Lehigh Gap Wildlife Refuge

Ecological Assessment

Natural Lands Trust

CONTINENTAL CONSERVATION

Botanical Inventory

July 2007

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Executive Summary

The 730-acre Lehigh Gap Wildlife Refuge lies mainly in East Penn Township, Carbon County, Pennsylvania between the Lehigh River and the summit of the Kittatinny Mountain (also called Blue Mountain); a 15-acre section stretches south into Washington Township, Lehigh County. As the unfortunate recipient of decades of toxic atmospheric deposition from nearby zinc smelters, the property's bare hillside is an historic landmark for local residents and a stark blemish on the green mountain to the hundreds of thousands of motorists that use the Pennsylvania Turnpike Northeast Extension each year. In 2002, the Wildlife Information Center—now the Lehigh Gap Nature Center (LGNC)—purchased the property to create a public wildlife refuge. The Natural Lands Trust of Media, Pennsylvania was hired in 2005 to complete a two-year ecological assessment of the property to inform the future stewardship and use of the site.

The property shares the geology and steep topography common to the Kittatinny Mountain, but its unusual plant communities reflect unique soil conditions as the result of heavy-metal contamination from the zinc smelters. Although the pollution killed hundreds of acres of the pre-smelter-era forest, which as a result were denuded by soil erosion and catastrophic wildfires, the property still harbors significant plant resources including several Pennsylvania species of special concern and one of the most extensive native grasslands in the state. These grasslands, along with on-site water resources, the adjacent Lehigh River, and surrounding protected lands, bolster the Refuge's role as an important resource for resident and migratory wildlife.

COMMUNITY AND ECOSYSTEM DIVERSITY

The assessment focused primarily on the plant resources within and around the Refuge. We defined a 1,100-acre plant community study area that goes beyond the land-ownership boundaries of the Refuge proper, comprising a unit that has a reasonable functional and ecological

basis. In it we identified 374 species of vascular plants, 264 (71%) native and 110 (29%) non-native, representing 222 genera in 89 families. The most diverse family is Poaceae (grasses) with 62 species. Sixteen vascular plant species are rare in Pennsylvania, including four on the state's endangered and threatened species lists and two others, Pitcher's stitchwort *(Minuartia patula)* and sea-thrift *(Armeria maritima)*, for which the Lehigh Gap area is the sole known location in the state. The

occurrences in the Refuge and in scattered locations on adjoining lands of wild bleeding-heart *(Dicentra eximia)*, classified as endangered in the state, may comprise the largest indigenous population of the species in Pennsylvania.

About 20 of the non-native species are truly invasive, showing clear signs that they have been spreading aggressively or are likely to do so if not contained. The most abundant invasive, introduced species are Japanese stiltgrass *(Microstegium vimineum)*, garlic-mustard *(Alliaria petiolata)* and alder buckthorn *(Rhamnus frangula)*, growing mainly in the floodplain and bottomlands surrounding the ponds, and butterfly-bush *(Buddleja davidii)*, rampant along the railroad rights-of-way and in meadows and scree on the lower mountain slopes. More localized problem species include tree-of-heaven *(Ailanthus altissima)*, spotted knapweed *(Centaurea stobe* ssp. *micranthus)*, Japanese knotweed *(Fallopia japonica)*, plume-poppy *(Macleaya cordata)* and common reed *(Phragmites australis* ssp. *australis)*. In the forests, woodlands and grasslands of the mid- to upper slopes and ridge top, virtually 100% of the total biomass and land cover are in native species.

We developed a hierarchical plant community classification encompassing 25 community types: 15 terrestrial (upland), one aquatic and 9 palustrine (wetland). Community types are also classified by origin of species composition, with two categories: mainly indigenous (19 types) and mainly cultural (6 types), and by predominant cover type, with various combinations of five categories: herbaceous, shrub, tree, open water and rock. Community mapping was based on interpretation of 21 October 2004 false-color infrared satellite photography and 14 April 1999 black-and-white stereo aerial photography, followed by ground-truthing throughout the 2005 and 2006 growing seasons.

The river birch–red maple floodplain forest and woodland along the Lehigh River were found to have the highest native plant species richness, 132 species. The perennial ponds, surrounding wetlands and adjoining upland fringe at the western end of the Refuge are also high in native plant diversity, with nearly 100 species. A significant finding is an intact occurrence of a rare plant community: a series of native grassland patches interspersed with woodland and forest on the ridge top and upper slopes classified as hairgrass–lowbush

blueberry savanna. Totaling around 100 acres along about 4 miles of the ridge top southwestward from the summit at Lehigh Gap, this complex comprises one of the half-dozen or so largest areas of wholly native, unplanted grassland remaining in the entire state. About 7 acres lie within the Refuge; the remainder is on adjoining State Game Land 217 (Pennsylvania Game Commission), Appalachian Trail corridor (National Park Service), and Interstate 476 corridor (Pennsylvania Turnpike Commission).

Two smaller studies on insects and lichens were conducted during the second year of the assessment. A 2006 study of insect diversity at three point-locations within the Refuge—one in a native grassland near the ridge top, one in woodland on the lower slope, and one in the wetland complex surrounding the ponds—focused on species that can be surveyed using ultraviolet light traps. Four hundred sixty-one species were described, predominantly moths but members of many other groups as well, notably beetles (Coleoptera), craneflies (Diptera: Tipulidae), dobson-flies (Megaloptera: Corydalidae) and a rare scorpionfly (Mecoptera: Meropeidae). Wetland insects were the most diverse habitat group. Five insect species recognized as rare enough to have conservation significance have been identified so far, including an apparently robust population in the ridge-top grassland of a rare oak-feeding moth. It is expected that collecting for a longer period of time, in more habitats, or using a wider variety of methods would turn up many additional species, including more insects with sparse local populations whose capture is a rare, random event.

The Lehigh Gap area is unusual in having hundreds of acres of communities where lichens make up a high proportion of total cover. Lichens in general are highly sensitive to air and soil pollution, however, so the species growing downwind of the former zinc smelters are a select group, including several known to be heavy-metal-tolerant. A 2006 survey repeated the methods and locations of a lichen study conducted 34 years earlier, 8 years before the smelters' shutdown. Species richness at Lehigh Gap increased from 5 to 56 species. The proportion of lichen species growing on the soil surface increased nearly five-fold since 1972, when nearly 90% grew on rocks. Total lichen cover on survey transects increased three-fold, a conservative indicator of recovery considering that lichens had disappeared from some transect sections because plant cover, increasing in parallel, had shaded them out.

STEWARDSHIP ISSUES AND RECOMMENDATIONS

A secondary focus of the assessment was on stewardship and how to manage the property to meet LGNC goals. The LGNC seeks to steward the Refuge in a manner that: (1) protects and enhances the important natural resources; and (2) provides a safe and enjoyable venue for public education and recreation. Through the assessment we cataloged the effects of past management and use on the Refuge and identified several major stewardship issues that currently jeopardize those goals. The residual effects of two regional rail lines and the zinc smelter pollution are the greatest issues facing the LGNC. Safety concerns include soil toxicity to visitors, hazardous structures, and unsightly and potentially toxic debris. An analysis of existing structures is needed to determine whether they are obsolete or potentially useful for future educational or recreational activities. This should be followed by a plan for securing and removing unwanted

structures and a plan to maintain and periodically replace necessary structures.

In addition to heavy metal contamination, the plant resources within the Refuge have been affected by an overabundance of white-tailed deer and the spread of exotic invasive plants. Overbrowsing by deer in winter and spring has devastated forest understory vegetation, decreasing native shrub and herbaceous species diversity, degrading vertical habitat structure for wildlife, and halting tree reproduction entirely. A deer management program should be implemented to decrease impacts on the forest ecosystem. Invasive plants should be monitored and controlled to prevent their spread into the most ecologically important areas—the ponds-wetlands complex and the ridge-top grasslands.

EDUCATIONAL AND RECREATIONAL OPPORTUNITIES

Despite these issues, there are significant research, educational and recreational opportunities at the Refuge. Recently, the LGNC has been conducting grassland reclamation on some 200 acres of slopes in the Refuge that had been denuded by the tree-killing fallout from the Palmerton zinc smelters and the resulting fires and erosion. This area and the remnant native grasslands on the ridge top are valuable as habitat for rare plant, bird and insect species. The LGNC has already established the Refuge as a regional pioneer in grassland reclamation using all-native species on challenging sites. Interest in native grassland restoration, reclamation and management is gaining momentum in Pennsylvania and the larger region. The Refuge is well equipped to expand its role as a "laboratory" and demonstration site for experimental investigations of alternative methods of native grassland conservation and species reintroduction.

Local schools and colleges have expressed much interest in using the site for class visits and research projects. The old railroad beds offer nearly six miles of stable surface in and along the edge of the Refuges, ideal for hiking and biking by people of all ages. Internal trails also connect to the national Appalachian Trail that runs along the ridge top. And the treeless hillside provides an unobstructed and unrivaled view of the annual hawk migration along the Kittatinny Mountain. The Refuge shows great potential to become a regionally important center for research, education and public recreation.

Introduction

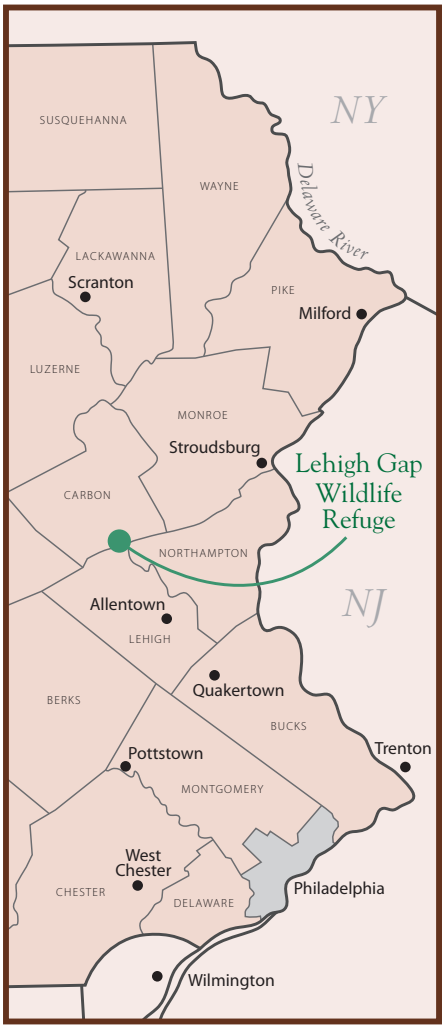
In 2002, the Wildlife Information Center (now Lehigh Gap Nature Center, or LGNC) purchased 730 acres[1] at the Lehigh Gap, part of which was severely degraded by industrial pollution. Due to the toxic levels of zinc and other heavy metals in the soil, much of the site, now called the Lehigh Gap Wildlife Refuge, was devoid of vegetation for decades. The Nature Center hopes to restore native plant communities on the site and use it as an outdoor classroom for its educational programs. It also plans to open the property for passive recreation.

In January 2005, staff of the Delaware and Lehigh National Heritage Corridor and State Heritage Park completed a master site plan for the Refuge. One of the recommendations of the plan was to conduct a baseline ecological assessment of the Refuge. This assessment will be used to guide the development of the educational and research programs and the types and levels of recreational activities that will be allowed on the site, and it will serve as a basis for an ecosystem restoration, management and monitoring program.

In October of 2004, LGNC received a grant from the Pennsylvania Department of Conservation and Natural Resources to support an ecological assessment of the Refuge. Natural Lands Trust was hired in May 2005 to complete a two-year study of the Refuge and produce a baseline ecological assessment. This was accomplished by meeting the following main objectives:

- Survey the extant plant communities, their component species (including any animal species of special concern) and current state of health.
- Catalog the current stewardship issues and provide general recommendations designed to protect and enhance native plant communities, facilitate educational opportunities and minimize impacts of proposed recreational uses.

To assist with the project, the Trust engaged Dr. Roger Latham of Continental Conservation and Claudia Steckel of Botanical Inventory to undertake a detailed survey of botanical resources within the Refuge and a larger project area. Field surveys were conducted between June and October 2005 and between March and



[1] 730 acres (295 ha) is the ground-surface area calculated from survey metes and bounds. Because much of the property is very steeply sloping mountainside, the area is foreshortened in aerial view and on maps to 670 acres (270 ha).

October 2006. At the end of the first year, the stakeholders (landowner, funder, consultants) reviewed the project results to date and discussed modifications to the original scope of work. The group decided to expand the surveys to include invertebrates, the biological resource least understood at the Refuge. Invertebrates were collected using light traps between April and November 2006 and sent to the Carnegie Museum of Natural History where they were identified by Dr. John Rawlins, Head of the Section of Invertebrate Zoology, and his associates. We also received assistance from interns of the Lehigh Earth Observatory program at Lehigh University who collected GPS data for the project.

Objectives completed during the first year of the project were:

1. Prepared plant lists by community type based on year one field surveys.
2. Developed a set of baseline maps of the Refuge and adjoining lands in GIS format.
3. Detailed stewardship issues and recommendations based on year one field surveys.
4. Highlighted potential educational and recreational opportunities.
5. Identified biological "hotspots" and key groups of organisms and organized year two surveys of them.

Objectives completed during the second year of the project were:

1. Revised plant lists by community type based on year two field surveys
2. Revised plant community map based on year two field surveys
3. Updated baseline maps based on year two field surveys
4. Conducted light-trap survey of invertebrates.

LOCATION

The Lehigh Gap Wildlife Refuge is located primarily in East Penn Township, Carbon County, between the Lehigh River and the summit of Blue (Kittatinny) Mountain; a 15-acre finger lies in Washington Township, Lehigh County and includes the Refuge's Nature Center, parking facilities, and main trailheads (see the **USGS Quadrangles** map, Fig. 1, **Landscape Context** map, Fig. 2, and **2004 Aerial Photography** map, Fig. 3). The Refuge is bordered by the Lehigh River to the north and east, the Pennsylvania Turnpike Northeast Extension (I-476) and a small-lot subdivision to the west, and National Park lands (the Appalachian Trail Corridor) and Pennsylvania State Game Land 217 to the south.

SOILS

According to the 1966 Carbon and Lehigh County Soil Surveys there are eleven soil types underlying the Lehigh Gap Wildlife Refuge (see the **Soils** map, Fig. 4). The table at right summarizes the characteristics of each soil.

TOPOGRAPHY AND SLOPES

Moderate to very steep slopes dominate the Refuge (see the **Slopes and Hydrology** map, Fig. 5). Over 480 acres (66% of the Refuge) have slopes of over 25%. The largest area with gentle slopes lies in the northwest corner of the property around the ponds. The Refuge exhibits an elevation change of almost 1,100 feet within its borders. The highest point is approximately 1,480 feet in the southwest corner; the lowest elevations are found at the entrance driveway (approximately 400 feet) in the southeast corner and the area around the ponds (approximately 420 feet).

Soils

SYMBOL	SERIES	TEXTURE	DEPTH TO SHWT	DEPTH TO BEDROCK	HYDRIC	AGRICULTURAL IMPORTANCE
DeB	Dekalb 0–8% slope	very stony loam	3'+	2'–3'	no	no
DeF	Dekalb 25–55% slope	very stony loam	3'+	2'–3'	no	no
HaB2	Hartleton 3–8% slope	silt loam	4'+	4'–8'	no	yes
HvD	Hartleton 8–25% slope	silt loam	4'+	4'–8'	no	no
Hy	Holly	silt loam	0'	4'–10'	yes	no
KvF	Klinesville 25–80% slope	very stony loam	3'+	0.5'–1.5'	no	no
LbD	Laidig 8–25% slope	very gravelly loam	2.5'–4'	2.5'–4'	no	no
LdD	Laidig 8–25% slope	very stony loam	3'+	4'–30'	no	no
LdF	Laidig 25–55% slope	rubble land	2.5'–5'	2.5'–4'	no	no
Ma	Made Land		variable	variable	no	no
VeF	Very Stony Land 25–120% slope	very stony land	>5'	0'–3.5'	no	no

HYDROLOGY

The Refuge contains a relatively small amount of surface water resources and hydric soils, primarily on the lower slopes of the mountain in the northern and eastern limits of the property (see the **Slopes and Hydrology** map, Fig. 5). Scattered along these lower slopes are seeps and springs that feed perennial and intermittent streams, which flow directly into the Lehigh River.

A pond/wetland/stream complex of approximately 5 acres occupies the northwest corner of the Refuge. It includes three spring- and seep-fed ponds connected by a small stream and five wetland plant communities; together they provide excellent habitat for birds and herptiles. Although the Lehigh River is not within the Refuge, it flows along the northern and

Seep *(upper left)*, **intermittent stream** *(upper right)*, **pond** *(lower left)*

eastern boundaries for almost three miles and enhances the Refuge's habitat for local and migratory wildlife, as well as the scenic views for human visitors.

The Lehigh River at the Refuge is classified as a trout-stocking fishery (TSF) by the Pennsylvania Department of Environmental Protection. A TSF is characterized by "maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat."

PLANT COMMUNITY STUDY AREA

We defined a study area for the plant community inventory that goes beyond the land-ownership boundaries of the Refuge proper, comprising a unit that has a reasonable functional and ecological basis (see the **Plant Communities** map, Fig. 6). In addition to the 670 acres (270 ha)[2] within the Refuge boundaries, it includes an additional 430 acres (170 ha):

- a narrow, 30-acre (12-ha) strip of land between the Refuge and the Lehigh River administered by the National Park Service as part of the D. & L. Trail system, which includes the Delaware and Lehigh Railroad right-of-way and the riverbank;
- 130 acres (53 ha) along the ridge top of Blue Mountain administered by the National Park Service as part of the Appalachian Trail system, which in this section does not include the Appalachian Trail itself but does include part of an Appalachian Trail loop (North Trail) and a spur (Devils Pulpit Trail);
- the 230 acres (93 ha) of State Game Land 217 (about 4% of S.G.L. 217's total area) that lies between the Appalachian Trail, which passes through the Game Land in this section, to the south, and the Refuge and National Park Service land to the north;
- private land parcels in two clusters, one of 21 acres (8 ha) between the east end of the Refuge and Pa. Rte. 873 and another of 21 acres (8 ha) between the west end of the Refuge and the southeast end of Riverview Road, plus a 1-acre (0.4-ha) private inholding near the west end.

The western boundary of the plant community study area is arbitrarily set at the property line between the Refuge and land of the Pennsylvania Turnpike Commission overlying the I-476 tunnel. The length of the plant community study area along the ridgeline from this point to the riverbank in Lehigh Gap is about 2.3 miles (3.7 km). The land on Blue Mountain from this point farther southwestward for another 2.3 miles (3.7 km) to Lehigh Furnace Gap, the next dip in the ridgeline and the next road crossing the mountain, has the closest functional and ecological interrelationship with the Refuge. The Pennsylvania Game Commission administers most of this land. State Game Land 217, which totals more than 6,000 acres (2,400 ha) along 14 miles (22 km) of Blue Mountain from Lehigh Gap southwest almost to the Lehigh-Berks County line, includes over 1,700 acres (690 ha) adjoining the Refuge between Lehigh Gap and Lehigh Furnace Gap (see the **Landscape Context** map, Fig. 2).

[2] 730 acres (295 ha) is the ground-surface area calculated from survey metes and bounds. Because much of the property is very steeply sloping mountainside, the area is foreshortened in aerial view and on maps to 670 acres (270 ha).

Community and Ecosystem Diversity

Good stewardship must be based on a thorough inventory of the land and its biota, and on a scientific understanding of their past, present and likely future transformations. The inventory phase of the present study focused on biotic communities and on vascular plants. Ecologists have noted for centuries that species tend to sort themselves out in a pattern of roughly repeated assemblages across the landscape. These species assemblages, called biotic communities or ecological communities, often blend into one another gradually rather than having distinct boundaries. Ecologists define a community as a group of interacting plants, animals, fungi and other organisms inhabiting a given area, and an ecosystem as a biotic community together with its abiotic environment, which includes such things as bedrock type, groundwater supply, angle of exposure to the sun, and rainfall.

Communities on land are classified by the dominant plant species (those that are largest and most abundant) because plants account for by far the greatest percentage of total ecosystem biomass and energy flow. On land, plants are responsible for most primary productivity—photosynthesis of living tissue from water, carbon dioxide and sunlight. For this reason, ecologists describe vascular plants (see definition in the next paragraph) as the dominant life form in most non-aquatic ecological communities. Shallow freshwater ponds are exceptional among aquatic ecosystems because in them, as in land-based communities, vascular plants are the dominant life form. The Lehigh River—adjacent to, but not included in, the plant community study area—is more typical of aquatic ecosystems in that algae and aquatic animals dominate biomass production and energy flow. However, even there much of the primary productivity comes originally from vascular plants growing on the river's banks and those of its tributaries, in the form of leaves and whole plants that fall into the water or are washed into the river during high flows and then serve as food for aquatic organisms. The only ecosystems within the plant community study area that are not overwhelmingly dominated by vascular plants are areas of nearly bare rock, where sparse vascular plants share dominance with lichens and mosses.

Vascular plants, also called tracheophytes, are those plants that have internal plumbing similar to an animal's circulatory system, except that there is no central pump. Sap flows through xylem and phloem "pipes"—in xylem by the negative pressure exerted by transpiration, which is the evaporation of water through stomates (tiny, adjustable valves on the surfaces of leaves and sometimes stems), and in phloem by the negative pressure exerted by the uptake of sugars and water by living plant cells. The main categories of vascular plants are lycophytes (quillworts, spikemosses and clubmosses),

ferns (including horsetails), conifers, and flowering plants. Non-vascular plants are the true mosses, liverworts and hornworts; there is disagreement among biologists on whether green algae should be classified as plants. All non-vascular plants are small because of the limitations on internal transport imposed by the lack of circulatory vessels. Other photosynthetic organisms exist besides plants and green algae, including several non-green groups of algae, lichens (symbiotic associations between fungi and algae), and photosynthetic bacteria and bacteria-like organisms.

Organisms other than vascular plants are also vital members of communities. Most vascular plants have mutualistic relationships with animals, fungi, and bacteria. The vigor, and often the very survival, of vascular plant individuals and populations depend on them. Some of the "services" performed by animals, fungi and bacteria in mutualistic association with plants include nutrient and water uptake (by mycorrhizal fungi), pollination, seed dispersal, nitrogen fixation, and defense. Animals, fungi and bacteria are essential to the decomposition process, without which ecosystems as we know them would not exist. They play key roles in soil formation and renewal. Although vascular plants are the dominant organisms in most ecosystems on land, in certain cases other life forms may be keystone species or "ecological engineers," species that exert a disproportionately powerful influence on ecosystem processes relative to their small share of total ecosystem biomass or energy flow. For instance, in areas where forest fragmentation and the lack of effective predators have allowed white-tailed deer to reach unprecedented population densities, these large herbivores have severely reduced forest understory vegetation and its ecosystem functional values, including shrub and herbaceous species diversity, tree reproduction, and vertical habitat structure for wildlife. In such places, deer, which make up an insignificant fraction of ecosystem biomass even at the highest population densities, are profoundly altering community composition, vegetation structure, and habitat for many other species.

Animals are also esthetically and scientifically important to people, often out of proportion to their influence on ecosystem function. Opportunities for the enjoyment, appreciation and study of birds, butterflies, turtles, fish, and many other kinds of wildlife are a key part of why we place such a high value on showpieces of biodiversity such as the Lehigh Gap Wildlife Refuge.

SURVEY OF THE VASCULAR FLORA

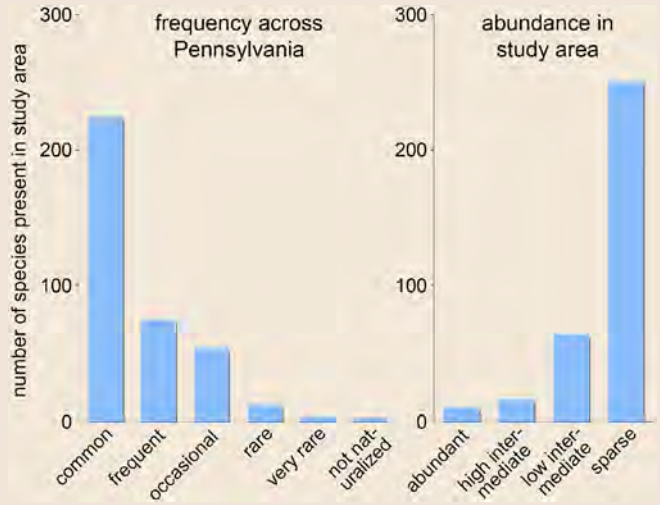
In numerous site visits across two years' growing seasons (2005–2006), we identified 374 species of vascular plants growing in the wild, in and adjacent to the plant community study area (**Appendix A**). They represent 222 genera in 89 families. The most diverse genus is *Carex* (sedges) with 19 species. Tied for second place are *Agrostis* (bentgrasses), *Eragrostis* (lovegrasses), *Galium* (bedstraws), *Quercus* (oaks), and *Rubus* (brambles) with six species each. The most diverse family is Poaceae (grasses) with 62 species, followed by Asteraceae (asters, goldenrods, hawkweeds and others) with 28, Cyperaceae (sedges, spike-rushes and bulrushes) with 26, and Rosaceae (brambles, cherries, juneberries, meadowsweet and others) with 21 (see **Appendix B**, **Table B7**). Within the grasses, 40 species have only the C_3 photosynthetic pathway (the cool-season

grasses), and 22 species also have the C_4 pathway (the warm-season grasses; see **Table B6**).

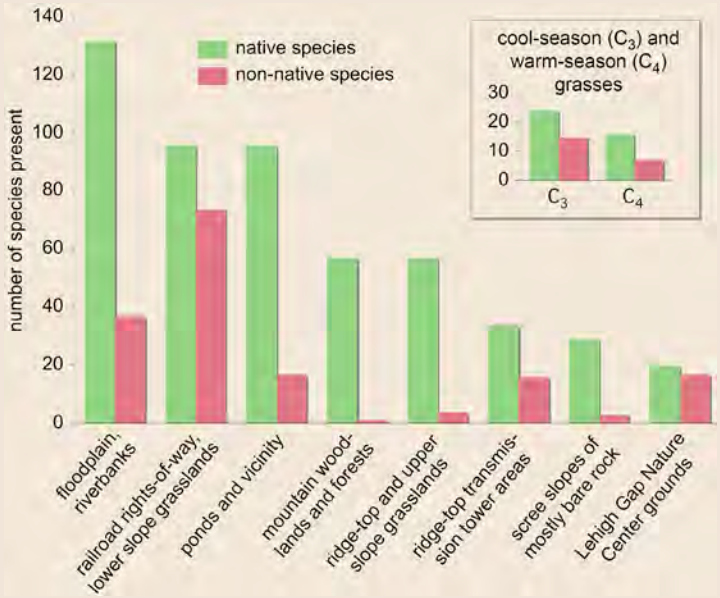
Of the 374 vascular plant species, 264 (71%) are native and 110 (29%) are non-native (see **Appendix B**, **Table B1**). The most frequent growth form (see **Table B2**) is herbaceous perennial, with 214 species (57%), followed by annual and biennial, 58 species (16%), deciduous shrub, 43 species (11%) and deciduous tree, 37 species (10%). Two hundred twenty-four species (60%) are ranked as "common" in Pennsylvania and only 16 (4%) are "rare" or "very rare" in the state (see **Table B3**). The relative abundance of species in the plant community study area shows the opposite trend; 12 species (3%) are rated as "abundant" in estimated average frequency over the entire plant community study area and 274 species (73%) are classified as "scarce" (see **Table B4**).

The 12 species classified as "abundant" in estimated average frequency across the plant community study area are red maple *(Acer rubrum)*, sweet birch *(Betula lenta)*, gray birch *(Betula populifolia)*, hay-scented fern *(Dennstaedtia punctilobula)*, common hairgrass *(Deschampsia flexuosa)*, common witchhazel *(Hamamelis virginiana)*, whorled loosestrife *(Lysimachia quadrifolia)*, Japanese stiltgrass *(Microstegium vimineum)*, black-

Proportions of the study area's vascular plant species by growth from (see Appendix B, Table B2).



The study area's vascular plant species classified by frequency across Pennsylvania (see Appendix B, Table B3) and by estimated local abundance (see Table B4).



Native and non-native plant species by location in the study area (see Appendix B, Table B9) and in two categories of grasses (see Table B6).

Wild bleeding-heart *(Dicentra eximia)*, an endangered species in the wild in Pennsylvania, is abundant in the ground layer of some red maple–mixed hardwood forest stands in ravines near the base of the mountain.

gum *(Nyssa sylvatica)*, northern red oak *(Quercus rubra)*, sassafras *(Sassafras albidum)* and lowbush blueberry *(Vaccinium angustifolium)*. Only one of these, Japanese stilt-grass, is non-native. Two other non-native species, garlic-mustard *(Alliaria petiolata)* and butterfly-bush *(Buddleja davidii)*, are classified as "fairly high" in overall average frequency.

Four species are on Pennsylvania's endangered and threatened species lists. Wild bleeding-heart *(Dicentra eximia)*, endangered in the state, lives mainly in the southern Appalachians. In the plant community study area, it occurs in mountain slope woodlands, ridge-top grasslands and along the railroad rights-of-way. The stands in the Refuge, on National Park Service land between the Refuge and the Lehigh River, and in scattered locations on adjoining lands may comprise the largest indigenous population of the species in Pennsylvania. Southern wild senna *(Senna marilandica)* endangered in the state, was spotted growing sparsely at just one location along one of the railroad rights-of-way. Eastern gamma-grass *(Tripsacum dactyloides)* endangered in Pennsylvania, occurs in the lower slope grasslands and along the railroad rights-of-way. Its occurrences in the plant community study area are probably all from planted stock and do not represent an indigenous population. Stiff sedge *(Carex tetanica*, threatened in Pennsylvania, was tentatively identified growing sparsely on the floodplain. The identification is in question because found specimens were not in peak fruiting condition. Efforts should be made to relocate plants of this species during the peak time of fruiting to confirm or refute the provisional identification. The best time-window for locating and identifying the species can be determined by noting the range of collection dates of locally collected specimens stored in the herbarium of the Academy of Natural Sciences of Philadelphia.

Pitcher's stitchwort *(Minuartia patula)* along the L.N.E. Trail; its population in and near the Refuge is the only occurrence of this species in Pennsylvania.

The Lehigh Gap area is the sole known location in Pennsylvania for two plant species. Pitcher's stitchwort or glade sandwort *(Minuartia patula)* is an annual plant of rock outcrops, barrens and meadows, living mainly in a roughly triangular range from the western Great Lakes region to Virginia, Alabama and Texas. Its populations are distributed sparsely, especially in the northern part of its range. Locally it occurs in meadows near the base of Blue Mountain next to the railroad rights-of-way, where it reaches 100% cover in some areas. Sea-thrift *(Armeria maritima)*, a showy, pink-flowered member of the leadwort family, grows profusely on unshaded, zinc-contaminated soils on the northeastern side of Lehigh Gap on the ridge top and along a railroad right-of-way curving around the base of Blue Mountain. Despite its superabundance just across the Lehigh

River, no individuals were seen during our surveys of the plant community study area. Sea-thrift is an introduced species here. The nearest indigenous populations are in northeastern Canada, but they are *Armeria maritima* ssp. *sibirica*, a different subspecies from the Lehigh Gap population. Sea-thrift was deliberately introduced in the 1980s as part of an early revegetation effort at Palmerton from seeds provided by Claude Lefèbvre, a plant systematist at the University of Brussels, who collected them from a heavy-metal-tolerant population growing on a zinc-lead mine site in Belgium (Ann F. Rhoads, personal communication). The subspecies is not any of those found in North America but is thought to be a hybrid of uncertain origin between two or more Eurasian subspecies (Lefèbvre 1974; Baumbach and Hellwig 2003).

Two common native tree species merit special mention. We repeatedly observed exceptionally prolific, vigorous flowering and fruiting of American chestnut trees *(Castanea dentata)* along the ridge top in and near the plant community study area, despite 100% infection by chestnut blight *(Cryphonectria parasitica)*, a deadly fungus introduced from Eurasia that has nearly eradicated American chestnuts of nut-producing size all across their former range. We and others have also noted the apparently unusually good health and vigor of eastern hemlock trees *(Tsuga canadensis)* in the plant community study area, despite heavy infestation by the hemlock woolly adelgid *(Adelges tsugae)*, an insect pest introduced from Eurasia and causing the widespread decline and death of hemlocks throughout the region. It is reasonable to hypothesize that the heavy metals taken up by the trees and permeating their leaves, wood and roots, despite the stress that it presumably causes the trees themselves, might give them added resistance to the normally devastating effects of the parasites. Various experimental approaches could be used to test this hypothesis for either of the two tree-parasite pairs.

Most of the 110 introduced (non-native) vascular plant species were found in low numbers, confined mainly to the most highly disturbed soils in the plant community study area, for instance, along the railroad beds or among the buildings and parking areas of the ridge-top transmission towers and the Lehigh Gap Nature Center. However, about 20 of these species are truly invasive, showing clear signs that they have been spreading aggressively or are likely to do so if not contained (see **Stewardship Issues and Recommendations**, pp. 44–46). The most abundant invasive, introduced species is Japanese stiltgrass *(Microstegium vimineum)*, whose dense ground cover excludes most native ground-layer species across much of the floodplain. The next most abundant invasive species are garlic-mustard *(Alliaria petiolata)* and alder buckthorn *(Rhamnus frangula)*, growing mainly in the floodplain and bottomlands surrounding the ponds, and butterfly-bush *(Buddleja davidii)*, rampant along the railroad rights-of-way and in meadows and scree on the lower mountain slopes. Low in abundance overall but locally invasive are tree-of-heaven *(Ailanthus altissima)*, spotted knapweed *(Centaurea stobe* ssp. *micranthus)*, Japanese knotweed *(Fallopia japonica)*, plume-poppy *(Macleaya cordata)* and common reed *(Phragmites australis* ssp. *australis)*. Plants that are still somewhat scarce in the plant community study area but considered to pose a strong risk of becoming widespread and invasive, based on their behavior elsewhere in the region, are Norway maple *(Acer platanoides)*, Japanese barberry *(Berberis thunbergii)*, oriental bittersweet *(Celastrus orbiculatus)*, Canada thistle *(Cirsium arvense)*, crown-vetch *(Coronilla varia)*, autumn-olive *(Elaeagnus umbellata)*, Amur honeysuckle

(Lonicera maackii), Morrow's honeysuckle *(Lonicera morrowii)*, Tatarian honeysuckle *(Lonicera tatarica)*, parrot's-feather *(Myriophyllum aquaticum)* and multiflora rose *(Rosa multiflora)*.

Among geographical sections of the plant community study area, those with the highest vascular plant species diversity are the floodplain and the railroad rights-of-way and adjoining lower mountain slope meadows, with 170 and 169 species respectively, 53 of which they share in common (see **Appendix B**, **Table B8**). The ponds and vicinity are next, with 113 species, 64 of which are also present on the floodplain. The third- and fourth-most diverse sections are the ridge-top and upper slope grasslands, 61 species, and the mountain woodlands and forests, 59 species.

Considering native and non-native species separately gives a different picture (see **Table B9**). In native species only, the floodplain is the most diverse section, with 132 species. The railroad rights-of-way/lower mountain slopes and the ponds and vicinity are nearly tied for second place, with 96 and 95 species, respectively. The mountain woodlands/forests and the ridge-top/upper slope grasslands are almost even in next place, with 58 and 57 species apiece. In terms of the percentage of species that are native, the mountain woodlands/forests top the list at 98%, followed by the ridge-top/upper slope grasslands at 93%. Next are scree slopes at 91%, and the ponds and vicinity at 85%. The highest number of non-native species occurs on the railroad rights-of-way/lower mountain slope meadows, 74 species, comprising 44% of the total richness in this section. The highest percentage of non-native species, 56%, belongs to an area adjoining the plant community study area that was partially inventoried for this study, the "Ecoloam" revegetation site on the slopes of Blue Mountain overlooking Palmerton, northeast of Lehigh Gap.

Percentages of native and non-native species richness are somewhat misleading, however, because they do not reflect relative species abundance. For instance, in the plant community study area's mountain woodlands/forests and ridge-top/upper slope grasslands, all of the non-native species present are extremely scarce. Virtually 100% of the total biomass and land cover in these two sections of the plant community study area are in native species. Conversely, in the "Ecoloam" revegetation site just outside the study area, non-native species cover in the ground layer appears to be considerably higher than the percentage of non-native species richness. A few of the introduced species were planted, for instance, bird's-foot trefoil *(Lotus corniculatus)*, Kentucky bluegrass *(Poa pratensis)* and intermediate wheatgrass *(Thinopyrum intermedium)*, but most are invasive and presumably seeded in by chance, including brown mustard *(Brassica juncea)*, hairy chess *(Bromus commutatus)*, smooth brome *(Bromus inermis)*, butterfly-bush *(Buddleja davidii)*, nodding thistle *(Carduus nutans)*, spotted knapweed *(Centaurea stobe* ssp. *micranthus)*, Canada thistle *(Cirsium arvense)*, Japanese hops *(Humulus japonicus)*, Morrow's honeysuckle *(Lonicera morrowii)*, common reed *(Phragmites australis* ssp. *australis)* and Canada bluegrass *(Poa compressa)*. The "Ecoloam" itself—a composted sewage sludge-fly ash mix—offered near-ideal conditions for the establishment and spread of many invasive species, which as a group tend to thrive in physically disturbed, nutrient-rich soils.

COMMUNITY CLASSIFICATION AND MAPPING

In this document, classification of the indigenous plant communities of the Lehigh Gap Wildlife Refuge is based on *Terrestrial and Palustrine Plant Communities of Pennsylvania* (Fike 1999), with minor modifications and additions, including one addition based on unpublished research by Roger Latham on native grassland and meadow communities statewide. In this context, terrestrial is close in meaning to upland, and palustrine is synonymous with wetland. The other major category of communities in the Refuge is aquatic. For aquatic community classification, an older source is used (Smith 1991), which has been updated and supplanted for land-surface communities (Fike 1999) but not for aquatic communities. Committees convened by the Pennsylvania Natural Heritage Program are currently in the process of refining aquatic, palustrine and terrestrial community classification.

One other fundamental distinction is made at the highest level of the classification scheme presented in this report: communities of mainly indigenous origin are separated from those that are of mainly cultural origin. In reality there is a continuum between the two categories and certainly no community in the Refuge has escaped some degree of cultural modification. For instance, it is safe to say that all of the vegetation in the Refuge has been affected by the deposition of heavy metals from the zinc smelters, and most has been modified by the feeding behavior of abnormally high white-tailed deer populations, stemming in part from the extirpation of their historical predators. Communities are classified as mainly cultural in origin if they are dominated by species not native to the region or if their species composition has been fundamentally or persistently changed by direct human influences such as earthmoving, planting or periodic mowing. We classified plant communities of mainly cultural origin according to the same principles as were used to classify indigenous plant communities in Fike (1999).

The classification system is hierarchical (**Table 1**). The highest level of classification is the ***origin of species composition***, with two categories: ***mainly indigenous*** and ***mainly cultural***. The next level, **domain**, consists of three categories: ***aquatic***, ***palustrine*** and ***terrestrial***. The third level is the ***predominant cover type***, with major categories ***herbaceous***, ***shrub*** and ***tree***, and additional categories consisting of combinations of these with each other and with ***open water*** and ***rock***. The map symbols (see **Plant Communities** map, Fig. 6 and **Table 1**, p. 12) reflect this hierarchy. The first letter of the symbol for each mainly indigenous community represents the domain, the second letter, the predominant cover type (for palustrine and terrestrial communities), and the last letter, the specific community. The first letter of the symbol for each mainly cultural community is "C," the second letter represents the domain, and the last letter, the specific community.

In the following community descriptions, beneath the name of each of the 25 community types are descriptions of these attributes:

(1) ***Location*** – general distribution within the plant community study area

Table 1. **Summary of plant community classification**

origin of species composition	domain	predominant cover type	plant community	map symbol	text location
mainly indigenous	**aquatic**	open water / herbaceous	perennial pond	AP	1.1
	palustrine	herbaceous	skunk-cabbage seep	PHS	2.1
			wet meadow	PHW	2.2
		shrub	buttonbush - tussock sedge wetland	PSB	2.3
			meadowsweet - river birch wetland	PSM	2.4
		tree	river birch - red maple floodplain forest/woodland	PTF	2.5
		tree / shrub	red maple - river birch swamp	PTM	2.6
			vernal (ephemeral) pond	not mapped	2.7
	terrestrial	herbaceous	little bluestem - broomsedge opening	THB	3.1
		herbaceous / shrub	hairgrass - lowbush blueberry savanna	THH	3.2
		rock / mixed	scree with moderately sparse, scattered vegetation	TRS	3.3
		rock	scree nearly devoid of vegetation	TRX	3.4
		tree	birch (black-gum) rocky slope woodland	TTB	3.5
			dry oak - heath forest + dry oak - heath woodland	TTD / TTW	3.6
			dry oak - heath woodland	TTW	3.6
			hemlock (white pine) forest	TTH	3.7
			red maple - mixed hardwood forest + forest/woodland of mainly cultural origin	TTM / CTW	3.8
			dry white pine (hemlock) - oak forest	TTP	3.9
			red oak - mixed hardwood forest	TTR	3.10
mainly cultural	**palustrine**	herbaceous	common reed marsh	CPP	4.1
		herbaceous / shrub	ruderal wetland	not mapped	4.2
	terrestrial	herbaceous	grass plantings	CTG	5.1
		mixed	dense, mixed herbaceous - shrub - scattered tree cover of mainly cultural origin	CTM	5.2
		rock / mixed	sparse, mixed herbaceous - shrub - scattered tree cover of mainly cultural origin	CTS	5.3
		tree	forest/woodland of mainly cultural origin	CTW	3.8

Table 2. **Areas ca. 2005 of plant communities** in the study area (total: 1,100 acres/450 ha) and within the Lehigh Gap Wildlife Refuge boundaries (670 acres/270 ha, 61% of the study area), in order of total size. Figures are rounded to two significant digits.

plant community	map symbol	total acres (ha) in study area	percentage of study area	acres (ha) within Refuge only	percentage of Refuge
dry oak - heath forest + dry oak - heath woodland	TTD / TTW	520 (210)	48%	300 (120)	45%
scree with moderately sparse, scattered vegetation	TRS	180 (74)	17%	160 (63)	23%
hairgrass - lowbush blueberry savanna	THH	62 (25)	5.6%	6.7 (2.7)	1.0%
scree nearly devoid of vegetation	TRX	59 (24)	5.4%	41 (17)	6.2%
sparse, mixed herbaceous - shrub - scattered tree cover of mainly cultural origin	CTS	44 (18)	4.0%	35 (14)	5.3%
birch (black-gum) rocky slope woodland	TTB	42 (17)	3.9%	23 (10)	3.5%
red maple - mixed hardwood forest + forest/woodland of mainly cultural origin	TTM / CTW	41 (16)	3.7%	5.1 (2.1)	0.8%
grass plantings	CTG	36 (15)	3.3%	35 (14)	5.2%
hemlock (white pine) forest	TTH	27 (11)	2.5%	20 (8.0)	3.0%
dense, mixed herbaceous - shrub - scattered tree cover of mainly cultural origin	CTM	22 (8.8)	2.0%	12 (4.9)	1.8%
forest/woodland of mainly cultural origin	CTW	16 (6.3)	1.4%	10 (4.2)	1.5%
red oak - mixed hardwood forest	TTR	12 (4.8)	1.1%	9.8 (4.0)	1.5%
dry oak - heath woodland	TTW	12 (4.8)	1.1%	< 1 (< 0.4)	< 0.1%
river birch - red maple floodplain forest/woodland	PTF	6.7 (2.7)	0.6%	< 1 (< 0.4)	< 0.1%
dry white pine (hemlock) - oak forest	TTP	3.8 (1.5)	0.3%	3.8 (1.5)	0.6%
meadowsweet - river birch wetland	PSM	3.4 (1.4)	0.3%	2.2 (0.9)	0.3%
perennial pond	AP	2.5 (1.0)	0.2%	2.5 (1.0)	0.4%
buttonbush - tussock sedge wetland	PSB	1.4 (0.6)	0.1%	1.4 (0.6)	0.2%
red maple - river birch swamp	PTM	1.3 (0.5)	0.1%	< 1 (< 0.4)	0.1%
little bluestem - broomsedge opening	THB	1.1 (0.5)	0.1%	< 1 (< 0.4)	0.1%
common reed marsh	CPP	< 1 (< 0.4)	< 0.1%	< 1 (< 0.4)	< 0.1%
herbaceous vernal (ephemeral) pond	not mapped	< 1 (< 0.4)	< 0.1%	< 1 (< 0.4)	< 0.1%
ruderal wetland	not mapped	< 1 (< 0.4)	< 0.1%	< 1 (< 0.4)	< 0.1%
skunk-cabbage seep	PHS	< 1 (< 0.4)	< 0.1%	< 1 (< 0.4)	0.1%
wet meadow	PHW	< 1 (< 0.4)	< 0.1%	< 1 (< 0.4)	< 0.1%

(2) ***Characteristic species*** – dominant canopy species[3] and noteworthy subordinate species, including those that are either moderately abundant, endangered or threatened in Pennsylvania, diagnostic indicators of the community type, invasive introduced species of management concern, or marked by special esthetic, educational or wildlife habitat significance

(3) ***Area*** – acreage in entire plant community study area and within the boundaries of the Lehigh Wildlife Refuge

(4) ***Ecosystem and community dynamics*** – comments on the ecology of the community type, including hypotheses about its origins and probable future within the plant community study area and observations about special management needs

(5) ***Wildlife habitat*** – comments for selected communities on the significance of the community type in providing habitats for animal life

Throughout the community descriptions, names of introduced (non-native) plant species are marked with an asterisk.

Community mapping (see **Plant Communities** map, Fig. 6) was based on interpretation of 21 October 2004 false-color infrared satellite photography (National Agriculture Imagery Program) and 14 April 1999 black-and-white stereo aerial photography (National Aerial Photography Program) by Roger Latham and 2005-2006 ground-truthing by Roger Latham and Claudia Steckel. Where two different communities are interspersed in a mosaic of small patches across a significant area of the landscape, it is enclosed in a single polygon on the Plant Communities map and labeled with both communities' symbols or names separated by a slash.

COMMUNITY DESCRIPTIONS

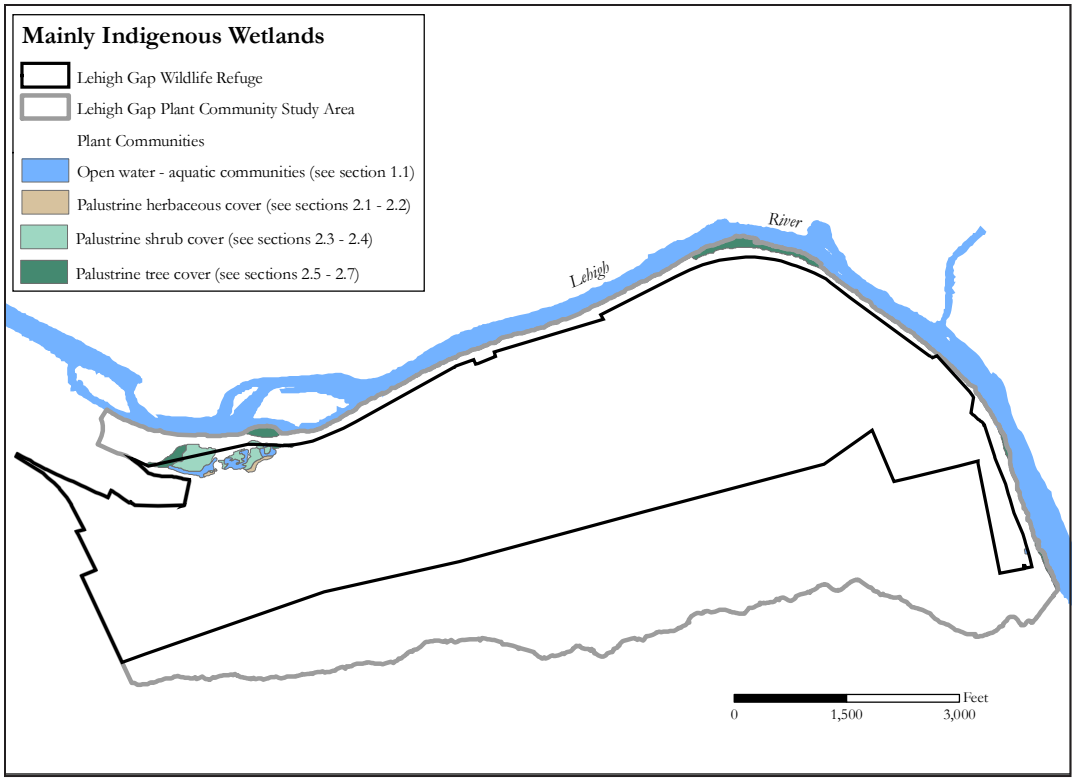
1.0 Aquatic communities

1.1 Perennial pond (AP)

Location. The three perennial ponds near the west end of the Refuge: from west to east, Mallard Pond, Kingfisher Pond, Wood Duck Pond. (The small pond at the Lehigh Gap Nature Center is excluded. Other plant species that may have occurred there have been crowded out by parrot-feather*, *Myriophyllum aquaticum**, an introduced native of South America.)

Characteristic species. Of the three major ponds, the middle (Kingfisher Pond) has the greatest diversity of aquatic plant species. Common to abundant emergent aquatic species along pond margins include three-way sedge *(Dulichium arundinaceum)*, limited to Kingfisher Pond, and American bur-reed *(Sparganium americanum)*. Rooted submergent aquatic species include two-headed water-starwort *(Callitriche heterophylla)*, limited to Mallard Pond; terrestrial water-starwort *(C. terrestris)*, observed in Mallard and Wood Duck Ponds; needle spike-rush *(Eleocharis acicularis)*, common throughout; and snail-

[3] **Dominant species** are those that exert strong control over environmental conditions by virtue of their majority share of total land coverage or ecosystem biomass. **Canopy** refers to the leaves of the tallest plants in a community. Thus the dominant canopy species in a forest, for example, are the most common tree species. Uncommon trees, even though they are also in the canopy, are termed **subordinate**, as are all tree seedlings and saplings, shrubs, and other low plants that live in the shade beneath the canopy. Similarly, the dominant canopy species in a grassland are the most abundant grasses and other plants of similar stature.



seed pondweed *(Potamogeton bicupulatus)*, limited to Kingfisher Pond. Spiral pondweed *(P. spirillus)*, a floating-leaved aquatic species, inhabits the northwest margin of Kingfisher Pond. Abundant herbaceous species occurring along the ponds' edges include blunt spike-rush *(Eleocharis obtusa* var. *obtusa)* and marsh-purslane *(Ludwigia palustris)*.

Area. Plant community study area total, 2.5 acres (1.0 ha), entirely within the Refuge.

Ecosystem and community dynamics. The ponds may be artifacts of historical earth-moving activity during railroad construction or maintenance.

Wildlife habitat. The ponds' value for wildlife habitat is vastly disproportionate to their small size. Many species of mammals, birds, turtles, snakes, amphibians, fishes, odonates (dragonflies and damselflies), crayfish, and other aquatic invertebrates occur in the plant community study

Perennial ponds

area only in and around the ponds for at least a part of their life cycles, although to date, only birds and insects that are attracted to light traps have been surveyed systematically. So far only one rare species has been verified in the ponds (Rawlins 2007, included as **Appendix D** at the end of this document), a ground beetle (family Carabidae) with no common name, *Agonum galvestonicum*, which inhabits and feeds on common cat-tail *(Typha latifolia)* around the pond margins.

2.0 Palustrine (wetland) communities of mainly indigenous origin, unplanted and dominated by native species (map symbols P...)

Mainly indigenous, palustrine communities dominated by herbaceous plants (map symbols PH...)

2.1 Skunk-cabbage seep (PHS)

Location. Adjacent to the ponds at the west end of the Refuge in a swale extending east-west along the forested base of the mountain slope.

Skunk cabbage seep

Characteristic species. Skunk-cabbage *(Symplocarpus foetidus)* is dominant. The most common associates include sensitive fern *(Onoclea sensibilis)*, cinnamon fern *(Osmunda cinnamomea)* and jewelweed *(Impatiens capensis)*. Less common species include false nettle *(Boehmeria cylindrica* var. *cylindrica)*, common white snakeroot *(Ageratina altissima)*, rice cutgrass *(Leersia oryzoides)*, spicebush *(Lindera benzoin)*, fringed loosestrife *(Lysimachia ciliata)* and mad-dog skullcap *(Scutellaria lateriflora)*.

Area. Plant community study area total, < 1 acre (< 0.4 ha), entirely within the Refuge.

Ecosystem and community dynamics. Skunk-cabbage seeps occur where groundwater comes to the surface in a diffuse flow, saturating the soil for most of the growing season but not forming persistent pools of standing water. They usually occur in the shade of trees. In the absence of shade, similar soil conditions most often lead to the development of wet meadows or marshes, dominated by species that are more light-demanding than the shade-tolerant skunk-cabbage and its associates.

2.2 Wet meadow (PHW)

Location. Adjacent to the ponds at the west end of the Refuge.

Characteristic species. Abundant species include Canada bluejoint *(Calamagrostis canadensis* var. *canadensis)*, swamp milkweed *(Asclepias syriaca* ssp. *syriaca)*, needle spike-rush *(Eleocharis acicularis)*, sensitive fern *(Onoclea sensibilis)*, and tapered rosette grass *(Dichanthelium acuminatum)*. Boneset *(Eupatorium perfoliatum)*, soft rush *(Juncus effusus* var. *solutus)*, cardinal-flower *(Lobelia cardinalis)*, seedbox *(Ludwigia alternifolia)* and needletip blue-eyed-grass *(Sisyrinchium*

mucronatum) occur occasionally. Infrequent inhabitants include Allegheny monkey-flower *(Mimulus ringens)*, wool-grass *(Scirpus cyperinus)*, golden ragwort *(Senecio aureus)*, blue vervain *(Verbena hastata)* and several sedge species *(Carex conjuncta*, *C. lurida*, *C. scoparia*, *C. stipata*, *C. straminea*, *C. vulpinoidea)*.

Area. Plant community study area total, < 1 acre (< 0.4 ha), entirely within the Refuge.

Ecosystem and community dynamics. The wet meadow appears to be maintained by yearly or more frequent mowing by residents of the adjacent vacation home, located in an inholding surrounded by Refuge lands.

Wet meadow

Mainly indigenous, palustrine communities dominated by shrubs (map symbols PS...)

2.3 Buttonbush–tussock sedge wetland (PSB)

Location. Among the ponds at the west end of the Refuge.

Characteristic species. Dominant elements include buttonbush *(Cephalanthus occidentalis)*, tussock sedge *(Carex stricta)* and young river birch *(Betula nigra)*. Meadowsweet *(Spiraea latifolia)* and skunk-cabbage *(Symplocarpus foetidus)* are common. Occasional elements include speckled alder *(Alnus incana* ssp. *rugosa)*, usually occurring in small colonies at the periphery, Japanese barberry* *(Berberis thunbergii*)*, common cat-tail *(Typha latifolia)*, wool-grass *(Scirpus cyperinus)* and winterberry *(Ilex verticillata)*. The cover of grasses increases eastward, most commonly Canada bluejoint *(Calamagrostis canadensis* var. *canadensis)*, wood reedgrass *(Cinna arundinacea)* and American mannagrass *(Glyceria grandis)*.

Buttonbush–tussock sedge wetlands

Area. Plant community study area total, 1.4 acres (0.6 ha), entirely within the Refuge.

Ecosystem and community dynamics. Of all of the native woody plants in the local species pool, buttonbush may be the most tolerant of anaerobic soil conditions and other stresses of living in fully inundated soils. The community is expected to be stable as long as there are no major changes in the site's hydrology such as the lowering of groundwater or pond surface levels due to prolonged drought, increased water extraction from nearby wells, or earthmoving or erosion affecting surface runoff patterns.

2.4 Meadowsweet–river birch wetland (PSM)

Location. Among the ponds at the west end of the Refuge.

Characteristic species. A dense cover of meadowsweet *(Spiraea latifolia)* and young river birch *(Betula nigra)* dominates this wetland type. The community alternates from a relatively even mix of meadowsweet and river birch to areas with a nearly exclusive cover of one or the other. Common associates include whitegrass *(Leersia virginica)*, alder buckthorn* *(Rhamnus frangula*)*, bristly greenbrier *(Smilax hispida)*, common greenbrier *(S. rotundifolia)*, sensitive fern *(Onoclea sensibilis)* and skunk-cabbage *(Symplocarpus foetidus)*. Occasional elements include buttonbush *(Cephalanthus occidentalis)*, spicebush *(Lindera benzoin)*, common elder *(Sambucus canadensis)* and southern arrow-wood *(Viburnum dentatum)*.

Meadowsweet–river birch wetland

Area. Plant community study area total, 3.4 acres (1.4 ha); within the Refuge, 2.2 acres (0.9 ha).

Ecosystem and community dynamics. Meadowsweet–river birch wetland is not a community defined in Fike (1999) and is most likely a successional (transitional) stage after a severe disturbance, possibly associated with railroad construction. If that hypothesis is correct, then without further severe disturbance the expected eventual outcome is the development of a red maple–river birch swamp forest or woodland. This intermediate stage appears to be relatively persistent, however, perhaps maintained by periodic disturbances such as flooding, ice-scour or fire.

Mainly indigenous, palustrine communities dominated by trees (map symbols PT...) — forests, woodlands

2.5 River birch–red maple floodplain forest[4] (PTF)

Location. Floodplain of the Lehigh River, in three segments or clusters, each along a 0.4 to 0.5-mile (0.6 to 0.8 km) reach of the river: at extreme eastern end of the plant community study area, along the northernmost edge of the Refuge, and adjacent to the ponds.

Characteristic species. River birch *(Betula nigra)* is abundant, dominating the canopy with estimated cover ranging from 60% to 90%. Height of the canopy tends to be stunted due to disturbance from periodic flooding and ice scour, but generally exceeds 15 feet (5 m) except on gravel bars, where it is dwarfed. Red maple *(Acer rubrum* var. *rubrum)*, green ash *(Fraxinus pennsylvanica)* and gray birch *(Betula populifolia)* are common, with the density of gray birch higher upstream. Occasional canopy elements include southern catalpa* *(Catalpa bignonioides*)*, bigtooth aspen *(Populus grandidentata)* and black willow *(Salix nigra)*. Silver maple *(Acer saccharinum)*, black-gum *(Nyssa sylvatica)*, American sycamore *(Platanus occidentalis)*, black cherry *(Prunus serotina)* and white crack willow* *(Salix* x *rubens*)* occur sparingly. Species commonly occurring in the generally sparse shrub layer include Japanese barberry* *(Berberis thunbergii*)*, locally abundant westward, and meadowsweet *(Spiraea latifolia)*. Scarce inhabitants include smooth alder *(Alnus serrulata)*, silky dogwood *(Cornus amomum)*, spicebush *(Lindera benzoin)*, ninebark *(Physocarpus opulifolius)*, alder buckthorn* *(Rhamnus frangula*)* and common elder *(Sambucus canadensis)*. Abundant herb layer elements include jewelweed *(Impatiens capensis)*, fringed loosestrife *(Lysimachia ciliata)* and Japanese stiltgrass* *(Microstegium vimineum*)*.

The relative densities of subordinate species vary among the three floodplain areas, often greatly (elements that are locally abundant on one floodplain area may be lacking on another). Virginia wild-rye *(Elymus virginicus)*, common white snakeroot *(Ageratina altissima)* and a few colonies of Japanese knotweed* *(Fallopia japonica*)*, limited to the middle and westernmost floodplain areas, are common. Occasional forbs and grasses include garlic mustard* *(Alliaria petiolata*)*, jack-in-the-pulpit *(Arisaema triphyllum* ssp. *triphyllum)*, false nettle *(Boehmeria cylindrica* var. *cylindrica)*, wood reedgrass *(Cinna arundinacea)*, wild yam *(Dioscorea villosa)*, spinulose woodfern *(Dryopteris carthusiana)*, rough bedstraw *(Galium asprellum)*, cleavers *(G. tinctorum)*, sensitive fern *(Onoclea sensibilis)*, dotted smartweed *(Persicaria punctata)*, smooth goldenrod *(Solidago gigantea* var. *gigantea)* and wrinkle-leaf goldenrod *(S. rugosa* ssp. *rugosa* var. *rugosa)*. Infrequent, noteworthy inhabitants include pink dogbane *(Apocynum androsaemifolium)* on cobble-strewn areas, green-dragon *(Arisaema draconitum)*, swamp milkweed *(Asclepias incarnata* ssp. *incarnata)*, common milkweed *(A. syriaca)*, beggars-ticks *(Bidens frondosa)*, short-hair sedge *(Carex crinita* var. *crinita)*, turtlehead *(Chelone glabra)*, false nutsedge

River birch–red maple floodplain forest

[4] **Forests** defined for this study as tree-dominated communities in which the leaf canopy is closed or nearly closed and the majority of tree crowns are overlapping, typically with between 60% and 100% tree cover. **Woodlands** are tree-dominated communities with between 20% and 60% tree cover.

