Rapid Inventory and Assessment of Landscape, Ecological and Biodiversity Resources Relative to Management Options

Erie Bluffs State Park

Erie County, Pennsylvania
Final Report
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Western Pennsylvania Conservancy
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Pittsburgh, PA 15222

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EXECUTIVE SUMMARY

Erie Bluffs State Park is one of the last undeveloped tracts of land along the Lake Erie coastline in Pennsylvania. The combination of natural communities and species found within the park represents a significant contribution to the biodiversity of Pennsylvania. Since the mid 1980s, the site, formerly known as the Pennelec Barrens or Coho Site, has been the focus of biological studies for many other researchers, such as Jim Bissell, Toby Cunningham, and Mike Campbell. Their findings contributed information that was used in identifying the site as a Biodiversity Area (Lake Plain Shoreline BDA) of exceptional significance in the Erie County Natural Heritage Inventory, and led to its eventual protection by the Western Pennsylvania Conservancy (WPC) and the Pennsylvania Department of Conservation and Natural Resources (DCNR) Bureau of State Parks.

In this report, WPC assembled data collected through a collaborative effort between local experts and professionals in ecology, botany, zoology, and geology in order to document the composition of plant and animal species, natural communities, and ecological site factors in what is now Erie Bluffs State Park, Girard Township Park, and the PA Fish and Boat Commission's (PAFB) Elk Creek Access. In this report, we present the findings of our collaborative rapid assessment of biological composition and analysis of ecological factors that contribute to the site's overall biodiversity value and sensitivity that will be used for conservation planning purposes.

The landscape along the coast of Lake Erie, including that of Erie Bluffs State Park, can be described as a patchwork of agriculture and forested areas. Landforms and soils of Erie Bluffs State Park are the result of Pleistocene glacial activity and fluctuating lake levels. Distinct landforms identified in this study were the fossil dune and beach ridges of glacial Lake Warren, Lake Warren's lake plain, the slump ravines, the Duck Run and Elk Creek floodplains and slopes, and the bluff face itself. The landforms and soils moderate the flow of water, and contribute to the diversity of plant communities, at Erie Bluffs State Park.

Erie Bluffs supports a number of rare plant communities including some of the last remaining black oak savanna and sand barren communities in Pennsylvania. Nearly 150 acres of the Erie Bluffs property, which historically supported black oak savannah and sand barrens communities, is actively farmed. To the north, where soils are decidedly less well drained, a number of uncommon forest communities are found, including the red maple – black ash palustrine forest, the Great Lakes Region lake plain palustrine forest, and "slump" ravines created as water eroded the sandy soils. The forests of the lake plain, floodplains, ravines and escarpment tops support several trees over one hundred feet tall and over 12 feet in circumference. The most significant area for older growth trees is on the escarpment tops of the bluffs, with trees approaching 200 years in age.

The vascular flora of Erie Bluffs is diverse due to the high diversity of landforms, soils, and site history. The bluffs, associated seepage slumps, steep tributary gorges, and the dune/beach ridge provide habitat for plant species rare or absent in other parts of Pennsylvania. During the 2004 Bioblitz at Erie Bluffs, and through other inventory efforts, botanists documented over 400 vascular plant species, of which 18 are considered rare in Pennsylvania (S1-S3), and can only be

found along the Lake Erie Coast. There are also nearly 100 species of non-native plants, primarily occurring in agricultural or developed areas of the park.

The diverse habitat types of Erie Bluffs provide foraging grounds for Bald Eagles and Northern Harriers, and breeding sites for Red-headed Woodpeckers and several forest interior bird species. The bluff face supports what could possibly be the largest colony of Bank Swallows in PA. Mammal surveys and results from the 2004 Bioblitz documented several bat species, such as the eastern red bat, the big brown and little brown bats, and the eastern pipistrelle. Results of invertebrate and plant surveys of the ephemeral pools indicated seepage wetlands that are fed by groundwater and remain saturated throughout the year. These wetlands provide breeding habitat for a number of amphibian species and the invertebrate composition. They also underscore the hydrologic connection between the lake plain and the upland areas within the watershed. The wet forest sites are also habitat for a number of insect species with forest-restricted habits. The interior forests, which are uncommon in this part of the state, may support several disjunct insect taxa more commonly found in areas with greater forest cover.

Sensitivity of the site is presented here based on the biological composition and function of ecological factors such as soils, slope, and hydrology. Because of the number of rare plants, plant communities, and the hydrologic connectivity within the area, much of the property is considered sensitive to development because the site quality of one area is directly linked to the quality of another.

Fragmentation, agriculture, and abuse from ATVs have compromised the quality of the native habitats at Erie Bluffs State Park. Several high quality plant community patches are isolated from the larger forested area by agricultural fields and power lines, reducing their quality and value to wildlife species. Invasive species pose additional threats to plant and animal species and habitat quality. Restoration of key sites will be important to protecting and enhancing the site quality. Restoration priorities identified by WPC range in scope from activities that enhance the quality of native habitat areas degraded by ATVs, that reforest successional and old clearcut patches, and that re-establish sand barren and oak savannah community types in areas that are currently farmed.

The overall objectives in ecological management of Erie Bluffs State Park should focus on maintaining and enhancing populations of rare species and elements, maintaining and enhancing ecological viability by increasing patch size and site connectivity through restoration, maintaining the relationship between site hydrology and ecosystem (habitat) character and function, and controlling non-native invasive species. In this report we present several site-specific management options to address the management objectives listed above.

INTRODUCTION

BACKGROUND

On June 4, 2004, Governor Edward G. Rendell named the largest tract of undeveloped land remaining on the Commonwealth's Lake Erie shoreline as Erie Bluffs State Park; Pennsylvania's 117th state park. The 540-acre Erie Bluffs State Park presents an important opportunity to incorporate integrated species monitoring efforts and sustainable conservation planning in an integrated management plan within the Department of Conservation and Natural Resources.

In the 1980s and 1990s Jim Bissell, botanist at the Cleveland Museum of Natural History, conducted plant inventories to describe the botanical significance of the property. In those reports, he indicated that the Museum found at least 11 species of special concern plants. WPC's Natural Heritage Program provided assistance in that work and also identified the location as an important biodiversity site within the Pennsylvania Natural Diversity Inventory system. WPC staff classified this site as one of Erie County's most important Biological Diversity Areas in private ownership and listed the tract as having exceptional ecological significance (Kline et al. 1993). Because of the high biodiversity value of the site, development and recreation activities must be of a sensitive nature.

This report presents the results of a rapid, but comprehensive resource inventory conducted by WPC that includes a preliminary description and maps of sensitive areas on the Erie Bluffs property that can assist with site planning and environmental protection activities at the Park. The report is structured around several maps describing plant communities, occurrences of rare plant and animal species, and areas deemed sensitive by WPC ecologists, experts in biology, geology, and forestry, and local residents of the area that are knowledgeable of the forest and land-use history of the Erie Bluffs site.

APPROACH

This study used the combined data collected by Jim Bissell of the Cleveland Museum of Natural History, Pennsylvania Natural Heritage Program (PNHP) staff, results of the 2004 Erie Bluffs Bioblitz, field work to inventory and assess the natural features and biological resources of the Erie Bluffs, and interviews with experts familiar with the Erie Bluffs site or similar sites on the Lake Erie coast. The research was summarized and synthesized to produce the resource inventory, sensitive areas maps, and discussion of restoration and management options for the site.

SITE DESCRIPTION AND LANDSCAPE POSITION

The elevation of Erie Bluffs State Park ranges from 730 feet on the dune and beach ridge features to 570 feet at the mouth of Elk Creek and along the shore of Lake Erie. The landscape along the coast of Lake Erie, including that of Erie Bluffs State Park, can be described as a patchwork of agriculture and forested areas. Based on the 1992 landcover/landuse data set (NLCD) for Pennsylvania (www.pasda.psu.org), nearly 70 percent (68.8 percent) of the 540-acre State Park is forested. The remainder is primarily composed of agricultural land. Analysis of the1992 NLCD found that 43.5 percent of the landscape within 2,000 meters of the Lake Erie coast is composed of forest (Table 1). Non-forested areas, including agriculture, residential, and other developments, constitute the majority of the landcover within 2,000 meters of the lake.

Table 1: Percent cover of the forested and non-forested areas along the Lake Erie border of Pennsylvania

Distance from Lake Erie (m)	% Forest	% Non-Forest
500	47.7%	52.3%
1,000	46.3%	53.7%
1,500	44.5%	55.5%
2,000	**43.5%**	56.5%

While nearly half of the landscape within 2,000 meters of the Lake Erie coast is forested, the forests are fragmented by residential or agricultural lands or other features that represent significant impediments to wildlife movement (e.g. highways and railroads). Therefore, the un-fragmented forest landscape of Erie Bluffs represents a significant biodiversity area, as it contains one of the largest contiguous forested areas along the Lake Erie shoreline of Pennsylvania.

Figure 1 below shows forested area (in green) in Erie County, PA and includes the location of Erie Bluffs State Park and other properties managed by state and local governments.

Figure 1. Location of Erie Bluffs State Park in relation to other properties managed by state and local governments and other areas of contiguous forest land in Erie County, PA (Sources: WPC, www.pasda.psu.edu).

LANDFORM, PHYSIOGRAPHY, AND SOILS

The current landscape of the Erie Bluffs State Park and surrounding area is the result of Pleistocene glacial activity including fluctuating lake levels associated with advances and retreats of the glacier and changing drainage outlets. In all, there were at least eight advances and retreats of glacial ice into northwest Pennsylvania within the pre-Illinoian, Illinoian, and Wisconsin Stages of the Pleistocene (Thomas et. al.1987). These glacial advances shaped the Lake Erie basin and greatly altered the topography and drainage of the region.

The lacustrine deposits that characterize the Erie Bluffs State Park were formed by depositional processes associated with the last and most extensive of the historic great glacial lakes to occupy the Erie Basin: Lake Whittlesey, which reached its highest level of 740feet, and Lake Warren (685 feet). Features of the most recent phase of Lake Warren (Warren III, 670 ft) are what are most obvious on the Erie Bluffs Landscape today (Schooler 1974). Landform features of Lake Warren I and II are more evident south of Rte. 5 (beyond the southern extent of Lake Warren III) (Foyle 2004, pers.com). The major landform features of the Erie Bluffs property are presented in Figure 2. Simplified sketches of the profile of the major glacial and lacustrine landforms and water movement through the landforms are presented in Figures 3 and 4. The glacial landforms of Erie Bluffs State Park are significant in that the flow of water at the site is moderated by the structure of the soils that compose the different landforms.

