Ulolonche culea (Gn.)	G5	S5
	Xestia dilucida (Morr.)		S5
	Xestia dolosa Franc.	G5	S5
	Xestia elimata (Gn.)	G5	S5
	Xestia normaniana (Grt.)	G5	S5
	Xylotype capax (Grt.)	G4	S3S4
	Zale aeruginosa (Gn.)		S5
	Zale bethunei (Gn.)		S4S5
	Zale duplicata (Bethune)		S2S4
	Zale galbanata (Morr.)	G5	S5
	Zale helata (Sm.)		S4S5
	Zale horrida Hbn.		S5
	Zale lunata (Dru.)	G5	S5
	Zale metata (Sm.)	G5	S4S5
	Zale metatoides McD.	G5	S4S5
	Zale minerea (Gn.)	G5	S5
	Zale obliqua (Gn.)	G5	S5
	Zale squamularis (Dru.)	G4	S3S5
	Zale undularis (Dru.)	G5	S4S5
	Zale unilineata (Grt.)		S5
	Zanclognatha cruralis (Gn.)	G5	S5
	Zanclognatha jacchusalis (Wlk.)		S3S5
	Zanclognatha obscuripennis (Grt.)		S5
Nolidae	Baileya australis (Grt.)	G5	S5
	Baileya dormitans (Gn.)	G5	S5
	Baileya levitans (Sm.)	G5	S3S5
	Baileya ophthalmica (Gn.)	G5	S5
Notodontidae	Clostera albosigma Fitch	G5	S4S5
	Clostera inclusa (Hbn.)	G5	S4S5
	Datana angusii Grt.& Rob.	G5	S5
	Datana contracta Wlk.	G5	S4S5
	Datana drexelii Hy. Edw.	G5	S4S5
	Datana integerrima Grt.& Rob.	G5	S5

Notodontidae	Datana major Grt.& Rob.	G4G5	S4S5
	Datana ministra (Drury)	G5	S5
	Ellida caniplaga (Wlk.)	G5	S5
	Gluphisia septentrionis Wlk.		S5
	Heterocampa biundata Wlk.	G5	S5
	Heterocampa guttivitta (Wlk.)	G5	S5
	Heterocampa obliqua Pack.	G5	S5
	Heterocampa subrotata Harv.	G4G5	S3S5
	Heterocampa umbrata Wlk.	G5	S5
	Hyparpax aurora (J.E.Sm.)	G5	S4
	Hyperaeschra georgica (H.-S.)	G5	S5
	Lochmaeus bilineata (Pack.)	G5	S5
	Lochmaeus manteo Doubleday	G5	S5
	Nadata gibbosa (J.E.Sm.)	G5	S5
	Nerice bidentata Wlk.	G4G5	S5
	**Odontosia elegans (Strecker)	G5	
	Oligocentria lignicolor (Wlk.)	G5	S5
	Peridea angulosa (J.E.Sm.)	G5	S5
	Peridea ferruginea Pack.	G5	S5
	Schizura ipomoeae Doubleday	G5	S5
	Schizura leptinoides (Grt.)	G5	S5
	Schizura unicornis (J.E.Sm.)	G5	S5
	Symmerista albifrons (J.E.Sm.) complex	G5	S5
Saturniidae	Actias luna (L.)	G5	S5
	Anisota stigma (F.)	G5	S5
	Anisota virginiensis (Dru.)	G5	S4S5
	Antheraea polyphemus (Cram.)	G5	S5
	Automeris io (F.)	G5	S5
	Callosamia angulifera (Wlk.)	G5	S4S5
	Callosamia promethea (Dru.)	G5	S4S5
	Dryocampa rubicunda (F.)	G5	S5
	Eacles imperialis (Dru.)	G5	S5
Sphingidae	Ceratomia amyntor (Geyer)	G4G5	S3S5
	Ceratomia undulosa (Wlk.)	G5	S5
	Darapsa myron (Cram.)	G5	S5
	Darapsa pholus (Cram.)	G5	S5
	Deidamia inscripta (Harr.)	G5	S5
	Laothoe juglandis (J.E.Sm.)	G5	S5
	Lapara coniferarum (J.E.Sm.)	G5	S5
	Manduca jasminearum (Guer.)	G4	S4
	Paonias excaecatus (J.E.Sm.)	G5	S5
	Paonias myops (J.E.Sm.)	G5	S5
Uraniidae	Calledapteryx dryopterata Grt.	G?	S5