(Cyperus strigosus), rough barnyard grass *(Echinochloa muricata)*, Canada wild-rye *(Elymus canadensis* var. *canadensis)*, hollow-stemmed joe-pye-weed *(Eutrochium fistulosum)*, grass-leaved goldenrod *(Euthamia graminifolia)*, rattlesnake mannagrass *(Glyceria canadensis)*, day-lily* *(Hemerocallis fulva*)*, whitegrass *(Leersia virginica)*, water-horehound *(Lycopus virginicus)*, swamp-candles *(Lysimachia terrestris)*, tall white beard-tongue *(Penstemon digitalis)*, blue marsh violet *(Viola cucullata)* and fox grape *(Vitis labrusca)*. Along the few floodplain backwater pools and sloughs, tussock sedge *(Carex stricta)*, blunt spike-rush *(Eleocharis obtusa* var. *obtusa)*, yellow iris* *(Iris pseudacorus*)*, northern blue flag *(Iris versicolor)*, sharp-fruited rush *(Juncus acuminatus)*, marsh-purslane *(Ludwigia palustris)*, water smartweed *(Persicaria amphibia)* and skunk-cabbage *(Symplocarpus foetidus)* occur sparingly

Area. Plant community study area total, 6.7 acres (2.7 ha); within the Refuge, < 1 acre (< 0.4 ha).

Ecosystem and community dynamics. The distinctive species composition of floodplain forests is shaped by the stresses of radically fluctuating soil moisture and soil oxygen levels and battering during times of high water by current, floating debris and ice. Only species that have traits conferring tolerance or resistance to these conditions persist there. For instance, seedlings and saplings of many of the characteristic tree species either have flexible stems that can spring back after being flattened by floodwaters or resprout readily from well-anchored, nutrient-packed roots after their stems have been sheared off.

Red maple–river birch swamp

2.6 Red maple–river birch swamp (PTM)

Location. Near the ponds at the west end of the Refuge.

Characteristic species. Red maple *(Acer rubrum* var. *rubrum)* and river birch *(Betula nigra)* dominate the canopy of this wooded wetland, which is transitional between the red maple–mixed hardwood woodland/forest community to the west and the meadowsweet–river birch wetland to the east. Ephemeral pools (man-made and some possibly naturally-occurring) dot the landscape (see **2.7 Vernal [ephemeral] pond**, below). Common to occasional canopy associates include green ash *(Fraxinus pennsylvanica)*, black-gum *(Nyssa sylvatica)*, black cherry *(Prunus serotina)* and sassafras *(Sassafras albidum)*. Occasional shrub layer inhabitants include Japanese barberry* *(Berberis thunbergii*)*, alder buckthorn* *(Rhamnus frangula*)*, common greenbrier *(Smilax rotundifolia)* and southern arrow-wood *(Viburnum dentatum)*. Whitegrass *(Leersia virginica)* is abundant throughout. Other abundant ground-layer elements include Japanese stiltgrass* *(Microstegium vimineum*)*, poison-ivy *(Toxicodendron radicans)*, common white snakeroot *(Ageratina altissima)*, field horsetail *(Equisetum arvense)*, fringed loosestrife *(Lysimachia*

ciliata) and Virginia-creeper *(Parthenocissus quinquefolia)*.

Area. Plant community study area total, 1.3 acres (0.5 ha); within the Refuge, < 1 acre (< 0.4 ha).

Ecosystem and community dynamics. Swamp forests and wetlands occur where the soil is saturated for much of the year, often with intermittent pools of standing water. Most of the plant species are tolerant of anaerobic soil conditions and other stresses of prolonged soil saturation.

2.7 Vernal (ephemeral) pond (not mapped separately; part of red maple–river birch swamp [PTM])

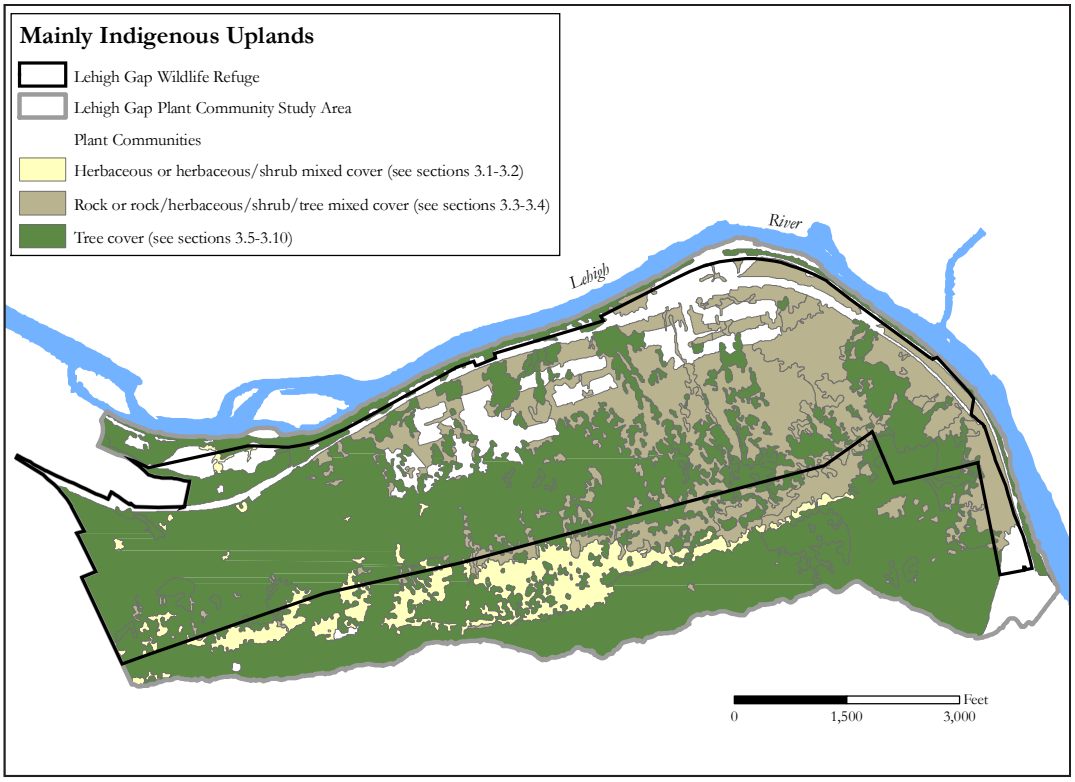
Location. Between the ponds and the D. & L. Trail (lower railroad bed) at the west end of the Refuge

Characteristic species. The tree canopy consists of species common to the red maple–river birch swamp woodlands and forests and other nearby communities, including red maple *(Acer rubrum* var. *rubrum)*, river birch *(Betula nigra)*, gray birch *(Betula populifolia)*, shagbark hickory *(Carya ovata)*, southern catalpa* *(Catalpa bignonioides*)*, green ash *(Fraxinus pennsylvanica)* and black-gum *(Nyssa sylvatica)*. The ground layer of the ponds themselves is nearly lacking in plant cover. Aquatic green algae are present in standing water. Common shrub and herb layer inhabitants in close proximity to the pools include creeping bentgrass* *(Agrostis stolonifera* var. *palustris*)*, Japanese barberry* *(Berberis thunbergii*)*, broom sedge *(Carex scoparia)*, wild yam *(Dioscorea villosa)*, whitegrass *(Leersia virginica)*, Japanese stiltgrass* *(Microstegium vimineum*)*, Virginia-creeper *(Parthenocissus quinquefolia)*, bristly greenbrier *(Smilax hispida)*, common greenbrier *(S. rotundifolia)* and summer grape *(Vitis aestivalis)*.

Vernal (ephemeral) pond

Ecosystem and community dynamics. Vernal ponds are seasonal wetlands that occupy shallow depressions on the landscape. In the plant community study area they occur under a tree canopy within the red maple–river birch swamp community, with little or no ground-layer vegetation. The depressions may be artifacts of historical earth-moving activity during railroad construction or maintenance. They typically are water-covered in late winter from snowmelt and rain, remain wet through spring, and dry up in mid- to late summer. They are important breeding habitats for certain animal species that are aquatic for a relatively brief fraction of their life cycle, especially amphibians. The critical factor is the complete lack of fish and the scarcity of large, carnivorous aquatic insects, which are voracious predators of tadpoles and larval salamanders.

Wildlife habitat. Many amphibians—toads, frogs, tree frogs, newts and salamanders—breed in large numbers in vernal ponds. They attract animals that prey on amphibian larvae, including herons and water snakes.



3.0 Terrestrial (upland) communities of mainly indigenous origin, unplanted and dominated by native species (map symbols T...)

Mainly indigenous, terrestrial communities dominated by herbaceous plants or low shrubs (map symbols TH...)

3.1 Little bluestem–broomsedge opening (THB)

Location. Near the ponds at the west end of the Refuge.

Characteristic species. Grasslands meander along low ridges, probably of sandy alluvial soil dumped during railroad construction, among the ponds and wooded swamps. Little bluestem *(Schizachyrium scoparium)* is dominant. Locally abundant patches of broomsedge *(Andropogon virginicus)*, hay-scented fern *(Dennstaedtia punctilobula)*, hair-cap moss *(Polytrichum* sp.*)* and meadowsweet *(Spiraea latifolia)* are scattered throughout. Other common species include big bluestem *(Andropogon gerardii)*, path rush *(Juncus tenuis* var. *tenuis)*, tapered rosette grass *(Dichanthelium acuminatum)* and deer-tongue grass *(D. clandestinum)*. Indian-grass *(Sorghastrum nutans)* is also present in small quantities.

Area. Plant community study area total, 1.1 acres (0.5 ha); within the Refuge, < 1 acre (< 0.4 ha).

Ecosystem and community dynamics. This community is typically a successional (transitional) species assemblage on acidic, low-nutrient, often sandy and drought-prone soils following a disturbance that results in large areas of exposed soil with no vegetation. It is most often seen on abandoned cropland with unproductive soils. Because the dominant species—both native warm-season grasses—are highly fire-tolerant, the community might also

arise on more productive soils as a result of repeated burning. This occurrence may be an artifact of earthmoving associated with the construction of the railroad that exposed sandy alluvium (river-deposited material). Soils that are drought-prone and low in nutrients slow plant growth in general and the dense, fibrous root mats and tightly packed stems of little bluestem and broomsedge deter seedling establishment and resist penetration by other plants' rhizomes (underground runners). Thus, compared with more typical early successional assemblages, this community is relatively persistent on sandy soils, even in the prolonged absence of fire.

Little bluestem–broomsedge opening

3.2 Hairgrass–lowbush blueberry savanna (THH)

Location. Mainly upper mountain slopes and ridge top, with small areas on steeper lower mountain slopes near the western end of the plant community study area.

Characteristic species. Common hairgrass *(Deschampsia flexuosa)* and early low blueberry *(Vaccinium angustifolium)* are dominant, sometimes in single-species patches and sometimes mixed together. The most abundant associates are late low blueberry *(V. pallidum)*, black huckleberry *(Gaylussacia baccata)*, sheep-laurel *(Kalmia angustifolia)* and hay-scented fern *(Dennstaedtia punctilobula)*. Other major subordinate herbaceous, low shrub and scrambling vine species include black chokeberry *(Photinia melanocarpa)*, poverty-grass *(Danthonia spicata)*, bush-honeysuckle *(Diervilla lonicera)*, whorled loosestrife *(Lysimachia quadrifolia)*, scrub oak *(Quercus ilicifolia)* and common greenbrier *(Smilax rotundifolia)*. Scattered trees and tall shrubs are mainly red maple *(Acer rubrum* var. *rubrum)*, smooth juneberry *(Amelanchier laevis)*, sweet birch *(Betula lenta)*, witch-hazel *(Hamamelis virginiana)*, mountain-laurel *(Kalmia*

Hairgrass–lowbush blueberry savanna

latifolia), black-gum *(Nyssa sylvatica)*, pitch pine *(Pinus rigida)*, eastern white pine *(P. strobus)*, scarlet oak *(Quercus coccinea)*, chestnut oak *(Q. montana)*, northern red oak *(Q. rubra)* and sassafras *(Sassafras albidum)*.

Species of special concern found so far are wild bleeding-heart *(Dicentra eximia)*, endangered in Pennsylvania, and climbing fern *(Lygodium palmatum)*, until recently classified as rare in Pennsylvania. Other native grasses in addition to common hairgrass and poverty-grass (which are C_3 or cool-season grasses) include big bluestem *(Andropogon gerardii)*, little bluestem *(Schizachyrium scoparium* var. *scoparium)* and smooth panic grass *(Panicum dichotomiflorum)*, all C_4 or warm-season grasses, and fly-away grass *(Agrostis scabra)* and bearded shorthusk *(Brachyelytrum aristosum)*, both C_3 grasses. To date, 54 native vascular plant species have been found in the hairgrass–lowbush blueberry savanna and only four introduced species—creeping bentgrass* *(Agrostis stolonifera* var. *palustris*)*, hard fescue* *(Festuca trachyphylla*)*, king-devil* *(Hieracium caespitosum*)* and giant foxtail* *(Setaria faberi*)*—represented by just a few widely scattered individuals.

Area. Plant community study area total, 62 acres (25 ha); within the Refuge, 6.7 acres (2.7 ha).

Ecosystem and community dynamics. More than a century ago, a naturalist described what was almost certainly hairgrass–lowbush blueberry savanna on Blue Mountain around Lehigh Gap before significant damage to forests from zinc smelting had occurred (Rehn 1903):

> *On the upper slopes of the mountains [on both sides of Lehigh Gap] the timber is smaller and poor, while the tops themselves are covered with a scragged growth, almost entirely pines and very open in character. A number of open, park-like spots on the very summits are thickly overgrown with two species of huckleberries.*

There is little doubt that the pines were pitch pines, which are common there today, and the "huckleberries" were the low blueberries and black huckleberry. The "park-like spots" most likely were expanses of common hairgrass. Comparing aerial photographs taken in 1937 with recent aerial and satellite imagery suggests that the grasslands have expanded considerably in the last half-century. The most likely explanation is that the native grassland ecosystem persisted relatively intact in areas peripherally affected by heavy metal deposition and spread into some of the area where forests were severely damaged. Its component species are more resilient to the stresses imposed by fallout from zinc smelter smoke plumes than those of the adjacent forests. Most types of human disturbance favor invasion by exotic species and fragment or destroy native habitats. In this case, however, acid precipitation and heavy-metal deposition generated by the zinc smelters imposed severe stresses on native vegetation but for the most part did not favor invasive species. Native forests declined in some areas and disappeared completely in others. Native grasslands not only persisted but were able to spread into areas vacated by forest vegetation.

Only two exotic species have spread widely on severely contaminated soils that were not otherwise disturbed by railroad construction and operation: sheep fescue* *(Festuca ovina*)* and sea-thrift* *(Armeria maritima*)*. Sheep fescue* is from Eurasia and is widely distributed in North America. Sea-thrift* was introduced in the 1980s from seeds collected at a zinc-lead mine site in Belgium (see **Survey of the Vascular Flora**, above). Neither of these has invaded the hairgrass–lowbush

blueberry savanna and they are unlikely to become invasive there in the future because they are poor competitors with plants that are already established. They have proliferated only in areas that had been thoroughly denuded of existing vegetation.

The patches of native grassland on Blue Mountain from Lehigh Gap southwest toward Furnace Gap—totaling around 100 acres (40 ha)—comprise one of the half-dozen or so largest areas of wholly native, unplanted grassland remaining in the entire state (R. Latham, unpublished data). Of the number of species found so far in the hairgrass–lowbush blueberry savanna, 93% are native but native species comprise virtually 100% of total cover and biomass. This is in strong contrast with the meadow vegetation on Blue Mountain just northeast of Lehigh Gap, where much of the ridge top is bare rock and, where sparse vegetation does exist, the introduced species sheep fescue* and sea-thrift* are dominant or share dominance with common hairgrass.

At present the native grasslands are probably relatively stable. The elevated levels of zinc and other contaminants in the soil and the dense root mat and shade of the hairgrass inhibit the establishment of non-grassland species from seed. Furthermore, signs of severe deer-browsing on many of the scattered trees and shrubs and the absence of tree seedlings suggest that, if any new seedlings appear, they are consumed. However, in the long term, woody vegetation can be expected to spread from the forest-grassland edge and from scattered tree "islands." Trees produce large quantities of dead organic matter every year, mainly leaves, which accumulates and decomposes into rich soil organic matter. Soils are deepened and made richer in nutrients and water-holding capacity by this process, making tree seedling establishment more likely. The activity of decomposers—soil animals, fungi and bacteria—may be drastically reduced by high levels of zinc, cadmium and lead in the soil (Jordan and Lechevalier 1975; Strojan 1978). However, the effect is greatly ameliorated by the presence of living plants, even where contamination is intense, and there is evidence for strains of fungi with higher tolerance of heavy metals replacing more sensitive strains in local populations (Jordan and Lechevalier 1975). Anecdotally, forests in the plant community study area do not appear to be accumulating undecomposed organic matter at abnormal rates. If leaf and woody debris decomposition rates are recovering, then soil-rebuilding processes will eventually lead to the gradual conversion of grassland to forest along the edge between the two communities.

The most effective way of deterring encroachment by forest vegetation on grassland will be to restore the disturbance that sustained most native grasslands in the region for thousands of years: fire (see **Appendix C** for additional background). Plant growth rates will always be slow on the ridge top and upper slopes due to severe weather conditions and relatively thin soils, therefore fires do not need to be frequent to be effective. Prescription burns, seasonally timed to minimize impacts on animal life, rotated among relatively small patches with an average fire return interval in any given patch of perhaps 10 to 20 years, would sustain the grassland plant community and habitat for grassland-dependent wildlife species indefinitely.

Wildlife habitat. The total area of hairgrass–lowbush blueberry savanna on Blue Mountain between Lehigh Gap and Furnace Gap, a distance of 4.6 miles, is estimated to be about 100 acres (40 ha), with ownership split among the

Lehigh Gap Nature Center, National Park Service and Pennsylvania Game Commission. These grassland patches are large enough to be a significant habitat cluster for several grassland bird species, including some that have exacting habitat minimum-area requirements. Declines in populations of neotropical migrant birds that breed in the forests of eastern North America have received much attention, but grassland birds in the region are in even greater peril. Analysis of breeding bird survey data show that 16 of the 19 species that breed in grasslands in the East have shown declining trends and 12 of them have declined significantly (Askins 1997). Populations of grassland nesting birds such as bobolink, eastern meadowlark, grasshopper sparrow, savanna sparrow, upland sandpiper and northern bobwhite have declined drastically in recent years due to the loss of habitat and the fragmentation of remaining habitat into pieces that are too small to meet their needs. The native grasslands of the Lehigh Gap Wildlife Refuge and adjoining State Game Land 217 and Appalachian Trail corridor land could increase in value as habitat for grassland birds if a long-term management program were established. Their value as nesting bird habitat will be enhanced by the nearby presence of native warm-season grass plantings in the Refuge near the base of the mountain (see **5.1 Grass plantings**, below).

Rehn (1903) reported seeing northern flicker, hairy woodpecker, yellow-breasted chat, common yellowthroat, black-capped chickadee and eastern towhee on the upper slopes and ridge top. He also noted savannah sparrow at Lehigh Gap without indicating where it was seen. Walking through the grassland today during nesting season, the most commonly heard songs are those of indigo bunting, eastern towhee, field sparrow and prairie warbler. Grassland-nesters seen in recent years in the plant community study area include savannah sparrow and northern harrier.

A survey of bird, mammal and amphibian diversity and abundance near the Palmerton zinc smelters in 1986 and 1987, six and seven years after the smelters ceased operation, confirms that the Refuge and vicinity are locally significant habitats for birds typical of smaller grasslands and grassland–forest edges (Storm et al. 1993). In the six 5-km (3-mile) segments of Blue Mountain targeted by the survey—two to the southwest of Lehigh Gap and four to the northeast—the segment containing the Refuge ranked highest in sightings of indigo bunting, chipping sparrow and field sparrow.

Three rare insect species were documented in the native grasslands in a recent light-trapping survey (Rawlins 2007, included as **Appendix D** at the end of this document), the modest Quaker moth *(Ulolonche modesta)*, fingered lemmeria moth *(Lemmeria digitalis)* and earwig scorpionfly *(Merope tuber)*. The fingered lemmeria is more typically associated with wetlands and the earwig scorpionfly with springs and seeps, so the specimens captured in the ridge-top grasslands may have been wanderers from populations centered elsewhere, perhaps in the wetland complex surrounding the ponds or the seepage wetlands along the base of the mountain (although they did not turn up at the light traps in these locations). The modest Quaker feeds on oaks (Panzer et al. 2006). Judging from its exceptionally high frequency in the light-trap survey, the abundant scrub oak and stunted chestnut, scarlet and northern red oaks in the hairgrass savanna evidently support a thriving population.

Mainly indigenous, terrestrial communities of mostly rock cover with sparse vegetation (map symbols TR...)

3.3 Scree with moderately sparse, scattered vegetation (TRS)

Location. Slopes and ridge top of Blue Mountain, mainly near the eastern end of the Refuge.

Characteristic species. Scree (exposed rock rubble) has some lichen cover (representative species are listed under **3.4 Scree nearly devoid of vegetation**, below). No vascular plant species is dominant except in small patches. The commonest species in this sparse cover are red maple *(Acer rubrum* var. *rubrum)*, sweet birch *(Betula lenta)*, gray birch *(B. populifolia)*, hay-scented fern *(Dennstaedtia punctilobula)*, common hairgrass *(Deschampsia flexuosa)*, black-gum *(Nyssa sylvatica)*, scarlet oak *(Quercus coccinea)*, sassafras *(Sassafras albidum)* and early low blueberry *(Vaccinium angustifolium)*. Other species include smooth juneberry *(Amelanchier laevis)*, butterfly-bush* *(Buddleja davidii*)*, povertygrass *(Danthonia spicata)*, switchgrass *(Panicum virgatum)*, pitch pine *(Pinus rigida)*, eastern white pine *(P. strobus)*, scarlet oak *(Quercus montana)*, northern red oak *(Q. rubra)* and eastern hemlock *(Tsuga canadensis)*.

Area. Plant community study area total, 180 acres (74 ha); within the Refuge, 160 acres (63 ha).

Ecosystem and community dynamics. Most of the areas that are now bare rock were covered in forest when the western zinc smelter began operation in 1898. The soil was held in place by roots and sheltered from rain and wind by leaves and a layer of dead plant material on the ground surface. Acidic fallout from the smoke plume killed the vegetation over large areas of the mountain. The large quantities of dead wood most likely fueled severe fires, which killed many of the trees and other plants that had not yet succumbed to pollution. Most of the soil was washed downslope by rain and snowmelt and redistributed by wind. The thin soil that remained in the crevices between rocks was heavily contaminated by zinc, lead, cadmium and other metals. By 1980, when zinc smelting stopped, there were large areas of sparsely vegetated or entirely barren rock. The scattered trees have a stunted, wind-sculpted growth form or they are root sprouts. Some individual trees are probably quite old; at least their root systems may date to the early twentieth century or earlier. Tree seedling establishment is virtually nil due to high temperatures and thin soils promoting desiccation and, in the eastern end of the plant community study area, to high heavy-metal concentrations in the soil (Jordan 1975).

In the western end of the plant community study area and continuing southwestward along Blue Mountain are several boulder fields that almost certainly predate the effects of zinc smelter

A mosaic of hairgrass–lowbush blueberry savanna, birch (black-gum) rocky slope woodland, scree with moderately sparse, scattered vegetation, scree nearly devoid of vegetation, and dry oak–heath forest

contamination. They were upwind of the smelters for most of the time of operation due to prevailing westerly winds. The rocks tend to be larger and more weathered than those of the scree areas where forests stood before the trees were killed by smelter emissions and most of the soil eroded away. They show clearly on the earliest aerial photographs, which were taken in 1937 and show the forest cover downwind from the smelters as still essentially intact.

Wildlife habitat. Few animals were observed in the course of fieldwork for this report living on the scree except spiders, which were not identified. Some areas of scree near forest edges on the ridge top are potential habitats for the endangered Allegheny (or Appalachian) woodrat (Balcom and Yahner 1996; Whittaker et al. 2005). Allegheny woodrats seldom live on north-facing slopes (Janet Wright, personal communication), but there are several boulder fields along the top of the ridge and extending onto the uppermost southeast-facing slope very near the Refuge on Pennsylvania Game Commission and National Park Service land. The nearest known active population is only about 7 miles (11 km) away, near Jim Thorpe (Janet Wright, personal communication). A survey of mammals and mammal habitat throughout the Refuge is a high priority.

Rehn (1903) noted a pair of peregrine falcons around Devils Pulpit on several visits and assumed that they were nesting there. He also reported common nighthawk, which is still present at the site along with killdeer, both of which may nest on scree where it is fine-textured.

3.4 Scree nearly devoid of vegetation (TRX)

Location. Mountain slopes and ridge top, mainly near the eastern end of the plant community study area.

Characteristic species. Crustose (flat, tightly clinging), saxicolous (rock-dwelling) lichens are the most abundant primary producers on boulder fields and rock rubble where plants are scarce or absent. Dominant species include erratic dot lichen, *Micarea erratica* and pebble lichen, *Trapelia involuta* (Howe and Lendemer 2006, included as **Appendix E** at the end of this document). Several terricolous (soil-dwelling) species are present between the rocks, including lipstick powderhorn, *Cladonia macilenta* var. *macilenta* and peg lichen, *Cladonia polycarpoides* (Howe and Lendemer 2006). Also noteworthy are several lichen species known to be tolerant of heavy-metal contamination, including scaly dot lichen, *Vezdaea leprosa* and sulphur-dust lichen, *Psilolechia lucida* (Howe and Lendemer 2006). This cover type in the plant community study area has either no vascular plants or a few scattered individuals and clumps (species are listed under **3.3 Scree with moderately sparse, scattered vegetation**, above). Air pollution and heavy-metal deposition for 82 years by the zinc smelters, ending in 1980, greatly reduced lichen diversity. In the early 1970s, only five species were found on Blue Mountain at Lehigh Gap compared with 65 species in similar habitat 28 miles (17 km) away on the same mountain ridge at the Delaware Water Gap (Nash 1975). Shadow dot lichen *Micarea peliocarpa* (= *M. trisepta*) was the most abundant in percent cover (Nash 1975) and probably biomass. Other lichens present included brown cobblestone lichen, *Acarospora fuscata*; cinder lichen or rimmed lichen, *Aspicilia cinerea* (= *Lecanora c.*); powdery paint lichen, *Leproloma membranaceum* (= *Lepraria membranacea*); and wart lichen, *Verrucaria nigrescens*. All of these species are tolerant of toxic conditions. A resurvey in 2006 showed profound changes in the lichen flora at

Lehigh Gap with 48 species altogether (Howe and Lendemer 2006).

Area. Plant community study area total, 59 acres (24 ha); within the Refuge, 41 acres (17 ha).

Ecosystem and community dynamics. (See under **3.3 Scree with moderately sparse, scattered vegetation**, above.)

Wildlife habitat. (See under **3.3 Scree with moderately sparse, scattered vegetation**, above.)

Mainly indigenous, terrestrial communities dominated by trees (map symbols TT...)

3.5 Birch (black-gum) rocky slope woodland[5] (TTB)

Location. Mountain slopes and ridge top.

Characteristic species. The usual dominant species is sweet (black) birch *(Betula lenta)*, with patches dominated by gray birch *(B. populifolia)* and black-gum *(Nyssa sylvatica)*. Other tree species include red maple *(Acer rubrum* var. *rubrum)*, scarlet oak *(Quercus coccinea)*, chestnut oak *(Q. montana)* and sassafras *(Sassafras albidum)*. The understory is usually dominated by hay-scented fern *(Dennstaedtia punctilobula)* with other herbaceous species occurring sporadically. Grasses are sometimes abundant, mainly common hairgrass *(Deschampsia flexuosa)* but also northern oat-grass *(Danthonia compressa)*, poverty-grass *(D. spicata)*, tapered rosette grass *(Dichanthelium acuminatum)*, deer-tongue *(D. clandestinum)* and little bluestem *(Schizachyrium scoparium* var. *scoparium)*.

Birch (black-gum) rocky slope woodland

Area. Plant community study area total, 42 acres (17 ha); within the Refuge, 23 acres (10 ha).

Ecosystem and community dynamics. The ecology of this community type is similar to that of dry oak–heath forest and black-gum ridge-top forest (above). The canopy of birch (black-gum) rocky slope woodland is more open and the understory is more likely to include species that are intolerant of shade. Relative to dry oak–heath forest or black-gum ridge-top forest, it is likely to have been exposed to more severe heavy-metal deposition, more recent or more severe fire, or other disturbance such as landslide. Conversely, areas of birch (black-gum) rocky slope woodland were probably exposed to less severe or less recent disturbance than areas of grassland or scree cover.

Wildlife habitat. Patches of birch (black-gum) rocky slope woodland are interspersed with a much larger area of dry oak–heath forest/woodland and black-gum ridge-top forest. The three communities can be regarded as a single unit in terms of their wildlife habitat characteristics (see under **3.6 Dry oak–heath forest and woodland**, below).

[5] **Forests** are defined for this study as tree-dominated communities in which the leaf canopy is closed or nearly closed and the majority of tree crowns are overlapping, typically with between 60% and 100% tree cover. **Woodlands** are tree-dominated communities with between 20% and 60% tree cover.

3.6 Dry oak–heath forest (TTD) and woodland (TTW), including undifferentiated patches of black-gum ridge-top forest[6]

Location. Mountain slopes and ridge top.

Characteristic species. Scarlet oak *(Quercus coccinea)* and chestnut oak *(Q. montana)* are the dominant trees over much of the area, interspersed by large patches dominated by black-gum *(Nyssa sylvatica)*. Chestnut oak is co-dominant mainly on upper slopes and on the ridge top, declining in abundance through mid- and lower slopes. The most abundant subordinate canopy species are red maple *(Acer rubrum* var. *rubrum)*, sweet birch *(Betula lenta)*, northern red oak *(Quercus rubra)* and sassafras *(Sassafras albidum)*. The understory has a strong component of early low blueberry *(Vaccinium angustifolium)*, mixed with or supplanted by hay-scented fern *(Dennstaedtia punctilobula)* in many areas, with common hairgrass *(Deschampsia flexuosa)*, witch-hazel *(Hamamelis virginiana)* and whorled loosestrife *(Lysimachia quadrifolia)* also common. Other heaths (members of the family Ericaceae) in the understory include black huckleberry *(Gaylussacia baccata)*, sheep-laurel *(Kalmia angustifolia)*, mountain-laurel *(K. latifolia)* and deerberry *(Vaccinium stamineum)*.

Dry oak–heath woodland *(above)* **resprouting after a wildfire and dry oak–heath forest** *(right)*

Area. Plant community study area total, 520 acres (210 ha); within the Refuge, 300 acres (120 ha).

Ecosystem and community dynamics. These two forest types are not differentiated on the map because they occur as a mosaic of patches that are indistinguishable in aerial and satellite photos. On mid- and lower slopes, they are the remnants of the oak-chestnut forest that covered much of Blue Mountain for many thousands of years until the 1930s, when the accidental importation of the chestnut blight fungus *(Cryphonectria parasitica)* from Eurasia eliminated American chestnut *(Castanea dentata)* from the forest canopy. An observer of

[6] Where two different communities are interspersed in a mosaic of small patches across a significant area of the landscape, it is enclosed in a single polygon on the **Plant Communities** map and labeled with both communities' symbols or names separated by a slash.

Blue Mountain around Lehigh Gap more than 100 years ago noted that chestnut trees were most abundant in the forests of the valley and lower slopes (Rehn 1903). Presumably scarlet oak and chestnut oak became progressively more abundant up the slope. The oak-chestnut and dry oak forest types probably would be classified separately region-wide if chestnut were still present as an abundant, full-stature tree. Alternatively, if acidic fallout and heavy-metal deposition from the zinc smelters had not placed extra stresses on the lower-slope forests in the plant community study area, they might have evolved with the loss of chestnut into dry oak–mixed hardwood forest or red oak–mixed hardwood forest.

The ericaceous (heath) understory characteristic of dry oak–heath forest has been severely damaged in the plant community study area—and across much of Pennsylvania and surrounding states—by overabundant deer. White-tailed deer densities soared after laws regulating deer hunting began to be enforced in the early twentieth century. They benefited from the extirpation of natural predators, abundant food on land recovering from indiscriminate timber-cutting in the nineteenth and early twentieth centuries, and the proliferation of "edge" habitat as second-growth forests were increasingly fragmented in the late twentieth century. Hay-scented fern is one of the least palatable native plants to deer. Normally a sparsely distributed member of the native flora, it tends to spread unchecked when deer eradicate most of the competing vegetation. Once it forms a continuous cover in the forest ground layer, its dense shade and fibrous root mat severely inhibit the establishment from seed of other herbaceous plants, shrubs and trees (Horsley 1993; Horsley et al. 2003).

The dry oak–heath woodland/forest and black-gum ridge-top forest mosaic covers 48% of the plant community study area (45% of the Refuge) and occurs across its entire length, from the lower slopes of Blue Mountain in Lehigh Gap southwest to and well beyond the vicinity of the turnpike tunnel. There is a gradient of soil contamination across this span, diminishing from northeast to southwest. Overlying this trend is presumably a more subtle, complex pattern of soil heavy-metal concentration produced by the localized influences of topography and microclimate on past deposition rates, downslope movement of eroded soil, and plants' tolerance of, or resistance to, heavy-metal effects on their health and survival. Measurement of soil chemical composition in a grid of sampling points across the plant community study area would clarify the relationships between the concentrations of soil contaminants and the distributions of plant communities.

Overbrowsing by deer has eliminated the tree seedling, sapling, and shrub layer in large areas of forest throughout the region. The result is a greatly simplified vertical structure and a lack of tree regeneration. The herbaceous layer has also been stripped of much of the species diversity that was once there. By the time the density of hay-scented fern exceeds 5 stems per square foot, species richness of other forest floor species is significantly reduced (Rooney and Dress 1997a). Unless deer numbers are reduced to levels of 4 to 10 animals per square mile (deCalesta and Stout 1997) and maintained there, the long-term prospects of the forests in the plant community study area looks bleak. Seedling oaks are among white-tailed deer's favorite foods so even if deer numbers are reduced below current levels but still above historical norms, the oaks would eventually be replaced by less-palatable species such as red maple.

Furthermore, the evidence is increasingly compelling that oak forests in eastern North America depend on periodic

fire for their long-term maintenance (Abrams 1992; Lorimer 1993; Brose et al. 2001). Oak seedlings are highly tolerant of fire but grow more slowly and are less shade-tolerant than the seedlings of less fire-resilient trees. Low-intensity surface fires occurred relatively frequently before the arrival of European settlers (Tome 1854; Abrams 1992; Lorimer 1993). The association of fire with the successful regeneration of oaks has been known for many years. The advent of fire suppression programs in the 1930s and 1940s coincided with the beginning of widespread oak regeneration problems. Prescribed burning (with temporary fencing to keep out deer, where necessary) has become an integral part of the accepted method for assuring oak regeneration by timber growers, including the Pennsylvania Bureau of Forestry.

Wildlife habitat. Oaks are noted for their masting behavior, that is, large variation in acorn crop size from year to year, with years of heavy production (mast years) occurring cyclically and synchronously across large regions within species or groups of closely related species. Despite this unpredictability, acorns are an important food source for many animal species, including wild turkey, ruffed grouse, wood duck, red-bellied woodpecker, blue jay, common grackle, white-breasted nuthatch, brown thrasher, tufted titmouse, white-footed mouse, deer mouse, chipmunk, gray squirrel, red squirrel, eastern flying squirrel, opossum, eastern cottontail, raccoon and white-tailed deer (Martin et al. 1951).

The distinct browse line (all twigs and branches chewed or consumed below about 5 feet (1.5 m) above the ground, where deer can reach) and prevalence of hay-scented fern indicate that sustained high deer density in the plant community study area has severely degraded understory tree and shrub layers in species diversity, height, and density. The formerly diverse ground layer has been reduced to hay-scented fern and a few other species that either are not preferred by deer or are resilient to repeated browsing. Some forest birds, such as ovenbird and eastern towhee, nest and feed in the ground layer. Reduced cover in this forest stratum increases nest predation and decreases the ability of birds to raise their young successfully (Leimgruber et al. 1994; DeGraaf et al. 1991). Other species, such as eastern wood-pewee, indigo bunting and black-and-white warbler, which use the intermediate layers of the forest, have declined in heavily browsed forests in the region (deCalesta 1994).

A survey of vertebrate diversity and abundance near the Palmerton zinc smelters in 1986 and 1987 suggested that forest birds in the Refuge and vicinity had been severely affected by smelter-related degradation beyond the effects of high deer density (Storm et al. 1993). The survey divided Blue Mountain into six 5-km (3-mile) segments, two southwestward from Lehigh Gap and four to the northeast. The segment containing the Refuge ranked substantially lower than the two northeasternmost segments, which lay farthest from the smelters, in sightings of eastern wood-pewee, wood thrush, red-eyed vireo and ovenbird.

3.7 Hemlock (white pine) forest (TTH)

Location. Mid- and upper slopes of Blue Mountain at the eastern end of the Refuge in and near Lehigh Gap.

Characteristic species. Eastern hemlock *(Tsuga canadensis)* is dominant, in some places forming nearly pure stands. Sparsely scattered broad-leaved trees include scarlet oak *(Quercus coccinea)*, chestnut oak *(Q. montana)*, northern red oak *(Q. rubra)*, sweet birch *(Betula lenta)*, gray birch *(B. populifolia)*, red maple *(Acer rubrum)* and sassafras *(Sassafras albidum)*. Eastern white

pine *(Pinus strobus)* is often a member of this community type in Pennsylvania but it is not present in significant numbers in the hemlock forest here, even though it is an important component of at least two other communities in the study area. The most abundant understory species is hay-scented fern *(Dennstaedtia punctilobula)*. In steep and rocky areas where deer are less likely to feed, there is a sparse shrub layer of red elder *(Sambucus pubens)*, wild hydrangea *(Hydrangea arborescens)*, witch-hazel *(Hamamelis virginiana)* and mountain-laurel *(Kalmia latifolia)*.

Area. Plant community study area total, 27 acres (11 ha); within the Refuge, 20 acres (8.0 ha).

Ecosystem and community dynamics. In forests of this type in the Refuge many of the hemlocks are stunted, with short vertical spaces between annual whorls of branches, reflecting the stressful growth conditions in the dry, thin, low-nutrient soils and cold, windy microclimate of the mountain slopes. In a few places, such as the cove (indentation in the mountainside) just south of Devils Pulpit, the trees are of full stature.

In all likelihood the hemlock stands on the Refuge are remnants of hemlock forest that pre-dates European settlement. Circumstantial support for this conjecture includes the slow growth rate of trees under the sites' stressful conditions, the large size of a few of the trees and large number of annual branch whorls of some stunted individuals, and the low likelihood of seedling establishment since the beginning of heavy-metal deposition from zinc smelting around 1900. An eyewitness account from more than 100 years ago provides additional support; Rehn (1903), in describing the mountain forests of Lehigh Gap, wrote:

> *The greater part is, of course, second growth, but some patches and scattered trees remain of the original hemlocks. These patriarchs rear their heads above the surrounding forest, and the mouldering, prostrate trunks of many of their brethren may be found on the slopes. … Hemlock is the prevailing tree in the gully on the northeastern peak, and a small patch exists at the base of the southwestern dome, but elsewhere it is the exception.*

Hemlock (white pine) forest

Against expectation, the hemlocks in these stands appear to be less severely parasitized by the hemlock woolly adelgid *(Adelges tsugae)* than at many other locations in the region. The adelgid is a Eurasian plant-sucking insect related to aphids that was introduced to eastern

North America in the 1950s. It is causing much mortality among eastern hemlocks throughout most of the tree's range. Its effects are especially severe where trees are growing in stressful conditions. The slopes in Lehigh Gap are windy and their soils are dry, thin and rocky. This would seem to be a marginal habitat for hemlocks, which are highly successful in competition with broad-leaved trees in deep, moist soils on less exposed sites in many locations in the region. Furthermore, prevailing winds would have steered the plume from one of the zinc smelters less than a mile away into a path directly through the hemlock stands. Presumably the soils still contain high zinc, cadmium and lead concentrations. It is conceivable that heavy-metal uptake by the hemlocks increases their resistance to parasitic attack by the hemlock woolly adelgid, a hypothesis that could be tested experimentally.

The future of these stands is uncertain, as it is for all hemlock forests in the region, because of the hemlock woolly adelgid. Even if the adelgid continues its unusually low level of virulence at this site, it is likely that heavy metal contamination in the soil is inhibiting the establishment of new hemlock seedlings. There are small hemlocks, but they might be root sprouts or severely stunted, old individuals. Whether hemlocks are reproducing on the site could be determined by a relatively modest research effort. Hemlock reproduction is severely constrained in many forests across the region by high white-tailed deer populations. However, even though the Refuge has a high density of deer, many trees in its hemlock stands have intact foliage and branches low to the ground, which indicates that few deer are venturing onto the steep, rocky slopes where most of the hemlock forest lies.

Wildlife habitat. Because of its dense, evergreen foliage, eastern hemlock provides winter cover for ruffed grouse, wild turkey and many other bird species. Hemlock stands are frequent nesting places for veery, black-throated blue warbler, black-throated green warbler, Blackburnian warbler and dark-eyed junco (Martin et al. 1951; Brauning 1992; McWilliams and Brauning 2000). The seeds provide food for small mammals, especially red squirrel, and for resident and migrating birds, including black-capped chickadee, pine siskin and red crossbill (Martin et al. 1951).

Red maple–mixed hardwood forest

3.8 Red maple–mixed hardwood forest (TTM) — mapped together with forest/woodland of mainly cultural origin (CTW)[7]

Location. Mainly near the railroad rights-of-way and on slopes along the riverbank.

Characteristic species. Dominant canopy species include red maple *(Acer rubrum* var. *rubrum)*, which is common throughout

[7] Where two different communities are interspersed in a mosaic of small patches across a significant area of the landscape, it is enclosed in a single polygon on the **Plant Communities** map and labeled with both communities' symbols or names separated by a slash.

and sassafras *(Sassafras albidum)*, which occurs in scattered, nearly exclusive stands. Common to occasional canopy elements include green ash *(Fraxinus pennsylvanica)*, tuliptree *(Liriodendron tulipifera)*, bigtooth aspen *(Populus grandidentata)*, tree-of-heaven* *(Ailanthus altissima*)*, shagbark hickory *(Carya ovata)*, blackgum *(Nyssa sylvatica)* and black cherry (Prunus serotina). Occurrences of bitternut hickory *(C. cordiformis)*, southern catalpa* *(Catalpa bignonioides*)*, white pine *(Pinus strobus)*, Virginia pine *(P. virginiana)* and quaking aspen *(Populus tremuloides)* are spotty. The understory layer is alternately dense or sparse. Commonly tree seedlings and saplings include red maple, gray birch *(Betula populifolia)*, green ash, sassafras and black cherry. Common small trees, shrubs and lianas include alder buckthorn* *(Rhamnus frangula*)*, which forms dense thickets, smooth juneberry *(Amelanchier laevis)*, meadowsweet *(Spiraea latifolia)*, Japanese barberry* *(Berberis thunbergii*)*, butterfly-bush* *(Buddleja davidii*)*, oriental bittersweet* *(Celastrus orbiculatus*)*, spicebush *(Lindera benzoin)*, bristly greenbrier *(Smilax hispida)* and common greenbrier *(S. rotundifolia)*. Bentgrasses *(Agrostis* spp.*)*, Japanese stiltgrass* *(Microstegium vimineum*)* and scattered pockets of hay-scented fern *(Dennstaedtia punctilobula)* carpet the ground. Locally abundant, robust populations of wild bleeding-heart *(Dicentra eximia)*, an endangered species in the state, are common. Other herbaceous species include big bluestem *(Andropogon gerardii)*, wild sarsaparilla *(Aralia nudicaulis)*, white wood aster *(Oclemena divaricata)*, rattlesnake fern *(Botrychium virginianum)*, Solomon's-seal *(Polygonatum biflorum)*, Solomon's-plume *(Maianthemum racemosum)* and Indian-grass *(Sorghastrum nutans)*.

Area. Plant community study area total, 41 acres (16 ha); within the Refuge, 5.1 acres (2.1 ha).

Ecosystem and community dynamics. These forests and woodlands are mostly on land that was heavily disturbed in the late nineteenth century by railroad construction. Species composition varies on a continuum from stands of mostly native species (red maple–mixed hardwood forest), most likely where soils were least disturbed or in borrow areas where lower soil horizons were exposed, to patches with a strong non-native component (forest/woodland of mostly cultural origin), in fill areas and anywhere soil horizons were thoroughly disrupted.

3.9 Dry white pine (hemlock)–oak forest (TTP)

Location. Mid-slopes of Blue Mountain, mainly in coves (indentations in the mountainside) near the western end of the Refuge.

Characteristic species. Eastern white pine *(Pinus strobus)* grows in mixture with several other tree species, mainly sweet birch *(Betula lenta)*, northern red oak *(Quercus rubra)* and scarlet oak *(Q. coccinea)*. Eastern hemlock *(Tsuga canadensis)* is often a member of this community type in Pennsylvania but it is not present in significant numbers in the white pine forest here. The most abundant understory species is striped maple *(Acer pensylvanicum)*; others include hay-scented fern *(Dennstaedtia punctilobula)*, marginal woodfern *(Dryopteris marginalis)*, witch-hazel *(Hamamelis virginiana)* and mountain-laurel *(Kalmia angustifolia)*.

Area. Plant community study area total, 3.8 acres (1.5 ha), entirely within the Refuge.

Ecosystem and community dynamics. Eastern white pine is intolerant of shade and rarely regenerates where many other forest trees do, in small canopy gaps opened up by the death or blow-down of

just one or a few trees. Its presence in the middle of a forest, especially in extended clusters, indicates a large disturbance at some time in the past involving many trees. Often neighboring white pines are an even-age cohort, all having seeded in following a single catastrophic event such as a downburst, tornado, landslide or severe fire during a drought. Eastern white pine commonly exceeds 200 years in age, sometimes reaching 450 years or older (Fowells 1965). Even though the white pine forest stands on the Refuge will not regenerate unless a severe disturbance opens up the forest canopy over a large area, those that have already survived the deposition of heavy metals from the smelters are likely to persist for many decades.

Wildlife habitat. Like hemlock, eastern white pine provides winter cover for ruffed grouse, wild turkey and many other bird species. White pine stands are frequent nesting places for mourning doves (Martin et al. 1951). The seeds provide food for small mammals, including red squirrel, gray squirrel, chipmunk, white-footed mouse and deer mouse, and for resident and migrating birds, including mourning dove, red-bellied woodpecker, black-capped chickadee, brown creeper, red crossbill, red-breasted nuthatch, white-breasted nuthatch, pine siskin and pine warbler (Martin et al. 1951; Brauning 1992; McWilliams and Brauning 2000).

Red oak–mixed hardwood forest

3.10 Red oak–mixed hardwood forest (TTR)

Location. Along the base of Blue Mountain near the ponds at the western end of the plant community study area.

Characteristic species. White oak *(Quercus alba)* dominates the canopy in this occurrence. Other commonly occurring oak species include northern red oak *(Q. rubra)*, chestnut oak *(Q. montana)* and black oak *(Q. velutina)*. Common to occasional occurrences of other hardwoods include red maple *(Acer rubrum* var. *rubrum)*, sweet birch *(Betula lenta)*, shagbark hickory *(C. ovata)*, green ash *(Fraxinus pennsylvanica)*, tuliptree *(Liriodendron tulipifera)*, black-gum *(Nyssa sylvatica)* and big-tooth aspen *(Populus grandidentata)*. The generally sparse shrub layer includes scarce to occasional occurrences of wild hydrangea *(Hydrangea arborescens)* and spicebush *(Lindera benzoin)*. Alder buckthorn* *(Rhamnus frangula*)* has invaded the Riverbend Road occurrence.

Area. Plant community study area total, 12 acres (4.8 ha); within the Refuge, 9.8 acres (4.0 ha).

Ecosystem and community dynamics. The origins and maintenance of red oak–mixed hardwood forests are similar to those of dry oak–heath forests (see above), except that the soils are more mesic (persistently and reliably moist) and often less acidic. A significant difference is that red oak–mixed hardwood forests are more prone

to invasion by introduced species such as alder buckthorn* and garlic-mustard* (*Alliaria petiolata**).

Wildlife habitat. (See under **3.6 Dry oak–heath forest and woodland**, above.)

4.0 Palustrine (wetland) communities of mainly cultural origin, planted or dominated by introduced species (map symbols CP...)

4.1 Common reed marsh (CPP)

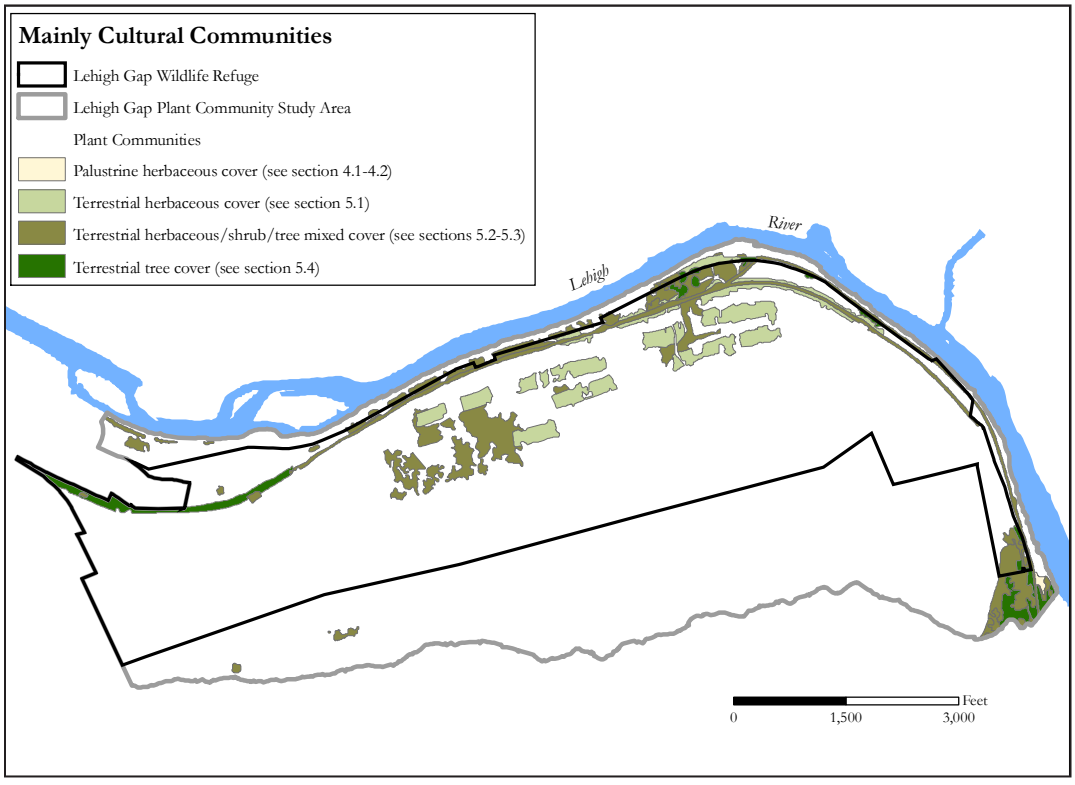
Location. Between the D. & L. Trail (lower railroad bed) and the Lehigh River near the Pa. Route 873 bridge.

Characteristic species. Consists of a near-monoculture of common reed* (*Phragmites australis* ssp. *australis**).

Area. Plant community study area total, < 1 acre (< 0.4 ha); within the Refuge, < 1 acre (< 0.4 ha).

Common reed marsh

Ecosystem and community dynamics. The Eurasian subspecies of common reed is an extremely aggressive invader of wetlands and mesic (moist-soil) uplands all across eastern North America. It spreads prolifically from the point of establishment,



forming dense stands that exclude virtually all other plants. A stand can spread onto inhospitable soils, growing and sustaining the invading phalanx of stems and leaves through vascular connections with roots in the colony's center.

4.2 Ruderal wetland (not mapped separately; small part of dense, mixed herbaceous–shrub–scattered tree cover of mainly cultural origin [CTM])

Location. Seeps along railroad rights-of-way.

Characteristic species. Composition is highly variable between and within patches of this type. Dominant or abundant species may include velvetgrass* *(Holcus lanatus*)*, boneset *(Eupatorium perfoliatum)*, false nettle *(Boehmeria cylindrica* var. *cylindrica)*, fowl mannagrass *(Glyceria striata)*, jewelweed *(Impatiens capensis)*, rice cutgrass *(Leersia oryzoides)*, plume-poppy* *(Macleaya cordata*)*, Japanese stilt-grass* *(Microstegium vimineum*)*, common reed* *(Phragmites australis* ssp. *australis*)* or common greenbrier *(Smilax rotundifolia)*.

Ruderal wetland

Ecosystem and community dynamics. Ruderal wetlands are formed by seeps that were dammed inadvertently by road or railroad construction. They are usually filled with silt and muck, which is concealed beneath a dense plant cover. Soils are kept saturated for much of the year by inflow from springs.

Wildlife habitat. Ruderal wetland vegetation may harbor amphibians, although the lack of standing water makes it unlikely that they breed there. A vertebrate survey near the Palmerton zinc smelters in 1986 and 1987, six and seven years after the smelters ceased operation, showed severe effects on most amphibian populations but some species appeared more resilient than others (Storm et al. 1993). Northern dusky salamander *(Desmognathus fuscus fuscus)* was found in ravines in the plant community study area in numbers comparable to sites remote from the smelters. Smaller numbers of northern spring salamander *(Gyrinophilus porphyriticus porphyriticus)*, northern two-lined salamander *(Eurycea bislineata bislineata)*, green frog *(Rana clamitans melanota)* and pickerel frog *(Rana palustris)* were also found.

5.0 Terrestrial (upland) communities of mainly cultural origin, planted or dominated by introduced species (map symbols CT...)

5.1 Grass plantings (CTG)

Location. Lower slopes.

Characteristic species. Big bluestem *(Andropogon gerardii)*, butterfly-bush* *(Buddleja davidii*)*, common hairgrass *(Deschampsia flexuosa)*, Canada wild-rye *(Elymus canadensis* var. *canadensis)*, sheep fescue* *(Festuca ovina*)*, hard fescue* *(F. trachyphylla*)*, glade sandwort* *(Minuartia*

Grass plantings on the middle and lower mountain slopes *(upper left in both photos)* **and hairgrass–lowbush blueberry savanna on the upper slopes and ridge top** *(foreground)*

patula)*, switchgrass *(Panicum virgatum)*, little bluestem *(Schizachyrium scoparium* var. *scoparium)*, eastern gamma-grass *(Tripsacum dactyloides)*.

Area. Plant community study area total, 36 acres (15 ha); within the Refuge, 35 acres (14 ha).[8]

Ecosystem and community dynamics. Plantings consisted of eight warm-season (C_4) grasses (six native and two non-native) and six cool-season (C_3) grasses (two native and four non-native). The C_4 species were big bluestem *(Andropogon gerardii)*, sand bluestem* *(Andropogon hallii*)*, sand lovegrass* *(Eragrostis trichodes*)*, beachgrass *(Panicum amarum* var. *amarulum)*, switchgrass *(Panicum virgatum)*, little bluestem *(Schizachyrium scoparium* var. *scoparium)*, Indian-grass *(Sorghastrum nutans)* and eastern gamma-grass *(Tripsacum dactyloides)*. The C_3 species were oats* *(Avena sativa*)*, common hairgrass *(Deschampsia flexuosa)*,

Grass plantings

Canada wild-rye *(Elymus canadensis* var. *canadensis)*, sheep fescue* *(Festuca ovina*)*, hard fescue* *(Festuca trachyphylla*)* and ryegrass* *(Lolium multiflorum*)*. Only the grasses listed above under ***Characteristic species*** have survived in significant numbers. Evidently there was some contamination in the seed of sand bluestem* and sand lovegrass*, both species of the western prairies; a few small clumps of another western C_4 prairie grass,

[8] Acreage has greatly expanded since 2005, the year represented by the **Plant Communities** map (Fig. 6), mostly into areas mapped as scree nearly devoid of vegetation (3.4) and scree with moderately sparse, scattered vegetation (3.3).

blue grama* *(Bouteloua gracilis*)*, were found flowering and fruiting along the L.N.E. Trail, the only known location for this species in the wild in Pennsylvania, although it is doubtful that it will persist at the site for longer than a few years.

Wildlife habitat. The wildlife habitat values of the planted grasslands are similar to those of the hairgrass–lowbush blueberry savanna (described above). Because the area available for grass planting is large, totaling around 200 acres (80 ha) within Refuge lands, and much of it is relatively unfragmented, the grass plantings have an even higher potential to provide nesting habitat for grassland-obligate bird species (those that require large contiguous areas of habitat) such as bobolink, eastern meadowlark, grasshopper sparrow, horned lark, northern bobwhite, red-winged blackbird, savannah sparrow or vesper sparrow (see **Appendix C** for additional background). One rare species has been documented in this community, the inclined dart moth, *Dichagyris acclivis (= Richia a.)*, which feeds on switchgrass at the larval stage (Rawlins 2007, included as **Appendix D** at the end of this document).

Mixed herbaceous–shrub–scattered tree cover of mainly cultural origin

5.2 Mixed herbaceous, shrub and scattered tree cover of mainly cultural origin (CTM)

Location. Lower slopes, embankments and edges along railroad rights-of-way, Lehigh Gap Nature Center area, power-line right-of-way.

Characteristic species. This and the following (see **5.3 Sparse vegetation of mainly cultural origin**, below) have the largest number of vascular plant species of any plant cover type in the plant community study area, but most of the species are represented by few individuals and nearly half are non-native. No species is consistently dominant but local patches may be dominated by one or a few species. Among the more abundant vascular plants are red maple *(Acer rubrum* var. *rubrum)*, sweet birch *(Betula lenta)*, gray birch *(B. populifolia)*, butterfly-bush* *(Buddleja davidii*)*, spotted knapweed* *(Centaurea stobe* ssp. *micranthus*)*, hay-scented fern *(Dennstaedtia punctilobula)*, common hairgrass *(Deschampsia flexuosa)*, Canada wild-rye *(Elymus canadensis* var. *canadensis)*, sheep fescue* *(Festuca ovina*)*, plume-poppy* *(Macleaya cordata*)*, glade sandwort *(Minuartia patula)*, black-gum *(Nyssa sylvatica)*, sassafras *(Sassafras albidum)* and meadowsweet *(Spiraea latifolia)*.

Area. Plant community study area total, 22 acres (8.8 ha); within the Refuge, 12 acres (4.9 ha).

Ecosystem and community dynamics. This community type and the next one include the parts of the plant community study area that have undergone the most severe soil disturbances. They also include the areas where vegetation is regularly managed by periodic mowing and pruning (Lehigh Gap Nature Center, communication tower areas, power-line

right-of-way). Railroad construction involved massive soil disturbance and the tracks were conduits for invasion by introduced species, as seeds from distant locations were dropped by chance, dumped at trackside with loads of ties or ballast or blown out of open freight cars in the wind or the air turbulence caused by the train's motion.

5.3 Sparse vegetation of mainly cultural origin (CTS)

Location. Lower slopes, embankments and edges along railroad rights-of-way, railroad beds, Lehigh Gap Nature Center grounds, communication tower areas.

Characteristic species. This type is essentially a more sparsely vegetated variant of the preceding plant community (see **5.2 Mixed herbaceous, shrub and scattered tree cover of mainly cultural origin**, above), with bare rock, road gravel or railroad ballast accounting for 50% or more of total cover.

Area. Plant community study area total, 44 acres (18 ha); within the Refuge, 35 acres (14 ha).

Ecosystem and community dynamics. (See under **5.2 Mixed herbaceous, shrub and scattered tree cover of mainly cultural origin**, above.)

5.4 Forest/woodland of mainly cultural origin (CTW) — mapped together with red maple–mixed hardwood forest (TTM)

(For description, see **3.8 Red maple – mixed hardwood forest**, above.)

Sparse vegetation of mainly cultural origin

Forest/woodland of mainly cultural origin

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Stewardship Issues and Recommendations

Like most natural lands in eastern Pennsylvania, the land within the Lehigh Gap Refuge has been directly and indirectly affected by human activities for centuries. Cleared for wood products, regraded and built upon to support two regional rail lines, and unintentionally used as a dump for atmospheric pollution, the Refuge now suffers from the residual effects of these human endeavors. It is important to understand the various stewardship issues that now exist within the Refuge so that the site can again provide local environmental and ecological benefits and be used to safely and effectively fulfill the educational, recreational, conservation and aesthetic goals established by the owners of the property. This section will detail the stewardship issues that are affecting the Refuge and provide general recommendations for addressing each issue (see **Stewardship Features and Issues** map, Fig. 7).