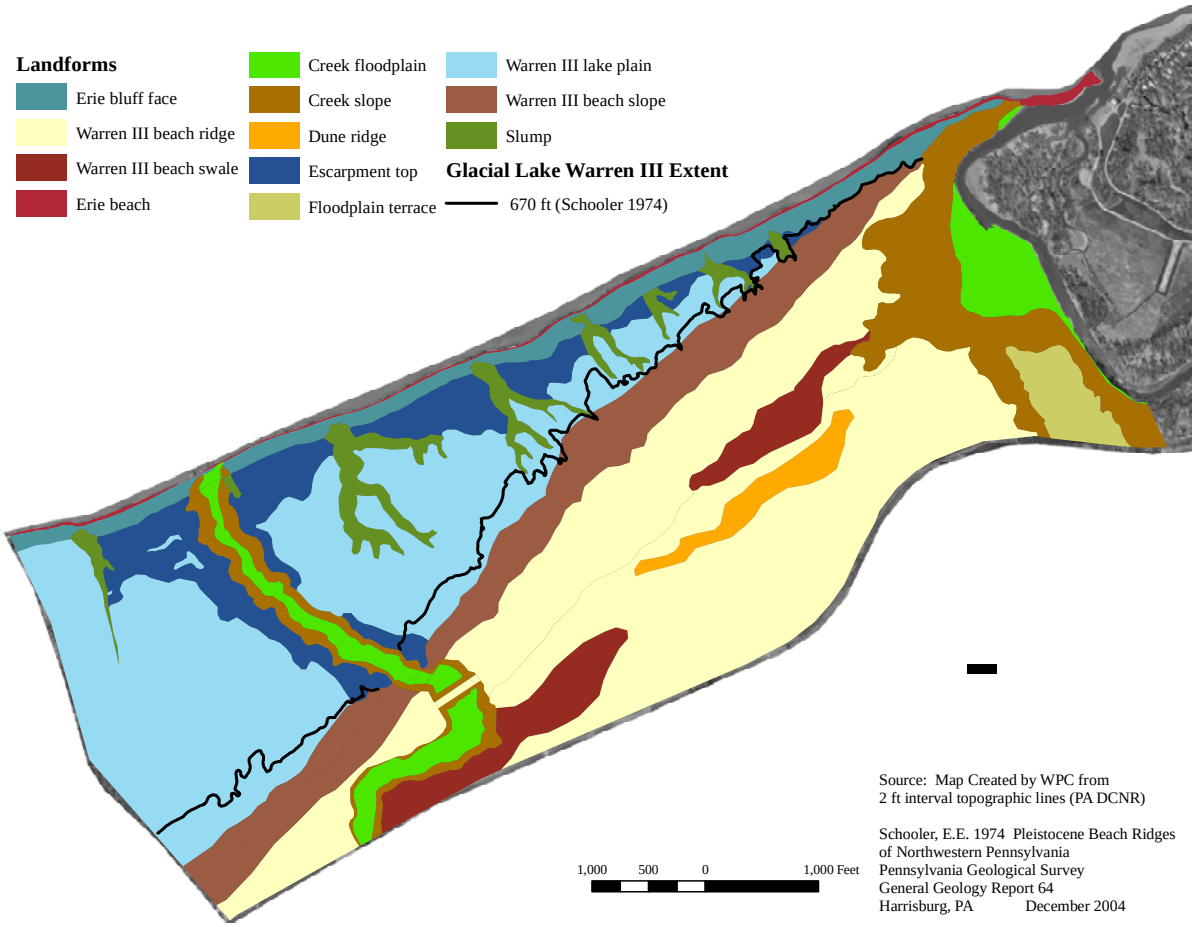


Figure 2. Glacial, lacustrine, and riverine landforms of Erie Bluffs State Parks and surrounding area.

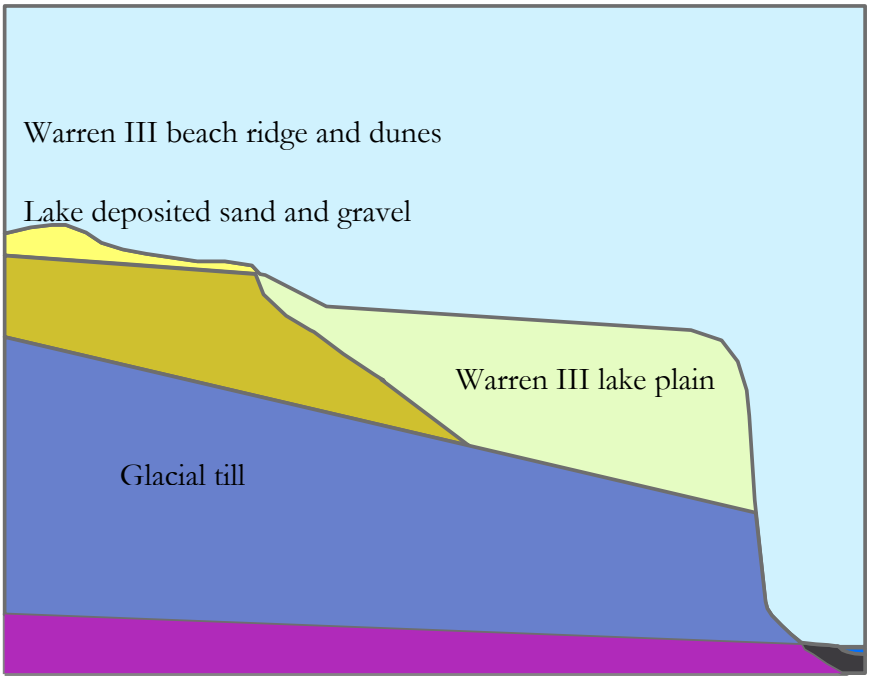


Figure 3. Simplified representation of the landscape profile of glacial landforms at Erie Bluffs State Park, Erie County, PA.

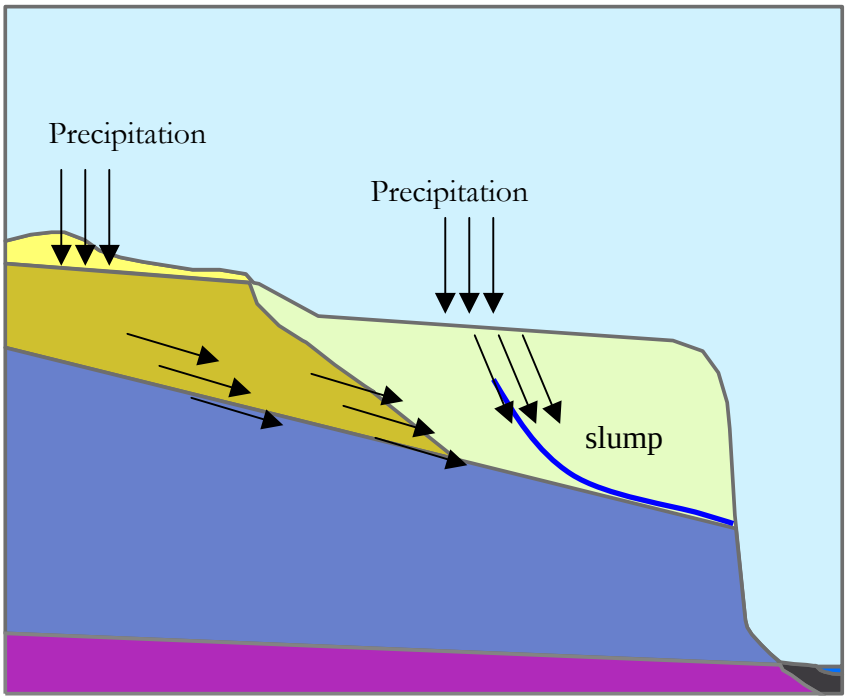


Figure 4. Simplified depiction of the flow of water flow through the soils of glacial landforms at Erie Bluffs State Park, Erie County, PA.

LANDFORM DESCRIPTION

Warren III Lake Plain and Escarpment Tops:
This broad flat landform represents the near-shore floor of the glacial Lake Warren III. Soils that are often saturated on this landform are of the Ottawa and Berrien soils series. These soils contain a significant amount of clay material and consist of water laid lacustrine sediments that were re-worked by lake waters. Soils here may be heavier, include a substantially greater percent of clay, and result in a greater amount of standing water on the soil surface than on the Warren II and Warren III Beach Ridges (see Soils discussion below). Schooler (1974) placed the extent of Lake Warren III at elevations below 670 feet in eastern Erie County, and cursory analysis of topographic maps and aerial photography of the Erie Bluffs site is consistent with the author's 1974 study.

The escarpment tops are composed of Berrien and Ottawa loamy sand, which is similar to other areas on the Warren III lake plain landform (Taylor 1960). However, the soils are decidedly drier and the vegetation indicates that there is a greater amount of calcium in the soil than on the rest of the lake plain landform.

Warren III Beach Slope:
This moderately sloping narrow landform represents the wave cut beach slope of Lake Warren III. Wave action eroded lacustrine sediments deposited by glacial lake waters when lake levels were higher (Delano 2004, pers.com). Soils are primarily of the Ottawa soil series.

Warren III Beach Ridges:
The Warren Beach Ridges, the youngest preserved beach ridges in Erie County, are apparent on topographic maps at elevations greater than 670 feet (the height of the Warren III Lake). Above 670 feet, wave action from lakes Warren I and Warren II resulted in deposition of sand and gravel (Thomas et.al. 1987; Schooler 1974). The soils are a mosaic of dune sands (that may have been wind deposited) and types of the Ottawa and Conotton soil series. The beach ridges were created as wave action and west to east water flow deposited sand in a process that has resulted in the characteristic ridge and swale topography. These depositional processes are similar to those seen today on Presque Isle (Foyle 2004, pers.com).

Dune:
The ancient dune feature may have been created by wind deposition of fine dune sand along the Warren III beach ridges. Soils are primarily described as Dune Sand, a miscellaneous category for the sandy deposits on the Beach Ridges deposited through wind or wave action. A portion of the dune landform is also composed of Ottawa loamy fine sand.

Slump Ravines:
There are several slump/seeps between Elk Creek and Duck Run that increase in size from east to west. Headward erosional processes create these features as water seeps out of the bluff face, resulting in steep, wet ravines. The dendridic pattern of these features appears to be limited to the Warren III lake plain landform. The ravines do not exist through the well-drained beach ridge/dune landforms where water percolates more rapidly downward through the soil. The predominant soil series in the ravines is Wauseon sandy loam, described as somewhat poorly

drained to poorly drained. The western slope of Elk Creek also contains several seeps and the forest type is similar to that of the slumps.

The water in the small streams and seeps in the ravines may originate far south of the ravine landforms (the up-slope area). Figure 3 is a representation of the pathway precipitation takes after it hits lacustrine sands. The water percolates out though the many seeps along the ravine slope, eventually exiting out through the bluff face. Therefore, changes in the hydrology of the upslope area, following changes in impervious surface area, water amount, and vegetation, may greatly affect the amount of water flowing through each ravine. This water flow can result in considerable changes to slope stability, erosion, and bluff recession as this water eventually makes its way to Lake Erie.

Creek Slopes, Terraces, and Floodplains of Duck Run and Elk Creek:
Duck Run and Elk Creek have formed large gorges as flowing water has cut down through the lacustrine sand to bedrock. Soils of the creek slopes are classified as escarpment soils and are loose, sandy, and saturated much of the year.

The soils of the Duck Run floodplains and terraces are classified as Wayland silt loam. While the soil type of Duck Run remains the same throughout much of the floodplain, the meander pattern of the stream is very interesting and suggests smaller scale differences in soil type and surficial geology from south to north than what is shown on the Erie County Soil Survey (Taylor 1960). At the south end of the ravine, just north of the railroad tracks, Duck Run forms three complete meanders before becoming more channelized as the stream approaches the mouth (Campbell 2004, pers.com). Due to the small scale, these meanders are not evident on most topographic and soils maps. Possible changes in substrate, velocity, or other factors contribute to the sudden change in meander pattern (Campbell 2004, pers.com, Foyle 2004, pers.com).

Erie Bluff Face:
The wave action of Lake Erie and mass wasting (extrusion) has created the cliffs along the Erie Bluffs shoreline, exposing roughly 90 vertical feet of sediment. Mass wasting processes that occur in the upper sandy portion of the bluff are: (1) sapping of sand (slow erosion caused by water flow) along the spring line, producing sand flow and sand fall (at the contact between sand and till layer or where there may be finer grained material); (2) large scale spring sapping (extrusion) of fine sand that overlays much lower permeable till during spring thaw and after high rainfall; (3) large scale slumping due to removal of underlying material or sand removal; and (4) sand or debris flow as a result of spring sapping, extrusion, snow melt, and rainfall. Other erosional processes include raindrop impact, wind and weakening of sand by bank swallows (Thomas, et. al. 1987). The effect of the bank swallows is unknown at Erie Bluffs. However, Tim Hoppe, Wildlife Diversity Biologist of Northwest Region, traversed the entire shoreline of the park and counted over 3,000 nest holes in three different colonies on the upper bluff face near Duck Run (Doug Gross in Bioblitz at Erie Bluffs State Park).

Mass wasting was responsible for recession of the bluff at a rate of 1.7 feet per year between 1938 and 1975 at a location nearby Erie Bluffs State Park (Thomas, et. al. 1987). This translates to a total 112.2 feet from 1938 to 2004. Pennsylvania Department of Environmental Protection's Coastal Zone Management Program documented bluff recession at five control points along the escarpment top at Erie Bluffs State Park from 1982 to 2003. During this time period, the bluff

face lost between 16 and 64 feet, at a rate of 0.75 feet per year to 3.82 feet per year (Hess 2004, pers.com).

Invasion of non-native plant species such as colt's foot (*Tussilago farfara*), common reed (*Phragmites australis*), and European alder (*Alnus glutinosa*) may have stabilized the bluff slopes. Additionally, alder's ability to fix nitrogen may further facilitate colonization of the slopes by stabilizing plants (Campbell 2004, pers.com). Alternatively, the weight from the additional plant biomass may contribute to slumping events, which could have significant consequences. The bluffs may become more stabilized in the short-term and result in a fewer small erosional events. However, the greater accumulation of plant material may result in larger, more catastrophic slumping events as large portions of the bluff face slump in response to the added weight.