Soil Contamination and Erosion Recommendations

- **Perform soil tests to determine the extent of contamination and how it varies among different areas of land within the Refuge.**
- **Test water resources within the Refuge, including ponds, streams, seeps and wetlands, to determine the extent of contamination.**
- **Determine whether any of the metals in the soil could be inhaled, ingested or absorbed by visitors—particularly children—and what if any activities (e.g., mountain biking, equestrian) might make these metals more available for assimilation by visitors.**
- **Continue the process of establishing native warm-season grasses and other native meadow plants on exposed areas to stabilize soil resources.**

SOIL CONTAMINATION AND EROSION

The most obvious stewardship issue at the Refuge is the extensive soil contamination caused by atmospheric discharge from the zinc smeltering plant across the Lehigh River during the twentieth century. The resulting toxic levels of zinc, cadmium and lead have significantly modified the natural plant communities on most of the Refuge and will be a major consideration in developing a restoration plan for the property.

This issue should also be considered as it affects the goal of using the Refuge for educational and recreational activities. Given the exposed soil condition of much of the site, there is potential for human visitors to come in contact with toxic materials. Of course, any activity that exposes visitors to toxic materials should be prohibited.

The lack of vegetation cover resulting from contamination has led to extensive loss of soil from the site. There are several large areas that lack sufficient mineral soil or organic material to support any plant cover.

HAZARDS

Residue from past human activities can often be found on natural lands. This can range from old structures (e.g., wells, foundations, fences) to scattered beer or oil cans to farm dumps filled with old fuels and pesticides. Natural lands are still often used as dumping sites for construction and landscape debris. This is not only unsightly, but can potentially introduce toxic material (asbestos, paint cans, painted wood, solvents, chemicals) or facilitate invasion by exotic vegetation into the area. To improve the aesthetic and recreational value of a property and to protect both humans and wildlife from harm, an effort should be made to prioritize and remove unsightly and potentially harmful materials and structures from natural lands.

The field surveys revealed several potential hazards within the Refuge. Outside the soil contamination issue (see **Soil Contamination** above), most of the hazards are residual structures or materials within the railroad rights-of-way. These include concrete supports, deteriorating railroad tie and concrete retaining walls, discarded railroad ties and telephone poles, storm water culverts and oil lamp reservoirs. Other potential hazards include an 8-foot by 8-foot block building (containing a buried steel tank) on the western boundary of the Refuge and a concrete cap with two upright bolts in the meadow on the east side of Mallard Pond (the westernmost pond). All of these materials and structures are either sources of hazardous material (e.g., creosote in the railroad ties and telephone poles) that could contaminate soil and water resources or attractive nuisances (retaining walls, culverts, block building, concrete supports) that could trap or injure visitors, particularly children.

Railroad oil lamp reservoir

Block building near Lehigh Tunnel

Hazards Recommendations

- **Secure or remove the block building.**
- **Determine which structures have historical significance.**
- **Remove any structure that is not of historic significance or a potential part of the educational program.**
- **Secure the oil lamp reservoirs and stormwater culverts to prevent entrance.**
- **Remove/repair retaining walls as needed.**
- **Remove old railroad ties and telephone poles.**
- **Investigate what, if anything, is under the concrete cap near the westernmost pond.**

PERPETUATION OF NATIVE GRASSLANDS

One of the features of greatest conservation value within the Refuge landscape is the extensive native grassland along the ridge top and upper northwest-facing slopes of Blue Mountain (described in **3.2 Hairgrass–lowbush blueberry savanna** and in **Appendix C**). This community is one of the largest, most intact native grasslands in the entire state and it provides valuable habitat for several bird species whose populations in the region have been declining. Unfortunately, a significant amount of the native grassland is located outside the Refuge proper, within the Appalachian Trail Corridor owned by the National Park Service and on State Game Land 217. The Park Service has discussed plans to reforest their portion of the grassland, which may exceed 80% of the total extent of the grasslands. This would destroy the ecological benefits of the native grassland and would be inappropriate on several counts:

1. There is historical documentation and additional, circumstantial evidence that the native grassland present there now was a natural community type that occurred on Blue Mountain before the zinc smelters existed. The same evidence suggests that the native grassland ecosystem persisted relatively intact in areas peripherally affected by heavy metal deposition and spread into some of the area where forests were severely damaged. Its component species are more resilient to the air and soil pollution than those of the adjacent forests.
2. Grassland habitats wholly composed of native plant species and the birds and other animal species that depend on them are in short supply in the region but young-growth mountain woods are not. The patches of native grassland on Blue Mountain from Lehigh Gap southwestward toward Lehigh Furnace Gap comprise one of the largest areas of wholly native, unplanted grassland remaining in the entire state.
3. The dominant grasses and shrubs appear to be holding the soil against erosion as well as, or better than, trees.
4. It is infeasible to grow a healthy forest—with well developed vertical structure and a level of native plant and animal species diversity comparable to an intact forest—given the present high deer density, which is unlikely to decline significantly in the foreseeable future.
5. The soil amendments that would be a part of any forest planting effort would

Native Grasslands Recommendations

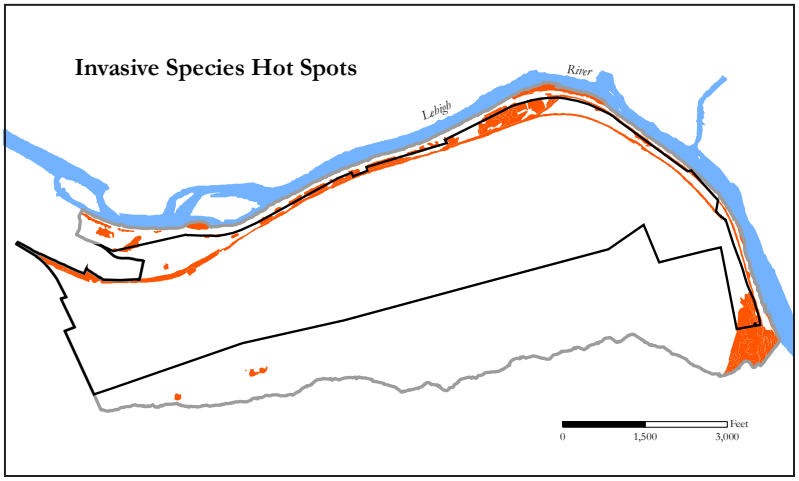
- **Educate the Park Service of the significance of the native grassland and the importance of perpetuating it.**
- **Explore the prospects for a swap of National Park Service lands with the portion of State Game Land 217 on which the current route of the Appalachian Trail runs as a means of perpetuating the native grassland.**
- **Together with the Pennsylvania Game Commission, develop a grassland management program with the goals of sustaining the current area of native grassland against encroachment by woody vegetation and invasive species, using prescribed burning and other means as needed, and of encouraging the spread of native grasslands onto adjacent areas now devoid of vegetation due to prior soil erosion.**
- **Design the program for establishing native warm-season grasses on the lower slopes of the Refuge specifically to avoid potential interference with natural processes on the existing native grasslands on the upper slopes and ridge top (e.g., by using locally collected seed of any species that already occur as native populations within the Refuge).**

lead to the proliferation of invasive non-native plants where none now occur.

6. No one actually knows how to establish a healthy, native forest ecosystem using artificial soil, or whether it is even possible to do so successfully. The "Ecoloam" reforestation project on 1,000 acres of Blue Mountain northeast of Lehigh Gap is now overwhelmingly dominated by non-native herbaceous species and shrubs, many of which are invasive. The scattered trees include both native species and non-native, invasive species, but many of the native trees there appear to be in poor condition.
7. The funds could be spent on something with a surer payoff, for instance, endowing a long-term grassland management program for the site.

The native grasslands on Blue Mountain from Lehigh Gap southwest toward Lehigh Furnace Gap should be protected and actively maintained. A conscientious effort is needed to avoid compromising their integrity in any reforestation program undertaken to remedy past damage by the zinc smelters at Palmerton.

Native grasslands on ridge top



INVASIVE PLANTS

One of the most serious problems encountered in the management of natural areas in eastern Pennsylvania—and increasingly recognized as a threat worldwide—is the presence of invasive plant species. An invasive species is one that rapidly spreads and out-competes multiple native species, in all likelihood chiefly because of the absence of the predators, pathogens and herbivores that keep it in check in its place of origin. Invasive plants have the ability to displace native vegetation, halt the natural process of succession from field to forest, and homogenize the structural and food resources of a site, thereby reducing its habitat value for native fauna, particularly migratory songbirds. They can also alter nutrient cycling, soil structure and chemistry, local hydrology, fire regimes, species diversity, habitat structural diversity, and resources available to wildlife, and they inhibit the recruitment and persistence of native species due to competition for light, nutrients and moisture.

In general invasive plants are not yet a significant problem within most of the Refuge area per se. However, they are well established on adjacent properties

Spotted knapweed on old railroad bed

Butterfly-bush on old railroad bed

Japanese stiltgrass on floodplain

including the D. & L. Trail (Delaware & Lehigh Railroad right-of-way), the riparian forest along the Lehigh River, and around the communication towers on the ridge. They are also well established along the L.N.E. Trail (Lehigh–New England Railroad right-of-way), around Osprey House and in the adjacent transmission line right-of-way. Their presence poses a threat to the ecological integrity of the Refuge and will complicate the restoration of open areas and the perpetuation of existing native plant communities.

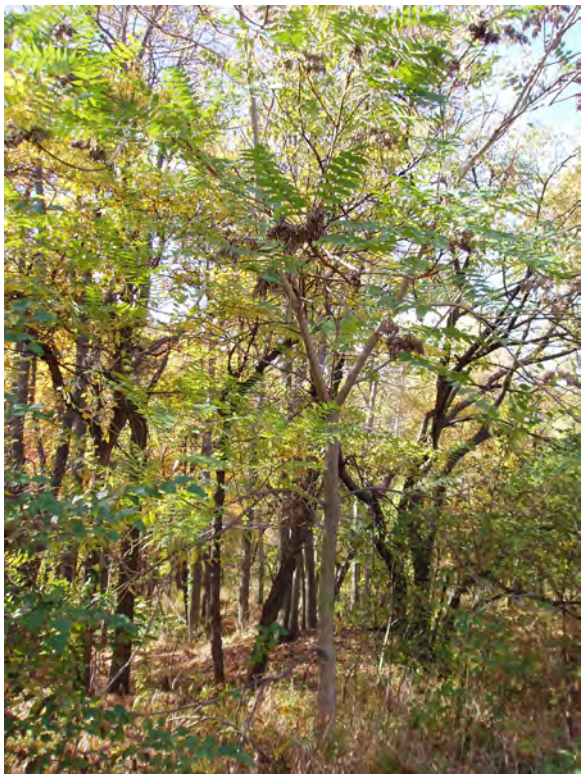
Invasive plant species encountered on or near the property include the following, listed roughly in order of the current extent of impact and future threat to native plant communities.

- **Spotted knapweed** *(Centaurea stobe* ssp. *micranthus)*: An herbaceous perennial, native to Europe, that is allelopathic, i.e., it spreads in part by releasing chemicals that stunt or kill neighboring plants. Given its location around the communications towers it is a major threat to the native grasslands along the ridge.
- **Butterfly-bush** *(Buddleja davidii)*: A tall shrub native to China that has aggressively colonized the abandoned Delaware & Lehigh Railroad right-of-way, from which it is moving into the Refuge.
- **Japanese stiltgrass** *(Microstegium vimineum)*: An herbaceous perennial native to Asia. It has moderate shade tolerance and can spread rapidly along waterways and trails in forested and open areas. Stiltgrass can modify the soil (increase pH and nitrogen) and surface environment (thick thatch) to the detriment of native plants. It is scattered throughout the floodplain forest in dense pockets.

- **Alder buckthorn** *(Rhamnus frangula)*: Shrub or small tree native to Europe and North Africa. It can aggressively colonize wet areas and displace native species. Seeds are dispersed by birds. It is well established along the railroad beds, floodplain and bottomlands surrounding the ponds.
- **Garlic mustard** *(Alliaria petiolata)*: A biennial herb native to Europe. Its moderate shade tolerance allows it to colonize disturbed areas in closed-canopy forests as well as more open areas. Recent research has shown that the species inhibits the growth and seedling establishment of many native tree, shrub and herbaceous species by interfering with their mycorrhizal fungus partners, which they depend on to compete for nutrients and water from forest soils. It is common along the railroad rights-of-way, bottomlands surrounding the ponds, and in the floodplain forest.
- **Tree-of-heaven** *(Ailanthus altissima)*: An exotic tree native to Asia that colonizes

Alder buckthorn west of the pond area

Japanese knotweed on floodplain



Ailanthus west of the pond area

Oriental bittersweet on river bank

Japanese barberry on floodplain

open areas and forest gaps and edges. It can spread by dispersal of its light seeds or through root sprouts. It is found in scattered patches on the lower slopes and floodplain.

- **Japanese knotweed** *(Falopia japonica)*: An herbaceous perennial native to Japan. Typically found along waterways, it spreads through seeds and stolons. It can be found in scattered patches on the banks of the Delaware & Lehigh Railroad bed north of Osprey House.
- **Norway maple** *(Acer platanoides)*: A large tree, native to Europe, that is extremely shade-tolerant and therefore able to monopolize the forest understory. Its dense shade prevents growth of all other plants. It is beginning to colonize the bank of the Delaware & Lehigh Railroad north of Osprey House.
- **Oriental bittersweet** *(Celastrus orbiculatus)*: A woody vine, native to Japan and China, which aggressively grows along forest edges and in open meadows. Its seeds are dispersed by birds and human collectors (the bright

Invasive Plants Recommendations

- **Develop an invasive plant management plan.**
- **Focus initial control efforts on invasive species within natural communities, including controlling oriental bittersweet, Norway maple, ailanthus, alder buckthorn, Japanese barberry and Japanese knotweed in the riparian forest.**
- **Address invasives along the old railroad beds after natural communities are stabilized and use plans are finalized.**

orange seed capsules are used for fall decorations). By growing into the tree canopy, the vine raises the center of gravity of the tree making it vulnerable to windthrow, and can stunt a tree's growth or increase its susceptibility to disease by shading its leaves. The vine grows in scattered patches along edges and within gaps of the floodplain forest.

- **Japanese barberry** *(Berberis thunbergii)*: A small shrub, native to Japan. Its fruits are consumed by birds which then deposit seeds in new areas. Barberry is found within the floodplain forest.
- **Plume-poppy** *(Macleaya cordata)*: A very large herbaceous perennial, native to eastern Asia. Patches exist along the abandoned Delaware & Lehigh Railroad bed. It forms spreading, single-species patches that shade and crowd out native vegetation.

Plume-poppy and butterfly-bush on old railroad bed

WHITE-TAILED DEER OVERABUNDANCE

There is a growing consensus among scientists and land managers that the impact of browsing by overabundant deer populations is clearly the most detrimental factor in forest decline in Pennsylvania. Even though other factors (e.g., acid precipitation) may be contributing to the problem, the lack of tree, shrub and herbaceous regeneration in forests results principally from unprecedented high populations of white-tailed deer. Deer have greatly impoverished or eliminated the shrub and herbaceous layers of many forests, eliminating habitat for birds and other wildlife that depend on an intact understory and severely reducing the carpets of native wildflowers that were formerly widespread. The removal of tree seedlings and saplings not only eliminates the defining component (canopy trees) of the future forest, it greatly amplifies the effects of other stressors by freeing up growing space to invasive plant species and making available soil water and nutrients that promote their spread.

Hay-scented fern understory (evidence of deer overabundance)

Addressing this stewardship issue will require an understanding of the effects of deer overabundance on the Refuge's plant resources. Monitoring vegetation indicators is a practical way to assess the effect of deer on natural lands and a means, over time, of determining the effectiveness of deer management strategies. Vegetation

can be assessed by two methods: (1) comparing the overall influence of deer browsing on existing vegetation to an established index or (2) quantitative sampling.

The US Forest Service and Penn State University have developed a five-level deer impact index to visually assess the level of deer influence on forest health:

Deer Impact Index 1
Very low: Occurs only within a well-maintained deer exclosure.

Deer Impact Index 2
Low: Species composition and height of regeneration is determined mainly by available light, nutrients and seed source. There is a well-developed shrub layer and native wildflowers are abundant and grow to their full size.

Deer Impact Index 3
Moderate: Evidence of browsing is common with a greater reduction in height and abundance of the most-preferred species than of the least-preferred species.

Deer Impact Index 4
High: Preferred species are sparse or absent and all plants are nearly the same height as a result of browsing. Vegetation in the shrub layer is sparse except for the least-preferred species (e.g., spicebush, American beech).

Deer Impact Index 5
Very high: A pronounced browse line is evident with virtually no vegetation below the browse line except for two rhizomatous fern species, hay-scented fern and New York fern.

The deer impact index is a qualitative measure; its utility for detecting change over intervals as short as one or two years is weak and its usefulness depends heavily on the level of experience and knowledge of the evaluator on food-plant preferences of deer, expected maximum sizes of various plant species under a variety of habitat conditions, and how to distinguish signs of deer browsing from plant damage by other animals and causes other than herbivory.

Quantitative sampling is more time-consuming but its interpretation involves less judgment and specialized expertise. A quantitative approach could include periodic surveys along a transect or cataloging vegetation change within fixed plots. The latter could be used in conjunction with the construction of deer exclosures. Methods need to be scientifically rigorous if the results are to be sufficiently credible to serve as the basis for labor-intensive and potentially costly deer management procedures. For example, the protocol should include:

- stratified random selection of areas to be sampled,
- large enough sampling plots or transects or wide enough dispersion of smaller subsampling plots within each exclosure or control area to cover the range of spatial heterogeneity,
- true replication with interspersion of treatment (exclosure) and control areas across the landscape, and

White-tailed Deer Recommendations

- **Undertake an annual or biennial monitoring program designed to track deer impacts on indicators of ecosystem health or integrity known to respond rapidly to increases and decreases in deer density.**
- **Develop a deer management program with the goal of maintaining the population consistent with deer impact level 2 that sustains threshold values of selected indicators of ecosystem health.**
- **Start a modest research and educational program focused on the effects of white-tailed deer on plant communities in the Refuge, including the construction of several demonstration deer exclosures.**

- sufficient replication for reasonably high statistical power, to increase the likelihood of early detection of relatively subtle differences.

The data gathered within sampling plots or along transects may include:

- percent cover of each plant species below 6' above ground surface (maximum height of deer browse),
- number of seedlings and saplings of each tree species, and
- special measures of indicator species (forest-floor species known to be vulnerable to deer but somewhat tolerant of moderate levels of browsing, e.g., Canada mayflower, Indian cucumber-root, and several trillium species); measures may include height of tallest plant or length of longest leaf in the plot, and number of flowering/fruiting individuals versus number of non-flowering/fruiting individuals of each indicator species in the plot.

The forested areas of the Refuge exhibit the signs of an overabundant deer population. The understory lacks adequate advanced tree regeneration (seedlings and saplings) and is often dominated by hay-scented fern (a native plant that spreads due to deer avoidance and disturbance), forest gaps are devoid of tree seedlings, and shrubs are heavily browsed. Although the soil contamination may be contributing to this problem, a high deer population is likely the main factor compromising forest health.

TRASH AND DEBRIS

The Refuge is relatively clean of residue from past human activities other than the items noted under **Hazards** above. There is scattered trash (e.g., bottles, cans, metal, tires) within the property and an old dump site exists along the upper railroad bed. The greatest concentration of trash is along the Lehigh River as the result of periodic flooding of the riparian forest. As mentioned under **Hazards** there are discarded railroad ties within the Delaware & Lehigh Railroad right-of-way. To improve the experience for future visitors, this issue should be addressed as available resources permit.

Trash and Debris Recommendations

- **Clean up scattered trash throughout the Refuge.**
- **Remove non-organic debris from the dump.**
- **Remove tire from Kingfisher Pond.**
- **Organize periodic cleanup days.**

Discarded railroad ties

Dump along upper railroad bed

GRAFFITI

The numerous rock outcrops and old railroad structures provide an attractive canvas for romantic expressions and other announcements. Like trailside trash, graffiti is not a hazard to visitors but degrades the beauty of the Refuge. Hopefully, the increase in responsible use of the property will discourage future incidents. Removal of new graffiti as quickly as possible will also discourage further occurrences.

Graffiti Recommendations

- **Remove graffiti as resources permit using environmentally safe cleaners.**
- **Monitor and address new incidents as quickly as resources permit.**

Graffiti on rock outcrop

PROPERTY BOUNDARIES

The stewardship of any property is made easier by clearly defined borders that ideally lie along a natural feature (river, stream, ridge top) or public road. Luckily, most of the Refuge borders well-marked public lands (Pennsylvania Game Commission, Pennsylvania Turnpike Commission, PennDOT, National Park Service). There are a few areas—particularly the northwestern border where there are many small lots and an in-holding—that require some attention to better define the boundaries.

Future stewardship of the property would be simplified if the in-holding eventually became part of the Refuge and the western boundary was expanded to the public road.

Property Boundary Recommendations

- **Confirm all property boundaries; survey and post as needed.**
- **Investigate acquisition potential of western in-holding and addition.**

MAINTENANCE OF RAILROAD BEDS

The existing railroad beds are supported by concrete and wood retaining walls and protected from stormwater runoff by numerous drainage structures (roadside swale, steel culverts with concrete headwalls) that move stormwater runoff around and under the beds. These structures are showing signs of deterioration and eventually their functions may be compromised, which could potentially affect the condition of the railroad beds. While it may be many years before their integrity is compromised, it would be prudent, given that the railroad beds will support much of the public use of the Refuge and adjacent D. & L. National Heritage Corridor, to assess these structures and develop a maintenance and replacement schedule for them. In addition to potential injury to staff or visitors, an unexpected structural failure could have a significant impact on public use and the Refuge budget.

Concrete and wood retaining walls
(above and right top and bottom)

Stormwater culvert

Railroad Bed Maintenance Recommendations

- **Engage a structural engineer to provide maintenance and capital replacement estimates for the support and drainage structures associated with the railroad beds.**
- **Develop an appropriate maintenance schedule to maximize the life of the support and drainage structures. Develop a capital replacement strategy as needed.**
- **As noted under *Hazards*, any structure that is not of historical or programmatic significance should be removed.**

Educational and Recreational Opportunities

The Refuge holds great promise for supporting numerous educational and recreational activities, assuming that its contaminated soil does not present a danger to visitors. Many factors contribute to the educational and recreational potential of the Refuge including its:

1. location along the Blue Mountain (Kittatinny Ridge);
2. plant resources;
3. access to national and regional trail systems;
4. extensive river access; and
5. historical land use.

Because of the many potential uses it will be necessary for the staff and board of the Refuge to determine which uses are most compatible with the conservation priorities for the site and available stewardship resources. Only those uses that directly support conservation priorities and can be monitored and controlled by available staff or volunteers should be allowed. At present, the following uses appear to be compatible with the natural resources of the Refuge. The level to which each is promoted will again depend on the conservation priorities of the Refuge and the future capacity of the Wildlife Information Center.

SECONDARY EDUCATION

The land use history of the Refuge, the impact of that use, and the ongoing restoration activities are potential topics for classroom discussion and field trips by local secondary students.

Secondary Education Recommendations

- **Inform local school districts of Refuge and its educational opportunities.**
- **Recruit and maintain contact with interested teachers in those districts.**

UNIVERSITY RESEARCH AND EDUCATION

Participation in the ecological restoration of the Refuge is a unique opportunity for local college students. Lehigh University has expressed a strong interest in using the site for field research. Dr. George Yasko and Maura Sullivan from Lehigh offered this perspective on the research and education potential of the Refuge.

"The Lehigh Gap Wildlife Refuge provides an outdoor laboratory for university students interested in learning field techniques in the environmental sciences and the chance to

observe and evaluate the dynamic interactions between earth systems and human endeavors first-hand. This site presents unique research and learning opportunities that are closely aligned with the mission of Lehigh University's Lehigh Earth Observatory (LEO). LEO is a distributed, multidisciplinary program that focuses study on the environment with a particular emphasis on understanding the science of environmental systems and the relationship between these systems and society. The Observatory, operated largely by undergraduate students in conjunction with faculty, research and technical staff, and graduate student mentors, has core facilities in Williams Hall at Lehigh University in association with the Environmental Initiative. While LEO has a focus on environmental systems, it reaches beyond the traditional bounds of science, drawing students from a variety of disciplines including policy, management, economics, journalism, business, art, and philosophy in addition to science and engineering, and attracts them to participate in observatory activities. LEO uses research-based experiential learning to expose students to a wide range of content, and to develop technical, analytical, and communication skills, thus bringing a new dimension to the curriculum.

LEO has already begun research at the Wildlife Refuge Center with the initiation of the Lehigh Gap internship in Fall 2005. The first priority of the student interns on this project is to create a comprehensive GIS basemap including the data collection of a multitude of GPS features. The next step will be to utilize this data in the analysis of broader scientific questions including the fate and transport of heavy metals. Listed in the outline below are both current projects and planned research activities continuing in the coming semesters and during summers."

Current Student Projects: GPS/GIS

Mapping

- Test Plots
- Trails
- Stewardship Issues (e.g. trash sites, oil reservoirs, retaining walls, etc)
- Parking Lots
- Seeps and Springs
- Erosion Sites
- Rare Plant and Animal Sites

Planned Research:

Heavy Metals Analysis

- Water Quality Studies (surface and groundwater)
- Metal Concentration in Plant Tissue
- Soil Studies

Economic Impact

- Human Health Issues
- Risk Assessment
- Fate and Transport Issues
- Animal Activity, Habitats, and Health

University Research and Education Recommendations

- **Continue established research and education programs with local colleges and universities, including Lehigh University, Moravian College, Muhlenberg College, University of Pennsylvania, Kutztown University, Lehigh Carbon Community College, and others.**
- **Inform other regional colleges and universities of the research and education opportunities at the Refuge to complement and expand the existing partnerships.**
- **Maintain contact with interested faculty in biology, environmental sciences and related fields at those institutions.**

D. & L. Trail on lower railroad bed

L.N.E. Trail on upper railroad bed

View from upper railroad bed looking northwest

WALKING TRAILS

Trails are a feature that can both facilitate management and enjoyment of a property and compromise management efforts and wildlife habitat. On the one hand, trails provide easier access through a natural area for management activities and recreation. On the other hand, they often serve as avenues for the spread of invasive plants and, if sufficiently wide and heavily used, they can become a barrier to the movement of some wildlife (mice, salamanders) and lead to adverse effects on nesting birds. For these reasons, trails within important natural areas should be minimized and designed to avoid sensitive resources.

A nascent trail system provides walking access throughout the lower and mid-slope areas of the Refuge (see **Trails** map, Fig. 8). The abandoned beds of the D. & L. and L.N.E. railroads run through and adjacent to the Refuge, respectively, and form the backbone of the trail system. They provide an excellent trail surface (stable, gentle

Walking Trail Recommendations

- **Monitor trails regularly to address potential hazards and erosion.**
- **Work with the D. & L. National Heritage Corridor to restore the D. & L. Railroad bed as a walking and biking trail.**
- **Determine if any species of concern are affected by existing trails; modify trail (reroute, install migration tunnels) if necessary and possible.**
- **Minimize future trails to minimize adverse effects on wildlife and sensitive plant species.**

grade) for walking and biking and link to national and regional trail systems. The D. & L. Trail (only a third of the old railroad bed is passable at this time) is the spine of the D. & L. National Heritage Corridor; currently it ends just south of the Refuge but eventually it will be 165 miles long, from Wilkes Barre to Bristol. Two internal trails—the Prairie Grass and Charcoal Trails—link the L.N.E. Trail to a loop (North Trail) and a spur (Devils Pulpit Trail) of the Appalachian Trail (A.T.) on adjacent National Park Service lands along the ridge top. The open ridge top and Refuge offers A.T. users panoramic views of the Lehigh River and the Pocono Plateau to the north.

RIVER ACCESS

The adjacent D. & L. National Heritage Corridor lands provide a direct link to the Lehigh River. A Lehigh River Water Trail access point, appropriate for canoe and kayak put-in and take-out, is located near the Osprey House (See **Stewardship Features and Issues** map, Fig. 7). In addition, the township plans to construct a river access just upstream from the Refuge. Promotion of these sites could greatly increase the amount and diversity of recreational use of the Refuge.

Proper management of the water access point will be needed to prevent degradation of the riverbank and unwarranted use of the surrounding area. Signs should be posted to inform users of what activities are and are not allowed. If use rises to a level that could lead to active erosion of the riverbank, the access point should be moved (perhaps by rotating among several sites to allow for natural stabilization periodically) or a more resistant surface created to accommodate the level of use.

Existing river access point

River Access Recommendations

- **Engage township, D. & L. National Heritage Corridor, and user groups to help monitor areas for unwarranted use.**
- **Monitor access to prevent environmental degradation; move or improve access points as needed.**

Open view of Kittatinny Ridge looking northeastward

Hawk Watching Recommendations

- **Determine extent of hawk watching preferred on the Refuge. If a significant increase is desired, explore potential to access the ridge top with the Pennsylvania Game Commission.**
- **Explore collaborative research with Pennsylvania Audubon and Hawk Mountain Sanctuary.**

HAWK WATCHING

The Kittatinny Mountain is one of the primary routes for the fall raptor migration in North America. The Refuge is a unique site along the route because it offers extensive open areas at the top of the mountain for viewing migrating birds. Because of this characteristic it has the potential to rival Hawk Mountain Sanctuary and Waggoners Gap (owned by Pennsylvania Audubon) for viewing and monitoring the raptor migration. The main hurdle for realizing this potential is access to the ridge top, which currently requires a strenuous climb on foot, via either the A.T. Access Trail from the Osprey House or the Prairie grass and Charcoal Trails that connect the L.N.E. Trail to the Appalachian Trail System on the ridge top. Expanded use by less mobile visitors would require vehicular access to the ridge top. One potential option is use the existing road in State Game Land 217 on the south side of the mountain which already provides access to the game lands for handicapped hunters. Implementing this option, however, would not only require approval by the Pennsylvania Game Commission, but also significant improvements to the road.

Major Recommendations Summary

The following table lists the major recommendations for the Lehigh Gap Wildlife Refuge, based on site visits, data collection, and research associated with the two-year study, and discussions with Refuge staff. Each recommendation has been given a priority rating based on four criteria:

1. ensuring public safety
2. fulfilling the Refuge's mission
3. ensuring the long-term financial stability of the Refuge
4. protecting and enhancing important natural resources identified through the Ecological Assessment

For the purpose of this study, priority rankings are defined as:

High: Items that relate directly to public safety and organizational liability. They should receive immediate and ongoing attention as financial resources permit.

Medium: Items that are critical to protecting and enhancing natural resources and fulfilling the educational and recreational opportunities of the Refuge. They should receive ongoing attention as staff time and financial resources permit.

Low: Items that will enhance Refuge use and stewardship, but are not, at this point, time sensitive.

Background and specific recommendations related to each of these major recommendations can be found under **Stewardship Issues and Recommendation**.

RECOMMENDATION	PRIORITY
Eliminate hazards.	High
Determine toxicity of soil and water to Refuge visitors.	High
Confirm all property boundaries; survey and post as needed.	High
Determine which structures are necessary for programmatic infrastructure or interpretation. Create a maintenance and capital replacement plan (including funding sources) for necessary structures; remove obsolete structures (secure until funding is in place to remove).	High
Continue discussions with PGC and NPS to develop a plan to protect and enhance the ridge-top native grasslands.	Medium
Continue the process of establishing native warm-season grasses on exposed areas to stabilize soil resources.	Medium
Develop an invasive plant management program with a primary focus of protecting native plant communities, including the ridge-top native grasslands, floodplain forest, and wetlands around the ponds.	Medium
Develop a deer management program.	Medium
Seek funding to complete trail system; work with D. & L. National Heritage Corridor to restore the D. & L. Railroad bed as a walking and biking trail.	Medium
Continue to explore research and education opportunities with local schools and colleges.	Medium
Clean up trash and residual debris from railroad use.	Medium
Develop interpretive materials (brochure, trail signage, etc.).	Medium
Seek additional funding for further biological surveys.	Medium
Seek funding to expand western boundary of preserve to the public road.	Low
Explore potential for hawk watch use of ridge and associated research.	Low
Remove graffiti from exposed rocks and railroad structures.	Low

Lehigh Gap Wildlife Refuge

1. USGS Quadrangles from Pennsylvania Spatial Data Access (www.pasda.psu.edu).
2. Study Area Boundary created in GIS by NLT.

This project was financed in part by a grant from the Growing Greener Fund, Community Conservation Partnerships Program under the administration of the Department of Conservation and Natural Resources, Bureau of Recreation and Conservation, PA Wild Resources Conservation Program, and the Wildlife Information Center.

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Lehigh Gap Wildlife Refuge

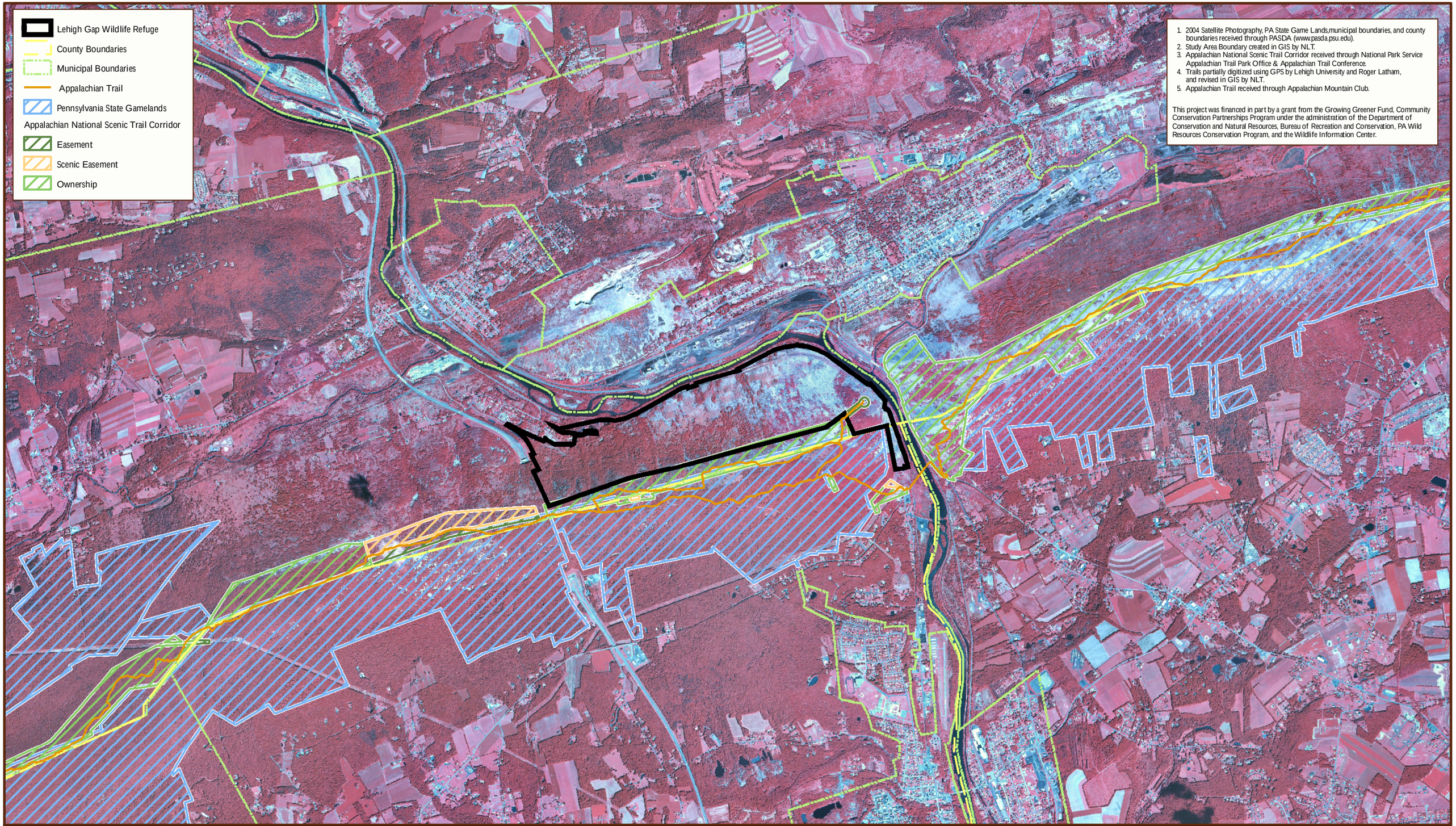
East Penn Township, Carbon County & Washington Township, Lehigh County, Pennsylvania

N

0 2,000 4,000 Feet

USGS QUADRANGLES
Figure 1

Compiled By: MEB 07/24/07



1. 2004 Satellite Photography, PA State Game Lands,municipal boundaries, and county boundaries received through PASDA (www.pasda.psu.edu).
2. Study Area Boundary created in GIS by NLT.
3. Appalachian National Scenic Trail Corridor received through National Park Service Appalachian Trail Park Office & Appalachian Trail Conference.
4. Trails partially digitized using GPS by Lehigh University and Roger Latham, and revised in GIS by NLT.
5. Appalachian Trail received through Appalachian Mountain Club.

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East Penn Township, Carbon County & Washington Township, Lehigh County, Pennsylvania

N

0 3,000 6,000 Feet

LANDSCAPE CONTEXT
Figure 2

Compiled By: MEB 07/24/07

Lehigh Gap Wildlife Refuge

County Boundaries

Municipal Boundaries

Parcel Boundaries

1. 2004 Satellite Photography, municipal boundaries, and county boundaries received through PASDA (www.pasda.psu.edu).
2. Study Area Boundary created in GIS by NLT.
3. Parcel Boundaries received through Carbon and Lehigh Counties.

This project was financed in part by a grant from the Growing Greener Fund, Community Conservation Partnerships Program under the administration of the Department of Conservation and Natural Resources, Bureau of Recreation and Conservation, PA Wild Resources Conservation Program, and the Wildlife Information Center.

Lehigh River

Lehigh Gap

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N

0 1,000 2,000 Feet

2004 AERIAL PHOTOGRAPHY
Figure 3

Compiled By: MEB 07/24/07

Lehigh Gap Wildlife Refuge

Lehigh Gap Wildlife Refuge Study Area

County Boundaries

Municipal Boundaries

Waterways

Soils

- Gc - Gibraltar 0 - 2% Slope
- HeD - Hazleton 8 - 25% Slope
- LbD - Laidig 8 - 25% Slope
- LbF - Laidig 25 - 55% Slope
- LdF - Laidig 25 - 55% Slope
- DeB - Dekalb 0 - 8% Slope
- DeF - Dekalb 25 - 100% Slope
- HaB2 - Hartleton 3 - 8% Slope (moderately eroded)
- HvD - Hazleton 8 - 25% Slope
- Hy - Holly
- KvF - Klinesville 25 - 80% Slope
- LdD - Laidig 8 - 25% Slope
- Ma - Made Land
- VeF - Very Stony Land 25 - 120% Slope

1. Municipal boundaries and county boundaries received through PASDA (www.pasda.psu.edu).
2. Study Area Boundary created in GIS by NLT.
3. Parcel Boundaries received through Carbon and Lehigh Counties.
4. Soils received through USDA NRCS.

This project was financed in part by a grant from the Growing Greener Fund, Community Conservation Partnerships Program under the administration of the Department of Conservation and Natural Resources, Bureau of Recreation and Conservation, PA Wild Resources Conservation Program, and the Wildlife Information Center.

Lehigh River

Lehigh Gap

Northampton County

Carbon County

Lehigh County

KvF
LdD
Hy
HaB2
Ma
Hy
LdD
LdD
DeF
VeF
LdF
DeB
LbF
LbD
LbD
Gc
HeD
LbD
HvD

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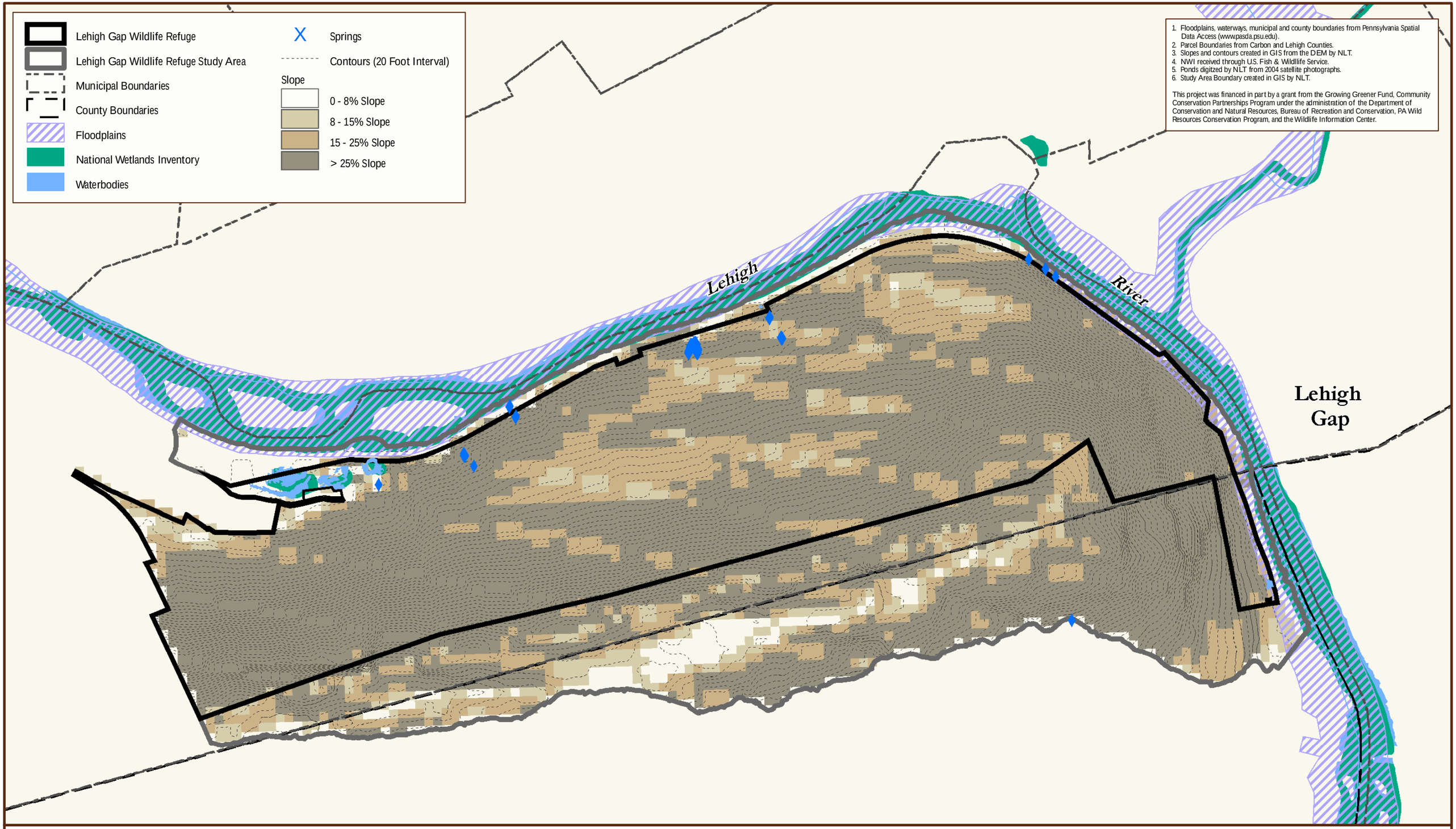
N

0 1,000 2,000 Feet

SOILS
Figure 4

Compiled By: MEB 07/27/07



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N

0 1,000 2,000 Feet

SLOPES & HYDROLOGY
Figure 5

Compiled By: MEB 07/27/07

Lehigh Gap Wildlife Refuge

Lehigh Gap Wildlife Refuge Study Area

County Boundaries

Municipal Boundaries

Waterways

Plant Communities

AP, Perennial Pond

CPP, Phragmites

CTG, Grass Plantings

CTM, Cultural Mixed

CTS, Cultural Sparse

CTW, Cultural Woods

PHS, Skunk-cabbage seep

PHW, Wet Meadow

PSB, Buttonbush

PSM, Meadowsweet

PTF, Birch - Maple Floodplain

PTM, Red Maple Swamp

THB, Bluestem - Broomsedge

THH, Hairgrass Savanna

TRS, Vegetated Scree

TRX, Bare Rock

TTB, Birch Talus Woodland

TTD, Oak - Heath

TTH, Hemlock

TTM, Red Maple - Cultural Woods

TTP, Pine - Oak

TTR, Red Oak

TTW, Oak - Hearth

1. Study Area Boundary created in GIS by NLT.
2. Parcel Boundaries received through Carbon and Lehigh Counties.
3. Plant Communities delineated by Roger Latham in 2005 & 2006 and digitized in GIS by NLT.

This project was financed in part by a grant from the Growing Greener Fund, Community Conservation Partnerships Program under the administration of the Department of Conservation and Natural Resources, Bureau of Recreation and Conservation, PA Wild Resources Conservation Program, and the Wildlife Information Center.

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Lehigh Gap Wildlife Refuge

East Penn Township, Carbon County & Washington Township, Lehigh County, Pennsylvania

N

0 1,000 2,000 Feet

PLANT COMMUNITIES (ca. 2005)
Figure 6

Compiled By: MEB 07/27/07

- Refuge Boundary
- Lehigh Gap Wildlife Refuge Study Area
- County Boundaries
- Municipal Boundaries
- Springs
- Waterbodies
- Monitoring Plots
- Monitoring Plot Markers
- Pavilion
- Old Dump
- Concrete Foundation
- Retaining Walls
- Opsrey House
- River Access
- Communication Towers
- Storm Water Culvert
- Oil Reservoirs
- Block Building
- Bridge Support
- D & L Trail
- L.N.E. Trail
- Three Ponds Trail
- Chestnut Oak Trail
- Prairie Water Trail
- Prairie Grass Trail
- Charcoal Trail
- Bobolink Trail
- AT Access Trail

Appalachian Trail System

- Appalachian Trail
- North Trail (Blue Trail)
- Devil's Pulpit Trail

1. Municipal boundaries, county boundaries, and waterways received through PASDA (www.pasda.psu.edu).
2. Study Area Boundary created in GIS by NLT.
3. Trails partially digitized using GPS by Lehigh University and Roger Latham, and revised in GIS by NLT.
4. Parcel Boundaries received through Carbon and Lehigh Counties.
5. Stewardship Issues entered into GPS by Lehigh University Students.

This project was financed in part by a grant from the Growing Greener Fund, Community Conservation Partnerships Program under the administration of the Department of Conservation and Natural Resources, Bureau of Recreation and Conservation, PA Wild Resources Conservation Program, and the Wildlife Information Center.

Water Reservoir

Lehigh River

Lehigh Gap

Kingfisher Pond

Seasonal Pond

Mallard Pond

Wood Duck Pond

Osprey House Pond

Northampton County

Carbon County

Lehigh County

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Lehigh Gap Wildlife Refuge

East Penn Township, Carbon County & Washington Township, Lehigh County, Pennsylvania

N

0 1,000 2,000 Feet

STEWARDSHIP FEATURES & ISSUES

Figure 7

Compiled By: MEB 07/24/07

Lehigh Gap Wildlife Refuge
County Boundaries
Municipal Boundaries
Waterways
Chestnut Oak Trail
Bobolink Trail
Prairie Water Trail
AT Access Trail
Prairie Grass Trail
Charcoal Trail
Three Ponds Trail
Appalachian Trail
North Trail (Blue Trail)
Devil's Pulpit Trail
D & L Trail
L.N.E. Trail

1. Municipal boundaries and county boundaries received through PASDA (www.pasda.psu.edu).
2. Trails partially digitized using GPS by Lehigh University and Roger Latham, and revised in GIS by NLT.
3. Appalachian Trail received through Appalachian Mountain Club.

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Lehigh
River
Lehigh Gap
Northampton County
Carbon County
Lehigh County

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Lehigh Gap Wildlife Refuge

East Penn Township, Carbon County & Washington Township, Lehigh County, Pennsylvania

N

0 1,000 2,000 Feet

TRAILS
Figure 8

Compiled By: MEB 07/24/07

Appendix A. Vascular flora of the Lehigh Gap Wildlife Refuge study area.

Plant taxa are arranged first by major clades; the first two are of spore-bearing vascular plants (pages A-1, A-2), the third is of non-flowering seed plants (conifers, page A-2), and the fourth, fifth and sixth are of flowering plants (magnoliids, page A-3; eudicots, pages A-3–A-20; and monocots, pages A-20–A-28). Within each clade, families are listed alphabetically. The codes for growth form, wetland status, statewide status, study area distribution, and study area abundance are explained at the end of the table (page A-29). The list is fully indexed by botanical names, synonyms and common names (beginning on page A-30). Field surveys were conducted in 2005 and 2006 by Roger Latham and Claudia Steckel, with assistance by Ann Rhoads. Nomenclature and general plant information are from the Pennsylvania Flora Project database (Rhoads and Block 2007a, 2007b).

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
lycophytes (clubmosses, spikemosses and quillworts)															
Lycopodiaceae															
Diphasiastrum digitatum (Dill. ex A.Braun) Holub	southern ground-cedar, fan clubmoss, deep-rooted running-pine	HP	FACU–	common					x						scarce
Lycopodium dendroideum Michx.	tree ground-pine, northern tree clubmoss, prickly tree clubmoss	HP	FACU	frequent					x						scarce
ferns and horsetails															
Equisetaceae															
Equisetum arvense L.	field horsetail, devil's-guts	HP	FAC	common	x			x							fairly high
Equisetum sylvaticum L.	woodland horsetail	HP	FACW	frequent						x					scarce
Lygodiaceae															
Lygodium palmatum (Bernh.) Sw.	climbing fern, Hartford fern	VP	FACW	rare				x	x						scarce
Ophioglossaceae															
Botrychium virginianum (L.) Sw.	rattlesnake fern	HP	FACU	common	x			x							scarce

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Osmundaceae															
Osmunda cinnamomea L.	cinnamon fern	HP	FACW	common	x										scarce
Osmunda claytoniana L.	interrupted fern	HP	FAC	common		x									scarce
Polypodiaceae															
Dennstaedtia punctilobula (Michx.) T.Moore	hay-scented fern	HP		common	x	x	x	x	x	x	x	x	x	x	abundant
Dryopteris carthusiana (Vill.) H.P.Fuchs	spinulose wood fern	HP	FAC+	common	x	x		x							scarce
Dryopteris cristata (L.) A.Gray	crested shield fern, crested wood fern	HP	FACW+	frequent	x			x							scarce
Dryopteris intermedia (Muhl.) A.Gray	evergreen wood fern, fancy fern	HP	FACU	common	x										scarce
Dryopteris marginalis (L.) A.Gray	marginal wood fern	HP	FACU–	common		x		x				x		x	fairly low
Onoclea sensibilis L.	sensitive fern	HP	FACW	common	x			x		x					fairly low
conifers															
Pinaceae															
Pinus rigida Mill.	pitch pine	TE	FACU	frequent		x			x	x	x	x			fairly high
Pinus strobus L.	eastern white pine	TE	FACU	common		x		x	x	x	x		x		fairly high
Pinus sylvestris L.*	Scots pine*	TE		occasional							x				scarce
Pinus virginiana Mill.	Virginia pine	TE		frequent	x			x							scarce
Pseudotsuga menziesii (Mirb.) Franco*	Douglas-fir*	TE		occasional				x							scarce
Tsuga canadensis (L.) Carriere	eastern hemlock	TE	FACU	common		x	x				x		x		fairly high

*Introduced (non-native) taxon †Tentative identification; needs to be re-collected and verified For explanation of codes, see page A-29.

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	study area abundance
magnoliids															
Lauraceae															
Lindera benzoin (L.) Blume	spicebush	SD	FACW–	common	x			x							scarce
Sassafras albidum (Nutt.) Nees	sassafras	TD	FACU–	common		x	x		x	x	x		x	x	abundant
Magnoliaceae															
Liriodendron tulipifera L.	tuliptree, yellow-poplar	TD	FACU	common				x		x					scarce
eudicots															
Adoxaceae															
Sambucus canadensis L.	American elder	SD	FACW	common	x			x						x	scarce
Sambucus racemosa L. var. *pubens* (Michx.) House	red-berried elder	SD	FACU	frequent	x	x			x	x	x	x			fairly low
Viburnum acerifolium L.	maple-leaved viburnum	SD		common		x			x						fairly low
Viburnum dentatum L.	southern arrow-wood	SD	FAC	common	x			x							scarce
Amaranthaceae															
Dysphania pumilio (R.Br.) Mosyakin & Clemants* [*Chenopodium p.* R.Br.]	clammy goosefoot, small crumbweed*	HA		very rare						x					scarce
Anacardiaceae															
Rhus copallina L. var. *latifolia* Engl.	shining sumac, dwarf sumac	SD		frequent			x								fairly low
Rhus glabra L.	smooth sumac	SD		frequent						x					fairly low
Rhus typhina L.	staghorn sumac	SD		common		x	x			x					fairly low
Toxicodendron radicans (L.) Kuntze	poison-ivy	VW	FAC	common	x	x		x	x	x					fairly low

*Introduced (non-native) taxon †Tentative identification; needs to be re-collected and verified For explanation of codes, see page A-29.

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Apiaceae															
Daucus carota L.*	Queen Anne's-lace, wild carrot*	HB		common						x					fairly low
Apocynaceae															
Apocynum androsaemifolium L.	pink dogbane, spreading dogbane	HP		common	x										scarce
Apocynum cannabinum L.	Indian-hemp	HP	FACU	common					x	x		x			scarce
Asclepias incarnata L. ssp. *incarnata*	swamp milkweed	HP	OBL	common	x			x		x					scarce
Asclepias syriaca L.	common milkweed	HP	FACU–	common	x									x	scarce
Aquifoliaceae															
Ilex montana (Torr. & A.Gray) A.Gray	mountain holly	SD		frequent		x									scarce
Ilex verticillata (L.) A.Gray	winterberry, black-alder	SD	FACW+	common	x										scarce
Araliaceae															
Aralia nudicaulis L.	wild sarsaparilla	HP	FACU	common	x	x						x			scarce
Aralia racemosa L.	spikenard	HP		occasional		x									scarce
Asteraceae															
Achillea millefolium L.*	common yarrow, milfoil*	HP	FACU	common			x			x				x	scarce
Ageratina altissima (L.) R.M.King & H.Robinson var. *altissima* [*Eupatorium rugosum* Houtt.]	common white snakeroot	HP		common	x			x		x		x			fairly low
Ambrosia artemisiifolia L.	common ragweed	HA	FACU	common	x					x		x		x	fairly low
Bidens frondosa L.	devil's beggar-ticks	HA	FACW	common	x										scarce

*Introduced (non-native) taxon †Tentative identification; needs to be re-collected and verified For explanation of codes, see page A-29.

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Carduus nutans L.*	nodding thistle, musk thistle*	HB		frequent								x		x	scarce
Centaurea stobe L. ssp. *micranthus* (S.G.Gmel. ex Gugler) Hayek.* [*C. maculosa* Lam.]	spotted knapweed, bushy knapweed*	HB		common	x			x		x		x		x	fairly low
Cirsium arvense (L.) Scop.*	Canada thistle*	HP	FACU	common	x			x		x				x	scarce
Conyza canadensis (L.) Cronquist var. *canadensis*	horseweed	HA	UPL	common						x					scarce
Crepis tectorum L.*	narrow-leaved hawk's-beard, annual hawk's-beard*	HA		very rare						x					scarce
Erechtites hieraciifolius (L.) Raf. ex DC.	fireweed, pilewort	HA	FACU	common					x	x					scarce
Erigeron philadelphicus L.	daisy fleabane	HP	FACU	frequent	x				x	x		x			scarce
Eupatorium perfoliatum L.	boneset	HP	FACW+	common	x			x		x					scarce
Eupatorium serotinum Michx.*	late eupatorium*	HP	FAC–	occasional						x					fairly low
Eurybia divaricata (L.) Nesom [*Aster divaricatus* L.]	white wood aster	HP		common						x					scarce
Euthamia graminifolia (L.) Nutt.	grass-leaved goldenrod, flat-topped goldenrod	HP	FAC	occasional	x										scarce
Eutrochium fistulosum (Barratt) E.E.Lamont [*Eupatorium f.* Barratt]	trumpetweed, hollow-stemmed joe-pye-weed	HP	FACW	common	x										scarce
Hieracium caespitosum Dumort.*	meadow hawkweed, field hawkweed, yellow king-devil*	HP		common			x		x			x		x	scarce

*Introduced (non-native) taxon †Tentative identification; needs to be re-collected and verified For explanation of codes, see page A-29.

major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Hieracium piloselloides Vill.*	tall hawkweed*	HP		occasional	x										scarce
Hieracium sabaudum L.*	New England hawkweed*	HP		occasional	x										scarce
Leucanthemum vulgare Lam.* [*Chrysanthemum leucanthemum* L.]	ox-eye daisy*	HP		common			x			x		x			scarce
Packera aurea (L.) W.A.Weber & A.Love [*Senecio aureus* L.]	golden ragwort	HP	FACW	common				x							scarce
Rudbeckia hirta L. var. *pulcherrima* Farw.	black-eyed-susan	HB / HP	FACU–	common						x					scarce
Solidago canadensis L. var. *canadensis*	Canada goldenrod	HP	FACU	occasional	x										scarce
Solidago gigantea Aiton var. *gigantea*	smooth goldenrod	HP	FACW	frequent	x		x			x		x		x	scarce
Solidago rugosa Aiton ssp. *rugosa* var. *rugosa*	wrinkle-leaf goldenrod	HP	FAC	common	x					x					scarce
Symphyotrichum lateriflorum (L.) A.Love & D.Love [*Aster lateriflorus* (L.) Britton]	calico aster	HP	FACW–	common						x					scarce
Taraxacum officinale F.H.Wigg.*	common dandelion*	HP	FACU–	common			x			x					scarce
Tussilago farfara L.*	coltsfoot*	HP	FACU	common						x					scarce
Balsaminaceae															
Impatiens capensis Meerb.	jewelweed, spotted touch-me-not	HA	FACW	common	x			x		x					fairly low
Berberidaceae															
Berberis thunbergii DC*	Japanese barberry*	SD		frequent	x	x		x		x					scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Betulaceae															
Alnus incana (L.) Moench ssp. *rugosa* (DuRoi) Clausen	speckled alder	SD		frequent	x										scarce
Alnus serrulata (Aiton) Willd.	smooth alder	SD	OBL	common	x			x							scarce
Betula lenta L.	black birch, sweet birch	TD	FACU	common		x	x		x	x	x	x			abundant
Betula nigra L.	river birch	TD	FACW	frequent	x			x		x					fairly high
Betula populifolia Marshall	gray birch	TD	FAC	common	x	x	x	x		x	x	x	x	x	abundant
Bignoniaceae															
Catalpa bignonioides Walter*	southern catalpa, Indian-bean*	TD	UPL	occasional	x			x		x				x	scarce
Boraginaceae															
Echium vulgare L.*	viper's bugloss, blueweed*	HB		frequent						x				x	scarce
Brassicaceae															
Alliaria petiolata (M.Bieb.) Cavara & Grande*	garlic-mustard*	HB	FACU–	common	x		x	x		x					fairly high
Brassica juncea (L.) Czern.*	brown mustard, Chinese mustard, leaf mustard*	HA		occasional						x				x	scarce
Cardamine bulbosa (Schreb. ex Muhl.) Britton, Stearns & Pobbenb.†	springcress, bittercress†	HP	OBL	frequent	x										scarce
Coincya monensis (L.) Greuter & Burdet*	coincya*	HA / HP		common						x					scarce
Descurainia pinnata (Walter) Britton*†	tansy-mustard*†	HA / HB		rare						x					scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Erysimum cheiranthoides L.*	worm-seed mustard, worm-seed wallflower*	HA	FAC	occasional						x					scarce
Hesperis matronalis L.*	dame's-rocket*	HP		common	x										scarce
Lepidium campestre (L.) R.Br.*	fieldcress*	HA / HB		common						x					scarce
Lepidium densiflorum Schrader*	wild pepper-grass*	HA / HB	FAC	frequent						x		x			scarce
Rorippa sylvestris (L.) Besser*	creeping yellowcress*	HP	FACW	frequent						x					scarce
Sisymbrium altissimum L.*	tumble-mustard*	HA	FACU–	frequent	x		x			x				x	scarce
Campanulaceae															
Lobelia cardinalis L.	cardinal-flower	HP	FACW+	frequent	x			x							scarce
Lobelia inflata L.	Indian-tobacco	HA	FACU	common						x					scarce
Cannabaceae															
Humulus japonicus Siebold & Zucc.*	Japanese hops*	HP	FACU	occasional										x	scarce
Caprifoliaceae															
Diervilla lonicera Mill.	bush-honeysuckle	SD		frequent		x			x						fairly high
Lonicera maackii (Rupr.) Maxim.*	Amur honeysuckle*	SD		common						x					scarce
Lonicera morrowii A.Gray*	Morrow's honeysuckle*	SD		common	x									x	scarce
Lonicera tatarica L.*	Tatarian honeysuckle*	SD	FACU	frequent						x					scarce
Caryophyllaceae															
Cerastium nutans Raf.	nodding chickweed	HA	FAC	frequent						x					scarce
Dianthus armeria L.*	Deptford pink*	HB		common			x			x		x			scarce
Minuartia patula (Michx.) Mattf.	glade sandwort, Pitcher's stitchwort	HA		occasional						x	x				fairly low

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Saponaria officinalis L.*	bouncing-bet, soapwort*	HP	FACU–	common						x					scarce
Silene vulgaris (Moench) Garcke*	bladder campion*	HP		common								x			scarce
Celastraceae															
Celastrus orbiculatus Thunb.*	oriental bittersweet*	VW	UPL	occasional				x		x					scarce
Convolvulaceae															
Calystegia sepium (L.) R.Br.	hedge bindweed	VP	FAC–	common	x										scarce
Convolvulus arvensis L.*	field bindweed*	VP		common	x										scarce
Cuscuta gronovii Willd. ex Schultz var. *latiflora* Engelm.	common dodder, scaldweed	VA		occasional	x			x							scarce
Cornaceae															
Cornus amomum Mill. ssp. *amomum*	silky dogwood, kinnikinik, red-willow	SD	FACW	common	x										scarce
Cornus florida L.	flowering dogwood	TD	FACU–	common		x									fairly low
Elaeagnaceae															
Elaeagnus umbellata Thunb.*	autumn-olive*	SD		common						x		x			scarce
Ericaceae															
Epigaea repens L.	trailing-arbutus	SE		frequent					x						scarce
Gaylussacia baccata (Wangenh) K.Koch	black huckleberry	SD	FACU	common		x			x	x	x	x			fairly low
Kalmia angustifolia L.	sheep-laurel	SE	FAC	common		x			x			x			fairly high
Kalmia latifolia L.	mountain-laurel	SE	FACU	common		x			x						fairly high
Rhododendron maximum L.	rosebay rhododendron, great-laurel	SE	FAC	common		x									scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Vaccinium angustifolium Aiton	low sweet blueberry, lowbush blueberry	SD	FACU–	common		x			x		x	x	x		abundant
Vaccinium corymbosum L.	highbush blueberry	SD	FACW–	common				x							scarce
Vaccinium pallidum Aiton	lowbush blueberry, Blue Ridge blueberry	SD		common					x						fairly low
Vaccinium stamineum L.	deerberry	SD	FACU–	frequent		x						x			fairly low
Euphorbiaceae															
Euphorbia maculata L. [*Chamaesyce m.* (L.) Small]	spotted spurge, milk-purslane	HA	FACU–	common						x					fairly low
Fabaceae															
Albizia julibrissin Durazz.*	mimosa, silktree*	TD		occasional						x					scarce
Coronilla varia L.*	crown-vetch*	HP		common						x					scarce
Desmodium canadense (L.) DC	showy tick-trefoil	HP	FAC	common						x					scarce
Lotus corniculatus L.*	bird's-foot trefoil*	HP	FACU–	frequent			x			x				x	scarce
Melilotus alba Medik.*	white sweet-clover*	HB / HA	FACU	common	x					x					scarce
Melilotus officinalis (L.) Lam.*	yellow sweet-clover*	HB / HA	FACU–	common								x			scarce
Robinia pseudoacacia L.	black locust	TD	FACU–	common						x				x	scarce
Senna marilandica (L.) Link	southern wild senna	HP	FAC+	PE; very rare						x					scarce
Trifolium arvense L.*	rabbit's-foot clover*	HA		common						x					scarce
Trifolium pratense L.*	red clover*	HP	FACU–	common						x					scarce
Trifolium repens L.*	white clover*	HP	FACU–	common						x					scarce
Fagaceae															
Castanea dentata (Marshall) Borkh.	American chestnut	TD		frequent		x			x	x			x		scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Quercus alba L.	white oak	TD		common		x		x							scarce
Quercus coccinea Muenchh.	scarlet oak	TD		common		x			x	x	x	x	x	x	fairly high
Quercus ilicifolia Wangenh.	scrub oak, bear oak	SD		frequent		x			x						fairly high
Quercus montana Willd.	chestnut oak	TD	FACW	common		x			x	x	x	x	x	x	fairly high
Quercus palustris Muenchh.	pin oak	TD	FACW	common				x							scarce
Quercus rubra L.	northern red oak	TD	FACU–	common		x			x	x	x	x	x	x	abundant
Grossulariaceae															
Ribes rotundifolium Michx.†	Appalachian gooseberry, round-leaved currant†	SD		frequent		x									scarce
Haloragaceae															
Myriophyllum aquaticum (Vell.) Verdc.*	parrot's-feather*	HP	OBL	rare			x								scarce
Myriophyllum humile (Raf.) Morong	low water-milfoil	HP	OBL	occasional				x							scarce
Hamamelidaceae															
Hamamelis virginiana L.	American witchhazel, common witchhazel	SD	FACU+	frequent		x			x	x		x			abundant
Hydrangeaceae															
Hydrangea arborescens L.	wild hydrangea, sevenbark	SD	FACU	common	x	x	x			x	x				fairly low
Hypericaceae															
Hypericum ellipticum Hook.	pale St. John's-wort	HP	OBL	frequent	x										scarce
Hypericum perforatum L.*	common St. John's-wort*	HP		common				x		x					scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Hypericum punctatum Lam.	spotted St. John's-wort	HP	FAC–	common			x								scarce
Juglandaceae															
Carya glabra (Mill.) Sweet	pignut hickory	TD	FACU–	common		x			x	x					fairly low
Carya ovata (P.Mill.) K.Koch	shagbark hickory	TD	FACU	common				x							scarce
Lamiaceae															
Collinsonia canadensis L.	horse balm, stoneroot	HP	FAC+	common	x			x							scarce
Lycopus virginicus L.	European water-horehound	HP	OBL	frequent	x			x							scarce
Mentha arvensis L.	field mint	HP	FACW	frequent	x										scarce
Nepeta cataria L.*	catnip*	HP	FACU	occasional										x	(outside)
Scutellaria lateriflora L.	mad-dog skullcap	HP	FACW+	common	x			x							scarce
Teucrium canadense L. var. *virginicum* (L.) Eaton	wild germander, wood-sage	HP	FACW	common	x										scarce
Malvaceae															
Malva neglecta Wallr.*	cheeses, common mallow*	HA / HB		common						x					scarce
Tilia americana L. var. *americana*	basswood, whitewood	TD	FACU	frequent	x	x					x				scarce
Menispermaceae															
Menispermum canadense L.	moonseed	VW	FACU	frequent						x	x				scarce
Molluginaceae															
Mollugo verticillata L.*	carpetweed*	HA	FAC	common	x										scarce
Myrsinaceae															
Anagallis arvensis L.*	scarlet pimpernel*	HA	UPL	common						x					fairly low
Lysimachia ciliata L.	fringed loosestrife	HP	FACW	frequent	x										fairly low

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Lysimachia quadrifolia L.	whorled loosestrife	HP	FACU–	common	x	x		x	x			x			abundant
Lysimachia terrestris (L.) Britton, Stearns & Poggenb.	swamp-candles	HP	OBL	common				x							scarce
Nyssaceae															
Nyssa sylvatica Marshall	blackgum, sourgum, tupelo	TD	FAC	common	x	x		x	x	x	x				abundant
Oleaceae															
Fraxinus americana L. var. *americana*	white ash	TD	FACU	common		x				x	x				fairly low
Fraxinus pennsylvanica Marshall	green ash	TD	FACW	frequent	x		x	x		x					fairly low
Onagraceae															
Circaea canadensis (L.) Hill ssp. *canadensis* (L.) Aschers. & Magnus [*C. lutetiana* L. ssp. *c.* (L.) Aschers. & Magnus]	enchanter's-nightshade	HP	FACU	common	x										scarce
Ludwigia alternifolia L.	seedbox, false loosestrife	HP	FACW+	frequent											scarce
Ludwigia palustris (L.) Elliott	marsh-purslane, marsh seedbox, water-purslane	HP	OBL	common				x							fairly low
Oenothera biennis L.	common evening-primrose, biennial evening-primrose	HB / HP	FACU–	common	x					x					fairly low
Oxalidaceae															
Oxalis stricta L.	common yellow wood-sorrel	HP	UPL	common						x					scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Papaveraceae															
Dicentra eximia (Ker-Gawl.) Torr.	wild bleeding-heart	HP		PE; very rare		x			x	x					fairly low
Macleaya cordata (Willd.) R.Br.*	plume-poppy, tree celandine*	HP		occasional						x					fairly low
Phrymaceae															
Mimulus ringens L.	Allegheny monkey-flower	HP	OBL	common				x							scarce
Phytolaccaceae															
Phytolacca americana L.	pokeweed	HP	FACU+	common	x					x					scarce
Plantaginaceae															
Callitriche heterophylla Pursh emend. Darby	two-headed water-starwort	HP	OBL	common				x							scarce
Callitriche terrestris Raf. emend. Torr.	terrestrial water-starwort	HA	FACW+	occasional				x							scarce
Chelone glabra L.	turtlehead	HP	OBL	frequent	x										scarce
Linaria vulgaris Hill*	butter-and-eggs*	HP		common						x					scarce
Penstemon digitalis Nutt. ex Sims	tall white beard-tongue	HP	FAC	common	x										scarce
Plantago lanceolata L.*	English plantain, ribgrass*	HP / HA	UPL	common	x		x	x		x		x			fairly low
Plantago major L.*	broad-leaved plantain, white-man's-foot*	HP	FACU	common	x		x	x				x			scarce
Plantago rugelii Decne.	Rugel's plantain, broad-leaved plantain	HP	FACU	common						x					scarce
Platanaceae															
Platanus occidentalis L.	sycamore	TD	FACW–	common	x										scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Plumbaginaceae															
Armeria maritima (Mill.) Willd.*	thrift*	HP		common									x		(outside)
Polygonaceae															
Fallopia convolvulus (L.) A.Love* [*Polygonum c.* L.]	black bindweed*	VA	FACU	common						x					scarce
Fallopia japonica (Hout.) Ronse Decraene* [*Polygonum cuspidatum* Sieb. & Zucc.]	Japanese knotweed, Mexican-bamboo*	HP	FACU–	common	x					x					fairly low
Fallopia scandens (L.) Holub [*Polygonum s*. L. var. *cristatum* (Engelm. & A.Gray) Gleason]	climbing false-buckwheat	VP	FAC	common	x										scarce
Persicaria amphibia (L.) S.F.Gray [*Polygonum amphibium* L. var. *emersum* Michx.]	water smartweed	HP	OBL	frequent	x										scarce
Persicaria maculosa S.F.Gray* [*Polygonum persicaria* L.]	lady's-thumb, heart's-ease*	HA	FACW	common	x										fairly low
Persicaria pensylvanica (L.) M.Gomez [*Polygonum pensylvanicum* L.]	Pennsylvania smartweed, pinkweed	HA	FACW	common	x										scarce
Persicaria punctata (Elliott) Small [*Polygonum punctatum* Ell. var. *punctatum*]	dotted smartweed, water smartweed	HP	OBL	common	x										scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Persicaria sagittata (L.) H.Gross *[Polygonum sagittatum* L.]	arrow-leaved tearthumb, scratch-grass	HA	OBL	common	x										scarce
Rumex crispus L.*	curly dock*	HP	FACU	common						x					scarce
Rumex obtusifolius L.*	bitter dock*	HP	FACU–	common				x							scarce
Portulacaceae															
Portulaca oleracea L.	purslane	HA	FAC	common			x								scarce
Ranunculaceae															
Clematis terniflora DC*	sweet autumn clematis*	VP	FACU–	occasional	x					x					scarce
Clematis virginiana L.	virgin's-bower	VP	FAC	frequent	x					x					scarce
Ranunculus hispidus Michx. var. *hispidus*	hairy buttercup	HP	FAC	common	x										scarce
Thalictrum pubescens Pursh	tall meadow-rue	HP	FACW+	common	x			x							scarce
Rhamnaceae															
Rhamnus frangula L.*	alder buckthorn*	SD		occasional	x			x		x					scarce
Rosaceae															
Agrimonia parviflora Aiton	southern agrimony	HP	FACW	frequent	x			x							scarce
Amelanchier laevis Wiegand	smooth juneberry, smooth serviceberry, smooth shadbush	TD		common	x	x	x	x	x	x	x				fairly high
Photinia melanocarpa (Michx.) K.R.Robertson & J.B.Phipps [*Aronia m.* (Michx.) Ell.]	black chokeberry	SD	FAC	common					x			x			fairly high
Physocarpus opulifolius Raf.	ninebark	SD	FACW–	frequent	x										scarce
Potentilla canadensis L.	dwarf cinquefoil	HP		common	x										scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Potentilla intermedia L.*	downy cinquefoil*	HP		rare			x								scarce
Potentilla recta L.*	sulfur cinquefoil*	HP		common						x					scarce
Potentilla simplex Michx.	old-field cinquefoil	HP	FACU–	common	x										scarce
Prunus pensylvanica L.f.	pin cherry, fire cherry	TD	FACU–	common					x			x			fairly low
Prunus serotina Ehrh.	wild black cherry	TD	FACU	common	x	x		x	x					x	fairly low
Prunus virginiana L.	choke cherry	SD / TD	FACU	frequent		x			x			x			fairly low
Rosa multiflora Thunb. ex Murray*	multiflora rose, Japanese rose*	SD	FACU	common			x								scarce
Rubus allegheniensis Porter	common blackberry	SD	FACU–	common								x			scarce
Rubus enslenii Tratt.	southern dewberry	VW	FACU	occasional	x										scarce
Rubus flagellaris Willd.	prickly dewberry, northern dewberry	VW	FACU	frequent	x										scarce
Rubus occidentalis L.	black-cap, black raspberry	SD		common										x	(outside)
Rubus odoratus L.	purple-flowering raspberry, thimbleberry	SD		common				x							scarce
Rubus phoenicolasius Maxim.*	wineberry*	SD		frequent	x									x	scarce
Sorbus americana Marshall	American mountain-ash	TD / SD	FACU	occasional					x						scarce
Spiraea latifolia (Aiton) Borkh.	meadowsweet	SD	FAC+	frequent	x	x	x	x	x	x					fairly low
Spiraea tomentosa L.	hardhack, steeple-bush	SD	FACW–	common					x						scarce
Rubiaceae															
Cephalanthus occidentalis L.	buttonbush	SD	OBL	common	x			x							fairly low
Galium aparine L.	stickywilly, cleavers	HA	FACU	common		x									scarce

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					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Galium asprellum Michx.	rough bedstraw	HP	OBL	common	x										scarce
Galium concinnum Torr. & A.Gray	shining bedstraw	HP	UPL	occasional	x										scarce
Galium odoratum (L.) Scop.*	sweet woodruff, sweet-scented bedstraw*	HP		occasional						x					scarce
Galium tinctorium L.	stiff marsh bedstraw	HP	OBL	common				x							scarce
Galium triflorum Michx.	sweet-scented bedstraw	HP	FACU	common	x			x							scarce
Salicaceae															
Populus deltoides Bartram ex Marsh.	eastern cottonwood	TD	FACU–	rare				x							scarce
Populus grandidentata Michx.	bigtooth aspen	TD	FACU–	common			x			x		x			fairly low
Populus tremuloides Michx.	quaking aspen	TD		common	x		x		x	x	x	x		x	fairly low
Salix babylonica L.	weeping willow*	TD	FACW–	occasional	x										scarce
Salix bebbiana Sarg.†	long-beaked willow, gray willow†	SD	FACW	frequent	x										scarce
Salix eriocephala Michx.	diamond willow	SD	FACW+	common						x					fairly low
Salix nigra Marshall	black willow	TD	FACW+	common	x										fairly low
Salix × *rubens* Schrank* [*S. alba* × *fragilis*]	white crack willow*	TD		occasional	x										scarce
Sapindaceae															
Acer pensylvanicum L.	striped maple, moosewood	TD	FACU	frequent		x			x	x		x			fairly low
Acer platanoides L.*	Norway maple*	TD	UPL	frequent	x										scarce
Acer rubrum L.	red maple, swamp maple	TD	FAC	common	x	x			x	x	x		x	x	abundant
Acer saccharinum L.	silver maple	TD	FACW	common	x										fairly low

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Saxifragaceae															
Saxifraga pensylvanica L. / *S. virginiensis* Michx.?†	swamp saxifrage / early saxifrage?†	HP	OBL / FAC–	common	x										scarce
Scrophulariaceae															
Buddleja davidii Franch.*	butterfly-bush, summer-lilac*	SD		occasional			x			x	x			x	fairly high
Verbascum blattaria L.*	moth mullein*	HB	UPL	common			x								scarce
Verbascum thapsus L.*	common mullein, flannel-plant*	HB		common						x				x	scarce
Simaroubaceae															
Ailanthus altissima (Mill.) Swingle*	tree-of-heaven, ailanthus*	TD	FACU–	common	x		x			x	x			x	fairly low
Solanaceae															
Solanum dulcamara L. var. *dulcamara**	trailing nightshade, bittersweet*	VW	FAC	common	x			x							scarce
Solanum nigrum L.*	black nightshade*	HA		frequent						x					scarce
Urticaceae															
Boehmeria cylindrica (L.) Sw. var. *cylindrica*	smallspike false nettle	HP	FACW+	common	x			x		x					fairly low
Urtica dioica L. ssp. *dioica*†*	stinging nettle, great nettle*†	HP	FACU	frequent	x										scarce
Urtica dioica L. ssp. *gracilis* (Aiton) Seland.	stinging nettle, great nettle	HP	FACU	common	x										scarce
Verbenaceae															
Verbena hastata L.	blue vervain, simpler's-joy	HP	FACW+	common				x		x					scarce
Violaceae															
Viola cucullata Aiton	blue marsh violet	HP	FACW+	common	x										scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Viola sagittata Aiton var. *sagittata*	arrow-leaved violet	HP	FACW	frequent								x			scarce
Vitaceae															
Parthenocissus quinquefolia (L.) Planch.	Virginia-creeper, woodbine	VW	FACU	common	x			x		x					fairly low
Vitis aestivalis Michx.†	summer grape, pigeon grape†	VW	FACU	common		x		x		x					fairly low
Vitis labrusca L.†	fox grape†	VW	FACU	frequent	x	x				x		x			fairly low
Vitis riparia Michx.	frost grape	VW	FACW	common	x										scarce
monocots															
Agavaceae															
Hosta ventricosa (Salisb.) Stearn*	blue plantain-lily*	HP		rare	x										scarce
Yucca flaccida Haw.*	Adam's-needle*	HP		occasional			x			x					scarce
Alliaceae															
Allium canadense L.	wild onion	HP	FACU	common	x										scarce
Allium vineale L.*	field garlic, wild scallions*	HP	FACU–	common	x										scarce
Araceae															
Arisaema dracontium (L.) Schott	green-dragon	HP	FACW	occasional	x										scarce
Arisaema triphyllum (L.) Schott ssp. *triphyllum*	jack-in-the-pulpit	HP	FACW–	common	x										scarce
Symplocarpus foetidus (L.) Salisb. ex W.P.C.Barton	skunk-cabbage	HP	OBL	common	x			x							fairly low
Asparagaceae															
Asparagus officinalis L.*	garden asparagus*	HP	FACU	occasional	x			x						x	scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Commelinaceae															
Commelina communis L. var. *ludens* (Miquel) C.B.Clarke*	Asiatic dayflower*	HA	FAC–	occasional	x										scarce
Cyperaceae															
Carex annectens (E.P.Bicknell) E.P.Bicknell	yellow-fruited sedge	HP	FACW	frequent				x		x					scarce
Carex argyrantha Tuck.	hay sedge, silvery sedge	HP		occasional						x					scarce
Carex atlantica Bailey ssp. *atlantica*	prickly bog sedge, Atlantic sedge	HP	FACW+	frequent	x										scarce
Carex communis Bailey	fibrous-root sedge, colonial oak sedge	HP		common						x					scarce
Carex conjuncta Boott	soft fox sedge	HP	FACW	occasional				x							scarce
Carex crinita Lam. var. *crinita*	long-hair sedge, fringed sedge	HP	OBL	frequent	x			x							scarce
Carex laxiflora Lam.†	beach wood sedge, broad loose-flower sedge†	HP	FACU	common	x										scarce
Carex lurida Wahlenb.	lurid sedge, shallow sedge	HP	OBL	common				x							scarce
Carex normalis Mack.	greater straw sedge	HP	FACU	common						x		x			scarce
Carex pensylvanica Lam.	Pennsylvania sedge	HP		common					x						scarce
Carex radiata (Wahlenb.) Small	eastern star sedge	HP		common	x			x							scarce
Carex scabrata Schwein.	eastern rough sedge	HP	OBL	frequent		x									scarce
Carex scoparia Schkuhr ex Willd.	broom sedge	HP	FACW	common				x	x	x					scarce
Carex stipata Willd. var. *stipata*†	stalk-grain sedge, owlfruit sedge†	HP		common				x							scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Carex straminea Willd.	eastern straw sedge	HP	OBL	occasional				x							scarce
Carex stricta Lam.	tussock sedge	HP	OBL	frequent	x			x							fairly low
Carex swanii (Fernald) Mack.	downy green sedge, Swan's sedge	HP	FACU	common		x									scarce
Carex tetanica Schkuhr†	stiff sedge, rigid sedge, Wood's sedge†	HP	FACW	PT; rare	x										scarce
Carex vulpinoidea Michx.	fox sedge, brown fox sedge	HP	OBL	common				x		x					scarce
Cyperus lupulinus (Sprengel) Marcks	Great Plains flatsedge, sand sedge	HP	UPL	frequent						x					scarce
Cyperus strigosus L.	false nutsedge	HP	FACW	common	x			x		x					scarce
Dulichium arundinaceum (L.) Britton var. *arundinaceum*	three-way sedge	HP	OBL	common	x			x							scarce
Eleocharis acicularis (L.) Roem. & Schult.	needle spike-rush	HP	OBL	common	x			x							scarce
Eleocharis obtusa (Willd.) Schult. var. *obtusa*	blunt spike-rush	HA	OBL	common	x			x		x					scarce
Eleocharis tenuis (Willd.) Schult. var. *tenuis*	slender spike-rush	HP	FACW+	common	x										scarce
Scirpus cyperinus (L.) Kunth	wool-grass	HP	FACW+	common	x			x							scarce
Dioscoreaceae															
Dioscorea villosa L.	wild yam	VP	FAC+	frequent	x			x							scarce
Hemerocallidaceae															
Hemerocallis fulva (L.) L.*	orange day-lily*	HP	UPL	common	x					x		x			scarce
Iridaceae															
Iris pseudacorus L.*	yellow flag, water flag, yellow iris*	HP	OBL	occasional	x										scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Iris versicolor L.	northern blue flag	HP	OBL	frequent	x										scarce
Sisyrinchium montanum Greene var. *crebrum* Fernald	mountain blue-eyed-grass	HP	FAC	occasional						x					scarce
Sisyrinchium mucronatum Michx.	needletip blue-eyed-grass	HP	FAC+	common				x							scarce
Juncaceae															
Juncus acuminatus Michx.	sharp-fruited rush	HP	OBL	frequent	x										scarce
Juncus dudleyi Wiegand	Dudley's rush	HP		occasional				x		x					scarce
Juncus effusus L. var. *solutus* Fernald & Wiegand	soft rush	HP	OBL	common				x		x					scarce
Juncus tenuis Willd. var. *tenuis*	path rush	HP	FAC–	common			x	x		x					fairly low
Luzula echinata (Small) F.J.Herm.	common woodrush	HP	FACU	frequent				x							scarce
Luzula multiflora (Ehrh.) Lej.	field woodrush	HP	FACU	common				x							scarce
Melanthiaceae															
Veratrum viride Aiton	Indian hellebore, false hellebore, Indian poke	HP	FACW+	common	x										scarce
Poaceae															
Agrostis capillaris L.*	Rhode Island bent*	HP		occasional						x					scarce
Agrostis gigantea Roth*	redtop*	HP	FACW–	occasional						x		x			fairly low
Agrostis hyemalis (Walter) Britton, Stearns & Poggenb.†	ticklegrass, spring bentgrass†	HP	FAC	rare	x										scarce
Agrostis perennans (Walter) Tuck.	autumn bentgrass, upland bentgrass	HP	FACU	common						x					fairly low

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Agrostis scabra Willd.	fly-away grass, ticklegrass, rough bentgrass	HP	FAC	occasional	x	x			x					x	scarce
Agrostis stolonifera L. var. *palustris* (Huds.) Farw.*	creeping bentgrass, carpet bentgrass*	HP	FACW	rare				x	x	x					fairly low
Andropogon gerardii Vitman	big bluestem, turkeyfoot	HP	FAC–	frequent				x	x	x					scarce
Andropogon virginicus L.	broomsedge	HP	FACU	frequent			x	x							scarce
Anthoxanthum odoratum L.*	sweet vernalgrass*	HP	FACU	common	x					x					scarce
Bouteloua gracilis (Kunth) Lag. ex Griffiths*	blue grama, eyelash grass*	HP		not naturalized						x					scarce
Brachyelytrum aristosum (Michx.) Trel.†	northern shorthusk†	HP		occasional?		x			x						scarce
Brachyelytrum erectum (Schreb.) P.Beauv.†	bearded shorthusk†	HP		common		x			x						scarce
Bromus commutatus Schrad.*	hairy chess*	HA		common								x		x	scarce
Bromus inermis Leyss.*	smooth brome*	HP		occasional										x	(outside)
Calamagrostis canadensis (Michx.) P.Beauv. var. *canadensis*	Canada bluejoint	HP	FACW+	occasional				x							fairly low
Cinna arundinacea L.	wood reedgrass	HP	FACW	frequent	x			x							fairly low
Dactylis glomerata L.*	orchardgrass*	HP	FACU	common	x			x		x					scarce
Danthonia compressa Austin	northern oatgrass	HP	FACU–	frequent							x				scarce
Danthonia spicata (L.) P.Beauv. ex Roem. & Schult.	povertygrass	HP		common			x		x		x	x			fairly high

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Deschampsia flexuosa (L.) Trin.	common hairgrass	HP		frequent		x			x	x	x	x	x		abundant
Dichanthelium acuminatum (Sw.) Gould and C.A.Clark [*Panicum a.* Swartz]	tapered rosette grass	HP	FAC	common				x			x				scarce
Dichanthelium clandestinum (L.) Gould [*Panicum c.* L.]	deer-tongue, deer-tongue grass	HP	FAC+	common	x			x		x	x				scarce
Dichanthelium linearifolium (Scribn.) Gould [*Panicum l.* Scribn.]	slim-leaved witchgrass	HP		common								x			scarce
Dichanthelium microcarpon (Muhl. Ex Elliott) Mohlenbr. [*Panicum m.* Muhl.]	small-fruited panic grass	HP	FACU	occasional				x							scarce
Digitaria sanguinalis (L.) Scop.*	northern crabgrass*	HA	FACU–	common	x					x					scarce
Echinochloa muricata (P.Beauv.) Fernald	rough barnyard-grass, cockspur	HA	FACW+	frequent	x										scarce
Elymus canadensis L. var. *canadensis*	Canada wild-rye	HP	FACU+	common	x					x					fairly high
Elymus virginicus L.	Virginia wild-rye	HP	FACW–	frequent	x										scarce
Eragrostis capillaris (L.) Nees	lacegrass	HA		common						x					fairly low
Eragrostis cilianensis (All.) F.T.Hubb.*	stinkgrass*	HA	FACU	common						x					scarce
Eragrostis frankii C.A.Mey. ex Steud.	sandbar lovegrass	HA	FACW	occasional						x					scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Eragrostis hypnoides (Lam.) Britton, Stearns & Poggenb.	creeping lovegrass	HA	OBL	occasional	x										scarce
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	HA	FAC	common						x					scarce
Eragrostis trichodes (Nutt.) Alph.Wood var. *trichodes**	sand lovegrass*	HP		not naturalized	x					x					scarce
Festuca ovina L.*	sheep fescue*	HP		occasional						x			x		scarce
Festuca trachyphylla (Hack.) Krajina*	hard fescue*	HP		very rare					x				x		scarce
Glyceria canadensis (Michx.) Trin.	rattlesnake mannagrass	HP	OBL	common				x							fairly low
Glyceria grandis S.Watson	American mannagrass	HP	OBL	occasional				x							scarce
Glyceria striata (Lam.) A.Hitchc.	fowl mannagrass	HP	OBL	common						x					scarce
Holcus lanatus L.*	velvetgrass*	HP	FACU	common						x					scarce
Leersia oryzoides (L.) Sw.	rice cutgrass	HP	OBL	common						x					fairly low
Leersia virginica Willd.	whitegrass	HP	FACW	common	x			x		x					scarce
Microstegium vimineum (Trin.) A.Camus.*	stiltgrass, Japanese stiltgrass*	HA	FAC	common	x					x					abundant
Muhlenbergia sobolifera (Muhl.) Trin.	creeping muhly	HP		occasional	x										scarce
Muhlenbergia sylvatica (Torr.) Torr. ex A.Gray	woodland muhly	HP	FAC+	occasional	x					x					scarce
Panicum dichotomiflorum Michx.	smooth panic grass	HA	FACW–	common					x	x					scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Panicum gattingeri Nash / *P. capillare* L. / *P. philadelphicum* Bernh. ex Trin.?†	Gattinger's panic grass / common witchgrass / Philadelphia panic grass?†	HA	FAC / FAC–	frequent						x					scarce
Panicum stipitatum Nash [*Panicum rigidulum* Bosc ex Nees var. *elongatum* (Pursh) Lelong]	redtop panic grass	HP	FACW+	occasional				x							scarce
Panicum virgatum L.	switchgrass	HP	FAC	common						x	x				fairly high
Phalaris arundinacea L.	reed canary-grass	HP	FACW	common	x			x						x	scarce
Phleum pratense L.*	timothy*	HP	FACU	common						x					scarce
Phragmites australis (Cav.) Trin. ex Steud. ssp. *australis*	common reed	HP	FACW	frequent				x		x				x	fairly low
Poa alsodes A.Gray	woodland bluegrass	HP	FACW–	frequent	x										scarce
Poa compressa L.*	Canada bluegrass*	HP	FACU	common						x				x	scarce
Poa pratensis L.*	Kentucky bluegrass*	HP	FACU	common						x		x		x	fairly low
Schedonorus arundinaceus (Schreb.) Dumort* [*Festuca elatior* L.]	tall fescue*	HP	FACU–	common						x		x			scarce
Schizachyrium scoparium (Michx.) Nash var. *scoparium*	little bluestem	HP	FACU	common					x	x	x				scarce
Setaria faberi Herrm.*	giant foxtail*	HA	UPL	common					x	x					scarce
Setaria pumila (Poir.) Schult.*	yellow foxtail*	HA	FAC	common						x					scarce
Sorghastrum nutans (L.) Nash	Indian-grass	HP	UPL	frequent			x	x							scarce

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major clade / family / taxon and authority	common name(s)	growth form	wetland status	statewide status	study area distribution										study area abundance
					FP	MW	NC	PV	RG	RR	SS	TT	XB	XE	
Thinopyrum intermedium (Host) Barkworth & D.R.Dewey* [*Elytrigia intermedia* (Host) Nevski]	intermediate wheatgrass*	HP		not naturalized						x				x	scarce
Tripsacum dactyloides (L.) L.	eastern gamma-grass	HP	FACW	PE; very rare						x					fairly low
Potamogetonaceae															
Potamogeton bicupulatus Fernald	snail-seed pondweed	HP	OBL	occasional					x						scarce
Potamogeton spirillus Tuck.	spiral pondweed	HP	OBL	occasional					x						scarce
Ruscaceae															
Maianthemum racemosum (L.) Link.. [*Smilacina racemosa* (L.) Desf.]	Solomon's-plume, false Solomon's-seal	HP		common	x	x			x						scarce
Polygonatum biflorum (Walter) Elliott var. *biflorum*	Solomon's-seal	HP	FACU	common	x										scarce
Smilacaceae															
Smilax glauca Walter	catbrier, cat greenbrier	VW	FACU	common	x	x			x				x		scarce
Smilax herbacea L.	carrion-flower	VP	FAC	common	x			x							scarce
Smilax rotundifolia L.	common greenbrier, round-leaved greenbrier, bullbrier	VW	FAC	common	x	x		x	x	x			x	x	fairly high
Sparganiaceae															
Sparganium americanum Nutt.	American bur-reed	HP	OBL	common				x							fairly low
Typhaceae															
Typha latifolia L.	common cat-tail	HP	OBL	frequent	x			x							scarce

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Growth form codes	
HA	herbaceous annual
HB	herbaceous biennial
HP	herbaceous perennial
SD	deciduous shrub
SE	evergreen shrub
TD	deciduous tree
TE	evergreen tree
VA	annual herbaceous vine
VP	perennial herbaceous vine
VW	woody vine

Statewide status in Pennsylvania	
common	relative frequencies in the wild statewide
frequent	
occasional	
rare	
very rare	
not naturalized	planted; not known to be persistent in the wild in Pennsylvania
PT	officially listed as threatened in Pennsylvania
PE	officially listed as endangered in Pennsylvania

Wetland status codes	
OBL	obligate wetland species
FACW	mainly wet or mesic habitats
FAC	mainly mesic habitats
FACU	mainly mesic or upland habitats
UPL	mainly upland habitats
+	wetter
–	drier

Study area distribution codes	
FP	floodplain, riverbanks
MW	mountain woodlands and forests
NC	Lehigh Gap Nature Center grounds
PV	ponds and vicinity
RG	ridge-top and upper slope grasslands
RR	railroad rights-of-way, lower slope grasslands
SS	scree slopes of mostly bare rock
TT	ridge-top transmission tower areas
XB	ridge-top barrens northeast of Lehigh Gap (outside study area; partial survey only)
XE	revegetated “Ecoloam” area northeast of of Lehigh Gap (outside study area; partial survey only)

Study area abundance (estimated over entire study area)	
abundant	> 100,000 stems
fairly high	10,000 – 100,000 stems
fairly low	1,000 – 10,000 stems
scarce	< 1,000 stems

Index to the vascular flora of Lehigh Gap Wildlife Refuge study area

*Introduced (non-native) taxon

aster, calico ..... eudicots: Asteraceae: *Symphyotrichum lateriflorum*
aster, white wood.....eudicots: Asteraceae: *Eurybia divaricata*
Atlantic sedge . monocots: Cyperaceae: *Carex atlantica* ssp. *atlantica*
autumn bentgrass ..... monocots: Poaceae: *Agrostis perennans*
autumn-olive* ..... eudicots: Elaeagnaceae: *Elaeagnus umbellata**
balm, horse..... eudicots: Lamiaceae: *Collinsonia canadensis*
barberry, Japanese* .....eudicots: Berberidaceae: *Berberis thunbergii**
barnyard-grass, rough..... monocots: Poaceae: *Echinochloa muricata*
basswood.....eudicots: Malvaceae: *Tilia americana* var. *americana*
beach wood sedge..... monocots: Cyperaceae: *Carex laxiflora*
bear oak .....eudicots: Fagaceae: *Quercus ilicifolia*
bearded shorthusk..... monocots: Poaceae: *Brachyelytrum erectum*
bedstraw, rough .....eudicots: Rubiaceae: *Galium asprellum*
bedstraw, shining..... eudicots: Rubiaceae: *Galium concinnum*
bedstraw, sweet-scented.....eudicots: Rubiaceae: *Galium triflorum*
bedstraw, sweet-scented*..... eudicots: Rubiaceae: *Galium odoratum**
beggar-ticks, devil's .....eudicots: Asteraceae: *Bidens frondosa*
bentgrass, autumn..... monocots: Poaceae: *Agrostis perennans*
bentgrass, carpet* .....
..... monocots: Poaceae: *Agrostis stolonifera* var. *palustris**
bentgrass, creeping* .....
..... monocots: Poaceae: *Agrostis stolonifera* var. *palustris**
bentgrass, rough..... monocots: Poaceae: *Agrostis scabra*
bentgrass, spring.....monocots: Poaceae: *Agrostis hyemalis*
bentgrass, upland ..... monocots: Poaceae: *Agrostis perennans*
*Berberis thunbergii** .....eudicots: Berberidaceae
Betula lenta .....eudicots: Betulaceae
Betula nigra .....eudicots: Betulaceae
Betula populifolia .....eudicots: Betulaceae
Bidens frondosa .....eudicots: Asteraceae
biennial evening-primrose ..eudicots: Onagraceae: *Oenothera biennis*
big bluestem.....monocots: Poaceae: *Andropogon gerardii*
bigtooth aspen.....eudicots: Salicaceae: *Populus grandidentata*
bindweed, black*.....eudicots: Polygonaceae: *Fallopia convolvulus**
bindweed, field* ....eudicots: Convolvulaceae: *Convolvulus arvensis**
bindweed, hedge ..... eudicots: Convolvulaceae: *Calystegia sepium*
birch, black..... eudicots: Betulaceae: *Betula lenta*
birch, gray .....eudicots: Betulaceae: *Betula populifolia*
birch, river..... eudicots: Betulaceae: *Betula nigra*
birch, sweet.....eudicots: Betulaceae: *Betula lenta*
bird's-foot trefoil*..... eudicots: Fabaceae: *Lotus corniculatus**
bitter dock*.....eudicots: Polygonaceae: *Rumex obtusifolius**
bittercress.....eudicots: Brassicaceae: *Cardamine bulbosa*
bittersweet* .....
.....eudicots: Solanaceae: *Solanum dulcamara* var. *dulcamara**
bittersweet, oriental* ..eudicots: Celastraceae: *Celastrus orbiculatus**
black bindweed* .....eudicots: Polygonaceae: *Fallopia convolvulus**
black birch .....eudicots: Betulaceae: *Betula lenta*
black cherry, wild .....eudicots: Rosaceae: *Prunus serotina*
black chokeberry .....eudicots: Rosaceae: *Photinia melanocarpa*
black huckleberry.....eudicots: Ericaceae: *Gaylussacia baccata*
black locust..... eudicots: Fabaceae: *Robinia pseudoacacia*
black nightshade* .....eudicots: Solanaceae: *Solanum nigrum**
black raspberry .....eudicots: Rosaceae: *Rubus occidentalis*
black willow .....eudicots: Salicaceae: *Salix nigra*
black-alder .....eudicots: Aquifoliaceae: *Ilex verticillata*
blackberry, common .....eudicots: Rosaceae: *Rubus allegheniensis*
black-cap .....eudicots: Rosaceae: *Rubus occidentalis*
black-eyed-susan.....
.....eudicots: Asteraceae: *Rudbeckia hirta* var. *pulcherrima*
blackgum .....eudicots: Nyssaceae: *Nyssa sylvatica*
bladder campion*.....eudicots: Caryophyllaceae: *Silene vulgaris**
bleeding-heart, wild .....eudicots: Papaveraceae: *Dicentra eximia*
blue flag, northern.....monocots: Iridaceae: *Iris versicolor*
blue grama* .....monocots: Poaceae: *Bouteloua gracilis**
blue marsh violet.....eudicots: Violaceae: *Viola cucullata*
blue plantain-lily* .....monocots: Agavaceae: *Hosta ventricosa**
Blue Ridge blueberry..... eudicots: Ericaceae: *Vaccinium pallidum*
blue vervain ..... eudicots: Verbenaceae: *Verbena hastata*
blueberry, highbush .....eudicots: Ericaceae: *Vaccinium corymbosum*
blueberry, lowbush ..... eudicots: Ericaceae: *Vaccinium angustifolium*
blueberry, lowbush ..... eudicots: Ericaceae: *Vaccinium pallidum*
blue-eyed-grass, mountain .....
.....monocots: Iridaceae: *Sisyrinchium montanum* var. *crebrum*
blue-eyed-grass, needletip.....
.....monocots: Iridaceae: *Sisyrinchium mucronatum*
bluegrass, Canada* .....monocots: Poaceae: *Poa compressa**
bluegrass, Kentucky*.....monocots: Poaceae: *Poa pratensis**

*Introduced (non-native) taxon

bluegrass, woodland ..... monocots: Poaceae: *Poa alsodes*
bluejoint, Canada ..... monocots: Poaceae: *Calamagrostis canadensis* var. *canadensis*
bluestem, big ..... monocots: Poaceae: *Andropogon gerardii*
bluestem, little ..... monocots: Poaceae: *Schizachyrium scoparium* var. *scoparium*
blueweed* ..... eudicots: Boraginaceae: *Echium vulgare**
blunt spike-rush ..... monocots: Cyperaceae: *Eleocharis obtusa* var. *obtusa*
Boehmeria cylindrica var. *cylindrica* ..... eudicots: Urticaceae
bog sedge, prickly ..... monocots: Cyperaceae: *Carex atlantica* ssp. *atlantica*
boneset ..... eudicots: Asteraceae: *Eupatorium perfoliatum*
Botrychium virginianum ..... ferns and horsetails: Ophioglossaceae
bouncing-bet* ..... eudicots: Caryophyllaceae: *Saponaria officinalis**
*Bouteloua gracilis** ..... monocots: Poaceae
Brachyelytrum aristosum ..... monocots: Poaceae
Brachyelytrum erectum ..... monocots: Poaceae
*Brassica juncea** ..... eudicots: Brassicaceae
broad loose-flower sedge ..... monocots: Cyperaceae: *Carex laxiflora*
broad-leaved plantain ..... eudicots: Plantaginaceae: *Plantago rugelii*
broad-leaved plantain* ..... eudicots: Plantaginaceae: *Plantago major**
brome, smooth* ..... monocots: Poaceae: *Bromus inermis**
*Bromus commutatus** ..... monocots: Poaceae
*Bromus inermis** ..... monocots: Poaceae
broom sedge ..... monocots: Cyperaceae: *Carex scoparia*
broomsedge ..... monocots: Poaceae: *Andropogon virginicus*
brown fox sedge ..... monocots: Cyperaceae: *Carex vulpinoidea*
brown mustard* ..... eudicots: Brassicaceae: *Brassica juncea**
buckthorn, alder* ..... eudicots: Rhamnaceae: *Rhamnus frangula**
*Buddleja davidii** ..... eudicots: Scrophulariaceae
bugloss, viper's* ..... eudicots: Boraginaceae: *Echium vulgare**
bullbrier ..... monocots: Smilacaceae: *Smilax rotundifolia*
bullbrier ..... monocots: Smilacaceae: *Smilax rotundifolia*
bur-reed, American ..... monocots: Sparganiaceae: *Sparganium americanum*
bush-honeysuckle ..... eudicots: Caprifoliaceae: *Diervilla lonicera*
bushy knapweed* ..... eudicots: Asteraceae: *Centaurea stobe* ssp. *micranthus**
butter-and-eggs* ..... eudicots: Plantaginaceae: *Linaria vulgaris**
buttercup, hairy ..... eudicots: Ranunculaceae: *Ranunculus hispidus* var. *hispidus*
butterfly-bush* ..... eudicots: Scrophulariaceae: *Buddleja davidii**
buttonbush ..... eudicots: Rubiaceae: *Cephalanthus occidentalis*
Calamagrostis canadensis var. *canadensis* ..... monocots: Poaceae
calico aster ..... eudicots: Asteraceae: *Symphyotrichum lateriflorum*
Callitriche heterophylla ..... eudicots: Plantaginaceae
Callitriche terrestris ..... eudicots: Plantaginaceae
Calystegia sepium ..... eudicots: Convolvulaceae
campion, bladder* ..... eudicots: Caryophyllaceae: *Silene vulgaris**
Canada bluegrass* ..... monocots: Poaceae: *Poa compressa**
Canada bluejoint ..... monocots: Poaceae: *Calamagrostis canadensis* var. *canadensis*
Canada goldenrod ..... eudicots: Asteraceae: *Solidago canadensis* var. *canadensis*
Canada thistle* ..... eudicots: Asteraceae: *Cirsium arvense**
Canada wild-rye ..... monocots: Poaceae: *Elymus canadensis* var. *canadensis*
canary-grass, reed ..... monocots: Poaceae: *Phalaris arundinacea*
Cardamine bulbosa ..... eudicots: Brassicaceae
cardinal-flower ..... eudicots: Campanulaceae: *Lobelia cardinalis*
*Carduus nutans** ..... eudicots: Asteraceae
Carex annectens ..... monocots: Cyperaceae
Carex argyrantha ..... monocots: Cyperaceae
Carex atlantica ssp. *atlantica* ..... monocots: Cyperaceae
Carex communis ..... monocots: Cyperaceae
Carex conjuncta ..... monocots: Cyperaceae
Carex crinita var. *crinita* ..... monocots: Cyperaceae
Carex laxiflora ..... monocots: Cyperaceae
Carex lurida ..... monocots: Cyperaceae
Carex normalis ..... monocots: Cyperaceae
Carex pensylvanica ..... monocots: Cyperaceae
Carex radiata ..... monocots: Cyperaceae
Carex scabrata ..... monocots: Cyperaceae
Carex scoparia ..... monocots: Cyperaceae
Carex stipata var. *stipata* ..... monocots: Cyperaceae
Carex straminea ..... monocots: Cyperaceae
Carex stricta ..... monocots: Cyperaceae

*Introduced (non-native) taxon

Carex swanii ..... monocots: Cyperaceae
Carex tetanica ..... monocots: Cyperaceae
Carex vulpinoidea ..... monocots: Cyperaceae
Carolina lovegrass ..... monocots: Poaceae: *Eragrostis pectinacea*
carpet bentgrass* ..... monocots: Poaceae: *Agrostis stolonifera* var. *palustris**
carpetweed* ..... eudicots: Molluginaceae: *Mollugo verticillata**
carrion-flower ..... monocots: Smilacaceae: *Smilax herbacea*
carrot, wild* ..... eudicots: Apiaceae: *Daucus carota**
Carya glabra ..... eudicots: Juglandaceae
Carya ovata ..... eudicots: Juglandaceae
Castanea dentata ..... eudicots: Fagaceae
cat greenbrier ..... monocots: Smilacaceae: *Smilax glauca*
*Catalpa bignonioides** ..... eudicots: Bignoniaceae
catalpa, southern* ..... eudicots: Bignoniaceae: *Catalpa bignonioides**
catbrier ..... monocots: Smilacaceae: *Smilax glauca*
catnip* ..... eudicots: Lamiaceae: *Nepeta cataria**
cat-tail, narrow-leaved ..... monocots: Typhaceae: *Typha latifolia*
celandine, tree* ..... eudicots: Papaveraceae: *Macleaya cordata**
*Celastrus orbiculatus** ..... eudicots: Celastraceae
*Centaurea maculosa** ..... = eudicots: Asteraceae: *Centaurea stobe* ssp. *micranthus**
Centaurea stobe ssp. *micranthus** ..... eudicots: Asteraceae
Cephalanthus occidentalis ..... eudicots: Rubiaceae
Cerastium nutans ..... eudicots: Caryophyllaceae
Chamaesyce maculata ..... = eudicots: Euphorbiaceae: *Euphorbia maculata*
cheeses* ..... eudicots: Malvaceae: *Malva neglecta**
Chelone glabra ..... eudicots: Plantaginaceae
*Chenopodium pumilio** ..... = eudicots: Amaranthaceae: *Dysphania pumilio**
cherry, choke ..... eudicots: Rosaceae: *Prunus virginiana*
cherry, fire ..... eudicots: Rosaceae: *Prunus pensylvanica*
cherry, pin ..... eudicots: Rosaceae: *Prunus pensylvanica*
chess, hairy* ..... monocots: Poaceae: *Bromus commutatus**
chestnut oak ..... eudicots: Fagaceae: *Quercus montana*
chestnut, American ..... eudicots: Fagaceae: *Castanea dentata*
chickweed, nodding ..... eudicots: Caryophyllaceae: *Cerastium nutans*
Chinese mustard* ..... eudicots: Brassicaceae: *Brassica juncea**
choke cherry ..... eudicots: Rosaceae: *Prunus virginiana*
chokeberry, black ..... eudicots: Rosaceae: *Photinia melanocarpa*
*Chrysanthemum leucanthemum** ..... = eudicots: Asteraceae: *Leucanthemum vulgare**
Cinna arundinacea ..... monocots: Poaceae
cinnamon fern ..... ferns and horsetails: Osmundaceae: *Osmunda cinnamomea*
cinquefoil, downy* ..... eudicots: Rosaceae: *Potentilla intermedia**
cinquefoil, dwarf ..... eudicots: Rosaceae: *Potentilla canadensis*
cinquefoil, old-field ..... eudicots: Rosaceae: *Potentilla simplex*
cinquefoil, sulfur* ..... eudicots: Rosaceae: *Potentilla recta**
Circaea canadensis ssp. *canadensis* ..... eudicots: Onagraceae
Circaea lutetiana ssp. *canadensis* ..... = eudicots: Onagraceae: *Circaea canadensis* ssp. *canadensis*
*Cirsium arvense** ..... eudicots: Asteraceae
clammy goosefoot* ..... eudicots: Amaranthaceae: *Dysphania pumilio**
cleavers ..... eudicots: Rubiaceae: *Galium aparine*
*Clematis terniflora** ..... eudicots: Ranunculaceae
Clematis virginiana ..... eudicots: Ranunculaceae
climbing false-buckwheat ..... eudicots: Polygonaceae: *Fallopia scandens*
climbing fern ..... ferns and horsetails: Lygodiaceae: *Lygodium palmatum*
clover, rabbit's-foot* ..... eudicots: Fabaceae: *Trifolium arvense**
clover, red* ..... eudicots: Fabaceae: *Trifolium pratense**
clover, white* ..... eudicots: Fabaceae: *Trifolium repens**
clubmoss, fan ..... lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
clubmoss, northern tree ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
clubmoss, prickly tree ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
cockspur ..... monocots: Poaceae: *Echinochloa muricata*
*Coincya monensis** ..... eudicots: Brassicaceae
coincya* ..... eudicots: Brassicaceae: *Coincya monensis**
Collinsonia canadensis ..... eudicots: Lamiaceae
colonial oak sedge ..... monocots: Cyperaceae: *Carex communis*
coltsfoot* ..... eudicots: Asteraceae: *Tussilago farfara**
Commelina communis var. *ludens** ..... monocots: Commelinaceae
common blackberry ..... eudicots: Rosaceae: *Rubus allegheniensis*

*Introduced (non-native) taxon

common cat-tail ..... monocots: Typhaceae: *Typha latifolia*
common dandelion* ..... eudicots: Asteraceae: *Taraxacum officinale**
common dodder ..... eudicots: Convolvulaceae: *Cuscuta gronovii* var. *latiflora*
common evening-primrose ..... eudicots: Onagraceae: *Oenothera biennis*
common greenbrier ..... monocots: Smilacaceae: *Smilax rotundifolia*
common hairgrass..... monocots: Poaceae: *Deschampsia flexuosa*
common mallow* ..... eudicots: Malvaceae: *Malva neglecta**
common milkweed ..... eudicots: Apocynaceae: *Asclepias syriaca*
common mullein* ... eudicots: Scrophulariaceae: *Verbascum thapsus**
common ragweed ..... eudicots: Asteraceae: *Ambrosia artemisiifolia*
common reed ..... monocots: Poaceae: *Phragmites australis* ssp. *australis*
common St. John's-wort* ..... eudicots: Hypericaceae: *Hypericum perforatum**
common white snakeroot ..... eudicots: Asteraceae: *Ageratina altissima* var. *altissima*
common witchgrass..... monocots: Poaceae: *Panicum capillare*
common witchhazel..... eudicots: Hamamelidaceae: *Hamamelis virginiana*
common woodrush ..... monocots: Juncaceae: *Luzula echinata*
common yarrow* ..... eudicots: Asteraceae: *Achillea millefolium**
common yellow wood-sorrel ..... eudicots: Oxalidaceae: *Oxalis stricta*
*Convolvulus arvensis** ..... eudicots: Convolvulaceae
Conyza canadensis var. *canadensis* ..... eudicots: Asteraceae
Cornus amomum ssp. *amomum* ..... eudicots: Cornaceae
Cornus florida..... eudicots: Cornaceae
*Coronilla varia** ..... eudicots: Fabaceae
cottonwood, eastern..... eudicots: Salicaceae: *Populus deltoides*
crabgrass, northern* ..... monocots: Poaceae: *Digitaria sanguinalis**
crack willow, white* ..... eudicots: Salicaceae: *Salix × rubens**
creeping bentgrass* ..... monocots: Poaceae: *Agrostis stolonifera* var. *palustris**
creeping lovegrass ..... monocots: Poaceae: *Eragrostis hypnoides*
creeping muhly ..... monocots: Poaceae: *Muhlenbergia sobolifera*
creeping yellowcress* ..... eudicots: Brassicaceae: *Rorippa sylvestris**
*Crepis tectorum** ..... eudicots: Asteraceae
crested shield fern ..... ferns and horsetails: Polypodiaceae: *Dryopteris cristata*
crested wood fern ..... ferns and horsetails: Polypodiaceae: *Dryopteris cristata*
crown-vetch* ..... eudicots: Fabaceae: *Coronilla varia**
crumbweed, small* .... eudicots: Amaranthaceae: *Dysphania pumilio**
curly dock* ..... eudicots: Polygonaceae: *Rumex crispus**
currant, round-leaved ..... eudicots: Grossulariaceae: *Ribes rotundifolium*
Cuscuta gronovii var. *latiflora*..... eudicots: Convolvulaceae
cutgrass, rice..... monocots: Poaceae: *Leersia oryzoides*
Cyperus lupulinus ..... monocots: Cyperaceae
Cyperus strigosus..... monocots: Cyperaceae
*Dactylis glomerata** ..... monocots: Poaceae
daisy fleabane..... eudicots: Asteraceae: *Erigeron philadelphicus*
daisy, ox-eye* ..... eudicots: Asteraceae: *Leucanthemum vulgare**
dame's-rocket* ..... eudicots: Brassicaceae: *Hesperis matronalis**
dandelion, common* ..... eudicots: Asteraceae: *Taraxacum officinale**
Danthonia compressa ..... monocots: Poaceae
Danthonia spicata ..... monocots: Poaceae
*Daucus carota** ..... eudicots: Apiaceae
dayflower, Asiatic* ..... monocots: Commelinaceae: *Commelina communis* var. *ludens**
day-lily, orange* ..... monocots: Hemerocallidaceae: *Hemerocallis fulva**
deep-rooted running-pine ..... lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
deerberry..... eudicots: Ericaceae: *Vaccinium stamineum*
deer-tongue grass ... monocots: Poaceae: *Dichanthelium clandestinum*
deer-tongue..... monocots: Poaceae: *Dichanthelium clandestinum*
Dennstaedtia punctilobula ..... ferns and horsetails: Polypodiaceae
Deptford pink* ..... eudicots: Caryophyllaceae: *Dianthus armeria**
Deschampsia flexuosa ..... monocots: Poaceae
*Descurainia pinnata** ..... eudicots: Brassicaceae
Desmodium canadense ..... eudicots: Fabaceae
devil's beggar-ticks..... eudicots: Asteraceae: *Bidens frondosa*
devil's-guts ..... ferns and horsetails: Equisetaceae: *Equisetum arvense*
dewberry, northern..... eudicots: Rosaceae: *Rubus flagellaris*
dewberry, prickly ..... eudicots: Rosaceae: *Rubus flagellaris*

*Introduced (non-native) taxon

dewberry, southern ..... eudicots: Rosaceae: *Rubus enslenii*
diamond willow .....eudicots: Salicaceae: *Salix eriocephala*
*Dianthus armeria** .....eudicots: Caryophyllaceae
Dicentra eximia ..... eudicots: Papaveraceae
Dichanthelium acuminatum .....monocots: Poaceae
Dichanthelium clandestinum .....monocots: Poaceae
Dichanthelium linearifolium.....monocots: Poaceae
Dichanthelium microcarpon .....monocots: Poaceae
Diervilla lonicera .....eudicots: Caprifoliaceae
*Digitaria sanguinalis** .....monocots: Poaceae
Dioscorea villosa..... monocots: Dioscoreaceae
Diphasiastrum digitatum ..... lycophytes: Lycopodiaceae
dock, bitter* ..... eudicots: Polygonaceae: *Rumex obtusifolius**
dock, curly* .....eudicots: Polygonaceae: *Rumex crispus**
dodder, common .....
.....eudicots: Convolvulaceae: *Cuscuta gronovii* var. *latiflora*
dogbane, pink.. eudicots: Apocynaceae: *Apocynum androsaemifolium*
dogbane, spreading.....
..... eudicots: Apocynaceae: *Apocynum androsaemifolium*
dogwood, flowering ..... eudicots: Cornaceae: *Cornus florida*
dogwood, silky .eudicots: Cornaceae: *Cornus amomum* ssp. *amomum*
dotted smartweed..... eudicots: Polygonaceae: *Persicaria punctata*
Douglas-fir* ..... conifers: Pinaceae: *Pseudotsuga menziesii**
downy cinquefoil*..... eudicots: Rosaceae: *Potentilla intermedia**
downy green sedge .....monocots: Cyperaceae: *Carex swanii*
Dryopteris carthusiana .....ferns and horsetails: Polypodiaceae
Dryopteris cristata .....ferns and horsetails: Polypodiaceae
Dryopteris intermedia .....ferns and horsetails: Polypodiaceae
Dryopteris marginalis .....ferns and horsetails: Polypodiaceae
Dudley's rush.....monocots: Juncaceae: *Juncus dudleyi*
Dulichium arundinaceum var. *arundinaceum* ..monocots: Cyperaceae
dwarf cinquefoil.....eudicots: Rosaceae: *Potentilla canadensis*
dwarf sumac.... eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
*Dysphania pumilio** .....eudicots: Amaranthaceae
early low blueberry.....eudicots: Ericaceae: *Vaccinium angustifolium*
early saxifrage..... eudicots: Saxifragaceae: *Saxifraga virginiensis*
eastern cottonwood..... eudicots: Salicaceae: *Populus deltoides*
eastern gamma-grass .....monocots: Poaceae: *Tripsacum dactyloides*
eastern hemlock ..... conifers: Pinaceae: *Tsuga canadensis*
eastern rough sedge.....monocots: Cyperaceae: *Carex scabrata*
eastern star sedge .....monocots: Cyperaceae: *Carex radiata*
eastern straw sedge .....monocots: Cyperaceae: *Carex straminea*
eastern white pine .....conifers: Pinaceae: *Pinus strobus*
Echinochloa muricata ..... monocots: Poaceae
*Echium vulgare** .....eudicots: Boraginaceae
*Elaeagnus umbellata** .....eudicots: Elaeagnaceae
elder, American ..... eudicots: Adoxaceae: *Sambucus canadensis*
elder, red-berried.....
..... eudicots: Adoxaceae: *Sambucus racemosa* var. *pubens*
Eleocharis acicularis .....monocots: Cyperaceae
Eleocharis obtusa var. *obtusa* .....monocots: Cyperaceae
Eleocharis tenuis var. *tenuis* .....monocots: Cyperaceae
Elymus canadensis var. *canadensis* ..... monocots: Poaceae
Elymus virginicus..... monocots: Poaceae
*Elytrigia intermedia** .....
..... = monocots: Poaceae: *Thinopyrum intermedium**
enchanter's-nightshade .....
..... eudicots: Onagraceae: *Circaea canadensis* ssp. *canadensis*
English plantain* ..... eudicots: Plantaginaceae: *Plantago lanceolata**
Epigaea repens..... eudicots: Ericaceae
Equisetum arvense ..... ferns and horsetails: Equisetaceae
Equisetum sylvaticum ..... ferns and horsetails: Equisetaceae
Eragrostis capillaris ..... monocots: Poaceae
*Eragrostis cilianensis** ..... monocots: Poaceae
Eragrostis frankii..... monocots: Poaceae
Eragrostis hypnoides ..... monocots: Poaceae
Eragrostis pectinacea ..... monocots: Poaceae
Eragrostis trichodes var. *trichodes** ..... monocots: Poaceae
Erechtites hieraciifolius ..... eudicots: Asteraceae
Erigeron philadelphicus ..... eudicots: Asteraceae
*Erysimum cheiranthoides** .....eudicots: Brassicaceae
Eupatorium fistulosum.....
.....= eudicots: Asteraceae: *Eutrochium fistulosum*
Eupatorium perfoliatum ..... eudicots: Asteraceae
Eupatorium rugosum .....
..... = eudicots: Asteraceae: *Ageratina altissima* var. *altissima*
*Eupatorium serotinum** ..... eudicots: Asteraceae
eupatorium, late* ..... eudicots: Asteraceae: *Eupatorium serotinum**