Lake Erie Beach:
At the current lake level, the shoreline of Lake Erie consists of a narrow, rocky, sparsely vegetated beach consisting of rounded cobbles, pebbles, and sand. The beach is nourished by locally eroded bluff material. Bruce and Thomas speculate that the construction of jetties and breakwaters at Conneaut, Ohio to the west greatly limits the transportation of coarse sediment from the littoral zone and bluffs in Ohio to the Pennsylvania portion of the Lake Erie shoreline (Thomas et. al. 1987).

SOILS

General descriptions of the soils series of Erie Bluffs State Park, as defined by Taylor (1960), are presented below and depicted in Figure 5. While there may be a high degree of inaccuracy in the exact boundaries of soil types delineated in USDA Soil Conservation Service soil maps for the Erie Bluffs Site, the soils do generally line up with topographic lines.

Soils on Erie Bluffs property are primarily sand and gravel and predominantly of lacustrine origin, having been deposited by glacial lakes or wave and wind action. A layer of glacial till underlies the sand and gravel lacustrine deposits (Foyle 2004, pers.com). The nearest exposed till is the Girard Till layer at 1000 feet in elevation many miles south of the park property. Several soil series, presented below, occur on the property (Figure 5). An understanding of these soils is important in understanding the local vegetation and plant communities of the site.

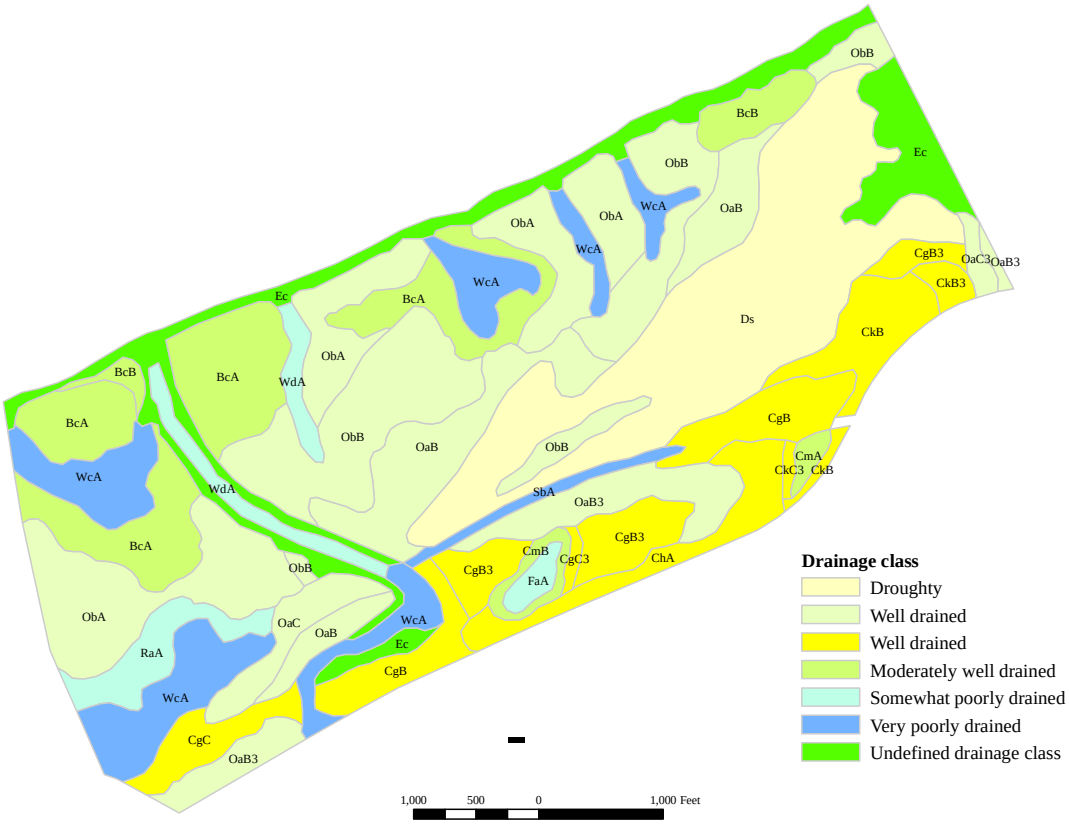


Figure 5. Soils of Erie Bluffs State Park (Taylor 1960). Map digitized from Taylor (1960) by Jeff Johns, DCNR. Map created by WPC.

Soils occurring on the Warren III beach ridge landform are well-drained except for the somewhat poorly drained Freedon soils found in depressions in the gravelly beach ridge. Somewhat poorly drained to very poorly drained soils (Rimer, Sloan, Wauseon, Wayland) occur in parts of the floodplains of streams where the water table is near the surface, or in wet depressions and in slump ravines where the soils are saturated by underground seeps. The Lake Plain landform is composed of soils ranging from well drained (Ottawa) to moderately well drained (Berrien). However, during field inventory, the lake plain soils were found to be moist, if not saturated, well into August, as compared to the well-drained types of the beach ridge. The layer of gray, calcareous material that occurs at depths of four feet or more may be less permeable to water and may result in wetter soils at the surface. This material, locally called "quicksand," is present at a much greater depth in the well-drained Conotton soils and may not be present at all in the Conotton variants and Dune sands of the beach ridge landform. In addition, the Berrien soils often contain a hardpan layer, which may also influence the amount of standing water at the soil surface.

Berrien fine sandy loam BcA, BcB
The Berrien series is made up of deep, moderately well-drained soils that are sandy and acidic. The soils are on the lake plain. Some of them are important for growing vegetables and fruits. The parent material was acidic, lacustrine sand that was sorted and deposited by water. The soils are low in clay; consequently, plant nutrients leach downward readily. A firm layer, or pan, that is slowly permeable to air and water is located 20 to 30 inches below the surface. At depths of 40 to 72 inches, there is a gray, calcareous material that is also slowly permeable to air and water. When saturated with water, this material is locally referred to as quicksand. This type occurs primarily in the vicinity of the erosional slumps, suggesting that the area occupied by this type on the Erie Bluffs property is much greater than described by 1970 Soil Survey.

Conotton gravelly loam ChA, Conotton gravelly loam sandy loam CkB, CkB3, Conotton coarse sandy loam CgB, CgB3, CgC, CgC3
The Conotton series consists of deep, well-drained soils on terraces of the beach ridges. The soils have formed from stratified, acidic, coarse sand and fine gravel containing a few thin layers of silt and clay. In most places the stratified material is underlain by calcareous quicksand at depths of 4 to 20 feet. Depth to the seasonally high water table ranges from 18 to 72 inches.

Conotton moderately well-drained variants: Conotton gravelly sandy loam 0 to 8 percent slope CmA, CmB
The Conotton variants differ from the other Conotton soils in being only moderately well-drained instead of well-drained. They occur in troughs or swales that lie between or at the bases of beach ridges. The parent material of the Conotton variants was made up of alternate layers of sand and gravel mixed with some silt and clay. This material was derived from acid shale bedrock and also from sandstone and granite of glacial origin. It was sorted and deposited by wave action. The soils have a firm, compact layer that is moderately permeable to air and water.

Dune sand, Ds
This miscellaneous land type consists of deep, loose, droughty, windblown sands and occurs west of the city of Erie. The sands were sorted from the lacustrine materials by wind and were blown into the shape of dunes. The dunes lack the characteristic crescent or oblong shape of

active dunes because they have been partially stabilized by a stunted stand of broom sedge, little bluestem, switchgrass, and cinquefoil.

Escarpments, Ec
This miscellaneous land type occurs on steep slopes that have formed as a result of stream cutting or lakeshore erosion. The areas are on the lake plain and on terraces. In general, the slopes range from 30 to 60 percent, and are between 50 and 200 feet long. The degree of erosion varies. The tops of the escarpment have a cover of soil, but at the bases of eroded slopes there are rocks and till. In some places the soil material is underlain by quicksand.

Fredon loam, 0 to 3 percent slopes, FaA
The Fredon series consists of deep, somewhat poorly drained to poorly drained soils. The soils are on flats and in depressions of the gravelly beach ridge of the lake plain and are also on gravelly outwash terraces along stream valleys in the upland. The parent material consisted of alternate layers of sand, silt, and gravel mixed with some clay. It was derived from acid shale bedrock and sediments of sandstone and granite of glacial origin. This material was sorted and deposited by water. These soils are porous and are moderately permeable to a depth of about 20 inches. Below this depth is a slowly permeable layer that restricts the movement of air and moisture and limits the penetration of roots.

Ottawa loamy fine sand, 2 to 8 percent slopes, ObB, and Ottawa loamy fine sand, 2 to 8 percent slopes, severely eroded, ObB3
The Ottawa soils are deep and well-drained. They are acidic and sandy, but are among the best soils of the lake plain for growing fruits and early maturing vegetables. Nevertheless, unless the supply of organic matter is maintained, plant nutrients leach rapidly out of the sandy soils. The parent material of these soils consisted of acidic, lacustrine sands that were sorted and deposited by water. Water infiltrates into the soil rapidly, and internal drainage is excessive. Gray, calcareous material occurs at depths of four feet or more. This material, locally called quicksand, is slowly permeable to air and water. It flows when saturated with water.

Rimer fine sandy loam, 0 to 2 percent slopes, RaA
The Rimer series is made up of deep, somewhat poorly drained to poorly drained, sandy soils. The soils are acidic, but they are among the most important soils of the lake plan for vineyards and for growing late maturing vegetables. The parent material consisted of acidic, lacustrine sands that were sorted by water and deposited as lake sediments. A firm layer (fragipan) is semi-permeable and water begins at depths of 12 to 20 inches. Gray, calcareous material, locally called quicksand, occurs at depths of 38 to 60 inches. This material is slowly permeable to air and water; it will flow if it is saturated with water.

Sloan silty clay loam, 0 to 3 percent slopes, SbA
The Sloan series consists of deep, very poorly drained soils of the bottomland. The soils occur on parts of the floodplains of streams where the water table is near the surface. In places they are permanently covered with water. The parent material consisted of silt and clay deposited in still, or slack, water. These sediments were washed down from the upland by streams and deposited on the floodplains. They were derived from acid shale bedrock and from sandstone, granite, and limestone of glacial origin.

Wauseon fine sandy loam, 0 to 2 percent, WcA
The Wauseon soils are deep, very poorly drained, acidic, and sandy. The parent material consisted of acidic, lacustrine sands that were sorted and deposited by water. A firm layer that is slowly permeable to air and water begins at depths of 6 to 10 inches. Gray, calcareous material, locally known as quicksand, occurs at depths of 24 to 48 inches. This material is slowly permeable to air and water; it will flow if it is saturated with water.

Wayland silt loam, 0 to 3 percent slope, WdA
The Wayland series consists of deep, somewhat poorly drained soils on the floodplains of streams. In spring, the soils are covered by water for long periods of time. The parent material was made up of sediments of silt and clay washed down from the uplands. They were derived from acid shale bedrock and from sandstone, granite, and limestone of glacial origin. A firm layer that is slowly permeable to air and water begins at depths of 12 to 18 inches.

LAND USE HISTORY

Non-forested areas on the Erie Bluffs property are predominantly agricultural and currently planted in corn and soybeans. Nearly 150 acres on the property are actively farmed under a lease administered and managed by DCNR Bureau of State Parks. The site was used for growing potatoes in the 1980s (Bissell 2004, pers.com). Currently, the cultivated area is limited to the Warren III beach ridge landform (under 670 feet in elevation) and does not extend north of the southern extent of the Warren III lake plain. North of the agricultural fields, the topography of the lake plain slopes toward the bluff and the soils are decidedly less well-drained. This area may have remained forested because of the poor drainage.