*Introduced (non-native) taxon

Euphorbia maculata ..... eudicots: Euphorbiaceae
European water-horehound .. eudicots: Lamiaceae: *Lycopus virginicus*
Eurybia divaricata ..... eudicots: Asteraceae
Euthamia graminifolia ..... eudicots: Asteraceae
Eutrochium fistulosum ..... eudicots: Asteraceae
evening-primrose, biennial .....
..... eudicots: Onagraceae: *Oenothera biennis*
evening-primrose, common .....
..... eudicots: Onagraceae: *Oenothera biennis*
evergreen wood fern .....
..... ferns and horsetails: Polypodiaceae: *Dryopteris intermedia*
eyelash grass* ..... monocots: Poaceae: *Bouteloua gracilis**
*Fallopia convolvulus** ..... eudicots: Polygonaceae
*Fallopia japonica** ..... eudicots: Polygonaceae
Fallopia scandens ..... eudicots: Polygonaceae
false hellebore ..... monocots: Melanthiaceae: *Veratrum viride*
false loosestrife ..... eudicots: Onagraceae: *Ludwigia alternifolia*
false nettle, smallspike .....
..... eudicots: Urticaceae: *Boehmeria cylindrica* var. *cylindrica*
false nutsedge ..... monocots: Cyperaceae: *Cyperus strigosus*
false-buckwheat, climbing .....
..... eudicots: Polygonaceae: *Fallopia scandens*
fan clubmoss .. lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
fancy fern .....
..... ferns and horsetails: Polypodiaceae: *Dryopteris intermedia*
fern, cinnamon .....
..... ferns and horsetails: Osmundaceae: *Osmunda cinnamomea*
fern, climbing .....
..... ferns and horsetails: Lygodiaceae: *Lygodium palmatum*
fern, fancy .....
..... ferns and horsetails: Polypodiaceae: *Dryopteris intermedia*
fern, Hartford .....
..... ferns and horsetails: Lygodiaceae: *Lygodium palmatum*
fern, hay-scented .....
..... ferns and horsetails: Polypodiaceae: *Dennstaedtia punctilobula*
fern, interrupted .....
..... ferns and horsetails: Osmundaceae: *Osmunda claytoniana*
fern, rattlesnake .....
..... ferns and horsetails: Ophioglossaceae: *Botrychium virginianum*
fern, sensitive .....
..... ferns and horsetails: Polypodiaceae: *Onoclea sensibilis*
fescue, hard* ..... monocots: Poaceae: *Festuca trachyphylla**
fescue, sheep* ..... monocots: Poaceae: *Festuca ovina**
fescue, tall* ..... monocots: Poaceae: *Schedonorus arundinaceus**
*Festuca elatior** .. = monocots: Poaceae: *Schedonorus arundinaceus**
*Festuca ovina** ..... monocots: Poaceae
*Festuca trachyphylla** ..... monocots: Poaceae
fibrous-root sedge ..... monocots: Cyperaceae: *Carex communis*
field bindweed* ..... eudicots: Convolvulaceae: *Convolvulus arvensis**
field garlic* ..... monocots: Alliaceae: *Allium vineale**
field hawkweed* ..... eudicots: Asteraceae: *Hieracium caespitosum**
field horsetail .. ferns and horsetails: Equisetaceae: *Equisetum arvense*
field mint ..... eudicots: Lamiaceae: *Mentha arvensis*
field woodrush ..... monocots: Juncaceae: *Luzula multiflora*
fieldcress* ..... eudicots: Brassicaceae: *Lepidium campestre**
fire cherry ..... eudicots: Rosaceae: *Prunus pensylvanica*
fireweed ..... eudicots: Asteraceae: *Erechtites hieraciifolius*
flag, water* ..... monocots: Iridaceae: *Iris pseudacorus**
flag, yellow* ..... monocots: Iridaceae: *Iris pseudacorus**
flannel-plant* ..... eudicots: Scrophulariaceae: *Verbascum thapsus**
flat-topped goldenrod .... eudicots: Asteraceae: *Euthamia graminifolia*
fleabane, daisy ..... eudicots: Asteraceae: *Erigeron philadelphicus*
flowering dogwood ..... eudicots: Cornaceae: *Cornus florida*
fly-away grass ..... monocots: Poaceae: *Agrostis scabra*
fowl mannagrass ..... monocots: Poaceae: *Glyceria striata*
fox grape ..... eudicots: Vitaceae: *Vitis labrusca*
fox sedge ..... monocots: Cyperaceae: *Carex vulpinoidea*
fox sedge, brown ..... monocots: Cyperaceae: *Carex vulpinoidea*
fox sedge, soft ..... monocots: Cyperaceae: *Carex conjuncta*
foxtail, giant* ..... monocots: Poaceae: *Setaria faberi**
foxtail, yellow* ..... monocots: Poaceae: *Setaria pumila**
Fraxinus americana var. *americana* ..... eudicots: Oleaceae
Fraxinus pennsylvanica ..... eudicots: Oleaceae
fringed loosestrife ..... eudicots: Myrsinaceae: *Lysimachia ciliata*
fringed sedge ..... monocots: Cyperaceae: *Carex crinita* var. *crinita*
frost grape ..... eudicots: Vitaceae: *Vitis riparia*
Galium aparine ..... eudicots: Rubiaceae
Galium asprellum ..... eudicots: Rubiaceae

*Introduced (non-native) taxon

Galium concinnum ..... eudicots: Rubiaceae
*Galium odoratum** ..... eudicots: Rubiaceae
Galium tinctorium ..... eudicots: Rubiaceae
Galium triflorum..... eudicots: Rubiaceae
gamma-grass, eastern .....monocots: Poaceae: *Tripsacum dactyloides*
garden asparagus* .. monocots: Asparagaceae: *Asparagus officinalis**
garlic, field*..... monocots: Alliaceae: *Allium vineale**
garlic-mustard*..... eudicots: Brassicaceae: *Alliaria petiolata**
Gattinger's panic grass..... monocots: Poaceae: *Panicum gattingeri*
Gaylussacia baccata .....eudicots: Ericaceae
germander, wild.....
.....eudicots: Lamiaceae: *Teucrium canadense* var. *virginicum*
giant foxtail*..... monocots: Poaceae: *Setaria faberi**
glade sandwort.....eudicots: Caryophyllaceae: *Minuartia patula*
Glyceria canadensis .....monocots: Poaceae
Glyceria grandis.....monocots: Poaceae
Glyceria striata.....monocots: Poaceae
golden ragwort.....eudicots: Asteraceae: *Packera aurea*
goldenrod, Canada.....
.....eudicots: Asteraceae: *Solidago canadensis* var. *canadensis*
goldenrod, flat-topped ... eudicots: Asteraceae: *Euthamia graminifolia*
goldenrod, grass-leaved .....
..... eudicots: Asteraceae: *Euthamia graminifolia*
goldenrod, smooth .....
.....eudicots: Asteraceae: *Solidago gigantea* var. *gigantea*
goldenrod, wrinkle-leaf.....
.....eudicots: Asteraceae: *Solidago rugosa* ssp. *rugosa* var. *rugosa*
gooseberry, Appalachian.....
.....eudicots: Grossulariaceae: *Ribes rotundifolium*
goosefoot, clammy* ...eudicots: Amaranthaceae: *Dysphania pumilio**
grama, blue* .....monocots: Poaceae: *Bouteloua gracilis**
grape, fox .....eudicots: Vitaceae: *Vitis labrusca*
grape, frost ..... eudicots: Vitaceae: *Vitis riparia*
grape, pigeon.....eudicots: Vitaceae: *Vitis aestivalis*
grape, summer .....eudicots: Vitaceae: *Vitis aestivalis*
grass, deer-tongue...monocots: Poaceae: *Dichanthelium clandestinum*
grass, eyelash* .....monocots: Poaceae: *Bouteloua gracilis**
grass, fly-away..... monocots: Poaceae: *Agrostis scabra*
grass, small-fruited panic .....
.....monocots: Poaceae: *Dichanthelium microcarpon*
grass-leaved goldenrod ..eudicots: Asteraceae: *Euthamia graminifolia*
gray birch.....eudicots: Betulaceae: *Betula populifolia*
gray willow.....eudicots: Salicaceae: *Salix bebbiana*
great nettle .....eudicots: Urticaceae: *Urtica dioica* ssp. *gracilis*
great nettle* .....eudicots: Urticaceae: *Urtica dioica* ssp. *dioica**
Great Plains flatsedge .....monocots: Cyperaceae: *Cyperus lupulinus*
greater straw sedge ..... monocots: Cyperaceae: *Carex normalis*
great-laurel .....eudicots: Ericaceae: *Rhododendron maximum*
green ash.....eudicots: Oleaceae: *Fraxinus pennsylvanica*
green sedge, downy ..... monocots: Cyperaceae: *Carex swanii*
greenbrier, cat..... monocots: Smilacaceae: *Smilax glauca*
greenbrier, common.....monocots: Smilacaceae: *Smilax rotundifolia*
greenbrier, round-leaved .....
.....monocots: Smilacaceae: *Smilax rotundifolia*
green-dragon .....monocots: Araceae: *Arisaema dracontium*
ground-cedar, southern .....
.....lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
ground-pine, tree .....
..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
hairgrass, common .....monocots: Poaceae: *Deschampsia flexuosa*
hairy buttercup .....
.....eudicots: Ranunculaceae: *Ranunculus hispidus* var. *hispidus*
hairy chess* .....monocots: Poaceae: *Bromus commutatus**
Hamamelis virginiana .....eudicots: Hamamelidaceae
hard fescue* .....monocots: Poaceae: *Festuca trachyphylla**
hardhack ..... eudicots: Rosaceae: *Spiraea tomentosa*
Hartford fern.....
.....ferns and horsetails: Lygodiaceae: *Lygodium palmatum*
hawk's-beard, annual*.....eudicots: Asteraceae: *Crepis tectorum**
hawk's-beard, narrow-leaved* .....
.....eudicots: Asteraceae: *Crepis tectorum**
hawkweed, field* ..... eudicots: Asteraceae: *Hieracium caespitosum**
hawkweed, meadow*.....
..... eudicots: Asteraceae: *Hieracium caespitosum**
hawkweed, tall* .....eudicots: Asteraceae: *Hieracium piloselloides**
hay sedge ..... monocots: Cyperaceae: *Carex argyrantha*

*Introduced (non-native) taxon

hay-scented fern..... ferns and horsetails: Polypodiaceae: *Dennstaedtia punctilobula*
heart's-ease* .....eudicots: Polygonaceae: *Persicaria maculosa**
hedge bindweed ..... eudicots: Convolvulaceae: *Calystegia sepium*
hellebore, false..... monocots: Melanthiaceae: *Veratrum viride*
hellebore, Indian..... monocots: Melanthiaceae: *Veratrum viride*
*Hemerocallis fulva** .....monocots: Hemerocallidaceae
hemlock, eastern..... conifers: Pinaceae: *Tsuga canadensis*
*Hesperis matronalis** ..... eudicots: Brassicaceae
hickory, pignut.....eudicots: Juglandaceae: *Carya glabra*
hickory, shagbark .....eudicots: Juglandaceae: *Carya ovata*
*Hieracium caespitosum**.....eudicots: Asteraceae
*Hieracium piloselloides**.....eudicots: Asteraceae
*Hieracium sabaudum**.....eudicots: Asteraceae
highbush blueberry..... eudicots: Ericaceae: *Vaccinium corymbosum*
*Holcus lanatus**.....monocots: Poaceae
hollow-stemmed joe-pye-weed ..... eudicots: Asteraceae: *Eutrochium fistulosum*
holly, mountain..... eudicots: Aquifoliaceae: *Ilex montana*
honeysuckle, Amur* .....eudicots: Caprifoliaceae: *Lonicera maackii**
honeysuckle, Morrow's*.....eudicots: Caprifoliaceae: *Lonicera morrowii**
honeysuckle, Tatarian* ..eudicots: Caprifoliaceae: *Lonicera tatarica**
hops, Japanese* ..... eudicots: Cannabaceae: *Humulus japonicus**
horse balm..... eudicots: Lamiaceae: *Collinsonia canadensis*
horse mint ..... eudicots: Lamiaceae: *Collinsonia canadensis*
horsetail, field .....ferns and horsetails: Equisetaceae: *Equisetum arvense*
horsetail, woodland .....ferns and horsetails: Equisetaceae: *Equisetum sylvaticum*
horseweed . eudicots: Asteraceae: *Conyza canadensis* var. *canadensis*
*Hosta ventricosa**..... monocots: Agavaceae
huckleberry, black .....eudicots: Ericaceae: *Gaylussacia baccata*
*Humulus japonicus**.....eudicots: Cannabaceae
Hydrangea arborescens ..... eudicots: Hydrangeaceae
hydrangea, wild ....eudicots: Hydrangeaceae: *Hydrangea arborescens*
Hypericum ellipticum ..... eudicots: Hypericaceae
*Hypericum perforatum**..... eudicots: Hypericaceae
Hypericum punctatum ..... eudicots: Hypericaceae
Ilex montana ..... eudicots: Aquifoliaceae
Ilex verticillata ..... eudicots: Aquifoliaceae
Impatiens capensis..... eudicots: Balsaminaceae
Indian hellebore .....monocots: Melanthiaceae: *Veratrum viride*
Indian poke.....monocots: Melanthiaceae: *Veratrum viride*
Indian-bean*..... eudicots: Bignoniaceae: *Catalpa bignonioides**
Indian-grass ..... monocots: Poaceae: *Sorghastrum nutans*
Indian-hemp .....eudicots: Apocynaceae: *Apocynum cannabinum*
Indian-tobacco..... eudicots: Campanulaceae: *Lobelia inflata*
intermediate wheatgrass* .....monocots: Poaceae: *Thinopyrum intermedium**
interrupted fern.....ferns and horsetails: Osmundaceae: *Osmunda claytoniana*
*Iris pseudacorus**.....monocots: Iridaceae
Iris versicolor.....monocots: Iridaceae
iris, yellow*.....monocots: Iridaceae: *Iris pseudacorus**
jack-in-the-pulpit .....monocots: Araceae: *Arisaema triphyllum* ssp. *triphyllum*
Japanese barberry*..... eudicots: Berberidaceae: *Berberis thunbergii**
Japanese hops* .....eudicots: Cannabaceae: *Humulus japonicus**
Japanese knotweed*.....eudicots: Polygonaceae: *Fallopia japonica**
Japanese rose*..... eudicots: Rosaceae: *Rosa multiflora**
Japanese stiltgrass*.....monocots: Poaceae: *Microstegium vimineum**
jewelweed..... eudicots: Balsaminaceae: *Impatiens capensis*
joe-pye-weed, hollow-stemmed .....eudicots: Asteraceae: *Eutrochium fistulosum*
Juncus acuminatus..... monocots: Juncaceae
Juncus dudleyi..... monocots: Juncaceae
Juncus effusus var. *solutus* ..... monocots: Juncaceae
Juncus tenuis var. *tenuis*..... monocots: Juncaceae
juneberry, smooth ..... eudicots: Rosaceae: *Amelanchier laevis*
Kalmia angustifolia ..... eudicots: Ericaceae
Kalmia latifolia ..... eudicots: Ericaceae
Kentucky bluegrass*..... monocots: Poaceae: *Poa pratensis**
king-devil, yellow* .... eudicots: Asteraceae: *Hieracium caespitosum**
kinnikinik..... eudicots: Cornaceae: *Cornus amomum* ssp. *amomum*
knapweed, bushy*.....eudicots: Asteraceae: *Centaurea stobe* ssp. *micranthus**

*Introduced (non-native) taxon

knapweed, spotted* ..... eudicots: Asteraceae: *Centaurea stobe* ssp. *micranthus**
knotweed, Japanese* ..... eudicots: Polygonaceae: *Fallopia japonica**
lacegrass ..... monocots: Poaceae: *Eragrostis capillaris*
lady's-thumb* ..... eudicots: Polygonaceae: *Persicaria maculosa**
late eupatorium* ..... eudicots: Asteraceae: *Eupatorium serotinum**
leaf mustard* ..... eudicots: Brassicaceae: *Brassica juncea**
Leersia oryzoides ..... monocots: Poaceae
Leersia virginica ..... monocots: Poaceae
*Lepidium campestre** ..... eudicots: Brassicaceae
*Lepidium densiflorum** ..... eudicots: Brassicaceae
*Leucanthemum vulgare** ..... eudicots: Asteraceae
*Linaria vulgaris** ..... eudicots: Plantaginaceae
Lindera benzoin ..... magnoliids: Lauraceae
Liriodendron tulipifera ..... magnoliids: Magnoliaceae
little bluestem ..... monocots: Poaceae: *Schizachyrium scoparium* var. *scoparium*
Lobelia cardinalis ..... eudicots: Campanulaceae
Lobelia inflata ..... eudicots: Campanulaceae
locust, black ..... eudicots: Fabaceae: *Robinia pseudoacacia*
long-beaked willow ..... eudicots: Salicaceae: *Salix bebbiana*
long-hair sedge ..... monocots: Cyperaceae: *Carex crinita* var. *crinita*
*Lonicera maackii** ..... eudicots: Caprifoliaceae
*Lonicera morrowii** ..... eudicots: Caprifoliaceae
*Lonicera tatarica** ..... eudicots: Caprifoliaceae
loose-flower sedge, broad ..... monocots: Cyperaceae: *Carex laxiflora*
loosestrife, false ..... eudicots: Onagraceae: *Ludwigia alternifolia*
loosestrife, fringed ..... eudicots: Myrsinaceae: *Lysimachia ciliata*
loosestrife, whorled ... eudicots: Myrsinaceae: *Lysimachia quadrifolia*
*Lotus corniculatus** ..... eudicots: Fabaceae
lovegrass, Carolina ..... monocots: Poaceae: *Eragrostis pectinacea*
lovegrass, creeping ..... monocots: Poaceae: *Eragrostis hypnoides*
lovegrass, sand* ..... monocots: Poaceae: *Eragrostis trichodes* var. *trichodes**
lovegrass, sandbar ..... monocots: Poaceae: *Eragrostis frankii*
low blueberry, early ..... eudicots: Ericaceae: *Vaccinium angustifolium*
low sweet blueberry ..... eudicots: Ericaceae: *Vaccinium angustifolium*
low water-milfoil ..... eudicots: Haloragaceae: *Myriophyllum humile*
lowbush blueberry ..... eudicots: Ericaceae: *Vaccinium angustifolium*
lowbush blueberry ..... eudicots: Ericaceae: *Vaccinium pallidum*
Ludwigia alternifolia ..... eudicots: Onagraceae
Ludwigia palustris ..... eudicots: Onagraceae
lurid sedge ..... monocots: Cyperaceae: *Carex lurida*
Luzula echinata ..... monocots: Juncaceae
Luzula multiflora ..... monocots: Juncaceae
Lycopodium dendroideum ..... lycophytes: Lycopodiaceae
Lycopus virginicus ..... eudicots: Lamiaceae
Lygodium palmatum ..... ferns and horsetails: Lygodiaceae
Lysimachia ciliata ..... eudicots: Myrsinaceae
Lysimachia quadrifolia ..... eudicots: Myrsinaceae
Lysimachia terrestris ..... eudicots: Myrsinaceae
*Macleaya cordata** ..... eudicots: Papaveraceae
mad-dog skullcap ..... eudicots: Lamiaceae: *Scutellaria lateriflora*
Maianthemum racemosum ..... monocots: Ruscaceae
mallow, common* ..... eudicots: Malvaceae: *Malva neglecta**
*Malva neglecta** ..... eudicots: Malvaceae
mannagrass, American ..... monocots: Poaceae: *Glyceria grandis*
mannagrass, fowl ..... monocots: Poaceae: *Glyceria striata*
mannagrass, rattlesnake ..... monocots: Poaceae: *Glyceria canadensis*
maple, Norway* ..... eudicots: Sapindaceae: *Acer platanoides**
maple, red ..... eudicots: Sapindaceae: *Acer rubrum*
maple, silver ..... eudicots: Sapindaceae: *Acer saccharinum*
maple, striped ..... eudicots: Sapindaceae: *Acer pensylvanicum*
maple, swamp ..... eudicots: Sapindaceae: *Acer rubrum*
maple-leaved viburnum .. eudicots: Adoxaceae: *Viburnum acerifolium*
marginal wood fern ..... ferns and horsetails: Polypodiaceae: *Dryopteris marginalis*
marsh bedstraw, stiff ..... eudicots: Rubiaceae: *Galium tinctorium*
marsh seedbox ..... eudicots: Onagraceae: *Ludwigia palustris*
marsh violet, blue ..... eudicots: Violaceae: *Viola cucullata*
marsh-purslane ..... eudicots: Onagraceae: *Ludwigia palustris*
meadow hawkweed* .. eudicots: Asteraceae: *Hieracium caespitosum**
meadow-rue, tall ..... eudicots: Ranunculaceae: *Thalictrum pubescens*
meadowsweet ..... eudicots: Rosaceae: *Spiraea latifolia*
*Melilotus alba** ..... eudicots: Fabaceae
*Melilotus officinalis** ..... eudicots: Fabaceae
Menispermum canadense ..... eudicots: Menispermaceae
Mentha arvensis ..... eudicots: Lamiaceae

*Introduced (non-native) taxon

Mexican-bamboo* ..... eudicots: Polygonaceae: *Fallopia japonica**
*Microstegium vimineum** ..... monocots: Poaceae
milfoil* ..... eudicots: Asteraceae: *Achillea millefolium**
milk-purslane ..... eudicots: Euphorbiaceae: *Euphorbia maculata*
milkweed, common ..... eudicots: Apocynaceae: *Asclepias syriaca*
milkweed, swamp ..... eudicots: Apocynaceae: *Asclepias incarnata* ssp. *incarnata*
mimosa* ..... eudicots: Fabaceae: *Albizia julibrissin**
Mimulus ringens ..... eudicots: Phrymaceae
mint, field ..... eudicots: Lamiaceae: *Mentha arvensis*
mint, horse ..... eudicots: Lamiaceae: *Collinsonia canadensis*
Minuartia patula ..... eudicots: Caryophyllaceae
*Mollugo verticillata** ..... eudicots: Molluginaceae
monkey-flower, Allegheny ... eudicots: Phrymaceae: *Mimulus ringens*
moonseed ..... eudicots: Menispermaceae: *Menispermum canadense*
moosewood ..... eudicots: Sapindaceae: *Acer pensylvanicum*
Morrow's honeysuckle* ..... eudicots: Caprifoliaceae: *Lonicera morrowii**
moth mullein* ..... eudicots: Scrophulariaceae: *Verbascum blattaria**
mountain blue-eyed-grass ..... monocots: Iridaceae: *Sisyrinchium montanum* var. *crebrum*
mountain holly ..... eudicots: Aquifoliaceae: *Ilex montana*
mountain-ash, American ..... eudicots: Rosaceae: *Sorbus americana*
mountain-laurel ..... eudicots: Ericaceae: *Kalmia latifolia*
Muhlenbergia sobolifera ..... monocots: Poaceae
Muhlenbergia sylvatica ..... monocots: Poaceae
muhly, creeping ..... monocots: Poaceae: *Muhlenbergia sobolifera*
muhly, woodland ..... monocots: Poaceae: *Muhlenbergia sylvatica*
mullein, common* .. eudicots: Scrophulariaceae: *Verbascum thapsus**
mullein, moth* ..... eudicots: Scrophulariaceae: *Verbascum blattaria**
multiflora rose* ..... eudicots: Rosaceae: *Rosa multiflora**
musk thistle* ..... eudicots: Asteraceae: *Carduus nutans**
mustard, brown* ..... eudicots: Brassicaceae: *Brassica juncea**
mustard, Chinese* ..... eudicots: Brassicaceae: *Brassica juncea**
mustard, leaf* ..... eudicots: Brassicaceae: *Brassica juncea**
mustard, worm-seed* ..... eudicots: Brassicaceae: *Erysimum cheiranthoides**
*Myriophyllum aquaticum** ..... eudicots: Haloragaceae
Myriophyllum humile ..... eudicots: Haloragaceae
narrow-leaved hawk's-beard* ..... eudicots: Asteraceae: *Crepis tectorum**
needle spike-rush ..... monocots: Cyperaceae: *Eleocharis acicularis*
needletip blue-eyed-grass ..... monocots: Iridaceae: *Sisyrinchium mucronatum*
*Nepeta cataria** ..... eudicots: Lamiaceae
nettle, great ..... eudicots: Urticaceae: *Urtica dioica* ssp. *gracilis*
nettle, great* ..... eudicots: Urticaceae: *Urtica dioica* ssp. *dioica**
nettle, stinging ..... eudicots: Urticaceae: *Urtica dioica* ssp. *gracilis*
nettle, stinging* ..... eudicots: Urticaceae: *Urtica dioica* ssp. *dioica**
New England hawkweed* ..... eudicots: Asteraceae: *Hieracium sabaudum**
nightshade, black* ..... eudicots: Solanaceae: *Solanum nigrum**
nightshade, trailing* ..... eudicots: Solanaceae: *Solanum dulcamara* var. *dulcamara**
ninebark ..... eudicots: Rosaceae: *Physocarpus opulifolius*
nodding chickweed ..... eudicots: Caryophyllaceae: *Cerastium nutans*
nodding thistle* ..... eudicots: Asteraceae: *Carduus nutans**
northern blue flag ..... monocots: Iridaceae: *Iris versicolor*
northern crabgrass* ..... monocots: Poaceae: *Digitaria sanguinalis**
northern dewberry ..... eudicots: Rosaceae: *Rubus flagellaris*
northern oatgrass ..... monocots: Poaceae: *Danthonia compressa*
northern red oak ..... eudicots: Fagaceae: *Quercus rubra*
northern shorthusk ..... monocots: Poaceae: *Brachyelytrum aristosum*
northern tree clubmoss ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
Norway maple* ..... eudicots: Sapindaceae: *Acer platanoides**
nutsedge, false ..... monocots: Cyperaceae: *Cyperus strigosus*
Nyssa sylvatica ..... eudicots: Nyssaceae
oak sedge, colonial ..... monocots: Cyperaceae: *Carex communis*
oak, bear ..... eudicots: Fagaceae: *Quercus ilicifolia*
oak, chestnut ..... eudicots: Fagaceae: *Quercus montana*
oak, pin ..... eudicots: Fagaceae: *Quercus palustris*
oak, scarlet ..... eudicots: Fagaceae: *Quercus coccinea*
oak, scrub ..... eudicots: Fagaceae: *Quercus ilicifolia*
oak, white ..... eudicots: Fagaceae: *Quercus alba*
oatgrass, northern ..... monocots: Poaceae: *Danthonia compressa*
Oenothera biennis ..... eudicots: Onagraceae
old-field cinquefoil ..... eudicots: Rosaceae: *Potentilla simplex*

*Introduced (non-native) taxon

onion, wild .....monocots: Alliaceae: *Allium canadense*
Onoclea sensibilis.....ferns and horsetails: Polypodiaceae
orange day-lily*.....
..... monocots: Hemerocallidaceae: *Hemerocallis fulva**
orchardgrass* ..... monocots: Poaceae: *Dactylis glomerata**
oriental bittersweet* ... eudicots: Celastraceae: *Celastrus orbiculatus**
Osmunda cinnamomea .....ferns and horsetails: Osmundaceae
Osmunda claytoniana.....ferns and horsetails: Osmundaceae
owlfruit sedge ..... monocots: Cyperaceae: *Carex stipata* var. *stipata*
Oxalis stricta..... eudicots: Oxalidaceae
ox-eye daisy* .....eudicots: Asteraceae: *Leucanthemum vulgare**
Packera aurea.....eudicots: Asteraceae
pale St. John's-wort.....eudicots: Hypericaceae: *Hypericum ellipticum*
panic grass, Gattinger's..... monocots: Poaceae: *Panicum gattingeri*
panic grass, Philadelphia.....
.....monocots: Poaceae: *Panicum philadelphicum*
panic grass, redtop.....monocots: Poaceae: *Panicum stipitatum*
panic grass, small-fruited.....
..... monocots: Poaceae: *Dichanthelium microcarpon*
panic grass, smooth .... monocots: Poaceae: *Panicum dichotomiflorum*
Panicum acuminatum.....
.....= monocots: Poaceae: *Dichanthelium acuminatum*
Panicum capillare .....monocots: Poaceae
Panicum clandestinum .....
..... = monocots: Poaceae: *Dichanthelium clandestinum*
Panicum dichotomiflorum.....monocots: Poaceae
Panicum gattingeri .....monocots: Poaceae
Panicum linearifolium.....
.....= monocots: Poaceae: *Dichanthelium linearifolium*
Panicum microcarpon.....
.....= monocots: Poaceae: *Dichanthelium microcarpon*
Panicum philadelphicum .....monocots: Poaceae
Panicum rigidulum var. *elongatum*.....
.....= monocots: Poaceae: *Panicum stipitatum*
Panicum stipitatum.....monocots: Poaceae
Panicum virgatum .....monocots: Poaceae
parrot's-feather* ..eudicots: Haloragaceae: *Myriophyllum aquaticum**
Parthenocissus quinquefolia..... eudicots: Vitaceae
path rush..... monocots: Juncaceae: *Juncus tenuis* var. *tenuis*
Pennsylvania sedge..... monocots: Cyperaceae: *Carex pensylvanica*
Pennsylvania smartweed .....
.....eudicots: Polygonaceae: *Persicaria pensylvanica*
Penstemon digitalis..... eudicots: Plantaginaceae
pepper-grass, wild*....eudicots: Brassicaceae: *Lepidium densiflorum**
Persicaria amphibia ..... eudicots: Polygonaceae
*Persicaria maculosa** ..... eudicots: Polygonaceae
Persicaria pensylvanica ..... eudicots: Polygonaceae
Persicaria punctata ..... eudicots: Polygonaceae
Persicaria sagittata ..... eudicots: Polygonaceae
Phalaris arundinacea ..... monocots: Poaceae
Philadelphia panic grass .....
..... monocots: Poaceae: *Panicum philadelphicum*
*Phleum pratense** ..... monocots: Poaceae
Photinia melanocarpa .....eudicots: Rosaceae
Phragmites australis ssp. *australis*..... monocots: Poaceae
Physocarpus opulifolius .....eudicots: Rosaceae
Phytolacca americana .....eudicots: Phytolaccaceae
pigeon grape .....eudicots: Vitaceae: *Vitis aestivalis*
pignut hickory ..... eudicots: Juglandaceae: *Carya glabra*
pilewort.....eudicots: Asteraceae: *Erechtites hieraciifolius*
pimpernel, scarlet*.....eudicots: Myrsinaceae: *Anagallis arvensis**
pin cherry.....eudicots: Rosaceae: *Prunus pensylvanica*
pin oak .....eudicots: Fagaceae: *Quercus palustris*
pine, pitch .....conifers: Pinaceae: *Pinus rigida*
pine, Scots* .....conifers: Pinaceae: *Pinus sylvestris**
pine, Virginia .....conifers: Pinaceae: *Pinus virginiana*
pink dogbane ...eudicots: Apocynaceae: *Apocynum androsaemifolium*
pink, Deptford* ..... eudicots: Caryophyllaceae: *Dianthus armeria**
pinkweed .....eudicots: Polygonaceae: *Persicaria pensylvanica*
Pinus rigida.....conifers: Pinaceae
Pinus strobus.....conifers: Pinaceae
*Pinus sylvestris**.....conifers: Pinaceae
Pinus virginiana.....conifers: Pinaceae
pitch pine .....conifers: Pinaceae: *Pinus rigida*
Pitcher's stitchwort ..... eudicots: Caryophyllaceae: *Minuartia patula*
*Plantago lanceolata**..... eudicots: Plantaginaceae
*Plantago major** ..... eudicots: Plantaginaceae
Plantago rugelii ..... eudicots: Plantaginaceae

*Introduced (non-native) taxon

plantain, broad-leaved ..... eudicots: Plantaginaceae: *Plantago rugelii*
plantain, broad-leaved* .... eudicots: Plantaginaceae: *Plantago major**
plantain, English* .....eudicots: Plantaginaceae: *Plantago lanceolata**
plantain, Rugel's ..... eudicots: Plantaginaceae: *Plantago rugelii*
plantain-lily, blue* .....monocots: Agavaceae: *Hosta ventricosa**
Platanus occidentalis ..... eudicots: Platanaceae
plume-poppy* ..... eudicots: Papaveraceae: *Macleaya cordata**
Poa alsodes .....monocots: Poaceae
*Poa compressa** .....monocots: Poaceae
*Poa pratensis** .....monocots: Poaceae
poison-ivy ..... eudicots: Anacardiaceae: *Toxicodendron radicans*
poke, Indian ..... monocots: Melanthiaceae: *Veratrum viride*
pokeweed ..... eudicots: Phytolaccaceae: *Phytolacca americana*
Polygonatum biflorum var. *biflorum*.....monocots: Ruscaceae
Polygonum amphibium var. *emersum* .....
.....= eudicots: Polygonaceae: *Persicaria amphibia*
*Polygonum convolvulus** .....
.....= eudicots: Polygonaceae: *Fallopia convolvulus**
*Polygonum cuspidatum** .....
.....= eudicots: Polygonaceae: *Fallopia japonica**
Polygonum pensylvanicum .....
.....= eudicots: Polygonaceae: *Persicaria pensylvanica*
*Polygonum persicaria** .....
..... = eudicots: Polygonaceae: *Persicaria maculosa**
Polygonum punctatum var. *punctatum*.....
.....= eudicots: Polygonaceae: *Persicaria punctata*
Polygonum sagittatum.....
.....= eudicots: Polygonaceae: *Persicaria sagittata*
Polygonum scandens var. *cristatum*.....
..... = eudicots: Polygonaceae: *Fallopia scandens*
pondweed, snail-seed .....
..... monocots: Potamogetonaceae: *Potamogeton bicupulatus*
pondweed, spiral.....
.....monocots: Potamogetonaceae: *Potamogeton spirillus*
Populus deltoides ..... eudicots: Salicaceae
Populus grandidentata..... eudicots: Salicaceae
Populus tremuloides..... eudicots: Salicaceae
Portulaca oleracea .....eudicots: Portulacaceae
Potamogeton bicupulatus ..... monocots: Potamogetonaceae
Potamogeton spirillus.....monocots: Potamogetonaceae
Potentilla canadensis.....eudicots: Rosaceae
*Potentilla intermedia** .....eudicots: Rosaceae
*Potentilla recta**.....eudicots: Rosaceae
Potentilla simplex .....eudicots: Rosaceae
povertygrass ..... monocots: Poaceae: *Danthonia spicata*
prickly bog sedge .....
.....monocots: Cyperaceae: *Carex atlantica* ssp. *atlantica*
prickly dewberry .....eudicots: Rosaceae: *Rubus flagellaris*
prickly tree clubmoss.....
..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
Prunus pensylvanica .....eudicots: Rosaceae
Prunus serotina .....eudicots: Rosaceae
Prunus virginiana .....eudicots: Rosaceae
*Pseudotsuga menziesii** .....conifers: Pinaceae
purple-flowering raspberry..... eudicots: Rosaceae: *Rubus odoratus*
purslane.....eudicots: Portulacaceae: *Portulaca oleracea*
quaking aspen..... eudicots: Salicaceae: *Populus tremuloides*
Queen Anne's-lace*.....eudicots: Apiaceae: *Daucus carota**
Quercus alba ..... eudicots: Fagaceae
Quercus coccinea.....eudicots: Fagaceae
Quercus ilicifolia .....eudicots: Fagaceae
Quercus montana.....eudicots: Fagaceae
Quercus palustris.....eudicots: Fagaceae
Quercus rubra .....eudicots: Fagaceae
rabbit's-foot clover* .....eudicots: Fabaceae: *Trifolium arvense**
ragweed, common..... eudicots: Asteraceae: *Ambrosia artemisiifolia*
ragwort, golden ..... eudicots: Asteraceae: *Packera aurea*
Ranunculus hispidus var. *hispidus*..... eudicots: Ranunculaceae
raspberry, black.....eudicots: Rosaceae: *Rubus occidentalis*
raspberry, purple-flowering..... eudicots: Rosaceae: *Rubus odoratus*
rattlesnake fern.....
.....ferns and horsetails: Ophioglossaceae: *Botrychium virginianum*
rattlesnake mannagrass..... monocots: Poaceae: *Glyceria canadensis*
red clover* ..... eudicots: Fabaceae: *Trifolium pratense**
red maple .....eudicots: Sapindaceae: *Acer rubrum*
red oak, northern .....eudicots: Fagaceae: *Quercus rubra*
red-berried elder.....
..... eudicots: Adoxaceae: *Sambucus racemosa* var. *pubens*

*Introduced (non-native) taxon

redtop panic grass ..... monocots: Poaceae: *Panicum stipitatum*
redtop* ..... monocots: Poaceae: *Agrostis gigantea**
red-willow ..... eudicots: Cornaceae: *Cornus amomum* ssp. *amomum*
reed canary-grass ..... monocots: Poaceae: *Phalaris arundinacea*
reed, common ..... monocots: Poaceae: *Phragmites australis* ssp. *australis*
reedgrass, wood ..... monocots: Poaceae: *Cinna arundinacea*
*Rhamnus frangula** ..... eudicots: Rhamnaceae
Rhode Island bent* ..... monocots: Poaceae: *Agrostis capillaris**
Rhododendron maximum ..... eudicots: Ericaceae
rhododendron, rosebay ..... eudicots: Ericaceae: *Rhododendron maximum*
Rhus copallina var. *latifolia* ..... eudicots: Anacardiaceae
Rhus glabra ..... eudicots: Anacardiaceae
Rhus typhina ..... eudicots: Anacardiaceae
Ribes rotundifolium ..... eudicots: Grossulariaceae
ribgrass* ..... eudicots: Plantaginaceae: *Plantago lanceolata**
rice cutgrass ..... monocots: Poaceae: *Leersia oryzoides*
rigid sedge ..... monocots: Cyperaceae: *Carex tetanica*
river birch ..... eudicots: Betulaceae: *Betula nigra*
Robinia pseudoacacia ..... eudicots: Fabaceae
*Rorippa sylvestris** ..... eudicots: Brassicaceae
*Rosa multiflora** ..... eudicots: Rosaceae
rose, Japanese* ..... eudicots: Rosaceae: *Rosa multiflora**
rose, multiflora* ..... eudicots: Rosaceae: *Rosa multiflora**
rosebay rhododendron . eudicots: Ericaceae: *Rhododendron maximum*
rosette grass, tapered ..... monocots: Poaceae: *Dichanthelium acuminatum*
rough barnyard-grass ..... monocots: Poaceae: *Echinochloa muricata*
rough bedstraw ..... eudicots: Rubiaceae: *Galium asprellum*
rough bentgrass ..... monocots: Poaceae: *Agrostis scabra*
rough sedge, eastern ..... monocots: Cyperaceae: *Carex scabrata*
round-leaved currant .. eudicots: Grossulariaceae: *Ribes rotundifolium*
round-leaved greenbrier ..... monocots: Smilacaceae: *Smilax rotundifolia*
round-leaved greenbrier ..... monocots: Smilacaceae: *Smilax rotundifolia*
Rubus allegheniensis ..... eudicots: Rosaceae
Rubus enslenii ..... eudicots: Rosaceae
Rubus flagellaris ..... eudicots: Rosaceae
Rubus occidentalis ..... eudicots: Rosaceae
Rubus odoratus ..... eudicots: Rosaceae
*Rubus phoenicolasius** ..... eudicots: Rosaceae
Rudbeckia hirta var. *pulcherrima* ..... eudicots: Asteraceae
Rugel's plantain ..... eudicots: Plantaginaceae: *Plantago rugelii*
*Rumex crispus** ..... eudicots: Polygonaceae
*Rumex obtusifolius** ..... eudicots: Polygonaceae
running-pine, deep-rooted ..... lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
rush, Dudley's ..... monocots: Juncaceae: *Juncus dudleyi*
rush, path ..... monocots: Juncaceae: *Juncus tenuis* var. *tenuis*
rush, sharp-fruited ..... monocots: Juncaceae: *Juncus acuminatus*
rush, soft ..... monocots: Juncaceae: *Juncus effusus* var. *solutus*
Salix alba × *fragilis** ..... = eudicots: Salicaceae: *Salix* × *rubens**
*Salix babylonica** ..... eudicots: Salicaceae
Salix bebbiana ..... eudicots: Salicaceae
Salix eriocephala ..... eudicots: Salicaceae
Salix nigra ..... eudicots: Salicaceae
Salix × *rubens** ..... eudicots: Salicaceae
Sambucus canadensis ..... eudicots: Adoxaceae
Sambucus racemosa var. *pubens* ..... eudicots: Adoxaceae
sand lovegrass* ..... monocots: Poaceae: *Eragrostis trichodes* var. *trichodes**
sand sedge ..... monocots: Cyperaceae: *Cyperus lupulinus*
sandbar lovegrass ..... monocots: Poaceae: *Eragrostis frankii*
sandwort, glade ..... eudicots: Caryophyllaceae: *Minuartia patula*
*Saponaria officinalis** ..... eudicots: Caryophyllaceae
sarsaparilla, wild ..... eudicots: Araliaceae: *Aralia nudicaulis*
Sassafras albidum ..... magnoliids: Lauraceae
sassafras ..... magnoliids: Lauraceae: *Sassafras albidum*
Saxifraga pensylvanica ..... eudicots: Saxifragaceae
Saxifraga virginiensis ..... eudicots: Saxifragaceae
saxifrage, early ..... eudicots: Saxifragaceae: *Saxifraga virginiensis*
saxifrage, swamp ..... eudicots: Saxifragaceae: *Saxifraga pensylvanica*
scaldweed ..... eudicots: Convolvulaceae: *Cuscuta gronovii* var. *latiflora*
scallions, wild* ..... monocots: Alliaceae: *Allium vineale**
scarlet oak ..... eudicots: Fagaceae: *Quercus coccinea*

*Introduced (non-native) taxon

scarlet pimpernel* ..... eudicots: Myrsinaceae: *Anagallis arvensis**
*Schedonorus arundinaceus** ..... monocots: Poaceae
Schizachyrium scoparium var. *scoparium* ..... monocots: Poaceae
Scirpus cyperinus ..... monocots: Cyperaceae
Scots pine* ..... conifers: Pinaceae: *Pinus sylvestris**
scratch-grass ..... eudicots: Polygonaceae: *Persicaria sagittata*
scrub oak ..... eudicots: Fagaceae: *Quercus ilicifolia*
Scutellaria lateriflora ..... eudicots: Lamiaceae
sedge, Atlantic ..... monocots: Cyperaceae: *Carex atlantica* ssp. *atlantica*
sedge, broom ..... monocots: Cyperaceae: *Carex scoparia*
sedge, fibrous-root ..... monocots: Cyperaceae: *Carex communis*
sedge, fox ..... monocots: Cyperaceae: *Carex vulpinoidea*
sedge, fringed ..... monocots: Cyperaceae: *Carex crinita* var. *crinita*
sedge, hay ..... monocots: Cyperaceae: *Carex argyrantha*
sedge, long-hair ..... monocots: Cyperaceae: *Carex crinita* var. *crinita*
sedge, lurid ..... monocots: Cyperaceae: *Carex lurida*
sedge, owlfruit ..... monocots: Cyperaceae: *Carex stipata* var. *stipata*
sedge, Pennsylvania ..... monocots: Cyperaceae: *Carex pensylvanica*
sedge, rigid ..... monocots: Cyperaceae: *Carex tetanica*
sedge, sand ..... monocots: Cyperaceae: *Cyperus lupulinus*
sedge, shallow ..... monocots: Cyperaceae: *Carex lurida*
sedge, silvery ..... monocots: Cyperaceae: *Carex argyrantha*
sedge, soft fox ..... monocots: Cyperaceae: *Carex conjuncta*
sedge, stalk-grain ... monocots: Cyperaceae: *Carex stipata* var. *stipata*
sedge, stiff ..... monocots: Cyperaceae: *Carex tetanica*
sedge, Swan's ..... monocots: Cyperaceae: *Carex swanii*
sedge, three-way ..... monocots: Cyperaceae: *Dulichium arundinaceum* var. *arundinaceum*
sedge, tussock ..... monocots: Cyperaceae: *Carex stricta*
sedge, Wood's ..... monocots: Cyperaceae: *Carex tetanica*
sedge, yellow-fruited ..... monocots: Cyperaceae: *Carex annectens*
seedbox ..... eudicots: Onagraceae: *Ludwigia alternifolia*
seedbox, marsh ..... eudicots: Onagraceae: *Ludwigia palustris*
Senecio aureus ..... = eudicots: Asteraceae: *Packera aurea*
Senna marilandica ..... eudicots: Fabaceae
sensitive fern ..... ferns and horsetails: Polypodiaceae: *Onoclea sensibilis*
serviceberry, smooth ..... eudicots: Rosaceae: *Amelanchier laevis*
*Setaria faberi** ..... monocots: Poaceae
*Setaria pumila** ..... monocots: Poaceae
sevenbark ..... eudicots: Hydrangeaceae: *Hydrangea arborescens*
shadbush, smooth ..... eudicots: Rosaceae: *Amelanchier laevis*
shagbark hickory ..... eudicots: Juglandaceae: *Carya ovata*
shallow sedge ..... monocots: Cyperaceae: *Carex lurida*
sharp-fruited rush ..... monocots: Juncaceae: *Juncus acuminatus*
sheep fescue* ..... monocots: Poaceae: *Festuca ovina**
sheep-laurel ..... eudicots: Ericaceae: *Kalmia angustifolia*
shield fern, crested ..... ferns and horsetails: Polypodiaceae: *Dryopteris cristata*
shining bedstraw ..... eudicots: Rubiaceae: *Galium concinnum*
shining sumac ..... eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
shorthusk, bearded ..... monocots: Poaceae: *Brachyelytrum erectum*
shorthusk, northern ..... monocots: Poaceae: *Brachyelytrum aristosum*
showy tick-trefoil ..... eudicots: Fabaceae: *Desmodium canadense*
*Silene vulgaris** ..... eudicots: Caryophyllaceae
silktree* ..... eudicots: Fabaceae: *Albizia julibrissin**
silky dogwood .. eudicots: Cornaceae: *Cornus amomum* ssp. *amomum*
silver maple ..... eudicots: Sapindaceae: *Acer saccharinum*
silvery sedge ..... monocots: Cyperaceae: *Carex argyrantha*
simpler's-joy ..... eudicots: Verbenaceae: *Verbena hastata*
*Sisymbrium altissimum** ..... eudicots: Brassicaceae
Sisyrinchium montanum var. *crebrum* ..... monocots: Iridaceae
Sisyrinchium mucronatum ..... monocots: Iridaceae
skullcap, mad-dog ..... eudicots: Lamiaceae: *Scutellaria lateriflora*
skunk-cabbage ..... monocots: Araceae: *Symplocarpus foetidus*
slender spike-rush ..... monocots: Cyperaceae: *Eleocharis tenuis* var. *tenuis*
slim-leaved witchgrass ..... monocots: Poaceae: *Dichanthelium linearifolium*
small crumbweed * .... eudicots: Amaranthaceae: *Dysphania pumilio**
smallspike false nettle ..... eudicots: Urticaceae: *Boehmeria cylindrica* var. *cylindrica*
smartweed, dotted ..... eudicots: Polygonaceae: *Persicaria punctata*
smartweed, Pennsylvania ..... eudicots: Polygonaceae: *Persicaria pensylvanica*
smartweed, water ..... eudicots: Polygonaceae: *Persicaria amphibia*

*Introduced (non-native) taxon

smartweed, water..... eudicots: Polygonaceae: *Persicaria punctata*
Smilacina racemosa .....
.....= monocots: Ruscaceae: *Maianthemum racemosum*
Smilax glauca .....monocots: Smilacaceae
Smilax herbacea .....monocots: Smilacaceae
Smilax rotundifolia.....monocots: Smilacaceae
smooth alder..... eudicots: Betulaceae: *Alnus serrulata*
smooth brome* .....monocots: Poaceae: *Bromus inermis**
smooth goldenrod.....
.....eudicots: Asteraceae: *Solidago gigantea* var. *gigantea*
smooth juneberry.....eudicots: Rosaceae: *Amelanchier laevis*
smooth panic grass .....monocots: Poaceae: *Panicum dichotomiflorum*
smooth serviceberry .....eudicots: Rosaceae: *Amelanchier laevis*
smooth shadbush .....eudicots: Rosaceae: *Amelanchier laevis*
smooth sumac .....eudicots: Anacardiaceae: *Rhus glabra*
snail-seed pondweed .....
..... monocots: Potamogetonaceae: *Potamogeton bicupulatus*
soapwort*..... eudicots: Caryophyllaceae: *Saponaria officinalis**
soft fox sedge..... monocots: Cyperaceae: *Carex conjuncta*
soft rush.....monocots: Juncaceae: *Juncus effusus* var. *solutus*
Solanum dulcamara var. *dulcamara** ..... eudicots: Solanaceae
*Solanum nigrum** ..... eudicots: Solanaceae
Solidago canadensis var. *canadensis*.....eudicots: Asteraceae
Solidago gigantea var. *gigantea*.....eudicots: Asteraceae
Solidago rugosa ssp. *rugosa* var. *rugosa*.....eudicots: Asteraceae
Solomon's-plume .. monocots: Ruscaceae: *Maianthemum racemosum*
Solomon's-seal .....
..... monocots: Ruscaceae: *Polygonatum biflorum* var. *biflorum*
Sorbus americana..... eudicots: Rosaceae
Sorghastrum nutans.....monocots: Poaceae
sourgum..... eudicots: Nyssaceae: *Nyssa sylvatica*
southern agrimony.....eudicots: Rosaceae: *Agrimonia parviflora*
southern arrow-wood .....eudicots: Adoxaceae: *Viburnum dentatum*
southern catalpa*.....eudicots: Bignoniaceae: *Catalpa bignonioides**
southern dewberry ..... eudicots: Rosaceae: *Rubus enslenii*
southern ground-cedar.....
..... lycophytes: Lycopodiaceae: *Diphasiastrum digitatum*
southern wild senna..... eudicots: Fabaceae: *Senna marilandica*
Sparganium americanum..... monocots: Sparganiaceae
speckled alder.....eudicots: Betulaceae: *Alnus incana* ssp. *rugosa*
spicebush ..... magnoliids: Lauraceae: *Lindera benzoin*
spikenard ..... eudicots: Araliaceae: *Aralia racemosa*
spike-rush, blunt.....
.....monocots: Cyperaceae: *Eleocharis obtusa* var. *obtusa*
spike-rush, needle .....monocots: Cyperaceae: *Eleocharis acicularis*
spike-rush, slender .....
.....monocots: Cyperaceae: *Eleocharis tenuis* var. *tenuis*
spinulose wood fern.....
..... ferns and horsetails: Polypodiaceae: *Dryopteris carthusiana*
Spiraea latifolia .....eudicots: Rosaceae
Spiraea tomentosa.....eudicots: Rosaceae
spiral pondweed .....
.....monocots: Potamogetonaceae: *Potamogeton spirillus*
spotted knapweed*.....
..... eudicots: Asteraceae: *Centaurea stobe* ssp. *micranthus**
spotted spurge .....eudicots: Euphorbiaceae: *Euphorbia maculata*
spotted St. John's-wort .....
..... eudicots: Hypericaceae: *Hypericum punctatum*
spotted touch-me-not .... eudicots: Balsaminaceae: *Impatiens capensis*
spreading dogbane .....
.....eudicots: Apocynaceae: *Apocynum androsaemifolium*
spring bentgrass ..... monocots: Poaceae: *Agrostis hyemalis*
springcress.....eudicots: Brassicaceae: *Cardamine bulbosa*
spurge, spotted .....eudicots: Euphorbiaceae: *Euphorbia maculata*
St. John's-wort, common* .....
..... eudicots: Hypericaceae: *Hypericum perforatum**
St. John's-wort, pale ... eudicots: Hypericaceae: *Hypericum ellipticum*
St. John's-wort, spotted .....
..... eudicots: Hypericaceae: *Hypericum punctatum*
staghorn sumac.....eudicots: Anacardiaceae: *Rhus typhina*
stalk-grain sedge ....monocots: Cyperaceae: *Carex stipata* var. *stipata*
star sedge, eastern .....monocots: Cyperaceae: *Carex radiata*
steeple-bush..... eudicots: Rosaceae: *Spiraea tomentosa*
stickywilly ..... eudicots: Rubiaceae: *Galium aparine*
stiff marsh bedstraw.....eudicots: Rubiaceae: *Galium tinctorium*
stiff sedge .....monocots: Cyperaceae: *Carex tetanica*
stiltgrass*.....monocots: Poaceae: *Microstegium vimineum**
stiltgrass, Japanese* .....monocots: Poaceae: *Microstegium vimineum**

*Introduced (non-native) taxon

stinging nettle ..... eudicots: Urticaceae: *Urtica dioica* ssp. *gracilis*
stinging nettle* ..... eudicots: Urticaceae: *Urtica dioica* ssp. *dioica**
stinkgrass* ..... monocots: Poaceae: *Eragrostis cilianensis**
stitchwort, Pitcher's ..... eudicots: Caryophyllaceae: *Minuartia patula*
stoneroot ..... eudicots: Lamiaceae: *Collinsonia canadensis*
straw sedge, eastern ..... monocots: Cyperaceae: *Carex straminea*
straw sedge, greater ..... monocots: Cyperaceae: *Carex normalis*
striped maple ..... eudicots: Sapindaceae: *Acer pensylvanicum*
sulfur cinquefoil* ..... eudicots: Rosaceae: *Potentilla recta**
sumac, dwarf ... eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
sumac, shining ..... eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
sumac, smooth ..... eudicots: Anacardiaceae: *Rhus glabra*
sumac, staghorn ..... eudicots: Anacardiaceae: *Rhus typhina*
sumac, winged ..... eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
summer grape ..... eudicots: Vitaceae: *Vitis aestivalis*
summer-lilac* ..... eudicots: Scrophulariaceae: *Buddleja davidii**
swamp maple ..... eudicots: Sapindaceae: *Acer rubrum*
swamp milkweed ..... eudicots: Apocynaceae: *Asclepias incarnata* ssp. *incarnata*
swamp saxifrage ..... eudicots: Saxifragaceae: *Saxifraga pensylvanica*
swamp-candles ..... eudicots: Myrsinaceae: *Lysimachia terrestris*
Swan's sedge ..... monocots: Cyperaceae: *Carex swanii*
sweet autumn clematis* ..... eudicots: Ranunculaceae: *Clematis terniflora**
sweet birch ..... eudicots: Betulaceae: *Betula lenta*
sweet blueberry, low .... eudicots: Ericaceae: *Vaccinium angustifolium*
sweet vernalgrass* ..... monocots: Poaceae: *Anthoxanthum odoratum**
sweet woodruff* ..... eudicots: Rubiaceae: *Galium odoratum**
sweet-clover, white* ..... eudicots: Fabaceae: *Melilotus alba**
sweet-clover, yellow* ..... eudicots: Fabaceae: *Melilotus officinalis**
sweet-scented bedstraw ..... eudicots: Rubiaceae: *Galium triflorum*
sweet-scented bedstraw* ..... eudicots: Rubiaceae: *Galium odoratum**
switchgrass ..... monocots: Poaceae: *Panicum virgatum*
sycamore ..... eudicots: Platanaceae: *Platanus occidentalis*
Symphyotrichum lateriflorum ..... eudicots: Asteraceae
Symplocarpus foetidus ..... monocots: Araceae
tall fescue* ..... monocots: Poaceae: *Schedonorus arundinaceus**
tall hawkweed* ..... eudicots: Asteraceae: *Hieracium piloselloides**
tall meadow-rue ..... eudicots: Ranunculaceae: *Thalictrum pubescens*
tall white beard-tongue ..... eudicots: Plantaginaceae: *Penstemon digitalis*
tansy-mustard* ..... eudicots: Brassicaceae: *Descurainia pinnata**
tapered rosette grass ..... monocots: Poaceae: *Dichanthelium acuminatum*
*Taraxacum officinale** ..... eudicots: Asteraceae
Tatarian honeysuckle* ... eudicots: Caprifoliaceae: *Lonicera tatarica**
tearthumb, arrow-leaved ..... eudicots: Polygonaceae: *Persicaria sagittata*
terrestrial water-starwort ..... eudicots: Plantaginaceae: *Callitriche terrestris*
Teucrium canadense var. *virginicum* ..... eudicots: Lamiaceae
Thalictrum pubescens ..... eudicots: Ranunculaceae
thimbleberry ..... eudicots: Rosaceae: *Rubus odoratus*
*Thinopyrum intermedium** ..... monocots: Poaceae
thistle, Canada* ..... eudicots: Asteraceae: *Cirsium arvense**
thistle, musk* ..... eudicots: Asteraceae: *Carduus nutans**
thistle, nodding* ..... eudicots: Asteraceae: *Carduus nutans**
three-way sedge ..... monocots: Cyperaceae: *Dulichium arundinaceum*
thrift* ..... eudicots: Plumbaginaceae: *Armeria maritima**
ticklegrass ..... monocots: Poaceae: *Agrostis hyemalis*
ticklegrass ..... monocots: Poaceae: *Agrostis scabra*
tick-trefoil, showy ..... eudicots: Fabaceae: *Desmodium canadense*
Tilia americana var. *americana* ..... eudicots: Malvaceae
timothy* ..... monocots: Poaceae: *Phleum pratense**
touch-me-not, spotted ... eudicots: Balsaminaceae: *Impatiens capensis*
Toxicodendron radicans ..... eudicots: Anacardiaceae
trailing nightshade* ..... eudicots: Solanaceae: *Solanum dulcamara* var. *dulcamara**
trailing-arbutus ..... eudicots: Ericaceae: *Epigaea repens*
tree celandine* ..... eudicots: Papaveraceae: *Macleaya cordata**
tree clubmoss, northern ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
tree clubmoss, prickly ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*
tree ground-pine ..... lycophytes: Lycopodiaceae: *Lycopodium dendroideum*

*Introduced (non-native) taxon

tree-of-heaven* ..... eudicots: Simaroubaceae: *Ailanthus altissima**
trefoil, bird's-foot* ..... eudicots: Fabaceae: *Lotus corniculatus**
*Trifolium arvense** ..... eudicots: Fabaceae
*Trifolium pratense** ..... eudicots: Fabaceae
*Trifolium repens** ..... eudicots: Fabaceae
Tripsacum dactyloides ..... monocots: Poaceae
trumpetweed ..... eudicots: Asteraceae: *Eutrochium fistulosum*
Tsuga canadensis ..... conifers: Pinaceae
tuliptree ..... magnoliids: Magnoliaceae: *Liriodendron tulipifera*
tumble-mustard* ..... eudicots: Brassicaceae: *Sisymbrium altissimum**
tupelo ..... eudicots: Nyssaceae: *Nyssa sylvatica*
turkeyfoot ..... monocots: Poaceae: *Andropogon gerardii*
turtlehead ..... eudicots: Plantaginaceae: *Chelone glabra*
*Tussilago farfara** ..... eudicots: Asteraceae
tussock sedge ..... monocots: Cyperaceae: *Carex stricta*
two-headed water-starwort ..... eudicots: Plantaginaceae: *Callitriche heterophylla*
Typha angustifolia ..... monocots: Typhaceae
upland bentgrass ..... monocots: Poaceae: *Agrostis perennans*
Urtica dioica ssp. *dioica** ..... eudicots: Urticaceae
Urtica dioica ssp. *gracilis* ..... eudicots: Urticaceae
Vaccinium angustifolium ..... eudicots: Ericaceae
Vaccinium corymbosum ..... eudicots: Ericaceae
Vaccinium pallidum ..... eudicots: Ericaceae
Vaccinium stamineum ..... eudicots: Ericaceae
velvetgrass* ..... monocots: Poaceae: *Holcus lanatus**
Veratrum viride ..... monocots: Melanthiaceae
*Verbascum blattaria** ..... eudicots: Scrophulariaceae
*Verbascum thapsus** ..... eudicots: Scrophulariaceae
Verbena hastata ..... eudicots: Verbenaceae
vernalgrass, sweet* ..... monocots: Poaceae: *Anthoxanthum odoratum**
vervain, blue ..... eudicots: Verbenaceae: *Verbena hastata*
Viburnum acerifolium ..... eudicots: Adoxaceae
Viburnum dentatum ..... eudicots: Adoxaceae
viburnum, maple-leaved ..... eudicots: Adoxaceae: *Viburnum acerifolium*
Viola cucullata ..... eudicots: Violaceae
Viola sagittata var. *sagittata* ..... eudicots: Violaceae
violet, arrow-leaved ..... eudicots: Violaceae: *Viola sagittata* var. *sagittata*
viper's bugloss* ..... eudicots: Boraginaceae: *Echium vulgare**
virgin's-bower ..... eudicots: Ranunculaceae: *Clematis virginiana*
Virginia pine ..... conifers: Pinaceae: *Pinus virginiana*
Virginia wild-rye ..... monocots: Poaceae: *Elymus virginicus*
Virginia-creeper ..... eudicots: Vitaceae: *Parthenocissus quinquefolia*
Vitis aestivalis ..... eudicots: Vitaceae
Vitis labrusca ..... eudicots: Vitaceae
Vitis riparia ..... eudicots: Vitaceae
wallflower, worm-seed* ..... eudicots: Brassicaceae: *Erysimum cheiranthoides**
water flag* ..... monocots: Iridaceae: *Iris pseudacorus**
water smartweed ..... eudicots: Polygonaceae: *Persicaria amphibia*
water smartweed ..... eudicots: Polygonaceae: *Persicaria punctata*
water-horehound, European ..... eudicots: Lamiaceae: *Lycopus virginicus*
water-milfoil, low ..... eudicots: Haloragaceae: *Myriophyllum humile*
water-purslane ..... eudicots: Onagraceae: *Ludwigia palustris*
water-starwort, terrestrial ..... eudicots: Plantaginaceae: *Callitriche terrestris*
water-starwort, two-headed ..... eudicots: Plantaginaceae: *Callitriche heterophylla*
weeping willow* ..... eudicots: Salicaceae: *Salix babylonica**
wheatgrass, intermediate* ..... monocots: Poaceae: *Thinopyrum intermedium**
white ash ..... eudicots: Oleaceae: *Fraxinus americana* var. *americana*
white beard-tongue, tall ..... eudicots: Plantaginaceae: *Penstemon digitalis*
white clover* ..... eudicots: Fabaceae: *Trifolium repens**
white crack willow* ..... eudicots: Salicaceae: *Salix* × *rubens**
white pine, eastern ..... conifers: Pinaceae: *Pinus strobus*
white snakeroot, common ..... eudicots: Asteraceae: *Ageratina altissima* var. *altissima*
white sweet-clover* ..... eudicots: Fabaceae: *Melilotus alba**
white wood aster ..... eudicots: Asteraceae: *Eurybia divaricata*
whitegrass ..... monocots: Poaceae: *Leersia virginica*
white-man's-foot* ..... eudicots: Plantaginaceae: *Plantago major**
white oak ..... eudicots: Fagaceae: *Quercus alba*

*Introduced (non-native) taxon

whitewood.....eudicots: Malvaceae: *Tilia americana* var. *americana*
whorled loosestrife .... eudicots: Myrsinaceae: *Lysimachia quadrifolia*
wild black cherry ..... eudicots: Rosaceae: *Prunus serotina*
wild bleeding-heart..... eudicots: Papaveraceae: *Dicentra eximia*
wild carrot* ..... eudicots: Apiaceae: *Daucus carota**
wild germander.....
.....eudicots: Lamiaceae: *Teucrium canadense* var. *virginicum*
wild hydrangea .....eudicots: Hydrangeaceae: *Hydrangea arborescens*
wild onion .....monocots: Alliaceae: *Allium canadense*
wild pepper-grass* .... eudicots: Brassicaceae: *Lepidium densiflorum**
wild sarsaparilla.....eudicots: Araliaceae: *Aralia nudicaulis*
wild scallions* ..... monocots: Alliaceae: *Allium vineale**
wild senna, southern..... eudicots: Fabaceae: *Senna marilandica*
wild yam..... monocots: Dioscoreaceae: *Dioscorea villosa*
wild-rye, Canada .....
.....monocots: Poaceae: *Elymus canadensis* var. *canadensis*
wild-rye, Virginia .....monocots: Poaceae: *Elymus virginicus*
willow, black.....eudicots: Salicaceae: *Salix nigra*
willow, diamond.....eudicots: Salicaceae: *Salix eriocephala*
willow, gray ..... eudicots: Salicaceae: *Salix bebbiana*
willow, long-beaked..... eudicots: Salicaceae: *Salix bebbiana*
willow, weeping* ..... eudicots: Salicaceae: *Salix babylonica**
willow, white crack* ..... eudicots: Salicaceae: *Salix* × *rubens**
wineberry* ..... eudicots: Rosaceae: *Rubus phoenicolasius**
winged sumac . eudicots: Anacardiaceae: *Rhus copallina* var. *latifolia*
winterberry.....eudicots: Aquifoliaceae: *Ilex verticillata*
witchgrass, common.....monocots: Poaceae: *Panicum capillare*
witchgrass, slim-leaved.....
..... monocots: Poaceae: *Dichanthelium linearifolium*
witchhazel, American.....
..... eudicots: Hamamelidaceae: *Hamamelis virginiana*
witchhazel, common .....
..... eudicots: Hamamelidaceae: *Hamamelis virginiana*
wood aster, white.....eudicots: Asteraceae: *Eurybia divaricata*
wood fern, crested .....
..... ferns and horsetails: Polypodiaceae: *Dryopteris cristata*
wood fern, evergreen.....
..... ferns and horsetails: Polypodiaceae: *Dryopteris intermedia*
wood fern, marginal.....
..... ferns and horsetails: Polypodiaceae: *Dryopteris marginalis*
wood fern, spinulose.....
..... ferns and horsetails: Polypodiaceae: *Dryopteris carthusiana*
wood reedgrass..... monocots: Poaceae: *Cinna arundinacea*
wood sedge, beach .....monocots: Cyperaceae: *Carex laxiflora*
woodbine .....eudicots: Vitaceae: *Parthenocissus quinquefolia*
woodland bluegrass .....monocots: Poaceae: *Poa alsodes*
woodland horsetail.....
..... ferns and horsetails: Equisetaceae: *Equisetum sylvaticum*
woodland muhly.....monocots: Poaceae: *Muhlenbergia sylvatica*
woodruff, sweet* .....eudicots: Rubiaceae: *Galium odoratum**
woodrush, common..... monocots: Juncaceae: *Luzula echinata*
woodrush, field .....monocots: Juncaceae: *Luzula multiflora*
wood-sage.....
..... eudicots: Lamiaceae: *Teucrium canadense* var. *virginicum*
Wood's sedge .....monocots: Cyperaceae: *Carex tetanica*
wool-grass .....monocots: Cyperaceae: *Scirpus cyperinus*
worm-seed mustard*.....
.....eudicots: Brassicaceae: *Erysimum cheiranthoides**
worm-seed wallflower* .....
.....eudicots: Brassicaceae: *Erysimum cheiranthoides**
wrinkle-leaf goldenrod .....
..... eudicots: Asteraceae: *Solidago rugosa* ssp. *rugosa* var. *rugosa*
yam, wild..... monocots: Dioscoreaceae: *Dioscorea villosa*
yarrow, common* ..... eudicots: Asteraceae: *Achillea millefolium**
yellow flag*.....monocots: Iridaceae: *Iris pseudacorus**
yellow foxtail* ..... monocots: Poaceae: *Setaria pumila**
yellow iris*.....monocots: Iridaceae: *Iris pseudacorus**
yellow king-devil* ..... eudicots: Asteraceae: *Hieracium caespitosum**
yellow sweet-clover* ..... eudicots: Fabaceae: *Melilotus officinalis**
yellow wood-sorrel, common .... eudicots: Oxalidaceae: *Oxalis stricta*
yellowcress, creeping* .... eudicots: Brassicaceae: *Rorippa sylvestris**
yellow-fruited sedge .....monocots: Cyperaceae: *Carex annectens*
yellow-poplar ..... magnoliids: Magnoliaceae: *Liriodendron tulipifera*
*Yucca flaccida** .....monocots: Agavaceae

*Introduced (non-native) taxon

Appendix B. Summary of statistics on the vascular flora of the Lehigh Gap Wildlife Refuge

All figures are counts or percentages of the 374 vascular plant species listed in Appendix A.