The dune ridge (also referred to as the ancient dune) landform contains some of the last remaining sand-barren and black oak woodland/savannah communities in northwest Pennsylvania (Bissell 2004, pers.com). Habitat information from mammal population studies in the 1970s (Cunningham 1989), and USGS topographic maps, suggests that these areas were once cultivated, or were pasture, and have succeeded to this early successional black locust forest type following abandonment. Cunningham (1989) describes this area as "fence-row" between agricultural fields. Since abandonment of agricultural activity at the higher points of the landform, much of the site has returned to native vegetation. For one of the savannah black oaks, an increment bore reading of just over 20 years old (Luthringer 2005, pers.com) is consistent with Cunningham's description and indicates these trees established following agricultural abandonment. Additionally, at least one-third of the area is currently composed of a black locust forest community type (see Plant Community Descriptions, pg. 27, for a more in-depth discussion), a type that occurs frequently after the cessation of farming activities. Other non-forested areas at Erie Bluffs are described as successional herbaceous openings and include recently abandoned agricultural sites, sites where periodic disturbance from ATVs has occurred, or areas that have been periodically mowed.

The forests on the Erie Bluffs are primarily composed of second growth stands and have experienced several different episodes of logging. The history of the swamp forests west of Duck Run and bordered by the Fuhrman property to the west is very well known. According to Tom Fuhrman, a long time landowner adjacent to what is now Erie Bluffs State Park, this site was clear-cut in the 1950s, following the decline of the blue pike fishery, as the landowner turned to the forests for income (Furman 2004, pers.com). There is an old cinder block building in the forest. A power line right-of-way is situated along the top of the escarpment, located just north of the end of the swamp forest that leads to Fuhrman's property, west of the forest stand. The power line also descends the creek slope to the mouth of Duck Run, where the former landowner operated a small recreational fishing boat concession. It is possible that eastern hemlock once dominated this site (over 50 to75 percent) prior to the first wave of logging (Bissell 2004, pers.com). However, currently hemlock never makes up more than 10 to15 percent of the current overstory.

The southern portion of Duck Run on the Erie Bluffs property, situated south of the railroad tracks as it flows west to east prior to its abrupt turn to the north, is also composed of second growth forest. A two-track road and stream crossing though this area once provided the only access to the small boating/fishing concession at the mouth of Duck Run. While Fuhrman had no information on the logging history of this area, the forest appears to have sustained several different episodes of selective logging based on the presence of numerous logging roads and the

number of stumps in various stages of decomposition. An upland area of even-aged younger tulip trees exists, just north of Rt. 5. The land use south of the park property is primarily agricultural. However, a large campground is situated south of Rt. 5 within the Duck Run watershed. The area was not surveyed for this study by WPC but was included as part of the Lake Plain Shoreline Exceptional Biodiversity Area (BDA) in the PNHP Erie County Natural Area Inventory (Kline 1993).

North of the railroad tracks, the Duck Run floodplain and associated slopes to the north of the railroad tracks contain some of the tallest trees (primarily tulip trees, red oaks, and hemlocks) on the property. The upper terraces, just north of the railroad tracks, contain significant archeological sites (Peddler 2004, pers.com.). This area contains some of the most extensive damage from ATV use on the Erie Bluffs property; large ruts and pools created by ATVs are prevalent.

Between Duck Run and Elk Creek, the forest communities occur primarily on the Warren III Lake plain, slump ravines, and escarpment tops. Several episodes of logging occurred within this area that greatly altered forest composition and structure, most significantly in the composition of sugar maple, white pine and eastern hemlock (Campbell 2004, pers.com). There are several small successional openings within the area that were clear-cut 10 to 15 years ago (Fuhrman 2004, pers.com). Since these areas were logged, early successional shrub and woody vine species have dominated. It is not clear at this time why these areas have remained shrub-dominated and not succeeded to forest as have other areas within the section. It is possible that the shrub and woody vine species have out competed tree species and prevented their establishment. This central forest region also contains patches of oak forests, occurring primarily on beach ridge soils (Dune Sand designation). These may represent later successional states of savannah type communities found on the dune landform. Several stumps and small stump-sprouts of American chestnut (*Castanea dentata*) suggest this species was more prevalent in the forest canopy. The chestnut blight, caused by the fungus *Cryphonectria parasitica,* was responsible for the absence of this species in the forest canopy of this area, as well as in forests throughout eastern North America.

At the eastern end of this area, along the bluff's escarpment top, the forest is primarily composed of black locust. From the early successional nature of the black locust stand and the USGS topographic maps depicting the area as un-forested, it is suspected that this area was at one time part of the agricultural fields to the south or was used as pasture land. Barbed wire, and trees that appear to be in rows, suggesting a fence-row, further suggests this area was once cropland or pastureland (Luthringer 2004, pers.com).

The steep slopes and slump ravines of the Elk Creek cove forest leading down to the Elk Creek floodplain (including the Girard Township Park and Fish and Boat Access area) contain the largest intact stand of "older-growth" trees on the Erie Bluffs site (Luthringer 2004, pers.com, see results and discussion Significant Forests Areas). The slopes of the Elk Creek cove are extremely steep and appear to be fairly unstable due to the many seeps. Some of the largest butternut trees on the property, and perhaps in the region, exist in this ravine (Luthringer 2004, pers.com). These individuals appear healthy and do not yet show the signs of butternut canker (Erdman 2004, pers.com).

Water from this cove forest flows through a developed recreation area and though a culvert beneath the Girard Township Park's parking lot before reaching Elk Creek. This area is substantially developed and includes a parking lot, rustic bathroom facilities, a picnic area, and garbage dumpsters. This site along the Elk Creek Floodplain is possibly the most developed; a significant anthropological footprint already exists. A paved road connects this area with Rt. 5, and there is another paved area at the top of the hill, adjacent to the highway, and overlooking Elk Creek. A concrete barrier blocks vehicle entry to this abandoned parking area.

INVENTORY AND ANALYSIS METHODS

PLANT COMMUNITY MAPPING

Plant community polygons representing areas of like vegetative cover were delineated in using aerial photographs provided by DCNR Bureau of State Parks ArcGIS 9.0. The dominant vegetative cover, condition, and landscape character of each delineated community polygon were described in the field. An attempt was made to type all plant communities to the classification descriptions of the Pennsylvania community classification (Fike 1999). Expert interviews and site visits helped to refine the plant community descriptions.

INVENTORY FOR SENSITIVE PLANT AND ANIMAL SPECIES

Known occurrences of rare plant and animal species and communities were determined by querying the PNHP database. Information obtained during the two Erie Bluffs Bioblitzes and by expert site visits also contributed to the species inventory. Field inventories for rare plant species were conducted, following Natural Heritage methodology. Species lists compiled from all Bioblitz participants are found in Appendix A. During field inventories, the presence of non-native plant species was recorded (Appendix B).

EPHEMERAL WETLAND SAMPLING

Wetland samples were collected April 11 and 12, 2005 in seven pools across various portions of the park. At each site, surface area was determined by measuring the longest length and 2 to 3 measurements of width. Sampling was conducted by taking one sample per 12.5 m^2. A D-frame net was used to sweep approximately 1 meter. To randomize sampling, a random numbers table was used to determine a compass bearing and where the sample would be taken. Depths were taken at each dipnet site. To sample for elusive taxa often missed during dipnet sampling, activity traps were deployed for a minimum of a 15-hour period. Environmental variables were measured at the beginning and end of the sampling period. Measured variables included temperature, dissolved oxygen, conductivity, pH, total dissolved solids, oxidation-reduction potential, and total hardness. All measurements, except for hardness, were taken using a YSI handheld meter (YSI, Yellow Springs, Ohio). Total hardness was measured using a LaMotte field kit. Measurements of canopy cover were taken using a spherical densiometer (Lemon 1957).

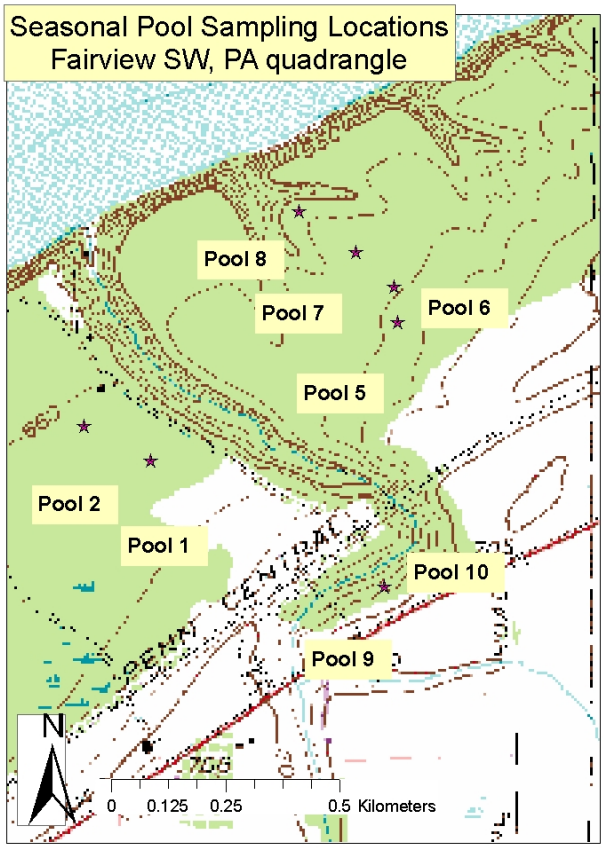


Figure 5. Locations of ephemeral wetland sample sites; Erie Bluffs State Park, Erie County, PA

PERMANENT MONITORING SITES

Staff from the Carnegie Museum of Natural History (CMNH) and WPC worked collaboratively to select six permanent monitoring sites for investigating invertebrate diversity within six community types at Erie Bluffs State Park. The sites were chosen to represent the range of different plant community types found at the park (Table 2, Figure 6).

Table 2. Permanent sampling sites identified by number and community type, Erie Bluffs State Park, Erie County, PA

Site Number	Site Name	Plant Community type
1	Bluff	Sugar maple basswood forest/ Great Lakes Region scarp woodland
2	Dune	Black oak woodland/savannah
3	Oak	Dry mixed oak forest
4	Wet Woods	Great Lakes Region palustrine lake plain forest
5	Hemlock	Hemlock northern hardwood forest
6	Duck Run	Hemlock northern hardwood forest

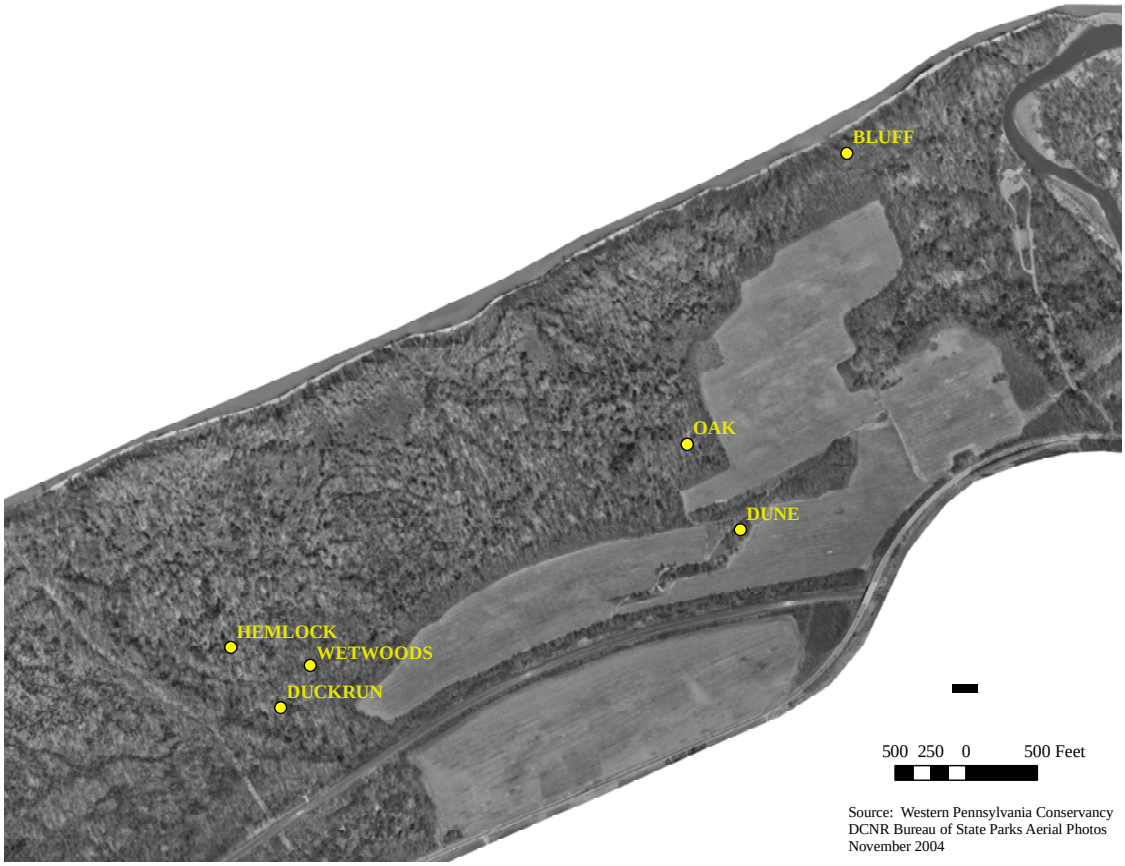


Figure 6. Locations of permanent monitoring plots at Erie Bluffs State Park

Plant community composition and structure was sampled at each of these sites in June 2005 in order to correlate insect diversity and habitat structure, as well as to provide baseline data for documenting plant community and ecosystem change over time. Methods and results are found in Appendix C.