Table B1. **Native and introduced species**

native	264	71%
introduced	110	29%

Table B2. **Species by growth form**

herbaceous perennials	214	57%
annuals and biennials	58	16%
deciduous shrubs	43	11%
deciduous trees	37	10%
lianas (woody vines)	12	3%
evergreen trees	6	2%
evergreen shrubs	4	1%

Table B3. **Species by frequency statewide**

common	224	60%
frequent	76	20%
occasional	55	15%
rare	12	3%
very rare	4	1%
not naturalized	3	1%

Table B4. **Species by estimated average frequency over entire study area**[1]

abundant	12	3%
fairly high	18	5%
fairly low	65	17%
scarce	275	74%

[1] Four species listed in Appendix A are not present in the study area proper but are prominent on Blue Mountain just across Lehigh Gap.

Table B5. **Species by state status**

PE (endangered)	3
PT (threatened)	1

Table B6. **C_3 and C_4 (cool-season and warm-season) grass species**[2]

C_3 (cool-season)	– native	24
	– non-native	16
C_4 (warm-season)	– native	15
	– non-native	7

Table B7**. Species in the 12 most diverse families**[3]

Poaceae (grasses)	62
Asteraceae	28
Cyperaceae	26
Rosaceae	21
Brassicaceae	11
Fabaceae (legumes)	11
Polygonaceae	10
Ericaceae	9
Plantaginaceae	8
Salicaceae	8
Fagaceae	7
Rubiaceae	7

[2] A few species in other vascular plant families have the C_4 photosynthetic pathway (of those at Lehigh Gap, most notably Cyperaceae and Amaranthaceae); most are C_3 plants.

[3] of 89 families in all

Table B8. **Species by location in study area**

railroad rights-of-way, lower slope grasslands and woodlands	170
floodplain, riverbanks	169
ponds and vicinity	113
ridge-top and upper slope grasslands	61
mountain woodlands and forests	59
ridge-top transmission tower areas	50
revegetated "Ecoloam" area northeast of Lehigh Gap (outside of study area; partial survey only)	43
Osprey House grounds	37
scree slopes of mostly bare rock	32
ridge-top barrens northeast of Lehigh Gap (outside of study area; partial survey only)	17

Table B9. **Native and non-native species by location in study area**

location	native	% native	non-native	% non-native
floodplain, riverbanks	132	78%	37	22%
railroad rights-of-way, lower slope grasslands	96	56%	74	44%
ponds and vicinity	96	85%	17	15%
mountain woodlands and forests	57	98%	1	2%
ridge-top and upper slope grasslands	57	93%	4	7%
ridge-top transmission tower areas	34	68%	16	32%
scree slopes of mostly bare rock	29	91%	3	9%
Osprey House grounds	20	54%	17	46%
revegetated "Ecoloam" area northeast of Lehigh Gap (outside of study area; partial survey only)	19	44%	24	56%
ridge-top barrens northeast of Lehigh Gap (outside of study area; partial survey only)	14	82%	3	18%

Appendix C. The native grasslands and meadows of the Lehigh Gap Wildlife Refuge: a unique opportunity for high-profile research and demonstration projects

There are two major native grassland and meadow landscapes in and adjacent to the Refuge: the hairgrass – lowbush blueberry savanna on the ridge top and upper slopes of Blue Mountain and the grassland/meadow planting area on the mid- and lower slopes. The native grasslands—about 100 acres spread out along several miles of the ridge top—are valuable as outstanding examples of a rare native community type, as habitat for rare plant and insect species, and potentially as a model for native grassland restoration and management. The planted grasslands—potentially over 200 acres of slopes nearly denuded by the tree-killing fallout from the Palmerton zinc smelters and subsequent fires and erosion—are valuable as habitat for rare bird and insect species and as a research area and demonstration site for native ecosystem reclamation on challenging sites.

The patches of hairgrass – lowbush blueberry savanna along the top of Blue Mountain from Lehigh Gap southwest toward Furnace Gap comprise one of the half-dozen or so largest areas of wholly native, unplanted grassland remaining in the entire state (R. Latham, unpublished data). Of the 54 vascular plant species found so far in these grasslands, 93% are native but native species comprise virtually 100% of total cover and biomass. This is in strong contrast with the meadow vegetation on Blue Mountain just northeast of Lehigh Gap, where much of the ridge top is bare rock and, where vegetation does exist, non-native plant species predominate.

Historically, Blue Mountain in and around the present-day Lehigh Gap Wildlife Refuge was a mosaic of forest and native grasslands. Comparing aerial photographs taken in 1937 with recent aerial and satellite imagery suggests that the grasslands have expanded considerably in the last half-century. The most likely explanation is that the native grassland ecosystem persisted intact in areas peripherally affected by contamination from the zinc smelters and spread into some of the area where forests were severely damaged. Its component species are more resilient to the stresses imposed by the zinc-smelter smoke plumes than those of the adjacent forests. Most types of human disturbance favor invasion by exotic species and fragment or destroy native habitats. In this case, however, acid precipitation and heavy-metal deposition generated by the zinc smelters inflicted severe stresses on native vegetation but for the most part did not favor invasive species. Native forests declined in some areas and disappeared completely in others. Native grasslands not only persisted but also were able to spread into areas vacated by forest vegetation.

It is likely that the grasslands existed at Lehigh Gap long before European settlement. For most of the time since the most recent major episode of global warming, which occurred between 8,000 and 4,500 years ago (Deevey and Flint 1957; Overpeck et al. 1992; Haas and McAndrews 2000; Williams et al. 2000), the regional climate has been relatively cool and wet with generally mild, short-lived droughts. Lightning is usually accompanied by heavy rainfall and is unlikely to ignite spreading wildfires except during unusually severe droughts (Loope and Anderton 1998), which occur rarely. However, the practice by Native Americans of regularly burning the woods and fields made it possible for grasslands and other fire-maintained plant communities to persist for centuries or thousands of years (Maxwell 1910; Day 1953; Thompson and Smith 1970; Webster 1983; Dent 1985; Denevan 1992; Casselberry and Evans 1994; Black and Abrams 2001). Grasslands are especially likely to persist where severe microclimate or thin, infertile soils slow the rate of post-fire recolonization by trees (Latham 2003). With the extreme weather at Blue Mountain's ridge top and the erosion-prone soils on the steep upper slopes, the

vegetation does not have to burn often to sustain a cover of grasses, dwarf shrubs and scattered, stunted trees.

Contrary to an often-held assumption, what is now the eastern United States was not covered by unbroken forest when the Europeans first arrived. Evidence is still accumulating from pollen core analysis and other scientific studies to verify what has long been known from the earliest historical records, namely, that grasslands and meadows were far more widespread in prehistoric eastern North America than is generally appreciated (Patterson and Sassaman 1988; Denevan 1992; Clark and Royall 1996; Delcourt and Delcourt 1997, 1998). American Indians used fire expansively, most likely to improve game habitat, clear land for crops, encourage the growth of certain fire-enhanced sources of food such as blueberries, huckleberries, blackberries and raspberries, and extend visibility to make hunting easier and to enhance "homeland security." Even the forests bore the marks of centuries or thousands of years of regular burning. The still-vast but declining oak forests of the central Appalachians and northern Piedmont are probably a direct result of Native American burning (Abrams 1992, 1998, 2003).

After the Indian populace was displaced, nearly all of the grasslands and meadows succeeded into forests or were converted into plowed farm fields. Only where the soils were too poor to grow crops or to support rapid invasion by forest trees—for instance, the thin soil on steep mountain slopes—were native grasslands sustained after the Indians' departure. In time, even those places were mostly covered over by forest vegetation. Only the few acres that were kept cleared in the last three centuries by livestock grazing, accidental wildfires or intentional burning have had continuous native grassland vegetation since prehistoric times.

In recent times, conservation organizations and agencies have made native grassland conservation intentional, using prescribed burning, restoration planting, and other management tools. The Lehigh Gap Wildlife Refuge is one of the pioneers in Pennsylvania in grassland reclamation using native species. Building on the experimental work already underway and with its more than 200 additional acres of potential grassland reclamation area, the Refuge presents a unique opportunity to create a model adaptive resource management program for native grasslands in Pennsylvania.

Temperate grasslands have been among the least-protected ecosystems and, as a result, now they are critically endangered

Scientists conducting a global study of conservation needs recently tallied the total areas of habitat converted or destroyed and of habitat protected in all of the major ecosystem categories (Hoekstra et al. 2004). The picture is upbeat for certain ecosystems—including tundra, boreal forest and taiga, montane grassland and shrubland, and temperate conifer forest—but it is bleak for many others. Of all ecosystem types evaluated, temperate grassland is in the direst straits (Fig. C1). For temperate grassland, savanna and shrubland together, the ratio of converted to protected land is ten to one, five times higher than even the beleaguered tropical rainforest. Only 4.6% of the land in temperate grassland, savanna and shrubland has been protected to date while 45.8% has already been destroyed. The figures are even more dismal for the eastern United States, where native grasslands have been under extreme pressure for more than 300 years and most were converted long ago to agricultural, residential, commercial and other uses.

Historically, grasslands (including savannas) and meadows occurred as breaks in the eastern deciduous forest resulting from disturbances such as fire, periodic flooding, dam-building and abandonment by beavers, insect infestation, and clearing by humans—first by American Indians and later by settlers from the Old World. Most grasslands and meadows in eastern North America are short-lived ecosystems. Without repeated disturbance, trees and other forest plants seed in rapidly and reestablish the forest.

Since the first European settlement, native grasslands and meadows have steadily declined. These plant communities were once composed of hundreds of native plant species that, for millions of years, provided the highest quality food and habitat for native meadow wildlife. The typical grassland or meadow today is an abandoned field invaded by a few introduced species—multiflora rose, autumn-olive, Japanese honeysuckle, Amur honeysuckle, Canada thistle, mile-a-minute and Japanese stilt-grass are examples—that crowd out most native plants and degrade the habitat for many native animal species. Most grasslands and meadows in Pennsylvania have an agricultural past (old hayfields or pasture) and are dominated by exotic cool-season grasses such as fescue, ryegrass, bluegrass, orchard grass and timothy. Native cool-season grass species dominate the hairgrass – lowbush blueberry savanna on the ridge top at the Lehigh Gap Wildlife Refuge, with scattered clumps of native warm-season grasses. In lower-elevation native

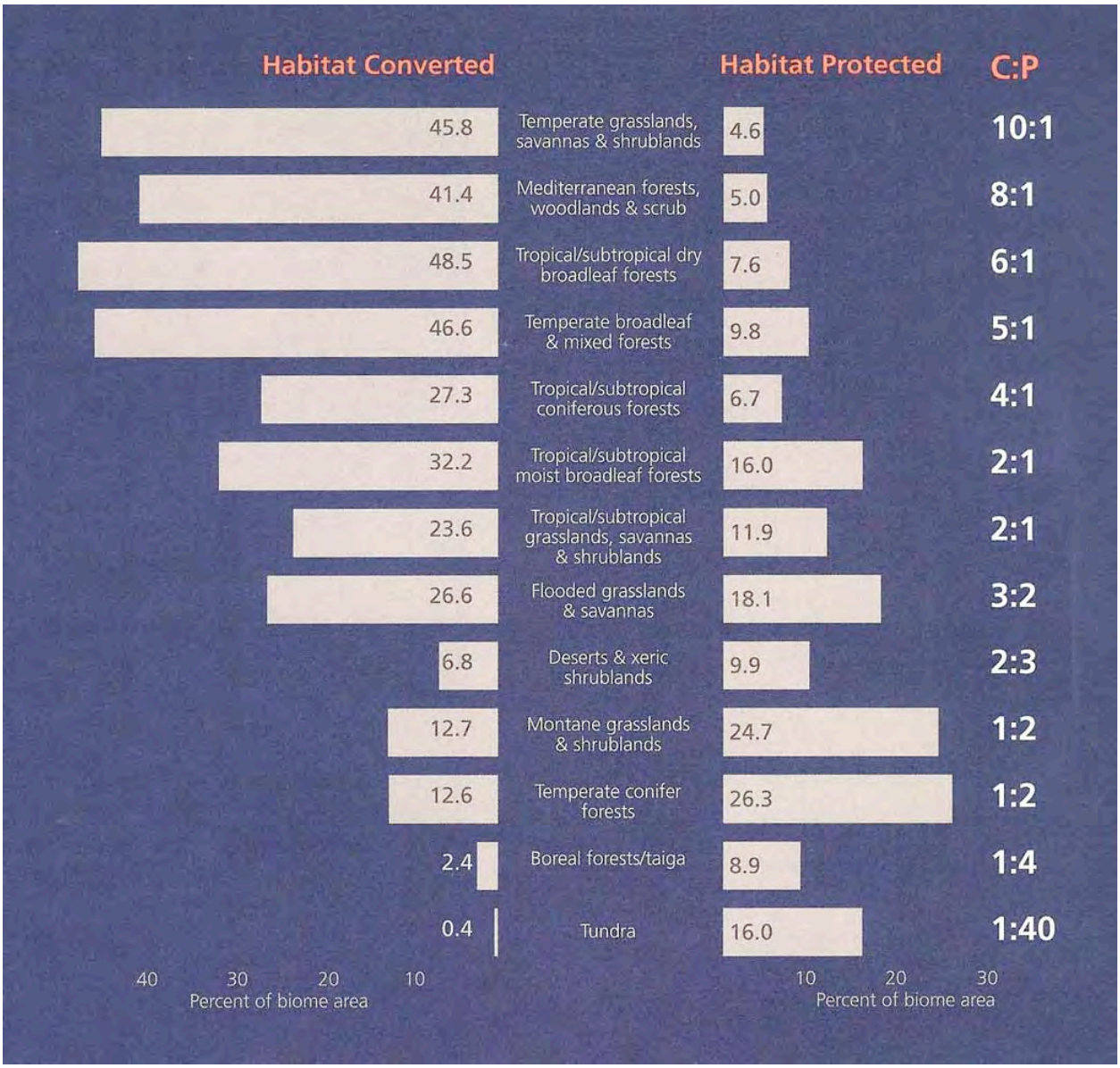

Figure C1. Estimates of the total areas of habitat converted or destroyed and of habitat protected in the world's major biomes (Hoekstra et al. 2004). "C:P" is the ratio of converted area to protected area in each biome.

grasslands and meadows in the region, the most abundant grasses are often warm-season species, including little bluestem, big bluestem, Indian grass, broomsedge and switchgrass. Because they have lived here for millions of years (with interruptions during ice ages), native grasses are well adapted to the soils and climate. They can thrive on marginal soils and the warm-season species are especially suited to survive periods of low rainfall due to their deep fibrous root systems, which penetrate the soil to a depth of 5 to 15 feet.

Wildlife species dependent on grasslands in the northeastern United States have shown consistent and severe population declines in recent decades

Declines in populations of neotropical migrant birds that breed in the forests of eastern North America have received much attention, but grassland birds in the region are in even greater peril. Analysis of breeding bird survey data show that 16 of the 19 species that breed only in grasslands in the East have shown declining trends and 12 of them have declined significantly (Askins 1997).

Populations of grassland-nesting birds such as bobolink, eastern meadowlark, grasshopper sparrow, savanna sparrow, upland sandpiper and northern bobwhite have declined drastically in recent years due to the loss of habitat and the fragmentation of remaining habitat into pieces that are too small to meet their needs. Most of this loss is from farm abandonment, residential and commercial development, and changes in farming practices, such as earlier mowing times and the widespread conversion of hayfields and pastureland to soybeans, corn and other non-grass crops.

The native grasslands of the Lehigh Gap Wildlife Refuge and adjoining State Game Land 217 and Appalachian Trail corridor land could increase in value as habitat for grassland-dependent wildlife if a long-term grassland restoration and maintenance program were established. The patches are large enough to be a significant habitat cluster for native grassland plant and insect species and their value would grow if their area were expanded. Their significance as breeding habitat for birds has been enhanced by the proximity of grassland reclamation plantings over a 200-acre block of the Refuge on the mid- and lower slopes of Blue Mountain. The large contiguous area of land involved in the grassland reclamation project is a special opportunity for attracting nesting pairs of grassland-obligate rare bird species, including some that have exacting habitat minimum-area requirements.. It is probably not large enough to support “source” populations of these species, that is, populations with the potential to produce a surplus of young birds that would colonize more-marginal habitats elsewhere in the region. However, it could serve as a research site and demonstration showpiece for how to create or enhance habitat on lands that do not presently support grassland birds, for instance, reclaiming some of the vast landscapes in northeastern and western Pennsylvania that have been catastrophically disturbed by coal mining.

Little is known about the effects of declining native grassland habitat upon other kinds of wildlife in Pennsylvania, including small mammals, snakes, lizards, insects and other arthropods, and various animals that live in the soil. But we can get some idea of the probable magnitude of the problem from surveys of moths and butterflies, one of the few groups other than birds that have been studied in native grasslands elsewhere in southeastern Pennsylvania. Native grassland remnants harbor, according to discoveries so far, more than 50 butterfly and moth species listed as endangered, threatened or rare in Pennsylvania (Pennsylvania Natural Heritage Program, unpublished data). Three rare insect species were documented in a recent light-trapping survey in the hairgrass – lowbush blueberry savanna at Lehigh Gap (Rawlins 2007): the modest Quaker moth *(Ulolonche modesta),* fingered lemmeria moth *(Lemmeria digitalis)* and earwig scorpionfly

(Merope tuber). The modest Quaker, which feeds on oaks, was found to be exceptionally abundant.

To date, not even basic inventories of most grassland wildlife have been given funding priority, much less scientific studies of key species interactions or of the effects of grassland decline or grassland restoration efforts on their populations. However, interest in native grassland restoration, reclamation and management is gaining momentum, and potential sources of funds for research and demonstration projects are taking notice. The Lehigh Gap Wildlife Refuge is well equipped to serve as a "laboratory" for such studies, including experimental investigations of alternative methods of grassland restoration and species reintroduction.

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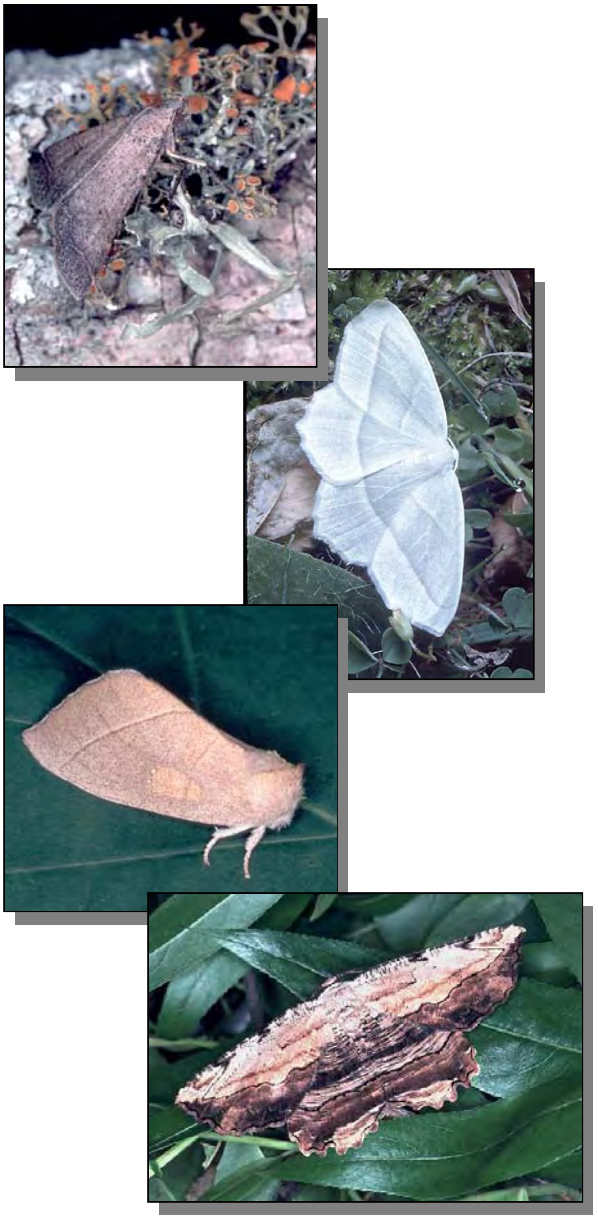

Appendix D

Lehigh Gap Nature Center:

Preliminary Faunal Assessment for

Insects

Prepared by

John E. Rawlins
Carnegie Museum of Natural History
Section of Invertebrate Zoology

May 5, 2007

Cover photographs (top to bottom):
Bleptina caradrinalis, bent-winged owlet (Lepidoptera: Noctuidae: Herminiinae) (Rank: S5G5)
Campaea perlata, pale beauty (Lepidoptera: Geometridae: Ennominae) (Rank: S5G5)
Nadata gibbosa, white-dotted prominent (Lepidoptera: Notodontidae) (Rank: S5G5)
Lytrosis unitaria, common lytrosis (Lepidoptera: Geometridae: Ennominae) (Rank: S5G5)
Dryocampa rubicunda**,** rosy maple moth (Lepidoptera: Saturniidae: Ceratocampinae) (Rank: S3G4)
Metarranthis duaria, ruddy metarranthis (Lepidoptera: Noctuidae) (Rank: S4G5)

Lehigh Gap Nature Center:

Preliminary Faunal Assessment for

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May 5, 2007

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This report may be cited as follows:

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Contributing primary investigators:
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Daniel R. Kunkle, Lehigh Gap Nature Center

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About this Document

New occurrence data for targeted insect lineages in this report reflect information from 2,720 professionally prepared specimens taken by fieldwork conducted by Daniel Kunkle. These Carbon County findings have not been formally reported elsewhere , but may be reviewed individually in the on-line database of insect specimens from Carnegie Museum of Natural History, Section of Invertebrate Zoology at

http://iz.carnegiemnh.org/CMNH/

or from the Section homepage at

http://iz.carnegiemnh.org/inverts/izhome.html.

To obtain listing for this project on the insect database homepage, use drop-down menus under Geographical Region to select Carbon Co.

Acknowledgments

Special appreciation is extended to collaborators and administrators who made this project possible, including David Steckel (Natural Lands Trust, Inc.) and Daniel R. Kunkle (Lehigh Gap Nature Center). Fieldwork was conducted by Daniel R. Kunkle and Jeff Frantz. The Carnegie Museum staff in the Section of Invertebrate Zoology undertook sorting, preparation and authoritative identification, led by coordinator Timothy J. Tomon, and involving input from Robert A. Androw, Robert L. Davidson, Hillary Fetzner, Jane C. Hyland, David P. Koenig, Vanessa Verdecia, Dr. Chen W. Young, and Walter A. Zanol.

Introductory Information

Site Selection

The three trapping sites for this survey were selected based on habitat characteristics and attempted to span the full range of habitats for purposes of maximizing information on the species occurring in the reserve. Some factors involved with site selection included:

1. Floristic composition emphasizing the woody vegetation (woodlands and brushy habitats),
2. Presence of wetland habitat types, including streams, swamps, fens, bogs, vernal pools, and mini-wetland types (persistent damp areas), and
3. Special habitat types reflecting edaphic and topographic features, such as serpentine, barrens (of various kinds), rocky slopes, and open habitats such as grasslands, meadows, or oldfields.

The three sites, all in Carbon County near Palmerton, Pennsylvania, were described on specimen labels as "Lehigh Gap Wildlife Refuge", more formally called the Lehigh Gap Nature Center. They include the following: **Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m – near the south ridgetop with grassy areas and blueberry thickets scattered in upland deciduous forest and a few pines (1,153 specimens prepared); **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m, located at the upper end of a small ravine in disturbed forest bordering on remediation grassy areas (639 specimens prepared); **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m, near the Lehigh River with ponds and wetland areas adjacent to oldfields and secondary regrowth forest (928 specimens prepared). In combination, these sites positioned traps near most species of plants growing at the Center, and were expected to maximize herbivorous insect representation in the light traps.

Precise trap locations were determined by Carnegie entomologist John E. Rawlins at the site, and sought to maximize adjacency to diverse vegetation or to emphasize ecotones between plant communities. No sites were recently disturbed from factors such as pest defoliators, tree cutting, or herbicide applications, all factors that would have influenced faunal composition, especially herbivorous lineages such as Macrolepidoptera. All of the sites, to a greater or less extent, have been impacted by wind-borne pollutants from historical operation of the nearby zinc smelter.

Field Sampling for Insects

The light traps in this study used a standardized 15-watt, 45 cm long, fluorescent UV lamp (Sylvania 350 Blacklight F15T8/350BL) powered by a 12-volt DC battery at reduced power output of 7.5 watts. Lamps were suspended vertically above a smooth stainless steel funnel (30 cm diameter)

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covering the mouth of a 20 liter plastic bucket. Four vanes of thin aluminum were placed on four sides of the lamp to intercept insects in flight near the bulb. The assembled trap was braced upright in the field and as necessary a tarp (approximately 2 × 3 m) was suspended above it to prevent precipitation from entering. Insects were killed in the traps by suspending three porous sticks (3 × 2 × 15 cm) of reinforced plaster of Paris saturated with tetrachloroethane just inside the funnel. This killing agent works quickly and leaves specimens flexible for immediate processing (no *rigor mortis* after death).

Samples were taken from 12 April to 1 November, 2006 (2,720 specimens prepared). In general, sampling was deficient for spring months, but that time period is disproportionately over-represented in entomological collections. Survey trips were generally conducted as convenient with every attempt to avoid collecting close to the night of the full moon, which is known to decrease the effectiveness of light trapping for nocturnal insects. Light trap tending was accomplished by Daniel Kunkle, sometimes accompanied by J. Frantz. Financial support for this project was supplied in part by the Natural Lands Trust with primary address at Hildacy Farm, 1031 Palmers Mill Road, Media, Pennsylvania 19063, in turn partially supported by a contract from the Pennsylvania Department of Conservation and Natural Resources in Harrisburg. CMNH provided collecting and processing equipment and supplies as well as training of field technicians on acceptable collecting techniques.

The original project agreement called for CMNH to prepare and identify insect specimens taken in a total of 63 samples from these light traps, run three times a month from mid-April to mid-November. The actual collections produced 51 samples. The original agreement mandated comprehensive preparation and identification of targeted taxonomic groups of invertebrates: Diptera (Tipulidae, Tabanidae), Coleoptera (Carabidae, Silphidae, Scarabaeidae, Cerambycidae, Scolytidae), all Macrolepidoptera (Apatelodidae, Geometridae, Drepanidae, Thyatiridae, Thyrididae, Noctuidae, Arctiidae, Lymantriidae, Notodontidae, Nolidae, Epiplemidae, Saturniidae, Sphingidae, Lasiocampidae, Limacodidae, Cossidae, Hepialidae, Zygaenidae, Sesiidae, Hesperiidae, Papilionidae, Pieridae, Nymphalidae, Lycaenidae), Odonata (all families), and Megaloptera (all families). Of these groups, all nocturnal forms were captured except for Thyrididae, Epiplemidae, Cossidae, and Hepialidae. No diurnal specimens of Hesperiidae, Papilionidae, Pieridae, Nymphalidae, Riodinidae, or Lycaenidae were provided for identification.

Sampling required two days per trip by field technicians, with the first day spent setting out one light trap at each site. The second day involved retrieving light trap samples. Environmental data and other information about each trap site and trapping event were recorded in the collector's

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notes, some of which is recorded on sample labels at CMNH and on specimen labels in the collection. These data include collector's names, date, time, precise GPS readings, elevation, and brief habitat descriptions.

Light trap samples were carefully transferred from trap buckets to labeled 1-gallon polyethylene bags (zip-lock style), intentionally left unsealed, and stacked 3-5 bags deep in hard plastic containers that prevent deformation or jostling of the contents. The samples were transported to a chest freezer at the Center headquarters, and then onward to CMNH in Pittsburgh with great care so as to avoid vibration or jarring that would damage Lepidoptera scalation.

Processing of Insect Samples

Light trap samples were retained in freezers at CMNH until sorting took place. Samples were thawed to room temperature for no longer than four hours, then carefully sorted by J.E. Rawlins following a strategy to optimize diversity information in each sample. Every Lepidoptera specimen in all samples was examined individually and retained according to the following protocol for each species:

a. If the sample contained a single specimen of a species, it was retained for preparation regardless of physical condition. **Thus survey results reflect occurrence of all species to the limits of the sorter's ability to recognize taxa by external visual examination**.
b. If the sample contained two specimens of that species, the second was retained unless it was in extremely poor condition. This protocol helped distinguish between species with abundances exceptionally rare and those that are just uncommon.
c. If the sample contained three to about eight specimens, then a third specimen was retained.
d. If the sample contained between about nine and about 25 specimens, a fourth voucher was retained. No attempt was made to precisely sort and count all specimens, and at this level retention of specimens becomes quite variable.
e. If the sample contained between about 25 to about 100 specimens, a fifth voucher was retained.
f. If samples contained more than 100 individuals of a species, then a fifth, sixth, or even seventh voucher was retained. Some samples contained hundreds of individuals of certain species (e.g., common species of caddis flies) and there is no precise relationship between the number of vouchers retained above four and the number of specimens actually captured.
g. More vouchers than listed in sections c-f above were retained if the species was thought to be of special interest, rarity, or concern. For example, in a sample containing six specimens of a very rare species, all six were retained as vouchers, while in a sample with six specimens

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of a common species, only three were retained. As a result, rare species are over-represented as voucher specimens relative to their comparative abundance. Given the logarithmic relation between total insects captured in a sample and the number vouchered under this protocol, a false impression of abundance might be gathered from literal interpretation of numbers when three or more vouchers were retained.

In summary, this sorting protocol (1) assures documentation of occurrence for every target species in every sample, (2) strongly registers the difference between one specimen and two or more, and (3) less rigorously reflects total abundance by the presence of three or more vouchers. Although between-species comparisons of abundance based on light trap samples are suspect for so many reasons as to not require further discussion, users of these data are warned to exert caution when interpreting voucher numbers of three or more in any given sample. For instance, the noctuid moth *Ulolonche modesta* associated with barrens and upland areas has not been documented in large numbers in Pennsylvania, therefore virtually every specimen of that species was retained (17), more than would have been kept using the above protocol.

In general, the above method produces a set of vouchers that reflects abundance of species in a sample. It is precise at low levels of occurrence and becomes less so as abundance increases. This method is both practical and essential, as this study must have captured far in excess of 100,000 specimens of insects. Samples of large size and diversity would overwhelm the sorter if precise counting were attempted for each and every species.

Many factors influence likelihood of capture in UV light traps, including interspecific differences in behavior, attraction to light, and flight patterns, not to mention influences caused by weather, trap placement, density of vegetation, sexual differences, and so on. Due to these factors, exhaustive counting of all specimens taken in light trap samples was not undertaken in this study. Not only is such counting expensive in terms of time, but also there is no clear evidence that it yields information of greater utility than the protocol specified above for determining species-specific phenologies and distribution, and for comparing faunal diversity between habitats. **In particular, it should not be inferred from absence of a given species in a sample that the species was not present at that time or place. This is especially true for rare species.** All that can be concluded with certainty based on a specimen record is the presence of a species at a certain site and date. The fact that all available samples were comprehensively examined for the species reported does provide meaningful information on phenology and voltinism.

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CMNH staff entomologists and preparators processed the samples collected according to strict curatorial standards for pinning, point-mounting, and labeling to ensure specimen conservation. After Lepidoptera vouchers were sorted from light trap samples and delicate specimens such as most tipulid flies were removed and prepared, the unwanted Lepidoptera were discarded and the remaining insects preserved as a bulk residue sample in fresh 80% ethanol. The alcohol residues were then sorted to remove all non-Lepidoptera specimens of interest (Carabidae, Cerambycidae, Scarabaeidae, Silphidae, Tabanidae, and many other families with special attention to any that contain well-known species of special concern). Although the primary reason for preserving these residual collections was to broaden documentation of the fauna, these samples were also selectively sorted in order to remove all specimens of several targeted lineages of insects of special interest to CMNH staff and of potential future comparative value for understanding forest ecosystems. A number of other species were documented in other families of Coleoptera and Diptera, but no attempt was made to voucher every species in every sample as was done for the Macrolepidoptera and the non-lepidopterous families listed above. For Macrolepidoptera, Carabidae, Silphidae, Cerambycidae, Tabanidae, and Tipulidae, the results of this survey may be considered exhaustive with respect to the specimens actually captured.

Authoritative identifications of insect specimens were provided by staff and associates of the CMNH Section of Invertebrate Zoology as follows: J.E. Rawlins (1,743 Lepidoptera and smaller orders); R.L. Davidson (367 Coleoptera: primarily Carabidae); C.W. Young (50 Diptera, especially Tipulidae); and R.A. Androw (560 Coleoptera: Cerambycidae and other non-carabid beetle families).

The future integrity and availability of specimens documenting this project are assured by permanent storage and curation in the CMNH entomological collection. CMNH technicians under the supervision of J.E. Rawlins provided data entry, database management, data analysis, and reporting for all samples.

Deposition and Access to Specimen-Data

A total of 2,720 invertebrate specimens were collected during this project, entirely from light traps, are deposited at CMNH, and are the property of CMNH. As appropriate to DCNR partial funding of the Natural Lands Trust for this project, information on specimens is available for transfer to the Pennsylvania Natural Diversity Inventory (PNDI), maintained by the Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Natural Heritage Program. Future access to all preserved specimens resulting from this survey and their associated data is the exclusive right of project sponsors and participants, including the Pennsylvania Department of Conservation and Natural Resources, the Natural Lands

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Trust, and the Lehigh Gap Nature Center, with suitable compensation for preparation and identification of specimens requiring extraction from bulk sample residues stored at CMNH.

Users are cautioned not to misinterpret information presented in this report. In particular, **the absence of a listing for a particular species at any locality or time should not be interpreted as conclusive evidence that the species is actually missing at that site or date.** No exhaustive effort was made to collect in all habitat types in this region of the state, and the taxa reported are in no way representative of the state fauna.. There are many valid reasons why a species actually present at the Lehigh Gap Nature Center and occurring at the sampled sites might not have been collected during this inventory, and a repeat of this effort would reveal additional species. Such is the nature of invertebrate diversity and our ability to cope with it. **On the other hand, presence of a species on this list is evidence of occurrence in space and time**, readily verified through specimen-based documentation by direct examination of the exact specimens involved.

These occurrence data are entirely supplemental and were gathered in only three habitat types in an attempt to better document species of special concern. They represent only a small fraction of the total species encountered in the samples themselves, let alone in the actual habitats or statewide. Sample residues from traps (unsorted and unprepared specimens of high quality in fluid preservatives) are retained in the sample archives of the Section of Invertebrate Zoology at Carnegie Museum of Natural History, and are available for future sorting, preparation, and documentation as needs dictate.

Table 1 is a complete data compilation for all insect specimens collected during fieldwork conducted by this project in 2006. Samples were taken by 102 person-days of collecting effort by Daniel Kunkle at 3 localities in Carbon Co., Pennsylvania. Specimens prepared represent 13 insect orders, 73 families, 251 genera, and 403 species-group taxa. Data are organized alphabetically and hierarchically by taxonomic groups, counties of occurrence, and individual localities. Under each locality information is organized temporally by date of collection and type of collecting method (UV light trap). Following the above information, the specimen or series of specimens is listed by giving their unique number codes from the Carnegie Museum collection. Future reference to any specimen may be made by requesting these unique numbers. All specimens are professionally prepared and have been deposited for maintenance in perpetuity in the research collection of Carnegie Museum of Natural History, Section of Invertebrate Zoology. These data are taken from the main project database supplied in spreadsheet form to the Natural Lands Trust and the Lehigh Gap Nature Center, and available with mapping utilities on the Carnegie Museum of Natural History's website (Insect Database of the Section of Invertebrate Zoology, http://iz.carnegiemnh.org/CMNH/)

Species of Special Concern or Interest

Species of Special Concern

Species of Special Concern are generally those species of interest to conservation science because they (1) are particularly rare; (2) have declined in certain regions to the extent that populations, or the entire species, are in danger of extinction; or (3) due to a lack of information the status of the species or its populations is unknown and the taxon is therefore potentially of concern to conservation. Such species often inhabit rare or unique habitats, or habitats of high condition or quality. In some cases a species may be dependent on habitats that themselves are declining and therefore the species is also under decline. In other situations, species of concern are rare or are experiencing decline for reasons that are unknown. The list of Species of Special Concern in Pennsylvania is maintained by the Pennsylvania Biological Survey, a consortium of scientific, conservation, and resource management organizations and agencies. This list is dynamic and data produced by studies such as the present one are utilized to update and refine the special concern list.

A more recent and comprehensive listing of this sort was provided for Pennsylvania invertebrates through funding by the US Fish and Wildlife's State Wildlife Grant program. Operating through the Pennsylvania Game Commission, an extensive and comprehensive report was compiled that will serve as a resource for invertebrate conservation in PA. This report should be made available on-line by mid-2007.

> Rawlins, J.E. 2005. Pennsylvania Comprehensive Wildlife Conservation Strategy (CWCS)-Priority Invertebrates. Appendix 5 (iii + 227 pp) in Williams, L., et al. (eds.). *Pennsylvania Comprehensive Wildlife Conservation Strategy*. Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission. Version 1.0 (October 1, 2005). 772 pp + appendices.

These lists of Species of Special Concern guides the state natural heritage program and its regulatory branch known as the Pennsylvania Natural Diversity Inventory (PNDI). As one of more than 50 state natural heritage programs in the U.S., PNDI maintains a list of special concern species utilizing standard methodology. These lists provide the conservation status of taxa by reporting the Global Rank and State Rank. Species described below that are of special concern for conservation have their Pennsylvania state and global conservation status (Heritage Network Ranking) indicated in red: S1 to S4, and G1 to G5.

COLEOPTERA

Carabidae

The Carabidae of Pennsylvania project records 28 species from Carbon County. Of the 63 species taken in this Lehigh Gap survey, 9 were already recorded from the county. The remaining 54 species are new county records, bringing the known total up to 82.

Species of Special Concern or Interest

Of the 63 species taken in this study, 42 are characteristic of various kinds of wetlands (including two relatively rarer and more restricted species which occur only on reedy vegetation like cattails and sedges). Five others are characteristic of open ground and disturbed areas where it is wet, so the overwhelming majority is associated with wet areas. I have not seen and do not know the terrain encompassed by this survey, so I cannot tell whether these species, taken I gather largely from light trap samples, occur on the property or flew in from adjacent habitats. Three of the remaining 16 species are arboreal and presumably came from trees on or near the sites. None of the species is a forest floor dweller; but most of these forest floor species do not fly and can be taken only by hand or pitfall or other such traps, so perhaps this is an artifact of the collecting methods. Four of the species are ectoparasites of chrysomelid pupae and are characteristic of flowery open fields where their host chrysomelids hang out. The remaining species are characteristic of open sandy cultivated or disturbed areas. But most of the many native species characteristic of open fields and meadows, or drier disturbed areas, were NOT taken. And quite surprisingly, only two species are introductions; none of the many synanthropic species introduced from Europe and thriving in disturbed habitats was taken.

***Ophonus puncticeps* Stephens**
This introduced European species is a specialized feeder on seeds of Queen Anne's Lace, and has followed that introduced plant across northeastern North America as far at least as Ohio. It therefore occurs in the same kind of open sandy habitats as the plant and is common in disturbed weedy habitats. It is an effective colonizer and is strongly favored by human activities.

***Perigona nigriceps* (Dejean)**
This species now occurs pretty much worldwide, spread by commerce due in part to its small size and its favoring decaying vegetation and plant roots. It is again an effective colonizer strongly favored by human activities. It prefers moist rich organic soils in open ground, compost heaps, gardens, in lowland areas.

***Stenolophus ochropezus* (Say)**
By far the commonest species in the survey, this is a broadly adapted wetland species, which occurs in nearly any kind of wet area. It also flies readily to lights and is usually very abundant wherever it occurs, which presumably accounts for its domination of the survey material.

***Leptotrachelus dorsalis* (Fabricius)**
This species is the northernmost representative of a largely tropical tribe. Its elongate shape is indicative of its habitat. It occurs primarily in the layers or sheaths of cattail (*Typha*), whence it can be pried during the day, and it forages up and down the leaf blades at night.

Species of Special Concern or Interest

***Agonum galvestonicum* (Casey)**
By far the rarest of the species taken in the survey, though as its habitat has become known, it is increasingly present in collections. When described, it was known only from two widely separated localities (Galveston, Texas; and southern Ontario, Canada), but has since been recorded from Ohio, Missouri and South Carolina (by us); and we have as yet unpublished records from West Virginia and elsewhere in Pennsylvania. Its habitat is much like the preceding, as is its behavior. It hides in cattail fronds by day and forages on the leaf blades at night. Two specimens were taken at Site 3 in late May. As typical of many rare insects, and in contrast to vascular plants and vertebrates, this species may be of special concern for conservation but is not on status lists or otherwise noted in the conservation literature.

Dryopidae
A single specimen of a species of the genus *Helichus* in the beetle family Dryopidae may provide some insight into the water quality of streams in the area. Dryopid beetles are wholly aquatic both in the larval and adult stages and require relatively clean, highly oxygenated water for their survival. They can generally be found in riffle areas of shallow, fast-moving streams where the aeration of the water is at its highest level. There are 4 or 5 species that may occur in the area, but identification to species is reliable only by dissection of males and examination of genitalic characters. Unfortunately, the single specimen collected appears to be female.

Scarabaeidae: Scarabaeinae
Five species of dung beetles found during the survey, *Dialytellus dialytoides* (Fall), *Dialytes truncatus* (Melsheimer), *Dialytes striatulus* (Say), *Copris minutus* (Drury) and *Aphodius rusicola* Melsheimer all feed in the dung pellets of deer. The diversity of these beetles in the samples indicates a ready availability of food materials and it can be assumed that there is a healthy number of deer in the area. Numerous deer in an area is typically the case for most of Pennsylvania, but many habitats harbor only introduced species of dung beetles, such as *Aphodius rusicola*,. The presence of the two native species of *Dialytes*, and of the less common *Dialytellus dialytoides*, may indicate a habitat capable of supporting native species as well as some of the introduced.

Silphidae
***Nicrophorus* spp.** - Relative to other Pennsylvania surveys, very few representatives of this genus were taken with the exception of two specimens of *Nicrophorus orbicollis* Say, which is usually the predominant species in most habitats. A single individual of *Nicrophorus pustulatus* Herschel was also taken, and while this species is not uncommon in the state, it is often the species represented by the fewest number of individuals in most surveys. *Nicrophorus pustulatus* has one of the most restricted larval food requirements, utilizing dead reptiles as a primary food source, and there is some evidence that it may act as a parasite on snake eggs. It should be noted that all of the specimens

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taken in this survey were in light traps. Using pitfall traps, especially if baited with decaying meat, would give a more accurate estimate of the silphid fauna at the site.

DIPTERA

Tipulidae

The sample of crane flies (Tipulidae) collected in light traps was representative of species usually found in somewhat dry, secondary woodland with aquatic habitats nearby. No carnivorous species are in these samples indicating a lack of clean cold streams, boggy areas or saturated or spring-fed seepages on hillsides for larval development. The presence of *Antocha (Antocha) saxicola* indicates a large body of water nearby (the river below Site 2). Stream edge and swamp species are *Dactylolabis (Dactylolabis) cubitalis*, *Tipula (Nippotipula) abdominalis, Tipula (Yamatotipula) furca, Tipula (Yamatotipula) sayi,* although specimens of the first two were taken at the ridgetop habitat and are borne considerable distances from wet habitats on the wind. The common woodland leaf-litter/soil species are *Tipula (Lunatipula) duplex, Tipula (Lunatipula) fuliginosa*, and *Tipula (Vestiplex) longiventris*. The ecotone species of areas between small grassy fields and edges of woods is *Tipula (Lunatipula) bicornis*. Notice the absence of another group of common ecotone species of *Tipula*, the subgenus *Nephrotoma,* in this survey. Larvae of *Tipula (Pterelachisus) trivittata* are usually found under moist decaying wood on the woodland floor, but here taken at the ridgetop site. And *Dolichopeza (Oromyza) sayi* is a common woodland moss feeder, a specimen in this survey at Site 3.

HETEROPTERA

Pentatomidae

***Halyomorpha halys* Stål,** the brown marmorated stink bug, or BMSB for short, is a species introduced from China first identified as an invasive species in 2001 from specimens taken in the Allentown, Lehigh County, Pennsylvania area. Since then it has spread quickly, recently being found in the Pittsburgh area, as well as at other sites in the U.S., including New Jersey and Oregon.

The species is phytophagous, both nymphs and adults attacking a wide range of plants - piercing the stems, leaves and fruits to feed on the plant's sap. Ornamental plants seem to be the most likely to be attacked in Pennsylvania, but there is growing evidence that this species poses a potential risk to agricultural crops, especially in the South, where it may be able to produce up to five broods in a season. There is a single brood in the North per season, due to the colder climes.

In Pennsylvania, *Halyomorpha halys* is primarily a nuisance pest due to its habit of congregating indoors to pass the colder months of winter. On warm days adults may emerge from their hiding places and gather on the inside of windows, causing consternation for the homeowner. Their tendency to

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release a noxious odor when disturbed makes their presence in the home even less welcome.

LEPIDOPTERA
Arctiidae: Arctiinae: Phaegopterini
***Cycnia oregonensis* (Stretch)**
Attractive little tiger moths in the genus Cycnia are common in many habitats throughout Pennsylvania. The most common of the three Pennsylvania species, *Cycnia tenera*, was found at Site 2 and Site 3 from late May to early August. The pale gray, fluffy woolly-bear caterpillar feeds on dogbane. A much less frequently encountered species, *Cycnia oregonensis*, was found at Site 1 in late June. Typically this species has pale wings with faint but definite, gray longitudinal streaks on the forewings, but the specimens in this survey were nearly uniform white. It has larvae feeding on dogbane as well, and quite similar in appearance to those of *C. tenera*. A third species, *Cycnia inopinatus*, is much rarer in Pennsylvania and it was expected but not discovered during this survey. It has larvae feeding on milkweed and the body is orange with setal grouping, quite different from the other two species.

Arctiidae: Lithosiinae
***Crambidia pallida* Packard**
The pale gray, relatively featureless adults of this species are usually missed by non-specialists, as their appearance is inconspicuous and they are assumed to be some unknown microlepidopteran. The larvae feed on free algae growing on barks and twigs of trees, or on rocks. Algal components of lichens are also eaten by grazing lichens (hence the common name of lichen moths), but there is no evidence that the fungal component of lichens is of interest to larvae, only incidental as they seek nutrition from the algal symbiont in the lichens. This species was taken at Site 1 and Site 3 in August. and October.

***Hypoprepia miniata* (Kirby)**
This easily recognized, intensely red little moth is one of the most easily recognized species in the Lehigh Gap Nature Center. The species appears to be double brooded, the first brood at Site 1 and Site 2 in this survey from late May to late June, then again in late August.

Noctuidae: Amphipyrinae
***Lemmeria digitalis* (Grote)**
Heritage Network Rank: S3G4; PA RESPONSIBILITY SPECIES
This pretty little moth occurs from Maine and Ontario to Pennsylvania, west to Illinois. It is most abundant in Pennsylvania and western New York, thereby becoming a Pennsylvania Responsibility Species for conservation. It is active as an adult in October, the specimen in this survey being taken at Site 1 on the first day of November. The life history is not known, but related moths are borers in the stems of woody or semi-woody wetland plants. It's occurrence at Site 1 is enigmatic, as it is usually known from bogs and fens. The life history is not known to this author.

Species of Special Concern or Interest

Noctuidae: Hadeninae
***Ulolonche modesta* (Morrison)**
Heritage Network Ranking: S4G5
Two species of this genus were taken at Lehigh Gap, including a single specimen from Site 1 in late May of the oak-feeding *Ulolonche culea* (Guenée) and an astonishing 17 specimens at Site 1 from late May to mid-June of the rare *Ulolonche modesta*. The larval food plant of this species isn't known to this author, but it is might be blueberry or other ericaceous plants along the Site 1 ridgetop. The species is ranked S4 by the Heritage Network.

Noctuidae: Noctuinae
***Dichagyris (Loxagrotis) acclivis* (Morrison)** formerly [*Richia acclivis*]
Heritage Network Ranking: S1G4
This infrequently encountered species was not rare near Site 2 in mid to late August. Known until just recently as *Richia acclivis*, it may be more abundant in this region than realized, and the Pennsylvania Heritage Rank of S1 may be unwarranted, perhaps S2 or even S3. The larvae feed on switchgrass, *Paspalum virgatum*, and this may explain its occurrence only at Site 2. A related species, *Dichagyris (Loxagrotis) grotei*, is much rarer and may truly warrant an S1 rating. It was not collected during this survey.

***Noctua pronuba* Linnaeus**
Common at all three sites, flying from June to September. This noctuid species was recently introduced from Europe by way of Canada and appeared in Pennsylvania in the early 1990's, reaching the Pittsburgh area in 1996. It has become abundant across the state, and as a generalist feeder, this large cutworm could become a serious pest in Pennsylvania as it frequently is in Europe.

Noctuidae: Rivulinae
***Melanomma auricinctaria* Grote**
This infrequently collected species was taken in late August at Site 3. It is small, inconspicuous, and the larva feeds on huckleberry, pupating in cavities it constructs in bark or pith of plant stems.

Nolidae: Sarrothripinae: Risobini
***Baileya australis* (Grote)**
This curious North American genus contains several species from Canada to Mexico, and five species occur widely in Pennsylvania. Of these, *Baileya australis* is the smallest and less frequently noticed species but in places can be abundant with larvae feeding on Juglandaceae, especially walnut and hickory. A single specimen was taken on 21 June at Site 1 on the ridgetop.

Notodontidae: Phalerinae
***Datana major* Grote and Robinson**

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This North American genus of distinctive prominent moths is easy to identify at the generic level, but difficult to recognize at the species level. One of the less commonly encountered species is *Datana major*, taken in mid-July at both Site 2 and Site 3, and taken together with the common *Datana angusii* at Site 3. The most frequently encountered species may be *Datana drexelii*. It flies earlier and was captured from mid-June to early July at Site 1 and Site 3. *Datana major* has larvae feeding on *Andromeda* and possibly other Ericaceae, especially in acid soil settings.

MECOPTERA
Meropeidae
***Merope tuber* Newman**
Heritage Network Ranking: SUG4. Consider ranking as S3 in PA.
This odd species of scorpionfly (the "earwigfly") is the only representative of the family Meropeidae in the United States. The males possess a pair of tong-like claspers on the end of their abdomen and can be readily identified by these unusual structures. The female's abdomen is unmodified. This insect has been the focus of extreme interest among entomologists for many years, as the larva is yet to be discovered, and is often referred to as the "Holy Grail" of entomology. The single female specimen taken at Site 1 on 20 September is unusual, late in the season for this species, and indicative of a population not clearly associated with seepages, springs, or wet talus or rocky substrates as found elsewhere. Although the life history of this species and the larval stages have been sought by entomologists for 150 years, we are no closer to knowing where the larva lives, how and upon what it feeds, or even what it may look like.

There has been much discussion among CMNH entomologists about attempting to find the unknown and "mythical" larva of this species. That only a single female was captured in a light trap may not be an indicator that the species is rare at Site 1...most records are taken at intercept traps and not in light traps, although the species does occasionally come to lights.

MEGALOPTERA
Corydalidae: Chauliodinae
Dobson-flies and their relatives are documented by six species in Pennsylvania, of which three species were taken at Site 3 during this survey. Larvae, call hellgrammites, are well known to fishermen, and make excellent bait. Males of *Corydalus cornutus* have extremely long mandibles, and when encountered are not soon forgotten. The other Pennsylvania species may occur at Lehigh Gap, but are more infrequently encountered. Further survey work will be necessary to confirm their presence at Lehigh Gap Nature Center.

Data Compilation of Survey Specimens

Table I. Complete data compilation for all insect species vouchered by prepared specimens at Carnegie Museum of Natural History during a 2006 assessment of habitats for conservation management of the ***Lehigh Gap Nature Center*** (on specimen labels termed the "Lehigh Gap Wildlife Refuge") near Palmerton in Carbon County, Pennsylvania. The survey was supported by the Natural Lands Trust of Media, Pennsylvania. Pin labels on each voucher specimen bear unique numbers (i.e., not duplicated in the CMNH collection); these are preceded by '#' in the compilation below. The list is arranged in taxonomic order, with subordinate categories arranged alphabetically throughout.

Order Blattodea

Blattodea undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438908); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438139). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#438472). [Total specimens=3]

Order Coleoptera

Coleoptera undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438876, *21 Jun 2006*, Daniel Kunkle, UV light trap (#439019). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#439232); *21 Aug 2006*, Daniel Kunkle, UV light trap (#438258). [Total specimens=4]

Suborder Adephaga

Carabidae

Harpalinae: Chlaeniini

***Chlaenius (Chlaeniellus) pennsylvanicus pennsylvanicus* Say**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437927, #439145); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435637, #438665). [Total specimens=4]

Harpalinae: Ctenodactylini

***Leptotrachelus dorsalis* (Fabricius)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437844). [Total specimens=1]

Harpalinae: Harpalini

***Acupalpus (Acupalpus) carus* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436474); *2 Jul 2006*, Daniel Kunkle, UV light trap (#439230). [Total specimens=2]

***Acupalpus (Acupalpus) pumilus* Lindroth**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438455, #438598); *2 Aug 2006*, Daniel Kunkle, UV light trap (#436051). [Total specimens=3]

***Acupalpus (Philodes) rectangulus* Chaudoir**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438463, #438540); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435812). [Total specimens=3]

***Acupalpus (Tachistodes) indistinctus* Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438148, #439016, #439290); *20 Jul 2006*, Daniel Kunkle, UV light trap (#436138); *2 Aug 2006*, Daniel Kunkle, UV light trap (#436626). [Total specimens=5]

***Acupalpus (Tachistodes) pauperculus* Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435285); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437413). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438857, #438870, #439286, *21 Jun 2006*, Daniel Kunkle, UV light trap (#435120, #435989); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434608, #434799, #434815, #434921, #434930, #435471, #436459, #437022, #437050, #437423, #438283, #438294, #438336, #438431, #438933, #439160, #439191); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435186). [Total specimens=25]

***Amphasia (Pseudamphasia) sericea* (T.W. Harris)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438732, #438872). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438097). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438279). [Total specimens=4]

***Anisodactylus (Spongopus) verticalis* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV

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light trap (#432418, #436996, #437207, #439066). [Total specimens=4]

***Bradycellus (Stenocellus) nigriceps* LeConte**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437534). [Total specimens=1]

***Bradycellus (Stenocellus) rupestris* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435750, #436015, #438865); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434593). [Total specimens=4]

***Bradycellus (Stenocellus) tantillus* (Dejean)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#435738). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438517, #438972); *20 Jul 2006*, Daniel Kunkle, UV light trap (#436330, #436348); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437695). [Total specimens=6]

***Harpalus (Pseudoophonus) erythropus* Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#435144, #437103, #437318, #439130). [Total specimens=4]

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***Harpalus (Pseudoophonus) pensylvanicus* (DeGeer)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434902); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434523, #435374). [Total specimens=3]

***Notiobia (Anisotarsus) terminata* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434175). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437417); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436396, #437471, #438116, *20 Jul 2006*, Daniel Kunkle, UV light trap (#437019, #437023, #437227, #438404, #439082); *16 Aug 2006*, Daniel Kunkle, UV light trap (#437701); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434946, #436402, #437048, #437353, #437511, #437606, #437639, #437796, #438043, #438067, #438183, #438252, #438282, #438428, #438585, #438723, #438801, #438920). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#436943); *21 Aug 2006*, Daniel Kunkle, UV light trap (#435463). [Total specimens=31]

***Ophonus puncticeps* (Stephens)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434864, #435417, #436969, #437792, #437809, #438510). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437421). [Total specimens=7]

***Selenophorus opalinus* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435825, #436382, #437039); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435457). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437506, *21 Jun 2006*, Daniel Kunkle, UV light trap (#437717); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437021). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438188); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436660). [Total specimens=9]

***Stenolophus (Agonoderus) comma* (Fabricius)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437197, #437834). [Total specimens=2]

***Stenolophus (Agonoderus) lecontei* (Chaudoir)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438486, #438688); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434933, #435152, #436511, #437195, #437412); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435972). [Total specimens=8]

***Stenolophus (Stenolophus) ochropezus* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435660, #436953, #437104, #437320); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435416, *21 Jun 2006*, Daniel Kunkle, UV light trap (#437616, #438821); *20 Jul 2006*, Daniel Kunkle, UV light trap (#436965); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434537). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436454, #437547); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435343, #436376, #438055); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434668, #434825, #435631, #436514, #436520, #436603, #437307, #437339, #437494, #437656, #437987, #439004); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435716, #435981, #437055, #437525, #439138); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435422, #438342, #438513, #438634, #439269); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434631, #435101, #435966, #437365, #437785). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438330, #438335); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437648, #438773); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438509); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434928, #435030, #435126, #435291, #435752, #436334, #436430, #437235, #438370, #438682, #439025); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434207, #436036, #438877); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434838, #437194, #437975, #438056). [Total specimens=64]

***Trichotichnus autumnalis* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N,

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75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436072, #437939). [Total specimens=2]

***Trichotichnus dichrous* (Dejean)**
[Det. by R.L. Davidson] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437188). [Total specimens=1]

Harpalinae: Lebiini
***Cymindis (Pinacodera) limbatus* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438161, #438359, #439147); *16 Aug 2006*, Daniel Kunkle, UV light trap (#438575). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438443); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437314). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437645); *2 Aug 2006*, Daniel Kunkle, UV light trap (#436280, #436952, #438070, #438189). [Total specimens=11]

***Cymindis (Pinacodera) platicollis* (Say)**
[Det. by R.L. Davidson] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436956, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437838). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439114). [Total specimens=3]

***Dromius (Dromius) piceus* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438724); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437111).
[Total specimens=2]

***Lebia (Lebia) fuscata* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437311). [Total specimens=1]

***Lebia (Lebia) solea* Hentz**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#435018). [Total specimens=1]

***Lebia (Lebia) viridis* Say**
[Det. by R.L. Davidson] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436942, #436977, #438620, #438718). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436955, #439229); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436944, #436970, #437008); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437114, #437138, #438042); *21 Aug 2006*, Daniel Kunkle, UV light trap (#438361, #438408). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437678); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438209); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437762); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437338). [Total specimens=18]

***Lebia (Loxopeza) grandis* Hentz**
[Det. by R.L. Davidson] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#439202). [Total specimens=1]

***Plochionus (Menidius) timidus* Haldeman**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437684). [Total specimens=1]

Harpalinae: Odacanthini
***Colliuris (Cosnania) pensylvanica* (Linnaeus)**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438287). [Total specimens=1]

Harpalinae: Oodini
***Oodes amaroides* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438514, #438903). [Total specimens=2]

Harpalinae: Perigonini
***Perigona nigriceps* (Dejean)**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437230, #437730, #438926). [Total specimens=3]

Harpalinae: Platynini
***Agonum (Agonothorax) decorum* (Say)**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437754). [Total specimens=1]

***Agonum (Agonothorax) extensicolle* (Say)**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438507). [Total specimens=1]

***Agonum (Agonothorax) harrisii* LeConte**
[Det. by R.L. Davidson] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438435). [Total specimens=1]

***Agonum (Agonothorax) melanarium* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438127). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437304, #437700). [Total specimens=3]

***Agonum (Agonothorax) moerens* Dejean**
[Det. by R.L. Davidson] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435781). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m:

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30 May 2006, Daniel Kunkle, UV light trap (#438468, #438813, #438840, #438895, #439081, #439139); *20 Jul 2006*, Daniel Kunkle, UV light trap (#438885). [Total specimens=8]

***Agonum (Agonothorax) tenue* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437640, #437997, #438405, #438912, #439146, *20 Jul 2006*, Daniel Kunkle, UV light trap (#436129, #439273); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437352, #438667). [Total specimens=9]

***Agonum (Circinalidia) aeruginosum* Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439218). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438430). [Total specimens=2]

***Agonum (Europhilus) galvestonicum* (Casey)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436108, #437815). [Total specimens=2]

***Agonum (Europhilus) lutulentum* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437658, #438790); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435032); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437646). [Total specimens=4]

***Platynus (Platynus) parmarginatus* Hamilton**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434481, #436319, #437578, #437923, #437966, #437978, #438084, #438302, #438385, #438499, #438569, #438624, #438646, #438987, #439103, #439150, #439256, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437988, #438722, #438775). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438804). [Total specimens=21]

***Platynus (Platynus) tenuicollis* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437723, #438615). [Total specimens=2]

***Tetraleucus picticornis* (Newman)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437243). [Total specimens=1]

Harpalinae: Pterostichini
***Pterostichus (Melanius) corvinus* (Dejean)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437891). [Total specimens=1]

Psydrinae: Bembidiini
***Bembidion (Furcacampa) affine* Say**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437431); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438596, #438827); *2 Aug 2006*, Daniel Kunkle, UV light trap (#438988); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437267, #438023, #438406, #439260). [Total specimens=8]

***Bembidion (Furcacampa) impotens* Casey**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#437095). [Total specimens=1]

***Bembidion (Furcacampa) versicolor* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437069). [Total specimens=1]

***Bembidion (Notaphus) patruele* Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438612, #438614); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437127, #438666, *21 Aug 2006*, Daniel Kunkle, UV light trap (#437631, #438477). [Total specimens=6]

***Bembidion (Notaphus) rapidum* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437042). [Total specimens=1]

***Elaphropus tripunctatus* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437746). [Total specimens=1]

***Elaphropus vivax* (LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438363). [Total specimens=1]

***Elaphropus xanthopus* (Dejean)**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434777). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435476, #437295); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434917, #436231, #436352, #436674, #437268, #438239, #438769); *2 Aug 2006*, Daniel Kunkle, UV light trap (#439151). [Total specimens=11]

***Paratachys oblitus* (Casey)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434875). [Total specimens=1]

***Paratachys proximus* (Say)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N,

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75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437947, #439235); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437567). [Total specimens=3]

Paratachys sagax (cf.) **(Casey)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437898); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435455); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436712). [Total specimens=3]

Paratachys scitulus **(LeConte)**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434978, #437269); *7 Jun 2006*, Daniel Kunkle, UV light trap (#431420); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437170); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437146, #438216, #438438, #438532); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436888); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437379); *2 Aug 2006*, Daniel Kunkle, UV light trap (#438102). [Total specimens=11]

Scaritinae: Clivinini

Clivina (Clivina) impressefrons **LeConte**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438203, #438307); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438082, #438444); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434565); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437277, #438047, #438743). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438896, *21 Jun 2006*, Daniel Kunkle, UV light trap (#438096, *20 Jul 2006*, Daniel Kunkle, UV light trap (#436973, #438604, #439196). [Total specimens=13]

Clivina (Paraclivina) bipustulata **(Fabricius)**
[Det. by R.L. Davidson] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437335); *2 Jul 2006*, Daniel Kunkle, UV light trap (#438673); *20 Jul 2006*, Daniel Kunkle, UV light trap (#438029). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438136). [Total specimens=4]

Clivina (Reichardtula) acuducta **Haldeman**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438968, #439251); *20 Jul 2006*, Daniel Kunkle, UV light trap (#438850). [Total specimens=3]

Clivina (Reichardtula) americana **Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438388, #438448); *2 Jul 2006*, Daniel Kunkle, UV light trap (#439110); *20 Jul 2006*, Daniel Kunkle, UV light trap (#439047); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437858). [Total specimens=5]

Clivina (Semiclivina) dentipes **Dejean**
[Det. by R.L. Davidson] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436704). [Total specimens=1]

Dytiscidae

Dytiscidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#427939). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437351); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437358, #437742, #438069, #438146, #438621, #438752, #438756, #438831, #438867); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434789, #437760, #437949, #438348, #438544, #439064, #439275). [Total specimens=18]

Suborder Polyphaga

Bostrichoidea

Anobiidae

Anobiidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437535); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437371, #437813). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437305). [Total specimens=4]

Bostrichidae

Bostrichidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435666, #438967). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436450, #438163). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439208, #439285). [Total specimens=6]

Byrrhoidea

Dryopidae

Helichus **undetermined sp.**
[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437354). [Total specimens=1]

Heteroceridae

Heteroceridae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436302, #437561, #437570); *20 Jul 2006*, Daniel Kunkle, UV light trap (#431619); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437286, #437473, #437628, #437896, #438162, #438263, #438851). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434317); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435847); *21 Aug 2006*, Daniel Kunkle, UV light trap (#432722, #434743, #437316, #437705, #438002, #438231, #438654, #438740, #438748, #439182, #439246). [Total specimens=24]

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Chrysomeloidea

Cerambycidae
Lamiinae: Saperdini
***Saperda candida* Fabricius**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#432777). [Total specimens=1]

Lepturinae: Lepturini
***Leptorhabdium pictum* (Haldeman)**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438367, #439070). [Total specimens=2]

Chrysomelidae
Chrysomelidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438660); *21 Jun 2006*, Daniel Kunkle, UV light trap (#422586, #437539, #437801); *20 Jul 2006*, Daniel Kunkle, UV light trap (#422894, #428252, #432544); *2 Aug 2006*, Daniel Kunkle, UV light trap (#431548, #431972, #432582). [Total specimens=10]

Cleroidea

Trogossitidae
Trogossitinae: Trogossitini
***Tenebroides* undetermined sp.**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437703). [Total specimens=1]

Cucujoidea

Coccinellidae
Coccinellinae: Coccinellini
***Anatis labiculata* (Say)**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437310). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437045). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437386). [Total specimens=3]

***Harmonia axyridis* (Pallas)**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437360, #437544, #437864, #437922); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437328, #437355, #438240); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437602); *20 Jul 2006*, Daniel Kunkle, UV light trap (#401890, #422888, #431529, #431576, #432313); *2 Aug 2006*, Daniel Kunkle, UV light trap (#425596, #427726, #430240, #431509, #431604, #432282); *16 Aug 2006*, Daniel Kunkle, UV light trap (#432725); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434851); *17 Oct 2006*, Daniel Kunkle, UV light trap (#432423); *1 Nov 2006*, Daniel Kunkle, UV light trap (#427064, #429555, #431832). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#431764); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436738, #437179, #437222, #437262, #437297, #437324, #437361, #437459, #437480, #437540, #437744); *20 Jul 2006*, Daniel Kunkle, UV light trap (#432308); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434508); *13 Sep 2006*, Daniel Kunkle, UV light trap (#427445). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437424); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437168, #437694, #437942, #438081, #438191); *20 Jul 2006*, Daniel Kunkle, UV light trap (#439291); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434767, #437282, #437589); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437258, #437974). [Total specimens=52]

Cryptophagidae
Cryptophagidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437392). [Total specimens=1]

Laemophloeidae
Laemophloeidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#430144). [Total specimens=1]

Latridiidae
Latridiidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#438785). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#438206). [Total specimens=2]

Nitidulidae
Nitidulidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438040, #438423, #439190); *16 Aug 2006*, Daniel Kunkle, UV light trap (#432653). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437706). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#437932). [Total specimens=6]

Curculionoidea

Anthribidae
Anthribinae: Cratoparini
***Euparius* undetermined sp.**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438824). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438779). [Total specimens=2]

Curculionidae
Curculionidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437599); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437177); *16 Aug 2006*, Daniel Kunkle, UV light trap (#428519); *20 Sep 2006*, Daniel Kunkle, UV light trap

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(#431905); *1 Nov 2006*, Daniel Kunkle, UV light trap (#428219, #429102, #429244, #429663, #430163, #432209). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#431913). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437649, #437688); *13 Sep 2006*, Daniel Kunkle, UV light trap (#429914); *10 Oct 2006*, Daniel Kunkle, UV light trap (#431667). [Total specimens=15]

Scolytinae: Scolytini

***Dryocoetes affaber* (Mannerheim)**

[Det. by R.A. Androw] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437217). [Total specimens=1]

***Dryocoetes autographus* (Ratzeburg)**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#435408, #437348). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437225); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437907). [Total specimens=4]

***Gnathotrichus materiarius* (Fitch)**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437302); *16 Aug 2006*, Daniel Kunkle, UV light trap (#429092). [Total specimens=2]

***Monarthrum mali* (Fitch)**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437313). [Total specimens=1]

***Pityophthorus* undetermined sp.**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437364). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437236, *2 Aug 2006*, Daniel Kunkle, UV light trap (#437240). [Total specimens=3]

***Xyleborus californicus* Wood**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#425866). [Total specimens=1]

***Xyleborus ferrugineus* (Fabricius)**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437588). [Total specimens=1]

***Xyleborus xylographus* (Say)**

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#428849, #436670, #436671, #436741, #437279, #437344, #437514, #437833, #438580, #438996). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437455, #437895). [Total specimens=12]

Elateroidea

Cantharidae

Cantharidae undetermined sp.

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#438194, #438339); *30 May 2006*, Daniel Kunkle, UV light trap (#438855, #438873); *7 Jun 2006*, Daniel Kunkle, UV light trap (#438603, #438721, #438745, #438963, #439113, #439228). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#438584). [Total specimens=11]

Elateridae

Elateridae undetermined sp.

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437584, #438120, #439199); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437084, #437189, #437239, #437251, #437255, #437281, #437971, #437976, #438160, #438838, #439270); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437347, #437818); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437284); *2 Aug 2006*, Daniel Kunkle, UV light trap (#422602, #431618, #438051); *21 Aug 2006*, Daniel Kunkle, UV light trap (#438874, #439159). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436387); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437444); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438449, #438993); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437183, #437190, #437219, #437300, #437375, #437512, #437521, #437563, #437637, #437784, #437963, #438150, #438182, #438238, #438277, #438475, #438557, #438907, #438942, #439018, #439068, #439097, #439155, #439225); *20 Jul 2006*, Daniel Kunkle, UV light trap (#432628). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437768); *20 Jul 2006*, Daniel Kunkle, UV light trap (#439044, #439233). [Total specimens=54]

Hydrophiloidea

Hydrophilidae

Hydrophilidae undetermined sp.

[Det. by R.A. Androw] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#429835, #432514). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437901); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436669); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435383, #437246, #438076). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438534); *15 Jun 2006*, Daniel Kunkle, UV light trap (#438783); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434027, #438815); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434435, #436533, #437529, #437817, #439293); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437541); *21 Aug*

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2006, Daniel Kunkle, UV light trap (#436095, #437398, #437517, #437553, #437560, #437862, #438526, #438976, #439185, #439201). [Total specimens=27]

Scarabaeoidea

Scarabaeidae

Aphodiinae: Aphodiini

***Aphodius rubripennis* Horn**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437660). [Total specimens=1]

***Aphodius rusicola* Melsheimer**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436266, #437378, #439131); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437292, #437345, #437476, #437772, #437989, #438105); *20 Jul 2006*, Daniel Kunkle, UV light trap (#431582). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438319); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435964); *15 Jun 2006*, Daniel Kunkle, UV light trap (#432143); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437552, #439008, #439175); *20 Jul 2006*, Daniel Kunkle, UV light trap (#428948, #429495, #431681, #432600); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437406, #439054). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436081, #436555, #437794, #437964); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437331, #437537, #438725); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437569, #437906, #437925, #438645, #438744); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435182). [Total specimens=35]

***Aphodius stercorosus* Melsheimer**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437336). [Total specimens=1]

Aphodiinae: Eupariini

***Ataenius imbricatus* (Melsheimer)**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#425269, #425843). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437265). [Total specimens=3]

***Ataenius strigatus* (Say)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437326). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437139); *20 Jul 2006*, Daniel Kunkle, UV light trap (#431993). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437426). [Total specimens=4]

***Dialytellus dialytoides* (Fall)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#432854). [Total specimens=1]

***Dialytes striatulus* (Say)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#431438, #432407). [Total specimens=2]

***Dialytes truncatus* (Melsheimer)**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437450, #437866, #437944, #438997). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#438936). [Total specimens=5]

Dynastinae: Cyclocephalini

***Cyclocephala borealis* Arrow**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438179, #438190). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438440). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438340, #438714). [Total specimens=5]

Melolonthinae: Macrodactylini

***Dichelonyx diluta* (Fall)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438763). [Total specimens=1]

***Dichelonyx elongatula* (Schönherr)**

[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439038). [Total specimens=1]

Melolonthinae: Melolonthini

***Phyllophaga anxia* (LeConte)**

[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#437057). [Total specimens=1]

***Phyllophaga drakii* (Kirby)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437224, #437557). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#436733). [Total specimens=3]

***Phyllophaga futilis* (LeConte)**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437568). [Total specimens=1]

***Phyllophaga quercus* (Knoch)**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#432037). [Total specimens=1]

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***Phyllophaga* undetermined sp.**
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437317). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#422899). [Total specimens=2]

Melolonthinae: Sericini
***Nipponoserica peregrina* (Chapin)**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438561, #438707); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438073, #439258); *2 Jul 2006*, Daniel Kunkle, UV light trap (#438778). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438701); *15 Jun 2006*, Daniel Kunkle, UV light trap (#439115); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438100, #439022). [Total specimens=9]

***Serica sericea* (Illiger)**
[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437298, #437299). [Total specimens=2]

***Serica* undetermined sp.**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438971); *21 Jun 2006*, Daniel Kunkle, UV light trap (#439050). [Total specimens=2]

Rutelinae: Anomalini
***Anomala orientalis* (Waterhouse)**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#422584). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#429337). [Total specimens=2]

Rutelinae: Rutelini
***Pelidnota punctata* (Linnaeus)**
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438200, #438381). [Total specimens=2]

Scarabaeinae: Coprini
***Copris minutus* (Drury)**
[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#427029, #429508). [Total specimens=2]

Trogidae
***Trox aequalis* Say**
[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437287, #437533). [Total specimens=2]

***Trox hamatus* Robinson**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437350). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#436774, #437312). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#430267). [Total specimens=4]

Scirtoidea

Scirtidae
Scirtidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#422711, #426976, #428570, #429708, #430047, #431666, #432130, #432276). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#439096, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437619, #437890). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#426931, #428610, #432844); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437449, #437856, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437428); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434673); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437325, #437479, #437558, #437562, #437659, #437999, #439093). [Total specimens=25]

Staphylinoidea

Leiodidae
Leiodidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437463); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437863). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#429466). [Total specimens=3]

Scydmaenidae
Scydmaenidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#431777). [Total specimens=1]

Silphidae
Nicrophorinae
***Nicrophorus orbicollis* Say**
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#432027). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437401). [Total specimens=2]

***Nicrophorus pustulatus* Herschel**
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438338). [Total specimens=1]

Staphylinidae
Staphylinidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV

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light trap (#432152); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437388); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437174). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437173, #437527); *20 Jul 2006*, Daniel Kunkle, UV light trap (#428217). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437202). [Total specimens=7]

Tenebrionoidea

Aderidae

Aderidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437368); *20 Jul 2006*, Daniel Kunkle, UV light trap (#432222). [Total specimens=2]

Anthicidae

Anthicidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437408). [Total specimens=1]

Cephaloidae

Cephaloinae

***Cephaloon* undetermined sp.**

[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437970). [Total specimens=1]

Colydiidae

Colydiidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#438052). [Total specimens=1]

Melandryidae

Melandryinae: Serropalpini

***Dircaea liturata* (LeConte)**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#438401, #438706, #439281); *2 Jul 2006*, Daniel Kunkle, UV light trap (#438655). [Total specimens=4]

Mordellidae

Mordellidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437166, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437520). [Total specimens=2]

Pyrochroidae

Pyrochroinae

***Neopyrochroa flabellata* (Fabricius)**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438260). [Total specimens=1]

Tenebrionidae

Alleculinae

Alleculinae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437666, #437764); *20 Jul 2006*, Daniel Kunkle, UV light trap (#407877, #422771, #422809, #425746, #427787, #430224, #432287); *2 Aug 2006*, Daniel Kunkle, UV light trap (#432673, #432779, #438817). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#438594); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435731, #437582, #438852, #439262); *20 Jul 2006*, Daniel Kunkle, UV light trap (#427352, #429666, #432057, #432669, #432689, #432729). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437841); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437823). [Total specimens=25]

Coelometopinae: Strongyliini

***Strongylium* undetermined sp.**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#429415). [Total specimens=1]

Diaperinae: Diaperini

***Platydema* undetermined sp.**

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437467). [Total specimens=1]

Order Diptera

Diptera undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#438133); *7 Jun 2006*, Daniel Kunkle, UV light trap (#438300, #438498, #438717). [Total specimens=4]

Suborder Brachycera

Tabanoidea

Tabanidae

Chrysopsinae: Chrysopsini

***Chrysops* undetermined sp.**

[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#400019). [Total specimens=1]

Suborder Nematocera

Bibionoidea

Bibionidae

***Bibio* undetermined sp.**

[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#397298, #403157, #406047, #408435, #409373, #416525, #417633). [Total specimens=7]

Pleciinae

***Penthetria heteroptera* (Say)**

[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#409953, #431580). [Total specimens=2]

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Cecidomyioidea

Cecidomyiidae

Cecidomyiidae undetermined sp.
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#396697, #398982, #406851, #410556). [Total specimens=4]

Tipuloidea

Tipulidae

Limoniinae: Hexatomini

***Dactylolabis (Dactylolabis) cubitalis* (Osten Sacken)**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#431952). [Total specimens=1]

Limoniinae: Limoniini

***Antocha (Antocha) saxicola* Osten Sacken**
[Det. by C.W. Young 2007] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 May 2006*, Daniel Kunkle, UV light trap (#429251). [Total specimens=1]

***Limonia (Dicranomyia) liberta* (Osten Sacken)**
[Det. by C.W. Young 2007] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 May 2006*, Daniel Kunkle, UV light trap (#432856). [Total specimens=1]

Tipulinae: Tipulini

***Dolichopeza (Oropeza) sayi* (Johnson)**
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#431679). [Total specimens=1]

***Tipula (Lunatipula) bicornis* Forbes**
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#416730). [Total specimens=1]

***Tipula (Lunatipula) duplex* Walker**
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#427942); *2 Aug 2006*, Daniel Kunkle, UV light trap (#428229); *21 Aug 2006*, Daniel Kunkle, UV light trap (#432397). [Total specimens=3]

***Tipula (Nippotipula) abdominalis* (Say)**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#407584). [Total specimens=1]

***Tipula (Pterelachisus) entomophthorae* Alexander**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#432735). [Total specimens=1]

***Tipula (Pterelachisus) trivittata* Say**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#427657, #428653, #431765, #432851). [Total specimens=4]

***Tipula (Vestiplex) longiventris* Löw**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#406393, #428819). [Total specimens=2]

***Tipula (Yamatotipula) furca* Walker**
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#427497); *13 Sep 2006*, Daniel Kunkle, UV light trap (#432045). [Total specimens=2]

***Tipula (Yamatotipula) sayi* Alexander**
[Det. by C.W. Young 2007] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#404075). [Total specimens=1]

Trichoceroidea

Trichoceridae

***Trichocera* undetermined sp.**
[Det. by C.W. Young 2007] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#362618, #430000); *10 Oct 2006*, Daniel Kunkle, UV light trap (#399159, #406578, #408964, #409713); *17 Oct 2006*, Daniel Kunkle, UV light trap (#411023, #412766, #414164, #431472); *1 Nov 2006*, Daniel Kunkle, UV light trap (#411313, #415699, #418195). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *25 Oct 2006*, Daniel Kunkle, UV light trap (#412405, #415108); *1 Nov 2006*, Daniel Kunkle, UV light trap (#412952, #429699). [Total specimens=17]

Order Heteroptera

Heteroptera undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#431786, #432633). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437992). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#430048, #431749, #431881). [Total specimens=6]

Miroidea

Miridae

Miridae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437196, *2 Aug 2006*, Daniel Kunkle, UV light trap (#431466, *16 Aug 2006*, Daniel Kunkle, UV light trap (#432249). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#439058); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437967, #438555). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437163). [Total specimens=7]

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Suborder Nepomorpha
Corixoidea

Corixidae

Corixidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#431516). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436337); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437199, #438210, #438564, #439272). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434294); *2 Aug 2006*, Daniel Kunkle, UV light trap (#438631); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437157, #438204, #438382). [Total specimens=11]

Suborder Pentatomomorpha
Lygaeoidea

Lygaeidae

Lygaeidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#431925). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437462, #438657, #439205); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437321). [Total specimens=5]

Pentatomoidea

Cydnidae

Cydnidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#432564). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#428803). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437221). [Total specimens=3]

Pentatomidae

Pentatomidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#439222); *20 Jul 2006*, Daniel Kunkle, UV light trap (#427138, #432364). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437576, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437950); *20 Jul 2006*, Daniel Kunkle, UV light trap (#432841). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#438006). [Total specimens=7]

Pentatominae: Carpocorini

***Halyomorpha halys* Stal**

[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#431606). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437559, #438071); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437356, #437439, #437647, #437821, #437943, #438670, #438977, #439052). [Total specimens=11]

Order Homoptera

Homoptera undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437753); *2 Aug 2006*, Daniel Kunkle, UV light trap (#432542); *16 Aug 2006*, Daniel Kunkle, UV light trap (#423102, #432259); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436798). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#431719). [Total specimens=6]

Membracidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437751). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437342, #437835); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437427). [Total specimens=4]

Suborder Auchenorrhyncha
Cicadelloidea

Cicadellidae

Cicadellidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#430206). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436706). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#436711, #437228, #437430, #437911).
[Total specimens=6]

Cicadellinae: Proconiini

***Oncometopia orbona* (Fabricius)**

[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439177). [Total specimens=1]

Order Hymenoptera

Hymenoptera undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#432183, #434325, #437241, #437256, #437968, #437996, #438539, #438637); *2 Aug 2006*, Daniel Kunkle, UV light trap (#431674). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#432737); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435017, #437410, #438024). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437291). [Total specimens=14]

Suborder Apocrita
Ichneumonoidea

Ichneumonidae

Ophioninae

Ophioninae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#435544, #435761, #437290, #437488, #437735,

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#437859, #438992); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434378, #434989, #435838, #437502, #437596, #437713, #437897). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437469, #439294); *20 Sep 2006*, Daniel Kunkle, UV light trap (#437613); *10 Oct 2006*, Daniel Kunkle, UV light trap (#431603). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#432067). [Total specimens=19]

Vespoidea

Formicidae

Formicidae undetermined sp.

[Det. by R.A. Androw] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#427579). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437404); *2 Jul 2006*, Daniel Kunkle, UV light trap (#438278); *20 Jul 2006*, Daniel Kunkle, UV light trap (#431496, *13 Sep 2006*, Daniel Kunkle, UV light trap (#431415, #432810). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437542); *1 Nov 2006*, Daniel Kunkle, UV light trap (#422797). [Total specimens=8]

Order Lepidoptera
Suborder Ditrysia
Bombycoidea

Apatelodidae

***Apatelodes torrefacta* (J.E. Smith)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434458). [Total specimens=1]

***Olceclostera angelica* (Grote)**

[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434237). [Total specimens=1]

Lasiocampidae

***Malacosoma americanum* (Fabricius)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434161, #434166, #434169, #434287, #434298, #434393, #434545, #434573); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434502, #434515). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434328, #434439, #434447); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434365, #434372, #434437, #434453, #434526). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434255, #434258, #434413); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434289, #434330, #434334, #434539); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434409, #434448). [Total specimens=27]

***Malacosoma disstria* Hübner**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434445); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434497). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434396, *21 Jun 2006*, Daniel Kunkle, UV light trap (#434446, *2 Jul 2006*, Daniel Kunkle, UV light trap (#434229); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434424). [Total specimens=6]

***Phyllodesma americana* (Harris)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#392807); *19 Apr 2006*, Daniel Kunkle, UV light trap (#396497). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#395638). [Total specimens=3]

***Tolype velleda* (Stoll)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#434124). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#433302). [Total specimens=2]

Saturniidae

Citheroniinae

***Dryocampa rubicunda* (Fabricius)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#434342). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434333). [Total specimens=2]

Hemileucinae

***Automeris io io* (Fabricius)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434462); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434275, #434418). [Total specimens=3]

Saturniinae

***Antheraea polyphemus* (Cramer)**

[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434293). [Total specimens=1]

Sphingidae

Macroglossinae: Macroglossini

***Deidamia inscripta* (Harris)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434247). [Total specimens=1]

Sphinginae: Smerinthini

***Paonias excaecatus* (J.E. Smith)**

[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#433860); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433730). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#433864); *20 Jul*

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2006, Daniel Kunkle, UV light trap (#433448). [Total specimens=4]

Sphinginae: Sphingini

***Ceratomia undulosa* (Walker)**

[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433790). [Total specimens=1]

***Lapara coniferarum* (J.E. Smith)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434655); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435454). [Total specimens=2]

***Sphinx gordius* Cramer**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433015). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433863); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433758). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#432981); *21 Jun 2006*, Daniel Kunkle, UV light trap (#432613). [Total specimens=5]

Gelechioidea

Gelechioidea undetermined sp.

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#435511, #436173); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435896, *15 Jun 2006*, Daniel Kunkle, UV light trap (#435625); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435153, #436578, #436653). [Total specimens=7]

Amphisbatidae

***Machimia tentoriferella* Clemens**

[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#437832). [Total specimens=1]

Geometroidea

Drepanidae

Drepaninae

***Drepana arcuata* Walker**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394754, #394828); *16 Aug 2006*, Daniel Kunkle, UV light trap (#398027). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394598); *16 Aug 2006*, Daniel Kunkle, UV light trap (#393169). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#393490); *20 Jul 2006*, Daniel Kunkle, UV light trap (#398152); *2 Aug 2006*, Daniel Kunkle, UV light trap (#393038, #396436, #398144). [Total specimens=10]

***Drepana bilineata* (Packard)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#395204); *30 May 2006*, Daniel Kunkle, UV light trap (#398102). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#393767). [Total specimens=3]

Geometridae

Ennominae: Abraxini

***Heliomata cycladata* Grote and Robinson**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394295). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#398173). [Total specimens=2]

Ennominae: Anagogini

***Cepphis armataria* (Herrich-Schäffer)**

[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#393118). [Total specimens=1]

***Metarranthis amyrisaria* (Walker)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434283, #434303, #434373, #434404, #435988); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434338, #434405, #434456, #434557, #435949); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434181, #434415, #434549, #436269). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434459, #435874). [Total specimens=16]

***Metarranthis angularia* Barnes and McDunnough**

[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436022). [Total specimens=1]

***Metarranthis duaria duaria* (Guenée)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434500). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434183). [Total specimens=2]

***Metarranthis obfirmaria* (Hübner)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#432473, #432835, #432874); *30 May 2006*, Daniel Kunkle, UV light trap (#433527, #433582, #433877, #434054, #434109, #434119). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433738). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433537, #434105). [Total specimens=12]

***Plagodis alcoolaria* (Guenée)**

[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433858); *30 May 2006*, Daniel Kunkle, UV light trap (#434088); *7 Jun 2006*, Daniel Kunkle, UV light

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trap (#433710); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433006, *20 Jul 2006*, Daniel Kunkle, UV light trap (#433878). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433330). [Total specimens=6]

***Plagodis phlogosaria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433305). [Total specimens=1]

***Plagodis pulveraria occiduaria* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#433876). [Total specimens=1]

***Plagodis serinaria* Herrich-Schäffer**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433814); *30 May 2006*, Daniel Kunkle, UV light trap (#432917, #433471, #433713, #433854, #433924, #433999, #434095, #434106, *7 Jun 2006*, Daniel Kunkle, UV light trap (#433852). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433192, #433391). [Total specimens=12]

***Probole amicaria* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433232, #433720); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433640, #433897, #433910). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433701); *30 May 2006*, Daniel Kunkle, UV light trap (#427238, #433213, #433221, #433344, #433381, #433994, #434029, #434134). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433109, #433742, #433830, #434099). [Total specimens=18]

Ennominae: Angeronini
***Euchlaena irraria* (Barnes and McDunnough)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433972); *7 Jun 2006*, Daniel Kunkle, UV light trap (#432470, #433517, #433953); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433097, #433449, #433828, #433840, #433925, #434057); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433695, #434093). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433468); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433889). [Total specimens=14]

***Euchlaena johnsonaria* (Fitch)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434238, #434292). [Total specimens=2]

***Euchlaena marginaria* (Minot)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434352, #435946, *30 May 2006*, Daniel Kunkle, UV light trap (#434290). [Total specimens=3]

***Euchlaena muzaria* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#437905); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437610). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437826). [Total specimens=3]

***Lytrosis unitaria* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#395109). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#396505). [Total specimens=2]

Ennominae: Azelinini
***Pero honestaria* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 May 2006*, Daniel Kunkle, UV light trap (#436180, #437162). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#437689); *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#428689, #432006, #432553); *20 Jul 2006*, Daniel Kunkle, UV light trap (#428667); *2 Aug 2006*, Daniel Kunkle, UV light trap (#428831). [Total specimens=8]

***Pero morrisonaria* (Henry Edwards)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#425523). [Total specimens=1]

Ennominae: Baptini
***Lomographa glomeraria* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#393369). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#393350, #396417). [Total specimens=3]

***Lomographa semiclarata* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433723, #433944). [Total specimens=2]

***Lomographa vestaliata* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436265); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434574, #435985, #435992, #436021, #436186, *15 Jun 2006*, Daniel Kunkle, UV light trap (#434252, #435917); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435866). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435905, #435916). [Total specimens=11]

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Ennominae: Bistonini

***Hypagyrtis unipunctata* (Haworth)**

[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437743). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434295). [Total specimens=2]

Ennominae: Boarmiini

***Aethalura intertexta* (Walker)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433467); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435907). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434235). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434172, #434370, #434513, #434548, #434566, *30 May 2006*, Daniel Kunkle, UV light trap (#429665, #434326). [Total specimens=10]

***Anavitrinella pampinaria* (Guenée)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434163); *30 May 2006*, Daniel Kunkle, UV light trap (#434270, #434329); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437605); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436226). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433984, #434568). [Total specimens=7]

***Ectropis crepuscularia* ([Denis and Schiffermüller])**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434184). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#434304). [Total specimens=2]

***Epimecis hortaria* (Fabricius)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#396947). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#397442); *7 Jun 2006*, Daniel Kunkle, UV light trap (#398142); *15 Jun 2006*, Daniel Kunkle, UV light trap (#396086). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#398075); *20 Jul 2006*, Daniel Kunkle, UV light trap (#396518, #397333). [Total specimens=7]

***Glena cognataria* (Hübner)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#435718, #435855, #436282); *30 May 2006*, Daniel Kunkle, UV light trap (#435823); *7 Jun 2006*, Daniel Kunkle, UV light trap (#436957, #438001); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435129, #436206, #436249). [Total specimens=9]

***Iridopsis defectaria* (Guenée)**

[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#436495). [Total specimens=1]

Ennominae: Campaeini

***Campaea perlata* (Guenée)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#436203); *7 Jun 2006*, Daniel Kunkle, UV light trap (#436085, #436115, #436194). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436158); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435895); *13 Sep 2006*, Daniel Kunkle, UV light trap (#436121). [Total specimens=7]

Ennominae: Ennomini

***Ennomos magnaria magnaria* Guenée**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#433845, #433985). [Total specimens=2]

***Ennomos subsignaria* (Hübner)**

[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434511).
[Total specimens=1]

Ennominae: Lithinini

***Homochlodes fritillaria* (Guenée)**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434900, #436659, #437115); *30 May 2006*, Daniel Kunkle, UV light trap (#438356, *7 Jun 2006*, Daniel Kunkle, UV light trap (#437038); *15 Jun 2006*, Daniel Kunkle, UV light trap (#438447, #438932); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436976, *2 Jul 2006*, Daniel Kunkle, UV light trap (#437914); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437306, #437670, #437917, #438214, #438759, #438986, *16 Aug 2006*, Daniel Kunkle, UV light trap (#436000). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#436621, #436896, *30 May 2006*, Daniel Kunkle, UV light trap (#438419); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437748); *16 Aug 2006*, Daniel Kunkle, UV light trap (#436480, #438053). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436922, #437680); *20 Jul 2006*, Daniel Kunkle, UV light trap (#438286, #439245); *2 Aug 2006*, Daniel Kunkle, UV light trap (#438077, #438207); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434877). [Total specimens=29]

Ennominae: Macariini

***Macaria aemulataria* Walker**

[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434961); *30 May 2006*, Daniel Kunkle, UV light trap (#433951); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434730). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2*

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Aug 2006, Daniel Kunkle, UV light trap (#435763). [Total specimens=4]

***Macaria argillacearia* (Packard)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#437165). [Total specimens=1]

***Macaria bicolorata* (Fabricius)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437945). [Total specimens=1]

***Macaria bisignata* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437546, #438501); *15 Jun 2006*, Daniel Kunkle, UV light trap (#438289); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437892); *16 Aug 2006*, Daniel Kunkle, UV light trap (#437654, #439074); *21 Aug 2006*, Daniel Kunkle, UV light trap (#438697). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#438812); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437523, #438875); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437843). [Total specimens=11]

***Macaria fissinotata* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437528). [Total specimens=1]

***Macaria granitata* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434224); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436149). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434386). [Total specimens=3]

***Macaria minorata* Packard**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435870); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435953); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434197, #434519); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434454). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434577); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434221). [Total specimens=7]

***Macaria signaria dispuncta* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437579). [Total specimens=1]

Ennominae: Melanolophiini
***Eufidonia convergaria* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437518, #437531, #437777); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437119, #437704); *21 Jun 2006*, Daniel Kunkle, UV light trap (#438229); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437958). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438558). [Total specimens=8]

***Melanolophia signataria* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434474); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434382). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433902). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434266, *20 Jul 2006*, Daniel Kunkle, UV light trap (#434273). [Total specimens=5]

Ennominae: Nacophorini
***Nacophora quernaria* (J.E. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433779). [Total specimens=1]

Ennominae: Ourapterygini
***Antepione thisoaria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#397765). [Total specimens=1]

***Besma endropiaria* (Grote and Robinson)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#393326, #396212); *15 Jun 2006*, Daniel Kunkle, UV light trap (#395441, #396894); *21 Jun 2006*, Daniel Kunkle, UV light trap (#396708). [Total specimens=5]

***Besma quercivoraria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#396451, #397255). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#398096). [Total specimens=3]

***Caripeta angustiorata* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#433744). [Total specimens=1]

***Eutrapela clemataria* (J.E. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#397877). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#393673). [Total specimens=2]

***Nematocampa resistaria* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N,

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75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#432873). [Total specimens=1]

***Prochoerodes lineola lineola* (Goeze)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#398095); *16 Aug 2006*, Daniel Kunkle, UV light trap (#395945); *21 Aug 2006*, Daniel Kunkle, UV light trap (#393311); *13 Sep 2006*, Daniel Kunkle, UV light trap (#397702). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#395276, #396649, #397990); *20 Jul 2006*, Daniel Kunkle, UV light trap (#397823); *21 Aug 2006*, Daniel Kunkle, UV light trap (#393417); *13 Sep 2006*, Daniel Kunkle, UV light trap (#393034). [Total specimens=10]

***Tetracis cachexiata* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394762, #395973, #396683, #398077, #398296, #435937); *7 Jun 2006*, Daniel Kunkle, UV light trap (#395037, #397631); *15 Jun 2006*, Daniel Kunkle, UV light trap (#394482, #436236, #436286). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#393096, *30 May 2006*, Daniel Kunkle, UV light trap (#395275); *20 Sep 2006*, Daniel Kunkle, UV light trap (#435363). [Total specimens=14]

***Tetracis crocallata* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#433776). [Total specimens=1]

Geometrinae: Hemitheini
***Hethemia pistasciaria pistasciaria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434941, #435300, #435308, #435553, #435837, #436086). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434493). [Total specimens=7]

Geometrinae: Nemoriini
***Nemoria bistriaria bistriaria* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437289). [Total specimens=1]

***Nemoria mimosaria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437390). [Total specimens=1]

Larentiinae: Eupitheciini
***Eupithecia* sp.**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 May 2006*, Daniel Kunkle, UV light trap (#434360, #434494). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434528); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434199, #434569); *2 Aug 2006*, Daniel Kunkle, UV light trap (#433639). [Total specimens=6]

Larentiinae: Hydriomenini
***Eulithis diversilineata* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434390). [Total specimens=1]

***Hydriomena transfigurata manitoba* Barnes and McDunnough**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437621, #438547). [Total specimens=2]

***Rheumaptera prunivorata* (Ferguson)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#396317, #397281). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#392948). [Total specimens=3]

Larentiinae: Xanthorhoini
***Costaconvexa centrostrigaria* (Wollaston)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#434239). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434441); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436225). [Total specimens=3]

***Orthonama obstipata* (Fabricius)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436150). [Total specimens=1]

Sterrhinae: Cosymbiini
***Cyclophora pendulinaria* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 May 2006*, Daniel Kunkle, UV light trap (#433309); *24 May 2006*, Daniel Kunkle, UV light trap (#433041); *30 May 2006*, Daniel Kunkle, UV light trap (#434480). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#432972). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434260); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433851); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433922). [Total specimens=7]

Sterrhinae: Scopulini
***Scopula limboundata* (Haworth)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433563). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433950); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433868); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433856, #433957, #434019); *2 Jul 2006*, Daniel Kunkle, UV light trap

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(#433785, #434075); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433485). [Total specimens=9]

Thyatiridae
Thyatirinae: Habrosynini
***Pseudothyatira cymatophoroides* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#397375).
[Total specimens=1]

Noctuoidea

Arctiidae
Arctiinae: Arctiini
***Apantesis carlotta* Ferguson**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#435860); *30 May 2006*, Daniel Kunkle, UV light trap (#434934, #436323); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435315). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435575); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434876, *21 Aug 2006*, Daniel Kunkle, UV light trap (#435658). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436491); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435014, #435719). [Total specimens=10]

***Apantesis nais* (Drury)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434223). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#435580). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#436609). [Total specimens=3]

***Grammia figurata* (Drury)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#396214, #397393, #398229); *7 Jun 2006*, Daniel Kunkle, UV light trap (#396356, *21 Jun 2006*, Daniel Kunkle, UV light trap (#393376). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 May 2006*, Daniel Kunkle, UV light trap (#392857); *30 May 2006*, Daniel Kunkle, UV light trap (#394613, #397625). [Total specimens=8]

***Grammia virgo* (Linnaeus)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#435906, #436032). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#436223); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435911). [Total specimens=4]

***Holomelina immaculata* (Reakirt)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436062); *2 Aug 2006*, Daniel Kunkle, UV light trap (#435857). [Total specimens=2]

***Hyphantria cunea* (Drury)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433706). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433956). [Total specimens=2]

***Spilosoma congrua* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433436, *21 Jun 2006*, Daniel Kunkle, UV light trap (#433433); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433240). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433861, #434005); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433998, #434126). [Total specimens=7]

***Spilosoma latipennis* Stretch**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433237, #433570); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433753); *21 Jun 2006*, Daniel Kunkle, UV light trap (#432228). [Total specimens=4]

***Spilosoma virginica* (Fabricius)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433450); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433907); *16 Aug 2006*, Daniel Kunkle, UV light trap (#433882). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432973). [Total specimens=4]

Arctiinae: Ctenuchini
***Cisseps fulvicollis* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433764, #434043, #434046, *21 Jun 2006*, Daniel Kunkle, UV light trap (#432303, #433874); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433329); *2 Aug 2006*, Daniel Kunkle, UV light trap (#427590, #433647, #433795, #433799); *21 Aug 2006*, Daniel Kunkle, UV light trap (#427708, #433942). [Total specimens=12]

Arctiinae: Phaegopterini
***Cycnia oregonensis* (Stretch)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437627, #438625). [Total specimens=2]

***Cycnia tenera* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433917); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433100). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433977, #434145); *2 Jul 2006*, Daniel Kunkle, UV light trap

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(#433296, #433792, #434114); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434074). [Total specimens=8]

***Halysidota tessellaris* (J.E. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433739). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433899); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433932). [Total specimens=3]

***Lophocampa caryae* Harris**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433832). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434080). [Total specimens=2]

Lithosiinae
***Crambidia pallida* Packard**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#436049); *10 Oct 2006*, Daniel Kunkle, UV light trap (#435445). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#435196, #436272). [Total specimens=4]

***Hypoprepia miniata* (Kirby)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434028); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433456, #433857). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432534, #432761, #433270, #433353, #433728, #433743, #433797, #433966, #433973, #433996, #434021, #434038, #434122); *7 Jun 2006*, Daniel Kunkle, UV light trap (#432984, #433194, #433976, #434061); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434125); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433893). [Total specimens=22]

Lymantriidae
***Dasychira obliquata* (Grote and Robinson)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#438484); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437543). [Total specimens=2]

***Lymantria dispar* (Linnaeus)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#393756, #393915); *2 Aug 2006*, Daniel Kunkle, UV light trap (#395661). [Total specimens=3]

***Orgyia leucostigma* (J.E. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#394394, #394566). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#397965); *20 Sep 2006*, Daniel Kunkle, UV light trap (#395819); *10 Oct 2006*, Daniel Kunkle, UV light trap (#397149, #397411). [Total specimens=6]

Noctuidae
Acontiinae
***Lithacodia albidula* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434180, #434236, #434451, #434501); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434318). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#434226). [Total specimens=6]

***Lithacodia muscosula* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434576, *2 Jul 2006*, Daniel Kunkle, UV light trap (#435947, #435952). [Total specimens=3]

***Maliattha synochitis* (Grote and Robinson)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433959); *15 Jun 2006*, Daniel Kunkle, UV light trap (#436144); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434206, #435950, #436259, #436263). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436258); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434274, #434354). [Total specimens=9]

***Pseudeustrotia carneola* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433324); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433960). [Total specimens=2]

***Thioptera nigrofimbria* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433266, *16 Aug 2006*, Daniel Kunkle, UV light trap (#434356, *21 Aug 2006*, Daniel Kunkle, UV light trap (#434450, #434541). [Total specimens=4]

Acronictinae
***Acronicta afflicta* Grote**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433454); *30 May 2006*, Daniel Kunkle, UV light trap (#429662, #431951, #433549, #433805, #433896, #434077, #434650); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434509); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434091); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434995). [Total specimens=11]

***Acronicta americana* (Harris)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434112); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434086, *16 Aug 2006*, Daniel Kunkle, UV light trap (#434346). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul*

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2006, Daniel Kunkle, UV light trap (#433709, #433829). [Total specimens=5]

***Acronicta dactylina* J.B. Smith**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434192); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434842). [Total specimens=2]

***Acronicta hasta hasta* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434771); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434296, #436633). [Total specimens=3]

***Acronicta increta* Morrison**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437868). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435104). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437554). [Total specimens=3]

***Acronicta interrupta* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#435289); *15 Jun 2006*, Daniel Kunkle, UV light trap (#436710). [Total specimens=2]

***Acronicta lobeliae* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437638). [Total specimens=1]

***Acronicta modica* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436643). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434555). [Total specimens=2]

***Acronicta noctivaga* Grote**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435373); *15 Jun 2006*, Daniel Kunkle, UV light trap (#438796, *2 Jul 2006*, Daniel Kunkle, UV light trap (#439215). [Total specimens=3]

***Acronicta sperata* Grote**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437661, #437908, #437985, #438346, *21 Jun 2006*, Daniel Kunkle, UV light trap (#437293, #438835). [Total specimens=6]

***Acronicta tritona* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436073, #436524); *7 Jun 2006*, Daniel Kunkle, UV light trap (#436791). [Total specimens=3]

***Polygrammate hebraeicum* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432199, #432926, #433420, #433721, #433798, #433844, #433867, #433937, #434010, #434117, #434132); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433415); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433783, #433834, #434116, *21 Jun 2006*, Daniel Kunkle, UV light trap (#433363, #433399, #433770, #433809, #433843, #433982); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433566, #433813, #434133); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433887); *2 Aug 2006*, Daniel Kunkle, UV light trap (#433724); *16 Aug 2006*, Daniel Kunkle, UV light trap (#433372). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433894); *21 Jun 2006*, Daniel Kunkle, UV light trap (#427209); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433749); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433908); *2 Aug 2006*, Daniel Kunkle, UV light trap (#433735, #433803). [Total specimens=33]

***Simyra insularis* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434361). [Total specimens=1]

Agaristinae

***Eudryas unio* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437791). [Total specimens=1]

Amphipyrinae

***Amphipyra pyramidoides* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#433765); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433823, #433890); *13 Sep 2006*, Daniel Kunkle, UV light trap (#432804). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433396). [Total specimens=5]

***Amphipyra tragopoginis* (Clerck)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#395572). [Total specimens=1]

***Athetis miranda* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#432218, #433808, #433891). [Total specimens=3]

***Callopistria mollissima* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433807); *15 Jun 2006*, Daniel Kunkle, UV light trap (#432507, #433593, #434026, *21 Jun 2006*, Daniel Kunkle, UV light trap (#433759); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433769); *2 Aug 2006*, Daniel Kunkle, UV light trap (#433711); *16 Aug 2006*, Daniel Kunkle, UV light trap (#433042). **Site 2,** Lehigh Gap

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Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433737); *20 Jul 2006*, Daniel Kunkle, UV light trap (#432902, #434089). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#428230); *2 Aug 2006*, Daniel Kunkle, UV light trap (#433152); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433659). [Total specimens=14]

***Chytonix palliatricula* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433142, #434120); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433931); *2 Jul 2006*, Daniel Kunkle, UV light trap (#432105, #434073, #434103); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433313). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#432863). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432985, #433699); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433736). [Total specimens=11]

***Condica vecors* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433811); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434024). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433654). [Total specimens=3]

***Cosmia calami* (Harvey)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#392941). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#393393); *20 Jul 2006*, Daniel Kunkle, UV light trap (#397996). [Total specimens=3]

***Elaphria cornutinis* Saluke and Pogue**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#437653); *30 May 2006*, Daniel Kunkle, UV light trap (#432103, #437745); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437655, #437693, #437913, #438281, #438757); *15 Jun 2006*, Daniel Kunkle, UV light trap (#429068, #431924, #437865); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437940). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437152, #438890). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435696, #437870); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436077, #438866, #439027). [Total specimens=19]

***Euplexia benesimilis* McDunnough**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#431768); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434210); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433489). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433488). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433815, #433949). [Total specimens=6]

***Lemmeria digitalis* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#398018). [Total specimens=1]

***Luperina passer* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436069). [Total specimens=1]

***Papaipema rutila* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#438407). [Total specimens=1]

***Phlogophora iris* Guenée**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433484); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433054, #433715); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434148). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433518). [Total specimens=5]

***Phosphila miselioides* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433507, #433954); *7 Jun 2006*, Daniel Kunkle, UV light trap (#431865, #433553, #433888, #433905, #434018, #434082, #434098); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434102); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433342, #433786, *2 Jul 2006*, Daniel Kunkle, UV light trap (#433991). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434007); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433825); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433445); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433689). [Total specimens=17]

***Phosphila turbulenta* Hübner**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433357, #434008). [Total specimens=2]

***Platyperigea multifera* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#437456, #437993, #438592). [Total specimens=3]

***Spodoptera frugiperda* (J.E. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#434147). [Total specimens=1]

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***Spodoptera ornithogalli* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#398387). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#392791). [Total specimens=2]

Catocalinae

***Allotria elonympha* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#431798, #432654, #435504); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433578); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433183); *16 Aug 2006*, Daniel Kunkle, UV light trap (#433496). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433667). [Total specimens=7]

***Argyrostrotis anilis* (Drury)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#394310). [Total specimens=1]

***Caenurgina crassiuscula* (Haworth)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438376, *16 Aug 2006*, Daniel Kunkle, UV light trap (#435081, #435774, #437315); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436945, #438140, #438326, #438490, #438820). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#435832, #437603); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437393). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#436684); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437319); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436987, #437438, #438556). [Total specimens=17]

***Catocala ilia ilia* (Cramer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#392692, #397233). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#395891, #398038). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#395187, #395947); *21 Aug 2006*, Daniel Kunkle, UV light trap (#392876). [Total specimens=7]

***Catocala palaeogama* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434524). [Total specimens=1]

***Drasteria grandirena* (Haworth)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432809, #433678, #433768); *15 Jun 2006*, Daniel Kunkle, UV light trap (#428228, #432935, #433297, #433451, #433903, #433914); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433524, #434032); *2 Jul 2006*, Daniel Kunkle, UV light trap (#432586, #433560, #434002, #434128). [Total specimens=15]

***Ledaea perditalis* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434173, #434219, #435865, #435910, #435986, #436023, #436102, #436104, #436184); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434473, #436147); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434204, #434263, #434331, #434332, #434442, #436229); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434168, #434490); *20 Jul 2006*, Daniel Kunkle, UV light trap (#436103, #436139, #436152, #436218); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434233, #436190); *21 Aug 2006*, Daniel Kunkle, UV light trap (#435871, #436025). [Total specimens=27]

***Mocis texana* (Morrison)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433912). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#432896, *16 Aug 2006*, Daniel Kunkle, UV light trap (#433970). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#433967). [Total specimens=4]

***Pangrapta decoralis* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#426900, #428417). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#422567, #431863, #431866). [Total specimens=5]

***Panopoda rufimargo* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433490, #433716). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433859). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434096, *2 Jul 2006*, Daniel Kunkle, UV light trap (#433707). [Total specimens=5]

***Parallelia bistriaris* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433810, #434051, #434092); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434130); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433103). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433412). [Total specimens=6]

***Phoberia atomaris* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light

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trap (#433289, #433516, #433604); *19 Apr 2006*, Daniel Kunkle, UV light trap (#433794). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433343, #433918). [Total specimens=6]

***Phyprosopus callitrichoides* Grote**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394614); *7 Jun 2006*, Daniel Kunkle, UV light trap (#397039). [Total specimens=2]

***Zale aeruginosa* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#439184); *7 Jun 2006*, Daniel Kunkle, UV light trap (#437493); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437366). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437854). [Total specimens=4]

***Zale helata* (J.B. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437915). [Total specimens=1]

***Zale lunifera* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#431775); *2 May 2006*, Daniel Kunkle, UV light trap (#431418). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#432188). [Total specimens=3]

Cuculliinae
***Eucirroedia pampina* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#396674). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#394689). [Total specimens=2]

***Eupsilia sidus sidus* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#436183). [Total specimens=1]

***Lithophane grotei* (Riley)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#434374, #437414). [Total specimens=2]

***Lithophane hemina* Grote**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#431743); *2 May 2006*, Daniel Kunkle, UV light trap (#432559); *10 Oct 2006*, Daniel Kunkle, UV light trap (#431518). [Total specimens=3]

***Lithophane innominata* (J.B. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434218). [Total specimens=1]

***Lithophane signosa* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#437736, #438155); *17 Oct 2006*, Daniel Kunkle, UV light trap (#437797). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *17 Oct 2006*, Daniel Kunkle, UV light trap (#437294). [Total specimens=4]

***Lithophane unimoda* (Lintner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#437879). [Total specimens=1]

***Metaxaglaea semitaria* Franclemont**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#434211). [Total specimens=1]

***Pyreferra hesperidago* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#433291, #433446, #434001); *19 Apr 2006*, Daniel Kunkle, UV light trap (#433293, #433341, #433827). [Total specimens=6]

***Sunira bicolorago* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#394808); *17 Oct 2006*, Daniel Kunkle, UV light trap (#393765, #394956, #395072, #398305); *1 Nov 2006*, Daniel Kunkle, UV light trap (#393316, #393638, #397112, #397570, #398183). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *17 Oct 2006*, Daniel Kunkle, UV light trap (#393441, #398391); *25 Oct 2006*, Daniel Kunkle, UV light trap (#392839). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#392679, #392819, #398244, #398331); *17 Oct 2006*, Daniel Kunkle, UV light trap (#393387, #393734, #394975, #396574); *1 Nov 2006*, Daniel Kunkle, UV light trap (#397462, #397478). [Total specimens=23]

Hadeninae
***Achatia distincta* Hübner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434020); *2 May 2006*, Daniel Kunkle, UV light trap (#433793). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433913, #434079); *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#434118). [Total specimens=5]

***Aletia oxygala oxygala* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light

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trap (#434279, #434299, #434416, #434547, #436031); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434394, #434535); *2 Jul 2006*, Daniel Kunkle, UV light trap (#426913). [Total specimens=8]

***Crocigrapha normani* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433128, #433965, #434108); *2 May 2006*, Daniel Kunkle, UV light trap (#433865). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#434067); *30 May 2006*, Daniel Kunkle, UV light trap (#433885). [Total specimens=6]

***Egira alternans* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433191, #433939). [Total specimens=2]

***Faronta diffusa* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#395676, #397755); *7 Jun 2006*, Daniel Kunkle, UV light trap (#393751); *15 Jun 2006*, Daniel Kunkle, UV light trap (#395155). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#397006, *21 Aug 2006*, Daniel Kunkle, UV light trap (#397805). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#398037). [Total specimens=7]

***Homorthodes lindseyi* (Benjamin)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#434182, #434455). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434534). [Total specimens=3]

***Lacanobia subjuncta* (Grote and Robinson)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#435913). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434426). [Total specimens=2]

***Lacinipolia renigera* (Stephens)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434050); *20 Sep 2006*, Daniel Kunkle, UV light trap (#433748). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433424); *20 Sep 2006*, Daniel Kunkle, UV light trap (#433080). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433881). [Total specimens=5]

***Leucania insueta* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435056, #435717); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435452); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434676). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434597). [Total specimens=5]

***Leucania lapidaria* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#438983). [Total specimens=1]

***Leucania linda* Franclemont**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#436841, #437728, #437965). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437799). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437234); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437711). [Total specimens=6]

***Leucania linita* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#438327). [Total specimens=1]

***Leucania phragmitidicola* Guenée**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437273). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437962). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#438274). [Total specimens=3]

***Leucania ursula* (Forbes)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#435488). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435598); *16 Aug 2006*, Daniel Kunkle, UV light trap (#435875). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435034, #435647). [Total specimens=5]

***Morrisonia confusa* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#432346, #433580, #433989). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434111). [Total specimens=4]

***Morrisonia evicta* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433526, *2 May 2006*, Daniel Kunkle, UV light trap (#434069); *24 May 2006*, Daniel Kunkle, UV light trap

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(#433224). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433600, #433601, #433635, #433746, #433818, #433928, #434036, *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#433641, #433789). [Total specimens=12]

***Morrisonia latex* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#394013, #394656, *21 Jun 2006*, Daniel Kunkle, UV light trap (#392732). [Total specimens=3]