The sampling methods used to assess the diversity of terrestrial insects were based on a model used for several other large insect surveys conducted between 1995 and 2003 by CMNH in Utah, West Virginia, and other regions of Pennsylvania. The data gathered by this survey are therefore qualitatively and quantitatively comparable to a wide range of other community types; the comparative aspects of which are not addressed in this report but may be discussed in future publications on insect communities.

At each of the six study sites, a fixed location was selected for an ultraviolet (UV) light trap. The UV light traps in this study used a standardized 15-watt, 18-inch 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 (12-inch diameter) covering the mouth of a 5-gallon 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 a tarp (approximately 2×3 m) was suspended above it to prevent precipitation from entering. These traps remained in place throughout the study period. Insects

were killed in the traps by suspending three porous sticks (1 × 1 × 6 in), made of reinforced plaster of Paris and saturated with killing agent, inside the bucket below the funnel.

A standard malaise trap was installed at the six sites. These traps were employed primarily to collect flying insects and to expand the taxonomic breadth of taxa sampled. A malaise trap is a tent-shaped structure made of fine mesh fabric (approximately 2 × 2 × 1.5 m wide), which is positioned in such a manner that one end is elevated and connected to a bottle of ethanol. Insects enter the tent and naturally move upward on the netting toward the peak, where their natural attempts to escape channel them into the opening of the collecting bottle. The insects then fall into the ethanol and are rapidly killed and preserved.

In addition to light and malaise traps, pitfall traps were placed at each of the six sites. Each pitfall trap consisted of two small plastic cups buried at each end of a two-foot long wooden baffle. When carefully positioned, walking insects encounter the baffle and move along it until they fall into the cups containing a preservative. Each pitfall cup contained an inner and outer cup that allowed the inner cup with preservative and specimens to be removed without disturbing the outer cup, which remained in the ground and retained its precise alignment with the baffle and flush with the surface of the ground.

A total of five trips were made by CMNH, WPC, or both (September 15, October 5, October 18, November 1, and November 3). Samples were taken in 2004 at the Bioblitz (July 17) and during the fall survey from September 15 to November 3, when traps were removed from the field. Sampling trips by WPC biologists were interspersed with trips made by CMNH staff. An attempt was made to avoid collecting close to the night of the full moon, which is known to decrease the effectiveness of light trapping for nocturnal insects. Traps were cleaned and maintained during regular sampling trips.

Sampling required two days per trip, with the first day spent setting out one light trap at each site and gathering malaise and pitfall samples. On the first day, an attempt was made to collect all insect specimens in the malaise traps and to empty all pitfall traps. The second day involved retrieving light trap samples and refurbishing equipment as necessary. Environmental data and other information about each trap site and trapping event were recorded on a standard field form. These data included collector, date, time, weather conditions prevailing over the trapping period, and notes on equipment problems.

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 a field laboratory located at Lake Pleasant Field Station. Great care was exercised in transporting samples to avoid vibration or jarring that would damage Lepidoptera scalation. Frozen samples were transported back to CMNH in Pittsburgh, Pennsylvania, for sorting. Malaise trap samples were field preserved and transported in 80 percent ethanol. Pitfall samples were extracted by passing trap contents through a fine mesh strainer, and then also stored in 80 percent ethanol. Samples were transported to CMNH for processing.

Samples collected through June 30, 2005 during invertebrate trapping activities were preserved and stabilized and will be sorted and identified following the field season.

HABITAT QUALITY AND SIGNIFICANT FOREST AREAS

Habitat quality, including issues of deer browsing and presence of invasive exotic plants, was qualitatively evaluated for the Erie Bluffs site during field visits and interviews with local experts. In addition to evaluating forest quality, Dale Luthringer, the Environmental Education Specialist for Cook Forest State Park, has worked closely with WPC and DCNR resource management officials to help delineate certain forested habitats in terms of big/tall tree reserves and maximum age of various timber stands. The big/tall tree data were compared to other studies currently being conducted by forest ecologists from the Eastern Native Tree Society (ENTS). Their collection efforts encompass the entire Eastern United States (http://www.uark.edu/misc/ents/).

SENSITIVE AREAS ANALYSIS / CONSERVATION CONCERNS

Maps depicting sensitive areas based on occurrences of rare plant species and significant plant community types were created using ArcGIS. The maps represent areas of conservation concern for populations of rare plant species and plant communities tracked in the PNHP database. These areas, referred to as "conservation planning polygons," include the area occupied by the population or populations of conservation concern, and the area of surrounding landscape that is required to maintain the viability of the population or community.

In addition to mapping significant occurrences of rare species and communities, the Erie Bluffs landscape was evaluated for conservation priority based on other physical ecosystem variables that contribute to overall landscape stability. These variables were: steep slopes (less than 25 percent); soil severity ratings for development activities listed in the Erie County Pennsylvania Soil Interpretations Manual (PA Department of Environmental Resources 1972), a companion to the Soil Survey for Erie County Pennsylvania (Taylor 1960); and plant community types found in ecosystems characterized by standing water or saturated soils (identified from field reconnaissance and GIS mapping). While no hydrological assessment was conducted for this project, hydrology was addressed through the conservation planning polygons because upland areas that surround groundwater recharge areas for slump ravines, streams, and wetlands are sensitive because of their contribution to the sustainability of plant and animal populations.

RESTORATION OPPORTUNITIES

Restoration opportunities were identified by WPC during inventory activities and site visits with experts. The sites identified as restoration sites represent areas that are currently degraded or are under active agriculture. Through restoration activities (e.g. reforestation), these sites may provide habitat and dispersal corridors for wildlife species, increase core habitat for forest interior species, increase protective buffers to protect populations of species of concern, or establish links between important habitat areas.

RESULTS AND DISCUSSION

PLANT COMMUNITY DESCRIPTIONS

A plant community is an assemblage of plant populations sharing a common environment and interacting with each other, with animal populations, and with the physical environment (Fike 1999). The following are the complete descriptions (listed in Table 3 and depicted in Figures 7 and 8) of the plant communities found at Erie Bluffs State Park. Many community types below are similar to those found in Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999) but represent regional variations. Others, for example, sand barren and black oak savannah, are not described in Fike (1999) due to their rarity in Pennsylvania.

While there exist many transitional zones between distinct communities, lines between communities were drawn for mapping purposes. Some boundaries may be fuzzier than others. The plant species of agricultural types, private lands, and transportation corridors were not inventoried, and although they were mapped, descriptions of these types are not presented below.

Table 3. Plant communities of Erie Bluffs State Park. Plant community types are described in the report text. Numbers correspond to specific geographic areas that are depicted on the plant community maps of the park (Figures 7 & 8).

Plant community	Numbered area	Global rank	State rank
Terrestrial forests (Fike 1999):			
Black locust forest	21, 81, 94, 103	G?	S5
Dry oak – mixed hardwood forest	89, 91, 92, 99	G?	S3
Red oak mixed hardwoods forest	62, 64	G?	S5
Hemlock – northern hardwood forest	2, 4, 5, 25, 32, 37, 42, 46, 50, 52, 54, 56, 60, 63, 70, 76, 82, 83, 117, 118	G?	S5
Northern hardwood forest	44, 47, 48, 49, 73, 80, 95, 104, 105, 106, 126, 127, 129	G?	S4
Sugar maple-basswood forest	13, 14, 16, 17, 18, 23, 24, 26, 27, 31, 33, 38, 39, 43, 71, 85, 114, 124	G?	S5
Tuliptree beech maple	10, 11, 59, 97	G?	S4
Palustrine forests (Fike 1999)			
Great Lakes Region lake plain palustrine forest (and shrubland)	29, 40, 108, 110, 41, 109	G?	S1
Red maple – black ash palustrine forest	119	G?	S2
Terrestrial woodlands (Fike 1999):			
Great Lakes Region scarp woodland	3, 45, 51, 53, 88	G?	S1
Terrestrial herbaceous openings (Fike 1999):			
Great Lakes Region sparsely vegetated beach	84	G?	S1
Great Lakes Region sand barren (Great Lakes Region sand plain)	20, 22, 67, 121	G?	S1
Other natural community types not described in Fike (1999)			
Black oak woodland/savannah	120, 122	G?	S?
Sand spits and Elk Creek Scour Zones	1, 72	G?	S?
Disturbed types not in Fike (1999)			
Early successional woodland	7, 12, 15, 19, 28, 30, 34, 35, 36, 61, 65, 68, 69, 74, 75, 86, 87, 90, 98, 101, 128	NA	NA
Successional herbaceous opening	57, 58, 115	NA	NA
Row crops	6, 8, 93, 113	NA	NA
Right of ways and transportation	9, 66, 77, 96, 100, 102, 107, 111, 112, 123	NA	NA
Developed land (inside and outside park)	55, 78, 79,100, 116, 125	NA	NA

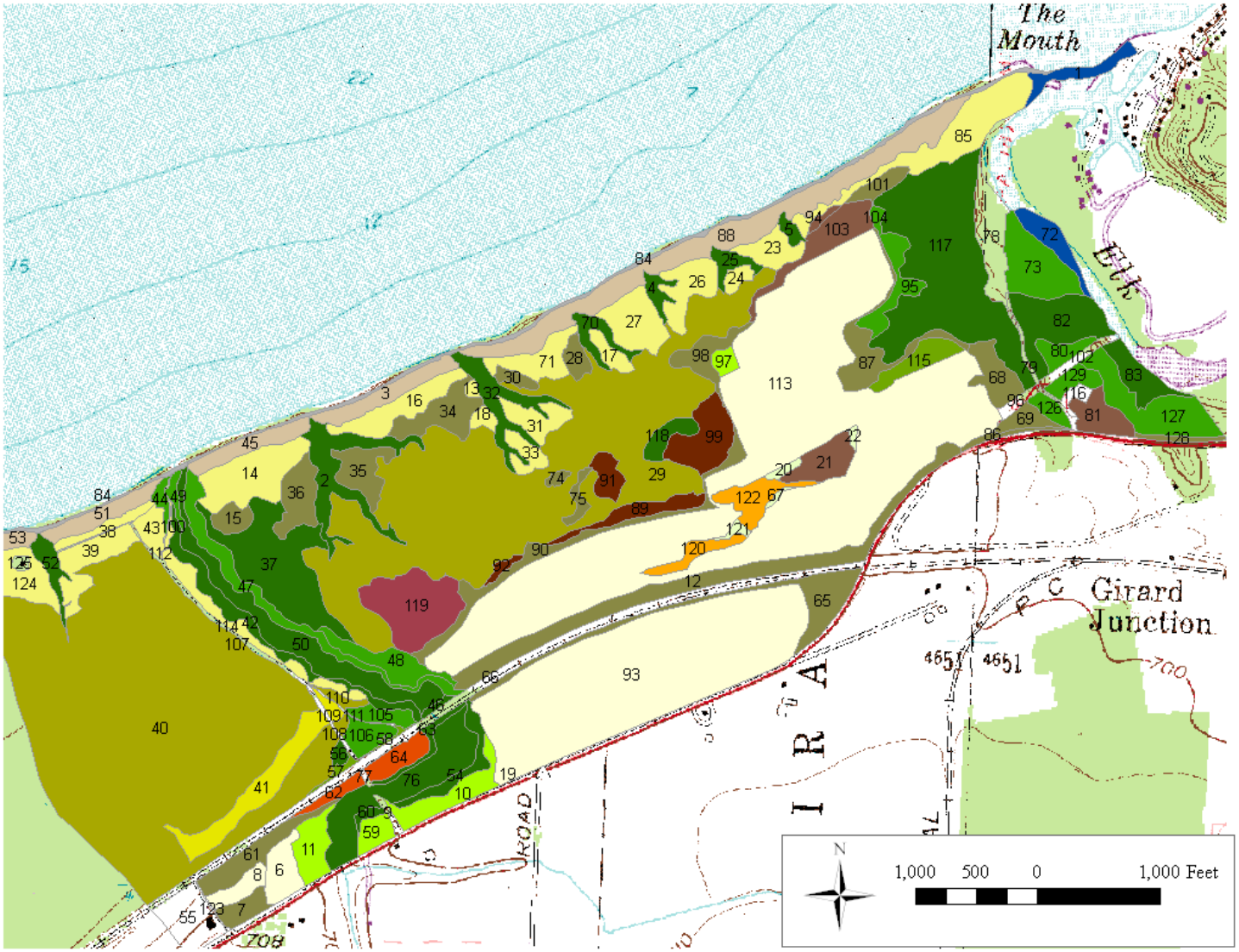


Figure 7. Terrestrial and palustrine plant communities of Erie Bluffs State Park, Erie County, PA; Base map: USGS 7.5-minute quadrangle Fairview, PA, Fairview SW, PA; Springfield NE, PA

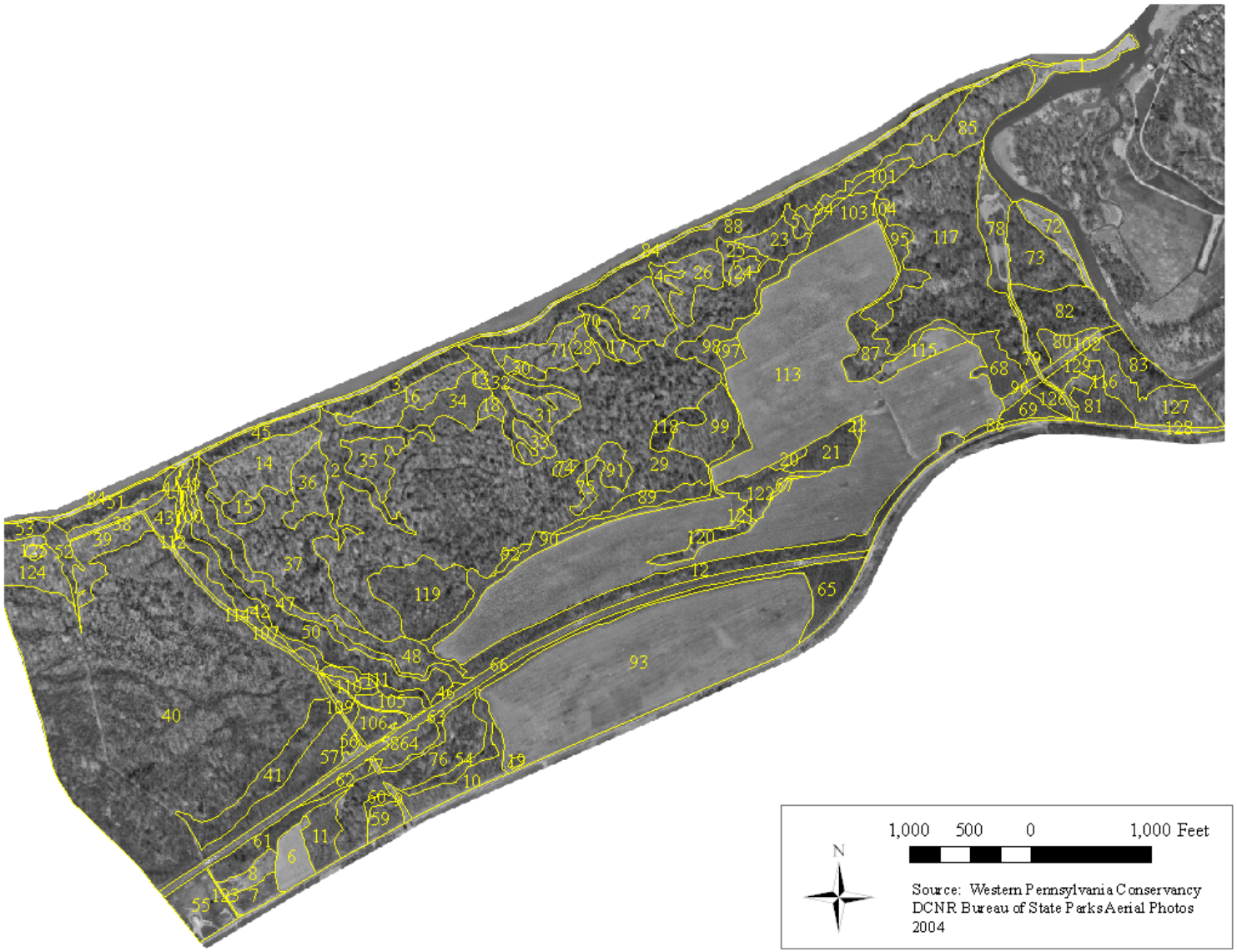


Figure 8. Terrestrial and palustrine plant communities of Erie Bluffs State Park, Erie County, PA. Basemap provided by PA Bureau of State Parks.

Community Types of the Warren III Beach Ridge, Lake Plain, and Escarpment Tops

Black locust forest

This community type occurs on the eastern portion of what is referred to as the relict dune, between the northeastern end of the agricultural field and the bluff face, and between the agricultural fields and the railroad/highway. *Robinia pseudoacacia* (black locust) is the dominant tree here. Other associates vary; typical representatives include *Acer rubrum* (red maple), *Sassafras albidum* (sassafras), various oaks (*Quercus* spp.), or *Prunus serotina* (black cherry). There is generally a sparse understory of graminoid species. *Toxicodendron radicans* (poison ivy) is common and abundant. Native shrubs include *Rubus spp*. (blackberries and raspberries) and *Rhus typhina* (staghorn sumac). Exotic species are usually common and include *Lonicera morrowii* (Morrow's honeysuckle), *Berberis thunbergii* (Japanese barberry), *Alliaria petiolata* (garlic-mustard), *Poa pratensis* (Kentucky bluegrass), *Dactylis glomerata* (orchard grass), and *Holcus lanatus* (velvet grass).

Early successional woodland

This community type represents the forest/woodland community type on the edge of the agricultural fields, in recently clearcut areas, and in sites along the roadsides and railroad rights-of-way at the Erie Bluffs property. The canopy is often more open than the Black locust forest type, and *Robinia pseudoacacia* (black locust) is not dominant. Shrubs and small trees dominate, and there is usually a heavy *Vitis riparia* (frost grape) component. In addition to the grape, the dominant shrubs include *Rubus spp*. (blackberries), *Rhus typhina* (staghorn sumac), and *Lindera benzoin* (spicebush). The dominant herbaceous species in this type is *Polygonum scandens* (climbing false buckwheat).

Black oak woodland/savannah

This community type is found on a portion of the relict dune landform not dominated by black locust. At Erie Bluffs, this type is dominated by *Quercus velutina* (black oak) trees of short stature. Canopy closure is less than 50 percent. Native shrubs include *Rubus flagellaris* (northern dewberry). Herbaceous species include *Lespedeza hirta* (bush-clover), *Sanicula spp*. (snakeroot), *Erigeron strigosus* (daisy fleabane), *Fragaria virginica* (wild strawberry), and several *Carex spp.* (sedges). This community type is prone to invasion by non-natives such as spotted knapweed (*Centaurea maculosa*). Once prevalent on the Lake Warren Beach Ridge landform along the southern Lake Erie Coast, this type is increasingly rare due to natural forest succession, invasion of tree species, gravel/sand mining, agriculture, and development. This may be the best example of black oak savannah in Erie County, and its extent was most likely larger prior to cultivation of the surrounding landscape and suppression of naturally occurring fires.

Sand barren

This community type is found on a portion of the relict dune landform not dominated by black locust. Sparse groundcover, absence of a tree canopy, and exposed soil distinguishes this type from the black oak woodland/savannah community. It may simply represent an earlier successional state of the black oak woodland/savannah or the mixed oak –hardwood forest. Like the rest of the dune, the agricultural fields, and the mixed oak types, the soil here is described as dune sand. *Rubus flagellaris* (northern dewberry) is the most abundant shrub. Together with the

black oak woodland/savannah community, this may be the best example of this community type in Erie County (Bissell 2004, pers.com), and thus the state, and its extent would undoubtedly have been larger prior to cultivation of the surrounding landscape and suppression of naturally occurring fires. A similar type is described in Fike (1999), but is established on a considerably younger geologic feature (Lake Erie Beach Ridges and dunes). This type of sand barrens is found only on beach ridges of Lake Warren.

Red oak woodland

This community type is found on highly modified sandy soils between Duck Run and the railroad tracks and most likely represents an earlier successional stage of the red oak mixed hardwood forest type. The type is dominated by small red oaks with an understory of small *Acer saccharum* (sugar maple) and *Rubus spp*. (blackberries and raspberries). Non-native *Lonicera morrowii* (Morrow's honeysuckle) and other invasive plants are common. This community type was separated from the red oak-mixed hardwoods forest type because of the small diameters of the dominant canopy trees and the higher proportion of non-native shrubs and herbaceous species in the understory.

Successional herbaceous opening

This miscellaneous community type, dominated by graminoid and herbaceous species, represents recently abandoned old-field sites and disturbed areas along the railroad right of way at Erie Bluffs. As a rule, this community type is not restricted to certain soil types and is usually more a function of recent or on-going disturbance. Graminoid species, such as *Dactylis glomerata* (orchard grass), *Phleum pratense* (timothy), and *Agrostis spp*. (bentgrass), are common. The non-native *Centaurea maculosa* (spotted knapweed) is also abundant in this type.

Tuliptree beech maple forest

The most consistent tree species for this often very mixed type are *Liriodendron tulipifera* (tuliptree) and *Acer rubrum* (red maple). *Fagus grandifolia* (American beech) is often present. The long list of possible associates includes various oaks, mostly *Quercus rubra* (red oak), as well as *Acer saccharum* (sugar maple), and *Carya ovata* (shagbark hickory). *Tsuga canadensis* (Eastern hemlock) may be present but will comprise less than 25 percent of the canopy. Common shrubs include *Carpinus caroliniana* (hornbeam), *Ostrya virginiana* (hop-hornbeam), *Hamamelis virginiana* (witch-hazel), and *Lindera benzoin* (spicebush). Herbaceous species include *Podophyllum peltatum* (may-apple), *Sanguinaria canadensis* (bloodroot), *Botrychium virginianum* (rattlesnake fern), *Dicentra cucullaria* (dutchman's-breeches), *D. canadensis* (squirrel corn), *Allium tricoccum* (wild leek), and *Claytonia virginica* (spring-beauty).

Dry oak –mixed hardwood forest

Quercus rubra (northern red oak) is usually present, often dominant/co-dominant, and occurs most often with *Quercus velutina* (black oak), *Carya ovata* (shagbark hickory), *Acer rubrum* (red maple), *Fraxinus americana* (white ash), *Fagus grandifolia* (American beech), and *Liriodendron tulipifera* (tuliptree). Shrubs include *Viburnum acerifolium* (maple-leaved viburnum), *Amelanchier arborea* (shadbush), *Carpinus caroliniana* (hornbeam), *Ostrya virginiana* (hop-hornbeam), *Hamamelis virginiana* (witch hazel), and *Lindera benzoin* (spicebush). The herbaceous layer is generally sparse. Representative species include *Uvularia sessilifolia* (wild-oats), *Smilacina racemosa* (false Solomon's-

seal), *Podophyllum peltatum* (may-apple), *Chimaphila maculata* (pipsissewa), *Medeola virginiana* (Indian cucumber-root), *Caulophyllum thalictroides* (blue cohosh), and *Dryopteris spp.* (wood ferns). The majority of this community type is found on soils classified as dune sand, which indicates rapidly drained, somewhat acidic conditions. Additionally, this indicates that all sites with soils described as dune sand may have at one time supported this type of forest.