***Nephelodes minians* Guenée**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#433750, #434013). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#433257). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#433909); *20 Sep 2006*, Daniel Kunkle, UV light trap (#433919). [Total specimens=5]

***Orthodes cynica* Guenée**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436111, #436241). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436075). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434891, #435446, #435932, #436076, *20 Jul 2006*, Daniel Kunkle, UV light trap (#436130). [Total specimens=8]

***Orthodes goodelli* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#434253). [Total specimens=1]

***Orthodes majuscula* Herrich-Schäffer**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#431740). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433457). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#432910, #434070); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433755, #433979). [Total specimens=6]

***Orthosia alurina* (J.B. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#437757). [Total specimens=1]

***Orthosia garmani* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#394203). [Total specimens=1]

***Orthosia hibisci* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#433575, #433788, #433875, #433980); *19 Apr 2006*, Daniel Kunkle, UV light trap (#433826, #433895). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#431564). [Total specimens=7]

***Orthosia revicta* (Morrison)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#433915); *19 Apr 2006*, Daniel Kunkle, UV light trap (#431446, #433767, #433898). [Total specimens=4]

***Orthosia rubescens* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#433279, #433741); *19 Apr 2006*, Daniel Kunkle, UV light trap (#433165, #433325, #433453, #433594, #434081). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434062). [Total specimens=8]

***Polia detracta* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#427823, #432944, #433397, #433869); *21 Jun 2006*, Daniel Kunkle, UV light trap (#430053, #433123, #433300, #434131, #435609, #435630, #435707). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433740). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433787). [Total specimens=13]

***Polia purpurissata* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#433718). [Total specimens=1]

***Protorthodes oviduca* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#434220); *24 May 2006*, Daniel Kunkle, UV light trap (#434071, #434241, #434259, #434291); *30 May 2006*, Daniel Kunkle, UV light trap (#437916, *7 Jun 2006*, Daniel Kunkle, UV light trap (#434256). [Total specimens=7]

***Pseudaletia unipuncta* (Haworth)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#395793). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 May 2006*, Daniel Kunkle, UV light trap (#393897); *2 Jul 2006*, Daniel Kunkle, UV light trap (#395858, #396599); *20 Jul 2006*, Daniel Kunkle, UV light trap (#396359); *20 Sep 2006*, Daniel Kunkle, UV light trap (#396912). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#392943); *2 Jul 2006*,

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Daniel Kunkle, UV light trap (#393020); *2 Aug 2006*, Daniel Kunkle, UV light trap (#394352); *10 Oct 2006*, Daniel Kunkle, UV light trap (#395182, #396243). [Total specimens=11]

***Spiramater grandis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#396571); *15 Jun 2006*, Daniel Kunkle, UV light trap (#396898, #397070); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435270). [Total specimens=4]

***Spiramater lutra* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#393691); *15 Jun 2006*, Daniel Kunkle, UV light trap (#394971); *2 Jul 2006*, Daniel Kunkle, UV light trap (#394955, #397638); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437465, #438678). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#392554, #392559). [Total specimens=8]

***Trichordestra legitima* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#434155, #434195, #434249, #434414); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434157, #434262, #434286, #434498). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#433983, #434267, #434375, #434432, #434468); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434152, #434156, #434198, #434284, #434482); *20 Sep 2006*, Daniel Kunkle, UV light trap (#434542). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#434242); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434188, #434254, #434288, #434369, #434379). [Total specimens=25]

***Ulolonche culea* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434087). [Total specimens=1]

***Ulolonche modesta* (Morrison)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#434257); *24 May 2006*, Daniel Kunkle, UV light trap (#434100, #434189, #434193, #434264, #434297, #434324, #434335, #434336, #434340, #434421); *30 May 2006*, Daniel Kunkle, UV light trap (#434357, #434465); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434359, #434420, #434422); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434402). [Total specimens=17]

Heliothinae

***Helicoverpa zea* (Boddie)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#429214); *10 Oct 2006*, Daniel Kunkle, UV light trap (#433340, #433850); *1 Nov 2006*, Daniel Kunkle, UV light trap (#433533). [Total specimens=4]

Herminiinae

***Bleptina caradrinalis* Guenée**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434797); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436397). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#435228, #435370, #436189, #437702); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433754, #434722, #435740, #436325). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436113); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434645, #434906, #436155, #436607, #436717, #437731). [Total specimens=17]

***Chytolita morbidalis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#437193, #437242, #437343, #437618, #437667, #437686, #438887); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437931). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#437206, *7 Jun 2006*, Daniel Kunkle, UV light trap (#438005); *15 Jun 2006*, Daniel Kunkle, UV light trap (#437395). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437749). [Total specimens=12]

***Idia aemula* Hübner**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#435078, #435699). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#435758); *10 Oct 2006*, Daniel Kunkle, UV light trap (#434738, #434866, #436350); *1 Nov 2006*, Daniel Kunkle, UV light trap (#435027). [Total specimens=7]

***Idia americalis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#435489, #436214); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434466, #436318); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435151, #436014, #436044, #436448); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435787, #437750). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#434214). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#435421); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434754, #436024, #436588); *10 Oct 2006*, Daniel Kunkle, UV light trap (#434758). [Total specimens=16]

***Idia laurenti* (J.B. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434689, #436316). [Total specimens=2]

***Idia rotundalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light

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trap (#437509); *16 Aug 2006*, Daniel Kunkle, UV light trap (#438266, #438884). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#436823, #437681, #438061, #438427, #438940). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437991, #438554, #438902); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437773, #437793, #437822, #437830, #437894, #437909, #437928, #437946, #438000, #438025, #438079, #438984, #439013, #439017, #439295); *2 Aug 2006*, Daniel Kunkle, UV light trap (#437204, #437811, #437869, #437882). [Total specimens=30]

***Lascoria ambigualis* Walker**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436434); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435520, #436427); *13 Sep 2006*, Daniel Kunkle, UV light trap (#434570, #434975). [Total specimens=5]

***Macrochilo absorptalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#431634, #432638, #432716, *21 Jun 2006*, Daniel Kunkle, UV light trap (#425485, #432320); *2 Jul 2006*, Daniel Kunkle, UV light trap (#431639); *20 Jul 2006*, Daniel Kunkle, UV light trap (#425276). [Total specimens=7]

***Macrochilo orciferalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#432392); *21 Aug 2006*, Daniel Kunkle, UV light trap (#428157). [Total specimens=2]

***Palthis angulalis* (Hübner)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#435704); *13 Sep 2006*, Daniel Kunkle, UV light trap (#436137). [Total specimens=2]

***Palthis asopialis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#438201). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437845, #438586). [Total specimens=3]

***Phalaenophana pyramusalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434844, #436700); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435227, #435278, #436456, *15 Jun 2006*, Daniel Kunkle, UV light trap (#435365, #435600, #436566). [Total specimens=8]

***Phalaenostola larentioides* Grote**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#439209); *21 Jun 2006*, Daniel Kunkle, UV light trap (#437847, #438758, #439148); *2 Jul 2006*, Daniel Kunkle, UV light trap (#439163); *16 Aug 2006*, Daniel Kunkle, UV light trap (#437990, #438301, #439107). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#438110, #438619, #438965, #439101); *2 Jul 2006*, Daniel Kunkle, UV light trap (#437756). [Total specimens=13]

***Phalaenostola metonalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#422991). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#431527, #431780); *21 Jun 2006*, Daniel Kunkle, UV light trap (#422867). [Total specimens=4]

***Renia discoloralis* Guenée**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437630). [Total specimens=1]

***Renia factiosalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438762); *20 Jul 2006*, Daniel Kunkle, UV light trap (#437710); *16 Aug 2006*, Daniel Kunkle, UV light trap (#437550). [Total specimens=3]

***Renia flavipunctalis* (Geyer)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437614). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437767, #437786). [Total specimens=3]

***Renia salusalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437798). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#438693). [Total specimens=2]

***Renia sobrialis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437714). [Total specimens=1]

***Tetanolita floridana* (J.B. Smith)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#437805). [Total specimens=1]

***Zanclognatha cruralis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#434308); *15 Jun 2006*, Daniel Kunkle, UV light trap (#439106, *21 Jun 2006*, Daniel Kunkle, UV light trap (#438629). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *24 May 2006*, Daniel Kunkle, UV light trap (#437771); *7 Jun*

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2006, Daniel Kunkle, UV light trap (#437275, #437935); *15 Jun 2006*, Daniel Kunkle, UV light trap (#438246). [Total specimens=7]

***Zanclognatha laevigata* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#433866). [Total specimens=1]

***Zanclognatha lituralis* (Hübner)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435045, #435703, #436335, #436394). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436677); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434423). [Total specimens=6]

***Zanclognatha ochreipennis ochreipennis* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437555, #438512). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437755, #439104); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435611). [Total specimens=5]

Hypeninae

***Bomolocha baltimoralis* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#396499). [Total specimens=1]

***Bomolocha manalis* (Walker)**
[Det. by J.E. Rawlins] **Carbon Co. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433842). [Total specimens=1]

***Plathypena scabra* (Fabricius)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#438897). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#434444); *25 Oct 2006*, Daniel Kunkle, UV light trap (#434278). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#434185). [Total specimens=4]

***Spargaloma sexpunctata* Grote**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433703). [Total specimens=1]

Noctuinae

***Abagrotis alternata* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#436918); *20 Sep 2006*, Daniel Kunkle, UV light trap (#436919). [Total specimens=2]

***Abagrotis anchocelioides* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437692); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437827); *20 Sep 2006*, Daniel Kunkle, UV light trap (#437727, #437960). [Total specimens=4]

***Agrotis ipsilon* (Hufnagel)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#396178); *2 Jul 2006*, Daniel Kunkle, UV light trap (#393794); *21 Aug 2006*, Daniel Kunkle, UV light trap (#395023); *17 Oct 2006*, Daniel Kunkle, UV light trap (#397479). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *30 May 2006*, Daniel Kunkle, UV light trap (#394718); *17 Oct 2006*, Daniel Kunkle, UV light trap (#397506, *1 Nov 2006*, Daniel Kunkle, UV light trap (#395660). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#393811, #396407); *17 Oct 2006*, Daniel Kunkle, UV light trap (#395850); *1 Nov 2006*, Daniel Kunkle, UV light trap (#395867). [Total specimens=11]

***Cerastis (Metalepsis) fishii* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433493). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#433662). [Total specimens=2]

***Dichagyris (Loxagrotis) acclivis* (Morrison)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#434033, #434107); *21 Aug 2006*, Daniel Kunkle, UV light trap (#433025, #433322, #433757, #433906). [Total specimens=6]

***Euxoa (Longivesica) messoria* (Harris)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#437223). [Total specimens=1]

***Feltia herilis* (Grote)**
[Det. by J.E. Rawlins] **Carbon Co. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#436061, #436217); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436227); *13 Sep 2006*, Daniel Kunkle, UV light trap (#434178, #434230, #436260). [Total specimens=6]

***Feltia jaculifera* (Guenée)**
[Det. by J.E. Rawlins] **Carbon Co. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#436267). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#436027). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#435869). [Total specimens=3]

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***Feltia tricosa* (Lintner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#436028). [Total specimens=1]

***Feltia (Trichosilia) geniculata* (Grote and Robinson)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#435793, #435851, #436233); *21 Aug 2006*, Daniel Kunkle, UV light trap (#435889, #436078, #436079); *13 Sep 2006*, Daniel Kunkle, UV light trap (#435859, #436089); *20 Sep 2006*, Daniel Kunkle, UV light trap (#435097). [Total specimens=9]

***Lycophotia phyllophora* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433752, #434047); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433155, #433222, #433824, #433872, #434004). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434044, #434063); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433012, #433943). [Total specimens=11]

***Noctua pronuba* Linnaeus**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434209, #434300); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434196, #434200, #434550, #434556, *2 Jul 2006*, Daniel Kunkle, UV light trap (#434227, #434243, #434306, #434341, #434436, #434470, #434472); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434280). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434561); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434327, #434407, #434440, #434479, #434488, #434575); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434533); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434203, #434540); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434431); *13 Sep 2006*, Daniel Kunkle, UV light trap (#434337). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434272, #434377, #434572); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434457); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434228). [Total specimens=31]

***Ochropleura implecta* Lafontaine**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433725); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434076). [Total specimens=2]

***Xestia (Megasema) dolosa* Franclemont**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433934, #433974, #434023); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433347). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#429998). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433760, #433986, *10 Oct 2006*, Daniel Kunkle, UV light trap (#433964). [Total specimens=8]

***Xestia (Xestia) dilucida* (Morrison)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#433804, #433862, #434428, #434485, #434641, #435161, #435211, #435306, #436131, #436140, #436439, #436509); *20 Sep 2006*, Daniel Kunkle, UV light trap (#434802, #435088, #435957). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#434412). [Total specimens=16]

***Xestia (Xestia) normaniana* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433673, #433762). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#433871). [Total specimens=3]

***Xestia (Xestia) smithii* (Snellen)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *13 Sep 2006*, Daniel Kunkle, UV light trap (#434034); *20 Sep 2006*, Daniel Kunkle, UV light trap (#434052). [Total specimens=2]

Nolinae

***Nola cilicoides* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434720). [Total specimens=1]

Pantheinae

***Charadra deridens* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#433606). [Total specimens=1]

***Colocasia propinquilinea* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434812); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434984, #435797, #436090); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435230). [Total specimens=5]

Plusiinae

***Anagrapha falcifera* (Kirby)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434135). [Total specimens=1]

***Autographa precationis* (Guenée)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *17 Oct 2006*, Daniel Kunkle, UV light trap (#433585, #433981). [Total specimens=2]

Psaphidinae

***Copivaleria grotei* (Morrison)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N,

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75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434113). [Total specimens=1]

***Psaphida resumens* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#433916). [Total specimens=1]

Rivulinae
***Melanomma auricinctaria* Grote**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#436101). [Total specimens=1]

Sarrothripinae
***Baileya australis* (Grote)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#437836). [Total specimens=1]

Notodontidae
Heterocampinae
***Heterocampa guttivitta* (Walker)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#434055); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433326, #433771, #433778, #433784, #433997); *15 Jun 2006*, Daniel Kunkle, UV light trap (#428110, #433418, #433668, #433988, #434011, #434059). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#434056, *30 May 2006*, Daniel Kunkle, UV light trap (#433987); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434144). [Total specimens=15]

***Hyperaeschra georgica* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *24 May 2006*, Daniel Kunkle, UV light trap (#433573); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433029); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433971). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#435923). [Total specimens=4]

***Macrurocampa marthesia* (Cramer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433929, #434042). [Total specimens=2]

***Schizura unicornis* (J.E. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#429178, #434142). [Total specimens=2]

Notodontinae
***Gluphisia septentrionis septentrionis* Walker**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434104). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433733). [Total specimens=2]

***Nadata gibbosa* (J.E. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433747); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433892). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#434136). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#433086, #433486, *2 Aug 2006*, Daniel Kunkle, UV light trap (#433938). [Total specimens=6]

***Peridea angulosa* (J.E. Smith)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#398408); *13 Sep 2006*, Daniel Kunkle, UV light trap (#395635). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#393030). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#393378). [Total specimens=4]

***Peridea ferruginea* (Packard)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433727); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434039); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433410); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433312, #433831, #434139). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#432769, #434066). [Total specimens=8]

Nystalaeinae
***Symmerista canicosta* Franclemont**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434898). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#436646). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#434202). [Total specimens=3]

Phalerinae
***Datana angusii* Grote and Robinson**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433632). [Total specimens=1]

***Datana drexelii* Henry Edwards**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#435084, #435427); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436145). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435302). [Total specimens=4]

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***Datana major* Grote and Robinson**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#435299). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#435802, #435840). [Total specimens=3]

Pyraloidea

Pyralidae

Pyralidae undetermined sp.
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#434614, #435808, #436345); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434724, #435003); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436642); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434952, #435071, #436219); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434791); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436522, #436552). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#435478, #436490); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435115, #435669); *20 Jul 2006*, Daniel Kunkle, UV light trap (#435092, #435176, #435547, #435749, #435827); *16 Aug 2006*, Daniel Kunkle, UV light trap (#434315, #434786, #435618, #436614); *21 Aug 2006*, Daniel Kunkle, UV light trap (#436142); *13 Sep 2006*, Daniel Kunkle, UV light trap (#436535); *20 Sep 2006*, Daniel Kunkle, UV light trap (#434499). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434726, #436595, #436668); *15 Jun 2006*, Daniel Kunkle, UV light trap (#434685, #434688); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434380, #434714, #434719, #435773, #436106, *2 Jul 2006*, Daniel Kunkle, UV light trap (#435015, #435195, #436476, *20 Jul 2006*, Daniel Kunkle, UV light trap (#434739, #435025, #435639, #436221); *21 Aug 2006*, Daniel Kunkle, UV light trap (#435307, #436705); *13 Sep 2006*, Daniel Kunkle, UV light trap (#435208). [Total specimens=48]

Crambinae: Argyriini

***Urola nivalis* (Drury)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#397504); *2 Aug 2006*, Daniel Kunkle, UV light trap (#396318). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#393016, #394215); *16 Aug 2006*, Daniel Kunkle, UV light trap (#397372). [Total specimens=5]

Pyraustinae: Spilomelini

***Desmia funeralis* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#434037). [Total specimens=1]

***Nomophila nearctica* Munroe**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#435369, #439162); *21 Aug 2006*, Daniel Kunkle, UV light trap (#437303). [Total specimens=3]

Sesioidea

Sesiidae

Sesiinae: Synanthedonini

***Synanthedon acerni* (Clemens)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#433148, #434094). [Total specimens=2]

Tineoidea

Acrolophidae

***Acrolophus arcanellus* (Clemens)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437285). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437498). [Total specimens=2]

***Acrolophus popeanellus* (Clemens)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#439170). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434828). [Total specimens=2]

Tortricoidea

Tortricidae

Tortricidae undetermined sp.
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *12 Apr 2006*, Daniel Kunkle, UV light trap (#435420, #436432); *19 Apr 2006*, Daniel Kunkle, UV light trap (#434769, #435821); *2 May 2006*, Daniel Kunkle, UV light trap (#434505, #434558, #434616, #435035, #436290); *24 May 2006*, Daniel Kunkle, UV light trap (#435006, *30 May 2006*, Daniel Kunkle, UV light trap (#435595, #435735, #436034); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435521, #435675); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435085); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434322, #434747, #435047, #435118, #435276). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#435033); *2 Jul 2006*, Daniel Kunkle, UV light trap (#436386, *13 Sep 2006*, Daniel Kunkle, UV light trap (#435386, *1 Nov 2006*, Daniel Kunkle, UV light trap (#436577). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435456, *21 Aug 2006*, Daniel Kunkle, UV light trap (#435464); *13 Sep 2006*, Daniel Kunkle, UV light trap (#435202). [Total specimens=28]

Yponomeutoidea

Yponomeutidae

Attevinae

***Atteva punctella* (Cramer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *10 Oct 2006*, Daniel Kunkle, UV light trap (#432921). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#433339); *1 Nov 2006*, Daniel Kunkle, UV light trap (#433117). [Total specimens=3]

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Zygaenoidea

Limacodidae

***Adoneta spinuloides* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#435054). [Total specimens=1]

***Apoda biguttata* (Packard)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#435650). [Total specimens=1]

***Euclea delphinii* (Boisduval)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#433531); *2 Jul 2006*, Daniel Kunkle, UV light trap (#433506, #433801, #433879, #434090); *20 Jul 2006*, Daniel Kunkle, UV light trap (#433900). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#433499). [Total specimens=7]

***Lithacodes fasciola fasciola* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#436466, *2 Jul 2006*, Daniel Kunkle, UV light trap (#436620). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#435066, #436119). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434705, #435879). [Total specimens=6]

***Prolimacodes badia* (Hübner)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#397258). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#396788). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#393806). [Total specimens=3]

***Sibine stimulea* (Clemens)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#434484). [Total specimens=1]

***Tortricidia pallida* (Herrich-Schäffer)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *20 Jul 2006*, Daniel Kunkle, UV light trap (#436550). [Total specimens=1]

***Tortricidia testacea testacea* Packard**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *30 May 2006*, Daniel Kunkle, UV light trap (#434713, #434757, #434913, #434968, #435064, #435316, #435366, #435587, #436447, #436498, #436623); *7 Jun 2006*, Daniel Kunkle, UV light trap (#435269, #436510); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434970); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434670). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#435829, #436220). [Total specimens=17]

Zygaenidae

***Pyromorpha dimidiata* Herrich-Schäffer**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433327, #433459, #433559, #434022); *15 Jun 2006*, Daniel Kunkle, UV light trap (#433360, #433732); *21 Jun 2006*, Daniel Kunkle, UV light trap (#433609, #433777, #434138). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#433083, #433106, #433726). [Total specimens=12]

Order Mecoptera

Meropeidae

***Merope tuber* Newman**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *20 Sep 2006*, Daniel Kunkle, UV light trap (#435872). [Total specimens=1]

Order Megaloptera

Corydaloidea

Corydalidae

Chauliodinae

***Chauliodes pectinicornis* (Linnaeus)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#435974). [Total specimens=1]

***Chauliodes rastricornis* Rambur**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *30 May 2006*, Daniel Kunkle, UV light trap (#436770). [Total specimens=1]

Corydalinae

***Corydalus cornutus* (Linnaeus)**
[Det. by J.E. Rawlins] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *2 Jul 2006*, Daniel Kunkle, UV light trap (#437607). [Total specimens=1]

Order Neuroptera
Suborder Hemerobiiformia

Chrysopidae

Chrysopidae undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *1 Nov 2006*, Daniel Kunkle, UV light trap (#438623). [Total specimens=1]

Mantispidae

Mantispidae undetermined sp.
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#437128, #437643). [Total specimens=2]

Order Orthoptera

Orthoptera undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *21 Aug 2006*, Daniel Kunkle, UV light trap (#438059). [Total specimens=1]

Data Compilation of Survey Specimens

Suborder Ensifera
Tettigonioidea

Tettigoniidae
Phaneropterinae: Phaneropterini

***Scudderia furcata* Brunner**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *16 Aug 2006*, Daniel Kunkle, UV light trap (#437394). [Total specimens=1]

***Scudderia septentrionalis* (Serville)**
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 Aug 2006*, Daniel Kunkle, UV light trap (#437172, #437278, #437441, #437566, #437712, #438871). [Total specimens=6]

Order Plecoptera

Plecoptera undetermined sp.
[Det. by R.A. Androw] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *7 Jun 2006*, Daniel Kunkle, UV light trap (#438409). [Total specimens=1]

Order Trichoptera

Trichoptera undetermined sp.
[Det. by J.E. Rawlins] **CARBON CO. Site 1,** Lehigh Gap Wildlife Refuge, 3.4 km SW Palmerton, 40°46'56"N, 75°38'27"W, 442 m: *2 May 2006*, Daniel Kunkle, UV light trap (#435254); *30 May 2006*, Daniel Kunkle, UV light trap (#434993, #435564, #435596, #435603, #435690, #436185, #436187, #436690); *7 Jun 2006*, Daniel Kunkle, UV light trap (#433775, #434205, #434234, #434735, #435222, #435259, #435336, #435393, #435500, #435551, #435975, #436333, #436703); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435159, #435632); *21 Jun 2006*, Daniel Kunkle, UV light trap (#436423); *2 Jul 2006*, Daniel Kunkle, UV light trap (#435067, #435537, #435818, #436443); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434353, #435475); *16 Aug 2006*, Daniel Kunkle, UV light trap (#435531, #435608, #435805, #435858, #436329); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434994, #435499, #435581, #435770, #436508, #436634); *13 Sep 2006*, Daniel Kunkle, UV light trap (#435040, #435775); *10 Oct 2006*, Daniel Kunkle, UV light trap (#435187, #435570); *17 Oct 2006*, Daniel Kunkle, UV light trap (#435057, #435190, #435236, #435999, #436716, *1 Nov 2006*, Daniel Kunkle, UV light trap (#435206). **Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *2 May 2006*, Daniel Kunkle, UV light trap (#434833, #435601, #435712, #436713); *24 May 2006*, Daniel Kunkle, UV light trap (#435513, #435984, #435990); *30 May 2006*, Daniel Kunkle, UV light trap (#435155, #435205, #435642); *7 Jun 2006*, Daniel Kunkle, UV light trap (#434638, #434958, #435145, #435150, #435238, #435560, #435663, #435668, #435801, #436582, #436648); *15 Jun 2006*, Daniel Kunkle, UV light trap (#435927, #435948, #436581, #436682); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435021, #435621, #436654); *2 Jul 2006*, Daniel Kunkle, UV light trap (#434783, #435477, #435662, #435757, #435951, #436182, #436678); *20 Jul 2006*, Daniel Kunkle, UV light trap (#434391); *16 Aug 2006*, Daniel Kunkle, UV light trap (#435131, #435257, #435436, #435747, #436667); *21 Aug 2006*, Daniel Kunkle, UV light trap (#435075, #435480, #436070, #436688); *13 Sep 2006*, Daniel Kunkle, UV light trap (#434887, #435168, #435721, #436107, #436663); *10 Oct 2006*, Daniel Kunkle, UV light trap (#435390); *17 Oct 2006*, Daniel Kunkle, UV light trap (#434868, #435711); *1 Nov 2006*, Daniel Kunkle, UV light trap (#434652, #436251, #436672). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *19 Apr 2006*, Daniel Kunkle, UV light trap (#434401, #435976, #436311, #436328); *2 May 2006*, Daniel Kunkle, J. Frantz, UV light trap (#435599); *24 May 2006*, Daniel Kunkle, UV light trap (#435413); *21 Jun 2006*, Daniel Kunkle, UV light trap (#434956, *2 Jul 2006*, Daniel Kunkle, UV light trap (#434350, #434410, #434544, #434761, #434938, #435466, #435693, #435754, #436314, #436463, #436640); *20 Jul 2006*, Daniel Kunkle, UV light trap (#436714, #438354); *2 Aug 2006*, Daniel Kunkle, UV light trap (#434624, #434818, #436237); *21 Aug 2006*, Daniel Kunkle, UV light trap (#434261, #435778, #436063, #436128, #439254); *13 Sep 2006*, Daniel Kunkle, UV light trap (#433264, #433870, #434982, #435676, #435809, #436005, #436248, #436694); *20 Sep 2006*, Daniel Kunkle, UV light trap (#435002, #435194, #435657, #436082, #436262, #436281, #436610); *10 Oct 2006*, Daniel Kunkle, UV light trap (#435082). [Total specimens=152]

Suborder Annulipalpia
Hydropsychoidea

Hydropsychidae
Macronematinae

***Macrostemum zebratum* Hagen**
[Det. by J.E. Rawlins] **CARBON CO. Site 2,** Lehigh Gap Wildlife Refuge, 2.4 km WSW Palmerton, 40°47'26"N, 75°38'03"W, 180 m: *21 Jun 2006*, Daniel Kunkle, UV light trap (#434911, #435836, #438410). **Site 3,** Lehigh Gap Wildlife Refuge, 3.4 km WSW Palmerton, 40°47'17"N, 75°38'46"W, 123 m: *15 Jun 2006*, Daniel Kunkle, UV light trap (#439178); *21 Jun 2006*, Daniel Kunkle, UV light trap (#435242, #435792, #436312, #436940, #437186, #437625, #438038, #438145, #438495, #438946). [Total specimens=14]

Appendix E
The Recovery of a Simplified Lichen Community near the Palmerton Zinc Smelter

Natalie M. Howe and James C. Lendemer

Abstract: In a landmark study in 1972, Thomas H. Nash, III surveyed the lichen communities at the Lehigh Gap immediately downwind of a large-scale operating zinc smelter in Palmerton, Pennsylvania, and at the relatively unpolluted Delaware Water Gap. He found that the lichen cover and diversity were considerably lower in the highly contaminated soils of the Lehigh Gap, and concluded that lichen diversity had been severely negatively impacted by the air pollution emanating from the zinc smelter there. In 2006, we repeated Nash's study of lichens in the Lehigh Gap using the same methodology in order to see what changes had occurred in the intervening 34 years with cessation of zinc smelting in 1980. We found increased lichen cover and species diversity in comparing the data from 1972 and 2006. We conclude that the lichen community is recovering because of the presence of more lichen species and the higher lichen cover, and the composition of the lichen mycota.

Introduction

Nash (1972) was among the first lichenologists to report on the lichens growing in the vicinity of Lehigh Gap, Carbon and Lehigh Counties, Pennsylvania. His study focused on the impact of a zinc smelter, in the nearby town of Palmerton, on the surrounding lichen communities. Not surprisingly, his study showed that the lichen communities suffered significant negative impact from the operation of the smelter that contaminated the area with high levels of zinc, cadmium, and lead. At the time of Nash's study there were fewer than a dozen species of lichens growing within roughly one kilometer of the Gap, and none of the species he found had any significant cover in his plots. Nash also reported a conspicuous absence of corticolous foliose or fruticose lichens. Smelting operations in Palmerton did not end until 1980, thus there were eight additional years of heavy metal accumulation following his study.

We were curious how the lichen communities in Lehigh Gap had changed in the decades following the closure of the smelter so we decided to relocate the original transects and repeat Nash's study. Upon visiting the area of the Lehigh Gap for the first time we were immediately confronted by a rocky landscape nearly devoid of trees and shrubs. We were daunted by what appeared, at first, to be a lack of lichens, despite a considerable amount of substrate that had been made available by the absence of nearly all vascular plants. Closer inspection however, revealed that in fact lichens were thriving in some parts of the Gap where they had previously been absent. Stimulated by the discovery of a small population of the zinc-tolerant *Vezdaea leprosa* (a species that we later found to be quite common) we began our study, the results of which are reported here.

Site Information

Palmerton, in Carbon County, Pennsylvania, is situated just north of Blue Mountain, the southernmost ridge in the Appalachian Ridge and Valley Province. The ridge rises 1500 ft. above sea level, and the valley sits at approximately 400 ft. At the Lehigh Gap in Palmerton, the Lehigh River cuts almost perpendicularly through the ridge. The bedrock in these mountains is Silurian Shawangunk conglomerate (Widmer, 1964), and the ridgetop soils that overlay this material are Dekalb very stony loams. (Fisher et al., 1962). On the north side of the mountain, Laidig very stony loams overlie sandstone, shale and conglomerate glacial till (Fisher et al., 1962). Soil classified as very stony lands lies on the mountainsides facing the Lehigh River. Emissions from the east

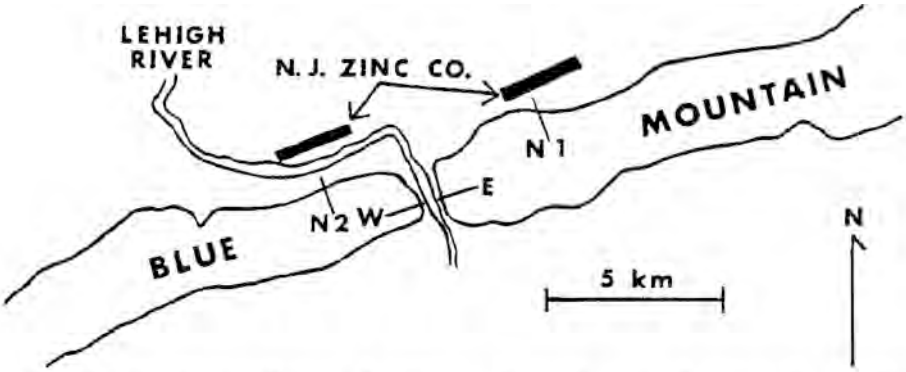
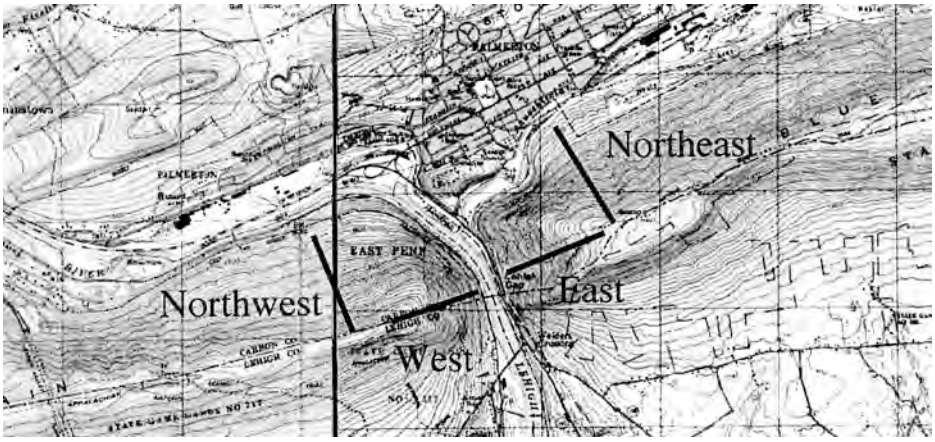


FIGURE 1. Lehigh Water Gap and vicinity, Pennsylvania, showing the position of the sampling base lines with respect to Blue Mountain, the New Jersey Zinc Company's divisions, and the Lehigh River. Each base line is designated by the aspect of the slope, *e.g.* east, west, north-1 and north-2 by E, W, N 1, and N 2 respectively.



The map of Nash's transects (top) compared with those in this study (bottom). In the lower map, one gridline is one kilometer, and vertical gridlines are going north and south. The city of Palmerton is to the north of the mountain, and the zinc smelters are the large black buildings to the west and east of the city.

and west smelters have significantly influenced the properties of all of these soils. The pH of the upper layers in these soils is uncharacteristically high, perhaps because of deposition of zinc oxide (Buchauer, 1973). The topmost soil (the organic horizon, or litter layer) also had high levels of Pb, Zn, Cd, and Cu several years after atmospheric deposition of these materials had ceased. (Storm et al., 1994). The organic horizons in the soils close to the smelters show decreased rates of respiration compared with those farther away (Strojan, 1978b).

Blue Mountain was originally classified as part of the Oak-Chestnut forest region (Braun, 1950). Logging, fires, and the chestnut blight have altered this community significantly, and now there is a mixed forest of chestnut oak (*Quercus montana* Willd.), northern red oak (*Quercus rubra* L.), red maple (*Acer rubrum* L.), sweet birch (*Betula lenta* L.), blackgum (*Nyssa sylvatica* Marsh.), sassafras (*Sassafras albidum* Nees), eastern hemlock (*Tsuga canadensis* Carrière), and eastern white pine (*Pinus strobus* L.) (Jordan, 1975). At the Lehigh Gap, these communities have been significantly modified by heavy air pollution.

After coal was discovered in the nearby town of Mauch Chunk (now called Jim Thorpe) in 1791, canals were built to carry the coal downriver to Philadelphia. During the Civil War, railroads were also built through the area. The increase in accessibility made the area more amenable to industry, and in 1898, the New Jersey Zinc Company began its operation at the gap and established the City of Palmerton. (Waltz, 1923). The company initially only used franklinite and willemite ores, which contain no sulfur or trace heavy metals (Jordan, 1975). However, after 1915, sulfide ores were also roasted, and these released cadmium, lead and copper in oxide form, as well as sulfur dioxide into the air. During this period, in the immediate vicinity of Palmerton, much vegetation was killed; a sequence of United States Department of Agriculture aerial photographs taken in 1938, 1947, 1959, and 1964 show increasing vegetation damage and erosion. (Jordan, 1975). The damage is most likely attributable to the emissions from the smelters (Nash, 1975; Jordan, 1975). Further, populations of bacteria, actinomycetes, and fungi in the soil have suffered severe population declines (Jordan and Lechevalier, 1975) such that dead tree trunks remain on the mountainside, undecomposed. Since the area was placed on the National Priority List by the Environmental Protection Agency in 1983, there have been various revegetation efforts (EPA, 2006; Sopper, 1989) and natural revegetation of the mountain by blackgum, sassafras, and Pitcher's stitchwort (*Minuartia patula* [Michx.] Mattf.) has occurred (Buchauer, 1973). The purpose of this study was to assess whether the lichen communities in the Lehigh Gap had changed since Nash's study in 1972. Since lichen growth was being suppressed by operation of the smelters (Nash, 1975), any recovery that did occur would have begun after 1980, when the smelting operations ceased.

Materials and Methods

Our survey was conducted in the spring (May and June) of 2006, in approximately the same locations as Nash's surveys. We attempted to relocate Nash's original transects however, their exact location (latitude/longitude or UTM) was not available. Using published (Nash, 1972) and unpublished (T.H. Nash, pers. comm., 2006)

data we established baselines (transects) in approximately the same location as the original study. The latitude and longitude of the starting point and ending point of each transect is included below; the location of each point on each transect is not provided here, however, is available from the authors.

As in the original study, we established four baselines (transects) on the slopes of the mountains surrounding the Gap. One baseline starts at the east side of the river where it passes through the gap, (40°47'23.8" N, 75°36'30.6" W) and goes to the top of the mountain (40°47'37.4" N, 75°35'57.5" W). Another baseline mirrors this one on the west side of the river (40°47'15.7" N, 75°36'37.1" W to 40°47'11.3" N, 75°37'04.7" W) The two other baselines go up the north sides of the mountain, one to the east of the river (40°47'58.6" N, 75°36'11.9" W to 40°47'35.9" N, 75°35'57.8" W) and one to the west (40°47'28.8" N, 75°37'44.8" W to 40°47'04.0" N, 75°37'36.9" W) Both baselines on the northern sides of the mountains were approximately 1 km from the gap itself. These sites are referred to as East, West, Northeast, and Northwest, respectively.

Each baseline includes 10 points ~35 m (100 ft) in elevation apart (~200 steps, or 140 m along the ground). At each point, the coordinates were determined using a GPS, and 20 contiguous 1-m^2 ground quadrats were established on either the right or left side (randomly chosen) of the baseline and perpendicular to it. In each quadrat, cover for each lichen was recorded. Where living trees greater than 10 cm in diameter were present, eight quadrats were examined on the four trees closest to the transect point. Closest trees were chosen and the species was recorded. These trees were chosen using the point centered-quarter method (Cottam and Curtis, 1956). On each tree eight 10 × 50-cm quadrats were established: one in each direction (N, S, E, and W), at breast height (1.3 m off the ground) and at the base of the tree (0.2 m off the ground). Within these tree quadrats, the percent cover of each lichen species was also recorded. From these data, a table was constructed to show the cover and frequency for each species in each transect (Table 1). Nash's values are included in the same table for comparison. Species diversity for each transect was calculated using the Shannon-Weiner Diversity Index (MacArthur and MacArthur, 1961). This index is often calculated using the formula $\Sigma\ p_i * -\log_2(p_i)$. In this equation p_i is the proportion of the i^{th} species (the total cover of that species in that transect, divided by the total cover of all lichens in that transect). The $p_i * -\log_2(p_i)$ values for each species are then all added together to get the diversity index for that transect. The second author (JCL) was responsible for the identification of representative voucher specimens. The first author (NMH) identified the species in each quadrat after studying the voucher specimens identified by JCL as well as numerous representative specimens in the herbarium of the second author (deposited in PH). Voucher specimens were placed in the above herbarium. Lichen nomenclature represented here follows Esslinger (2006), however any deviations from that index reflect the views of the second author.

Results

When Nash (1972) studied the simplification of lichen communities at the Lehigh Gap he found fewer than a dozen lichen species within ~1 km of the Gap. Our re-survey of the same site resulted in the checklist presented below and the discovery that the lichen

Table 1. ***Frequency and cover data for lichens from Lehigh Gap in 1972 compared with 2006.*** F ***indicates frequency, the number of points out of 10 at which each species occurred on a transect.*** C ***is cover in cm² lichen/m² substrate. Species collected on a slope but not in a transect are listed in the Appendix. Species represented here with 0.0 cover were present in transects with cover of less than 0.05 cm²/m². Sorediate species are indicated with an (*S) , and other asexual propagation methods used by these lichens are indicated as follows (*B) = blastidia, (*G) = granules.***

transect →	East								West								Northeast								Northwest							
	rocks and soils				trees				rocks and soils				trees				rocks and soils				trees				rocks and soils				trees			
	1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006	
species	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C
Acarospora fuscata (Ach.) Arnold	3	4.5	5	1.9					4	5.5	6	0.67													1	0.0	5	1.8				
Aspicilia cinera (L.) Körber									1	0.5																	3	1.0				
Aspicilia laevata (Acharius) Arnold																											1	1.2				
(*S) *Caneleriella* cf. *Efflorescens* R.C. Harris & Buck							1	0.0			1	0.6			3	2.9											1	0.0				
(*S) *Cladonia cristatella* Tuckerman			2	5.2							2	1.6							1	0.5							1	0.4				
(*S) *Cladonia grayi* G. Merrill *ex* Sandstede			4	20.8							3	2.2			1	1.2			5	51.9							8	17.1				
(*S) *Cladonia macilenta* Hoffman var. *macilenta*			5	21.7							4	3.6							6	25.6							9	37.3				
(*S) *Cladonia occhroclora* Flörke											3	3.5			1	1.2											1	0.0			2	30.9
(*S) *Cladonia polycarpoides* G. Merrill			2	14.0							1	0.3							4	23.6							2	6.9				
(*S) *Cladonia rei* Schaerer			1	3.0							1	0.0			1	0.2			2	1.0							4	22.4				
(*S) *Cladonia* sp.			9	166.3			5	12.5			10	53.9	1	0.2	6	53.1			8	63.4			1	4.6			9	10.2			5	26.6
Flavoparmelia baltimorensis											1	0.0																				
(*S) *Flavoparmelia caperata* (L.) Hale							2	3.1			1	0.0			1	0.5							1	1.6			1	0.0			3	1.9
(*S) *Plavopunctelia soredica* (Nyl.) *Hale*							3	1.9			1	0.0																				
(*S) *Hypocenomyces anthracophylla*																											1	0.7				
(*S) *Hypocenomyces scalaris* (Ach.) M. Choisy							1	0.2					2	4.0																		
Lecanora sp.																															2	7.5
Lecanora oreinoides (Kõrber) Hertel & Rambold			2	0.5							1	0.1							3	1.7							1	1.5				
Lecanora strobilina (Sprengel) Kieffer							3	0.5																							2	84.4
(*S) *Lepraria caesiella* Harris																															2	7.5
Lepraria incana (L.) Ach.													1	0.2																		
Lepraria lobificans Nylander			2	3.1							2	3.8			3	10.3									1	0.5						
Lepraria neglecta (Nyl.) Erichsen			2	0.0							2	0.2							1	0.1			1	0.5			1	0.2				
Micarea erratica (Kõrber) Hertel et al.			9	69.9							7	113							9	90.9					7	189.5	10	62.8				
Micarea peliocarpa (Anzi) Coppins & R. Sant.	5	76.5							10	84.0							6	18.0														
(*S) *Parmelia sulcata* Taylor							5	9.3			2	0.6			3	1.7							2	1.6			2	0.2			6	15.3
(*S) *Parmotrema hypotropum* (Nyl.) Hale							1	0.2			1	0.0			2	0.5															1	1.3

transect →	East								West								Northeast								Northwest							
	rocks and soils				trees				rocks and soils				trees				rocks and soils				trees				rocks and soils				trees			
	1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006		1972		2006	
species	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C
Phaeophyscia hirsuta (Mereschk.) Essl.							1	0.0																								
(*B) *Physcia millegrana* Degelius			3	0.6			8	75.1			3	2.1			6	124					4	58.9				3	0.3			8	262.4
Placinthiella sp.			2	0.8							3	5.1							8	3.1						3	1.3				
Polysporina simplex (Davies) Vězda											1	1.8																				
Porpidia albocaerulesens (Wulfen) Hertel & Knoph																			3	5.6						1	1.2					
Porpidia crustulata (Acharius) Hertel & Knoph			5	0.2							3	0.6							7	2.4						4	9.9					
Porpidia soredizodes (Nyl. *ex* Lamy)																																
Porpidia tahawaisiana																										1	0.5					
(*S) *Psiolechia lucida* (Acharius) M. Choisy																										2	7.75					
Punctelia rudecta (Ach.) Krog							3	0.5			1	0.1			3	1.08					1	2.2								1	0.7
(*S) *Punctelia subrudecta* auct. Amer.																														1	2.5	
Rhizocarpon reductum			4	0.3							2	1.3							2	0.6												
Rhizocarpon rubescens Th. Fr.																										2	0.91					
(*S) *Scolisosporum chloroccoum* (Stenh.) Vězda					8	54.9							7	53.3							2	18.1				2	2.7	5	45.3	1	0.1
Scolisosporum umbranum (Ach.) Arnold			8	9.0							8	12.2							10	36.2						8	50.0				
Stereocaulon saxatile H. Magn.																										3	1.8					
Sterile grey crust													2	5.8							2	5.4						1	0.4		
Sterile sorediate crust, prolitolic acid							2	0.6							2	1.06														2	4.4
Trapelia involuta (Taylor) Hertel et al.			6	8.4							7	3.4							7	8.5						5	9.3				
(*S) *Trapelia placodiodes* Coppins & P. James																										2	1					
Trapeliopsis flexuosa (Fr.) Coppins & P. James																										1	1					
(*S) *Trapeliopsis granulosa* (Hoffman) Lumbsch																										1	1					
Verrucaria sp.			2	1.0													1	0.1							1	1.0	5	6.4				
Verrucaria nigrescens Pers.																																
(*G) *Vezdaea leprosa* (P. James) Vězda											1	0.1							4	2.5						2	0.1				
Xanthoparmelia plitii (Gyelnk) Hale			1	0.0																												
total species	2		19		1		12		3		27		5		12		2		16		2		6		4		35		2		13	
total cover	81.0		326.7		54.9		103.9		90.0		210.8		63.5		197.7		18.1		317.6		23.5		69.4		191.0		258.9		45.7		445.5	

diversity has greatly increased in the 20 years since the smelter was shut down in 1980 (Table 2). While the vascular flora is still compromised in areas that have not been addressed by revegetation projects (Sopper, 1989), the lichen flora of the Lehigh Gap is in the initial stages of succession. This is indicated by the presence of "pioneer" species such as members of the genera *Cladonia* and *Trapelia* as well as *Micarea erratica,* which are among the first lichens to colonize a recently disturbed area (Brodo, 1969). The changes in the lichen flora were likely unnoticed by anyone conducting ecological studies at the Lehigh Gap following the closure of the smelter as many of the species are small and relatively inconspicuous. The more than threefold increase in species level diversity coupled with a marked increase in total cover directly contradicts the notion that the area of the Lehigh Gap impacted by the activity of the smelter has remained unchanged due to zinc, cadmium, and lead contamination.

Table 1 shows that there was a marked increase in the number of lichen species. In 1972, Nash found 5 species at the Gap in his transects; in 2006, we found 48. Eight additional species were found at the site that did not occur inside the transects: *Dibaeis baeomyces, Lecanora polytropa. Phaeocalicium polyporeum, Physcia adscendens, Physcia stellaris, Porpidia soredizodes,* and *Sarcogyne similis.*

Nash pointed out that his surveys reflected a "simple" community structure: there was only one dominant species (cover greater than 50 cm^2/m^2 on at least one slope), one species of intermediate importance (cover from 5 to 50 cm^2/m^2) and 3 subordinate species (cover less than 5 cm^2/m^2). The lichen community he found at the Delaware Water Gap consisted of 5 dominant species, 20 species of intermediate importance, and 39 subordinate species. The present lichen community at the Lehigh Gap represents intermediate values between these two. Now, there are 5 dominant species, 11 species of intermediate importance, and 32 subordinate species. This significant increase is reflected in the marked increase in species diversity values at the Lehigh Gap, in 2006 as compared to 1972. However, the diversity, particularly of corticolous lichens, is still significantly below the levels of an undisturbed area, the Delaware Water Gap.

	Ground Quadrats		Corticolous Quadrats	
	1977	2006	1977	2006
East	0.3089	2.325	0.0000	1.396
West	0.3802	2.104	0.8338	1.486
Northeast	0.4983	2.934	0.7806	0.9183
Northwest	0.07308	3.469	0.08039	2.104

Table 2. ***Species diversities of lichens at the Lehigh Gap in 1972 compared with species diversities in 2006, calculated by the Shannon-Wiener diversity index using the cover data by slope for corticolous and ground quadrats.***

The striking increase in diversity from 1972 to 2006 is shown in Table 2. This could be due to several factors. Since zinc smelting no longer occurs at Palmerton, there is less sulfur dioxide in the air, the contaminant that Nash (1975) found to be severely negatively impacting the lichen community at Palmerton in the seventies. In addition, as will be discussed below, revegetation projects have helped in establishing grass cover on the mountain; this has provided patches of land where suitable soil is available for species of *Cladonia* to grow. In areas where natural revegetation has occurred, roots help to stabilize slopes, allowing for growth of more lichens.

In 1972, saxicolous (rock-dwelling) lichens dominated the ground lichen communities. 86.6% of the lichens in the ground quadrats were saxicolous, 9.2% terricolous (ground-dwelling), and 2.2% lignicolous (living on dead wood). Now, the distribution is somewhat more even. 50% are saxicolous, 42.5% terricolous, and 6% lignicolous. (The remaining 1.5% are corticolous species that were in the ground quadrat because the slab of bark or branch they had been growing on had fallen into the ground quadrats). The significant increase in terricolous lichens is due in large part to the reemergence of the *Cladonia* species. Nash found them growing very thinly, at only one point on the west slope. However, now they constitute a conspicuous proportion of the lichen flora at the Lehigh Gap.

The reason these lichens can grow on the ground is that there is sufficient soil available for them to grow on. It is difficult to determine if this organic matter has arisen from the decomposition of tree leaves and aeolian debris, or whether it is part of the soil substitutes (ECOLOAM or compost) that have been added to the mountainsides in efforts to promote revegetation of the slopes. On the northwest slope, compost has been applied by hand to some areas, and by helicopter to others. We assume that the grassy areas on this slope represented revegetation efforts and not natural vegetation recovery. The first 4 points on the Northeast transect were also effected by human-assisted recovery. Remains of the roads that had been cut into the moutainside were evident in the form of leveled terraces, and a flower that had escaped from the test plots, thrift (*Armeria maritima* Willd.) was common in the quadrats at the second and third points on this transect. Higher up on this slope, point 5 and 6, was a carpet of ferns between trees. Since ferns were not part of the revegetation efforts as described by Sopper (1989), this part of the slope was not affected by the revegetation efforts.

There are also many lichens growing on exposed rocks. The *Trapelia* species were frequently found on small, flat, pebble-sized rocks where the slope was stabilized enough that these smaller rocks would not slide away. *Micarea erratica* tended to grow on larger rocks. In the areas that were the most exposed, on the top of the western side of the mountain, and on the bottom of the northeastern face, *M. erratica* grew sparsely and was often confined to fissures in the rocks. This may be because the conditions in the exposed areas were too dry. The lignicolous lichens have not yet rebounded. This may be because the community of decomposers is slower to return to the area. That community might also be more sensitive to the residual heavy metals remaining on the dying wood. So, the dead wood that is available for lignicolous lichens might still be too dry, as it has been subjected mostly to physical weathering, and less to the chemical decomposition

that creates humus, which has a high water holding capacity, and creates the wetter conditions on which lignicolous lichens depend.

Nash (1972) described little altitudinal shift in lichen species composition. We did not find this to be the case. At low elevations, there was less cover, fewer species were found, and the thalli were more often sterile or had deformed apothecia. On some transects, in particular the NW, and E, there was a considerable spike in number of species found towards the top of the mountain. However, at the very top, there was a considerable decrease in lichen species found. There were also drastic differences in lichen diversity due only to microhabitat that far exceeded the differences in elevation. For example, many plots were carpeted with ferns, greenbriar, or blueberries, and little light was able to penetrate to the ground surface below. Consequently, points where quadrats ran through such habitats were disproportionately depauperate of lichens.

In 1972, the first identifiable fruticose species in the Palmerton area was *Cladonia bacillaris* (= *Cladonia macilenta* var. *bacillaris*), which was found 3 km to the west of the Gap and 9 km to the east. The first foliose lichens were found 4.5 km to the west and 11km to the east, *Actinogyra muhlenbergii* (= *Umbilicaria muhlenbergii*) and *Parmelia conspersa* (= *Xanthoparmelia conspersa*) were the first foliose lichens observed. Now, there are foliose and fruticose lichens occuring within ~1 km of the Gap. Foliose and fructicose lichens now constitute 23% and 33%, respectively, of the cover at the Lehigh Gap (crustose lichens made up 44% of the cover). In several studies reviewed by Garty (2001), foliose lichens accumulated more airborne heavy metals than fruticose or crustose lichens did. Garty also points out that most heavy metals in lichen thalli are of atmospheric origin. This may have depressed foliose lichen populations while smelting still occurred, but would presumably not be impacting the communities today.

Most (58%) of the species found were sorediate. Further, sorediate lichens represent 92% of the lichen cover at the site. The success of species using asexual reproduction techniques is not unique to lichens. Smith et al. (1997) point out that in early stages of succession of the vascular plant community, asexually reproducing trees including *Sassafras albidum* were also the most successful. When apothecia were present on lichen thalli at the Lehigh Gap, they were often sterile, or deformed. Perhaps the residual heavy metals in the soil interfere with the production and development of apotheica (and functional ascospores). In England, Hawksworth and McManus (1989) found that when sulfur dioxide concentrations rapidly fell, pollution sensitive species often had more or more easily dispersed propagules than pollution-tolerant species, and were able to reestablish themselves on formerly polluted sites more quickly. This trend might not be exhibited at Palmerton because the presence of heavy metals was deterring sensitive species.

With regard to vascular plants, Amiro and Courin (1981) noted that species near the edge of their ranges are particularly susceptible to damage from stressful conditions. This is obviously true of lichens as well. Most of the species recorded in this study were widespread across the eastern United States, or North America. If, in future studies, lichens found here are on the edges of their range, their presence might indicate that the conditions at the Lehigh Gap are such that lichens are less subject to moisture or nutrient stress, or stress induced by the presence of heavy metals.

Discussion

It has been speculated that severely damaged sites, with no vegetation, and no soil, have undergone such significant changes in soil chemistry and microhabitat that recovery of the site is simply precluded (Amiro and Courtin, 1981). This study suggests that this is not the case, though recovery is certainly quicker and more thorough when some vegetation or some soil remains.

Why is the recovery of corticolous lichens less robust than the recovery of saxicolous lichens? In the study area, many plots simply had few trees for lichens to grow on. In addition, some tree species consistently lacked corticolous lichens in the study area. *Sassafras albidum* and *Tsuga canadensis* both fell into this category. On the other hand, oaks (*Quercus* sp.) encountered during the course of this study had very high levels of lichen coverage. Brodo (1968) points out that many lichens show significant associations with particular tree species. It is likely that several factors are contributing to the poverty of the corticolous lichen community: scarcity of suitable tree species, excessive dryness of the bark due to the openness of the canopy, continuing poor air quality and slow arrival of lichen spores and propagules from other areas.

Grasses have been chosen as a main revegetation tool for the site (Sopper, 1989). Grasses are naturally early colonizers of smelter damaged sites (Freedman and Hutchinson, 1979) but it has been recognized by Watt (1947) that many lichens thrive in areas were grasses are in a decay phase. It is therefore desirable for the grasses to be present in uneven-aged patches, so lichens will have continuously available refugia. It has also been found that lichens benefit from having lower levels of soil nutrients (Willis, 1963). These observations suggest that lichens will do best in areas where fertilizers or lime are used sparingly.

Notably, some species found at this site appear to thrive in polluted conditions. In the Lehigh Gap, *Vezdaea leprosa* is abundant because of elevated levels of zinc. *Vezdaea leprosa* has been recognized as a species often associated with elevated levels of zinc (Buck et al., 1999). *Psiolechia lucida*, found on the undersides of boulders on the mountains at Palmerton, also occurs on church walls in England that have been enriched in heavy metals by leaching of copper from grills protecting stained glass windows (Purvis, 1987). Lastly, Hickmott (1980) mentioned *Scolisospum umbrinum* as one of few lichens that can grow on lead lettering on gravestones.

Suggestions for Further Research

It will be very interesting to see, in the coming decades, whether the lichen community stalls in the early successional stage because its progression is retarded by the presence of heavy metals, or whether it proceeds through the normal stages of succession. If the latter were the case, corticolous lichen cover and diversity would increase. In addition, vascular plants would begin to shade more of the mountainside, and there would be decreases in cover of the lichens growing on exposed rocks, (*Micarea erratica* and *Trapelia* spp.*)* and on exposed soil, (*Cladonia* spp.*)*. High levels of heavy metals remained in the soil, leaf litter, amphibians, and mammals at the Palmerton site six years after the smelters had shut down (Storm et al., 1994) and high concentrations of metal contaminants are likely to remain in the soil for many centuries (Strojan, 1978a). In

assessing the impacts of the residual contaminants on the ecosystem, it might be useful to determine whether contaminant levels in the flora and fauna of the Lehigh Gap have changed since these studies were undertaken. It will also be valuable to investigate the lichen community on an east-west transect across the north face of the mountain; previous studies have found that diversity of arthropods (Strojan, 1978a), vertebrates (Beyer, 1985) and survival of woodlice (*Porcellio scaber* Latreille) in the soil (Beyer et al., 1984) all increase with increasing distance from the smelters. Other smelter-affected sites have been studied by aerial photographs and chemical tests of the soil to more thoroughly study the gradient of impact, from the area just downwind of the smelter to the intact forest several miles away (Gordon and Gorham, 1963). If such studies were performed at the Lehigh Gap and repeated, the extent and rates of recovery could be more thoroughly quantified.

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CHECKLIST OF THE LICHENS IN THE LEHIGH GAP

The list is arranged alphabetically by genus and species with unidentified sterile crusts at the end of the list. The collection numbers are those of the first author (JCL) and voucher specimens of all collections are deposited in the herbarium of the first author, which is presently housed at the Academy of Natural Sciences of Philadelphia (PH).

Acarospora fuscata (Ach.) Arnold – *6785.*
Candelaria concolor (Dicks.) Stein – *6780.*
Candelariella cf. *efflorescens* R.C. Harris and Buck – *6776* (sterile).
Cladonia macilenta Hoffm. var. *macilenta – 6760.*
Cladonia ochrochlora. Flörke – *6775.*
Cladonia polycarpoides G. Merr. – *6759.*
Dibaeis baeomyces (L.) Rambold and Hertel – *6777.*
Flavoparmelia caperata (L.) Hale – *6786.*
Flavopunctelia soredica (Nyl.) Hale – *6787.*

Hypocenomyce scalaris (Ach.) M. Choisy – *6788*.
Lecanora sp. – *6766, 6772*.

The above collections are superficially similar to *Lecanora conizaeoides*, a pollution-tolerant lichen known from Europe and scattered reports in North America. Our material does not represent this taxon and requires further study.

Lecanora oreinoides (Körb.) Hertel and Rambold – *6790*.
Lecanora polytropa (Hoffm.) Rabenh. – *6765*.
Lepraria caesiella R.C. Harris – *6764* (corticolous), *6761* (saxicolous).

6761 contains fatty acids and was found on rock in moist, cool overhang, a habitat more typical of other species of *Lepraria* and of *Psilolechia lucida*.

Micarea erratica (Körb.) Hertel et al. – *5920*.
Parmelia sulcata Taylor – *6767*.
Parmotrema hypotropum (Nyl.) Hale – *6755*.
Phaeocalicium polyporaeum (Nyl.) Tibell – *6791*.
Physcia adscendens (Th. Fr.) H. Olivier – *6778*.
Physcia millegrana Degel. – 6768.
Physcia stellaris (L.) Nyl. – 6779.
Porpidia albocaerulescens (Wulfen) Hertel and Knoph – 6789.
Porpidia crustulata (Ach.) Hertel and Knoph – 6774.
Porpidia soredizodes (Lamy ex Nyl.) J.R. Laundon - *6758*.
Porpidia subsimplex (J. Lowe) Fryday – 6783.
Psilolechia lucida (Ach.) M. Choisy – 6784.
Punctelia subrudecta auct. Amer. – 6771.
Rhizocarpon rubescens Th. Fr. – *6763*.
Sarcogyne similis H. Magn. – *6770*.
Scoliciosporum chlorococcum (Graewe ex Stenh.) Vězda – *6773*.
Scoliciosporum umbrinum (Ach.) Arnold – *5921*.
Stereocaulon saxatile H. Magn. – *6757*.
Trapelia involuta (Taylor) Hertel et al. – *6782*.
Trapelia placodioides Coppins and P. James – *6781*.
Trapeliopsis granulosa (Hoffm.) Lumbsch – *6769*.
Vezdaea leprosa (P. James) Vězda – *5918*.
Sterile sorediate crust 1 (atranorin, fatty acid, psoromic acid) – *6762*.

The above collections represents a taxon commonly seen at higher elevations in the Lehigh Gap, most often co-occurring with *Trapelia placodioides*. The blue-gray rimose-areolate thallus with soralia arising from the areoles is rather distinctive.

Sterile sorediate crust 3 (no lichen substances) – *6756*.

The above collection is corticolous and superficially similar to *Ropalospora viridis*.