Sugar maple-basswood forest

This type is most prominent on the well-drained, sandy Ottawa loamy-fine sand soils of the escarpment tops of Lake Erie and slumps. *Acer saccharum* (sugar maple) predominates this type. Occasional *Tilia americana* (basswood), *Quercus rubra* (northern red oak), *Fraxinus americana* (white ash), *Liriodendron tulipifera* (tuliptree), and *Betula alleghaniensis* (yellow birch), are also present. The understory shrub layer is characteristically sparse. There is generally a rich vernal flora; species include *Anemone quinquefolia* (wood anemone), *Geranium maculatum* (wood geranium), *Caulophyllum thalictroides* (blue cohosh), *Allium tricoccum* (wild leek), *Hepatica acutiloba* (liverleaf), *Sanguinaria canadensis* (bloodroot), *Erythronium americanum* (trout-lily), *Claytonia virginica* (spring-beauty), *Arisaema triphyllum* (jack-in-the-pulpit), *Cardamine concatenata* (cut-leaved toothwort), *Trillium grandiflorum* (large flowered trillium), *T. erectum* (wakerobin), and *Asarum canadense* (wild ginger). Other herbaceous species include *Smilacina racemosa* (false Solomon's-seal), *Dryopteris spp. (*woodferns*)* and *Botrychium virginianum* (rattlesnake fern).

Great Lakes Region lake plain palustrine forest

This type describes the wet forests found on the Warren III lake plain dominated by a mixture of hardwood species and hemlock. The lake plain landform to the east and west of Duck Run at Erie Bluffs is characteristically wet. Soils are of the Ottawa fine sandy loam, Ottawa loamy fine sand, and Berrien fine sandy loam series. There is often standing water in the spring, which may or may not dry completely over the course of the year. *Tsuga canadensis* (Eastern hemlock) is often, but not always present, and contributes less than 25 percent of the canopy. The most common hardwood species are *Acer rubrum* (red maple), *Fraxinus americana (*white ash*), Fraxinus pennsylvanica (*red ash*), Betula alleghaniensis* (yellow birch), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera (*tuliptree*). Lindera benzoin* (spicebush) dominates the shrub layer. Herbaceous species include *Symplocarpus foetidus* (skunk-cabbage), *Viola spp*. (violets), *Osmunda cinnamomea* (cinnamon fern), *Carex spp.* (sedges), and *Onoclea sensibilis* (sensitive fern). This community type contains some of the only occurrences of *Fraxinus profunda* (pumpkin ash) and *Quercus shumardii* (swamp red oak) in Pennsylvania. However, these species are not consistently distributed across the site and found only on the lake plain directly east and west of Duck Run.

Great Lakes Region lake plain palustrine shrubland

This is a miscellaneous category representing areas on Warren III lake plain without an intact forest canopy. *Populus tremuloides* (trembling aspen) seedlings, *Lindera benzoin* (spicebush) and *Cornus amomum* (silky dogwood) dominate the shrub layer. Species composition and soils are similar to those of the *Great Lakes Region lake plain palustrine forest.*

Red maple – black ash palustrine forest
This is a palustrine forest enriched by base-rich groundwater that occurs just north of the agricultural fields and east of Duck Run. The substrate of this type, as with other occurrences of this type statewide, is mineral soil with a thin layer of organic matter. There are large pools of standing water throughout this type that are most likely fed by groundwater. This type is differentiated from the Great Lakes Region lake plain palustrine forest by the dominance of black ash (*Fraxinus nigra*). Dominant trees here are red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), white ash (*Fraxinus americana*), American elm (*Ulmus americana*), and peach leaf willow (*Salix amygdaloides*). The understory is dominated by spicebush (*Lindera benzoin*) and winterberry (*Ilex verticillata*). The herbaceous layer is dominated by skunk cabbage (*Symplocarpus foetidus*), sedges (*Carex spp*.), sensitive fern (*Onoclea sensibilis*), and jewelweed (*Impatiens spp*.).

Community Types of the Lakeshore Cliffs and Slumps, Creek Slopes and Floodplains, and the Lake Erie Shoreline

Great Lakes Region scarp woodland
The bluff face communities are characteristically open with a mixture of shrubs and sometimes with scattered trees. This is a very dynamic system and the structure of the vegetation depends largely on its successional status. Recently slumped areas are first colonized by bryophytes and *Equisetum spp*. (horsetails). As the substrate becomes more stable, and organic matter accumulates, graminoids, other herbs, and shrubs colonize the seep. Eventually, perhaps due to the weight of the vegetation and organic matter, the entire community will slump or slide down-slope and the cycle begins again (Fike 1999). Physiognomic differences generally reflect different seral stages in this dynamic system. Common woody species include *Cornus rugosa* (round-leaved dogwood), *C. sericea* (red-osier dogwood), *Alnus incana* (speckled alder), *A. glutinosa* (alder), *Salix spp*. (willows), and *Rhus typhina* (staghorn sumac). Herbaceous species include *Aster spp.*, (New England aster), *Solidago flexicaulis* (zigzag goldenrod), and *Impatiens pallida* (jewelweed). Exotic species include *Phragmites australis* (common reed) and *Tussilago farfara* (colt's foot).

Hemlock – northern hardwood forest
This type describes the forest communities found on the ravine slopes and bottoms, the Duck Run and Elk Creek floodplain and associated slopes, and in the upland area immediately east of Duck Run. The ravine bottoms are nutrient rich, support many mesophytic species, and are tracked by PNHP as the Great Lakes Region scarp seep community. Soils of the ravine bottoms are usually of the Wauseon Fine Sandy Loam and Wayland Silt Loam. The overstory is often composed of *Tsuga canadensis* (Eastern hemlock), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Quercus rubra* (red oak), and *Fagus grandifolia* (American beech). Shrub and small tree species in the subcanopy include *Amelanchier arborea* (shadbush), *Ostrya virginiana* (hornbeam), *Hamamelis virginiana* (witch-hazel), *Lindera benzoin* (spicebush), and *Viburnum spp*. (viburnums). Herbaceous species found in the groundcover are similar to those found in the adjacent rich upland forest types including *Caulophyllum thalictroides* (blue cohosh), *Allium tricoccum* (wild leek), *Hepatica acutiloba* (sharp-lobed hepatica), *Erythronium americanum* (trout-lily), *Claytonia virginica* (spring-beauty), *Arisaema triphyllum* (jack-in-the-

pulpit), *Mitella diphylla* (bishop's-cap), *Cardamine concatenata* (cut-leaved toothwort), *Smilacina racemosa* (false Solomon's-seal), *Botrychium virginianum* (rattlesnake fern), and *Asarum canadense* (wild ginger). *Symplocarpus foetidus* (skunk cabbage) is common. This community type also contains the Great Lakes Region scarp seep community found at the mouth of the slump ravines.

Northern hardwood forest
This community type is very similar to the hemlock northern hardwood forest community described above, but contains little or no *Tsuga canadensis* (Eastern hemlock). This type is found on the east end of the Erie Bluffs property and on the adjacent property owned by Girard Township. *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Quercus rubra* (red oak), *Juglans nigra* (black walnut), and *Fagus grandifolia* (American beech) compose the overstory. There are also several *Juglans cinerea* (butternut) found in this area. Shrub and small tree species in the subcanopy include *Amelanchier arborea* (shadbush), *Ostrya virginiana* (hornbeam), *Hamamelis virginiana* (witch-hazel), *Lindera benzoin* (spice bush), and *Viburnum spp*. (viburnums). Herbaceous species found in the groundcover are similar to those found in the adjacent rich upland forest types including *Caulophyllum thalictroides* (blue cohosh), *Allium tricoccum* (wild leek), *Hepatica acutiloba* (sharp-lobed hepatica), *Erythronium americanum* (trout-lily), *Claytonia virginica* (spring-beauty), *Arisaema triphyllum* (jack-in-the-pulpit), *Mitella diphylla* (bishop's-cap), *Cardamine concatenata* (cut-leaved toothwort), *Smilacina racemosa* (false Solomon's-seal), *Botrychium virginianum* (rattlesnake fern), and *Asarum canadense* (wild ginger). *Symplocarpus foetidus* (skunk cabbage) is common.

Great Lakes Region sparsely vegetated beach
The cobble and sand substrate of this type is, for the most part, devoid of vegetation. *Cakile edentula* (sea rocket) is a rare species that grows here.

Sand spits and Elk Creek Scour Zones
Sand and gravel deposited by Elk Creek supports very little vegetation as wave action and creek flow routinely scour the shores of the lake and creek margins.

PLANT AND ANIMAL SPECIES AND PLANT COMMUNITY TYPES OF SPECIAL CONSERVATION CONCERN

Jim Bissell of the Cleveland Museum of Natural History documented 14 plant species of special concern during field surveys dating back to the early to mid 1980s. Additional populations of these and additional species were documented during subsequent field surveys by WPC from 1992 to 2004 and during the 2004 Erie Bluffs Bioblitz. The rare elements tracked by the PNHP database, and other important biological elements found at Erie Bluffs, are presented in Table 4. The rare plant species are also organized by plant community type. A list of all species found at the 2004 Erie Bluffs Bioblitz can be found in the "Bioblitz at Erie Bluffs State Park" document and also in Appendix A.

Vascular Plants and Plant Communities

The vascular flora of Erie Bluffs is diverse due to the high variety of landforms, hydrological regimes, and varied site history. The bluffs, associated seepage slumps, steep tributary gorges, and the dune/beach ridge provide habitat for plant species rare or absent in other parts of Pennsylvania. The Great Lakes cobble beaches are, of course, also unique to the northern edge of Erie County, PA. Four hundred and sixteen distinct taxa (412 full species, three hybrids, and a second variety of one species) of vascular plants were recorded during the 2004 Bioblitz (Appendix A). Further surveys covering all habitat types at varying times during the growing season would probably reveal at least half again this number. Ninety-eight of the 416, or 24 percent, are not native to Pennsylvania (Appendix B), much lower than the 37 percent reported for the state as a whole (Rhoads and Klein 1993). If more attention at the 2004 Bioblitz had been focused on recording weeds in the agricultural fields on the property, the number of non-native plants would certainly be higher (Grund in Bioblitz at Erie Bluffs State Park).

Eighteen plant species are species of conservation concern (listed, or proposed to be listed under Pennsylvania's Wild Resources Conservation Act) (Table 4, Figure 8), nine of which were observed at the 2004 Erie Bluffs Bioblitz (Grund in Bioblitz at Erie Bluffs State Park). An additional two species are on a Pennsylvania Biological Survey watch list of species that may be eligible in the future for conservation status.

Floristically, perhaps the most interesting plant to inhabit the park is the pumpkin ash (*Fraxinus profunda*) (Grund in Bioblitz at Erie Bluffs State Park). This swamp species is found on the coastal plain from VA to northern FL, and sporadically west to LA. It is disjunct in the Mississippi Valley from AR north to southern IL, with scattered locations to northern IL and across OH to northwestern PA. This distribution is consistent with a pattern of coastal plain species that are disjunct in the Great Lakes region (Reznicek 1994).

Six terrestrial and palustrine communities described by Fike (1999) at Erie Bluffs State Park are tracked in the PNHP database as significant community element occurrences (ranked S3 or above; Table 4, Figure 10). An additional type, black oak woodland/savannah, which is not described in Fike (1999), is also a distinct and rare community type. These communities represent types unique to the Great Lakes Ecoregion and more specifically the lake plains of glacial lakes Warren and Maumee, predecessors of Lake Erie and important components of Pennsylvania's native biodiversity. While historically rare in Pennsylvania due to limited lake

Table 4. Species of special concern and other important biological elements documented during surveys at Erie Bluffs State Park (mapped in Figure 9 and 10).

Scientific name	Common name	Global Rank	State Rank	State Status	Proposed State Status
Juncus torreyi	Torrey's rush	G5	S2	PT	PE
Juncus brachycephalus	Small-headed rush	G5	S2	PT	PT
Juncus alpinoarticulatus ssp. Nodulosis	Richardson's rush	G5T5?	S2	PT	PT
Carex disperma	Soft-leaved sedge	G5	S3	PR	PR
Alisma triviale	Broad-leaved water plantain	G5	S1	PE	PE
Equisetum variegatum	Variegated horsetail	G5	S1	PE	PE
Equisetum x ferrissi	Ferris's scouring-rush	GNR	S1	PE	PE
Ptelea trifoliata	Common hop-tree	G5	S2	PT	PT
Fraxinus profunda	Pumpkin ash	G4	S1	N	PE
Rubus setosus	bog-blackberry	G5	SH	TU	TU
Cardamine X maxima	Large toothwort	G5Q	S1	N	TU
*Phragmites australis ssp. Americanus**	American reed	???	???	N	PE
Panicum laxiflorum	Lax-flower witchgrass	G5	SNR	N	PE
Potentilla anserina	Silverweed	G5	S3	PT	PR
Iris virginica	Blue flag	G5	S2	N	PE
Cakile edentula	American sea rocket	G5	S3	PR	PR
Samolus parviflorus	Pine pimpernel	G5	S2	TU	PE
*Quercus shumardii**	Swamp red oak	G5	S1	PE	PE
Rare plant communities tracked in PNHP database					
Great Lakes Region lake plain palustrine forest and shrubland		GNR	S1		
Great Lakes Region scarp seep (slump ravine)		GNR	S1		
Great Lakes Region scarp woodland (bluff face)		GNR	S1		
Sand barren (Great lakes region dry sand plain)		GNR	S1		
Great lakes region sparsely vegetated beach		GNR	S1		
Red maple black ash palustrine forest		GNR	S2		
Dry oak-mixed hardwood forest		GNR	S3		
High-gradient clearwater creek*		GNR	S3		
Other Important Biological Elements, not tracked in PNHP database *					
Black oak savannah community	---	---			
*Buxbaumia aphylla**	Bug on a stick moss		G?	S?	
*Actaea rubra**	Red baneberry	G?	S?	watch list	
*Juglans cinerea**	Butternut	G3G4	S4	N	??
*Smilacina stellata**	Starry false-Solomon's seal	G?	S?	watch list	

*species/communities not mapped

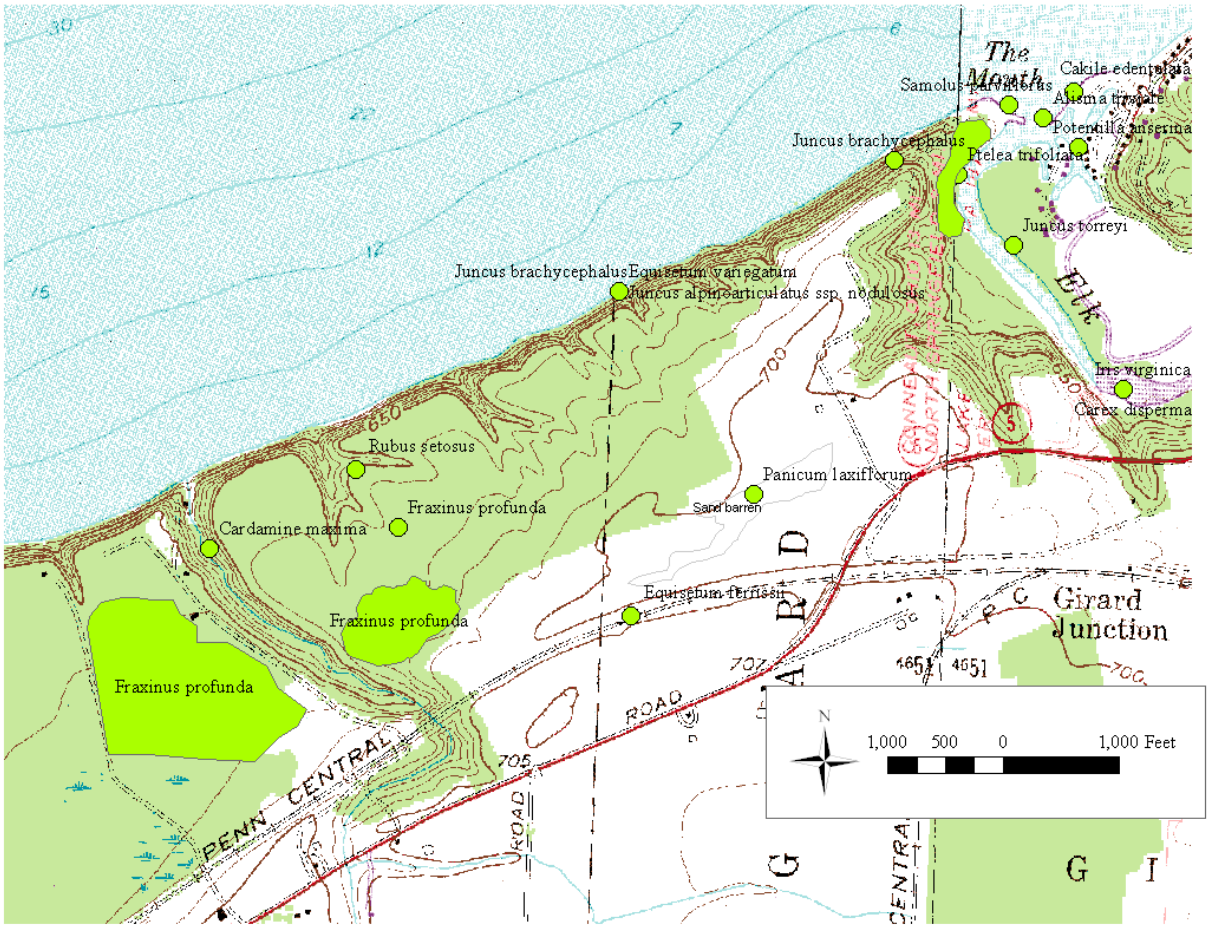


Figure 9. Plants of special concern at Erie Bluffs State Park, Erie County, (Base map: USGS 7.5-minute quadrangles Fairview, PA, Fairview SW, PA Springfield NE PA)

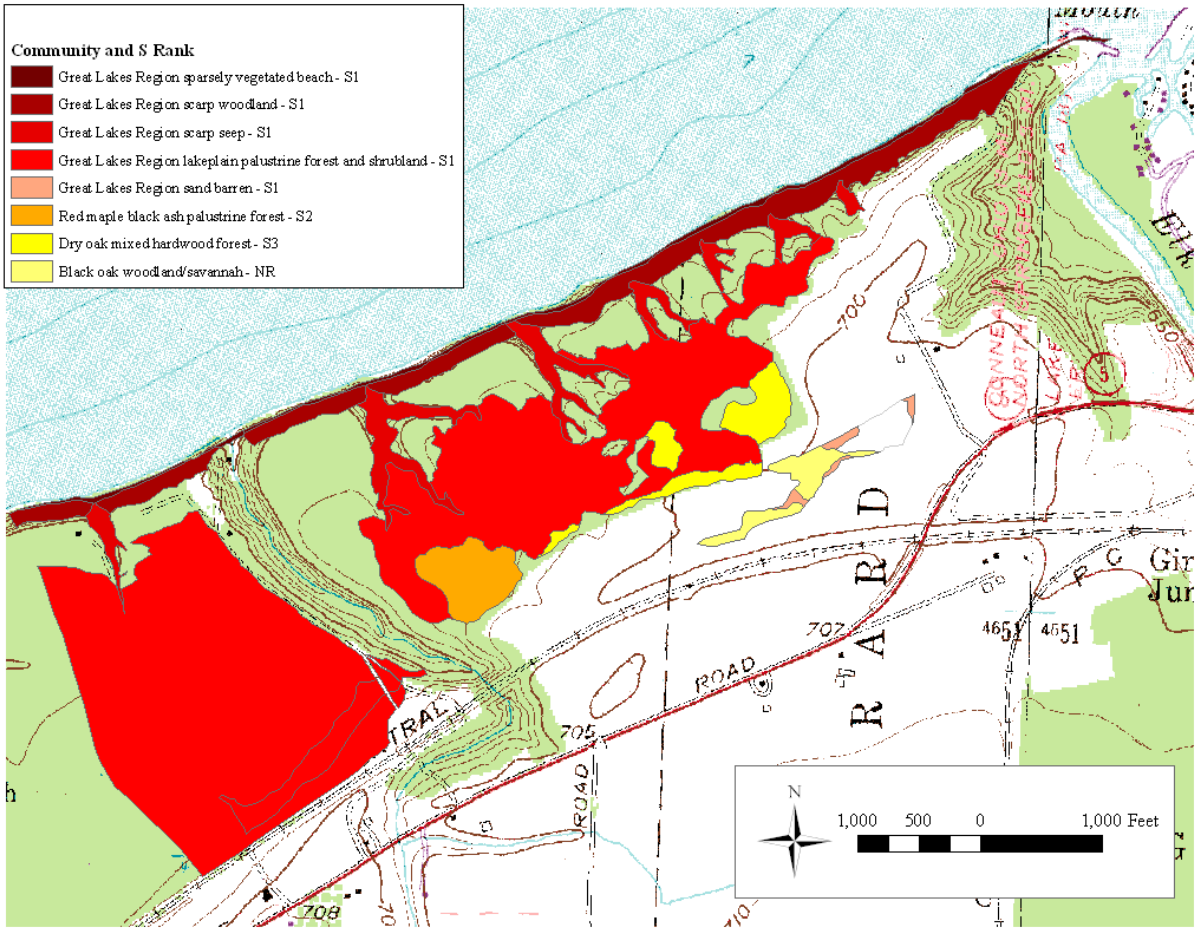


Figure 10. Plant communities of special concern at Erie Bluffs State Park, Erie County, (Base map: USGS 7.5-minute quadrangles Fairview, PA, Fairview SW, PA Springfield PA)

frontage, these types have been largely converted to residential land and agriculture along the Lake Erie coastline. At Erie Bluffs, the most extensive community type is the Great Lakes Region lake plain palustrine forest, which is more commonly found west of Pennsylvania on glacial lake plain landforms along the Lake Erie Coast. The Great Lakes Region scarp seep communities of the slump ravines contain some of the highest quality habitat and largest trees on the property. Their contribution to the Lake Erie system has been discussed by Mike Campbell and Andrew Martin Associates (Andrew Martin Associates, Inc. 2001). The oak savannah/dry oak forests of the dune and beach ridge types are also limited to glacial Lake Warren beach ridges in Northwest Pennsylvania and Ohio (Bissell 2005, pers.com.). However, these types are threatened by the invasion of garlic mustard, black locust, oriental bittersweet and other invasive species.

Invasive Plant Species

Ninety-eight species of non-native plants were recorded during the 2004 Bioblitz and through other assessment activities (Appendix B). In general, non-native invasive plant species are plant species that were introduced accidentally or intentionally into places where they were not originally from. These plant species compete with native plants and result in changes in habitat structure and ecosystem processes. Many non-native invasive plant species have benefited from human disturbance. Species such as bush honeysuckle rapidly colonize old fields following agricultural abandonment.

The number of non-native plants found at the 2004 Erie Bluffs Bioblitz (24 percent) was much lower than the 37 percent reported for the state as a whole (Rhoads and Klein 1993). However, there are most likely several weed species in the agricultural fields on the property not recorded. Because of this, the number of non-native plants would certainly be significantly higher (Grund in Bioblitz at Erie Bluffs State Park). The non-native plants currently found on the edges of the agricultural areas present a significant management concern. The list of invasive exotic plant species and management strategies is presented in Appendix B. Not all non-native species are considered invasive. However, those listed in Appendix B pose a significant threat to native biodiversity, and populations of these species should be monitored and managed. Management priority and recommendations (ranging from hand pulling and mowing to cutting and use of herbicides) are presented in Appendix B, and were compiled from several on-line sources including:
http://www.paflora.org/Invasive%20species%20fact%20sheets.htm
http://www.natureserve.org/getData/plantData.jsp
http://www.nature.nps.gov/biology/invasivespecies/strat_pl.htm.
http://www.nps.gov/plants/alien/factmain.htm

In addition, Appendix B provides National I ranks for many species occurring at Erie Bluffs State Park. National I ranks were developed by NatureServe for 382 non-native species according to their impacts on native biodiversity (Morse, et. al. 2004). Several of these plant species were present at Erie Bluffs, and ratings for these plants, based on their occurrence and their level of threat to native biodiversity nationwide, are presented in Appendix B. An in-depth discussion of the I ranks and their meaning can be found at http://www.natureserve.org/getData/plantData.jsp.

While many of these species may be impossible to eradicate over the entire park property, invasive plant species control should be a part of the management of select areas (i.e. relict dune/savannah community). Additionally, the threat posed by these species varies considerably, and efforts should focus on species noted as having a high management priority over all others. Control measures vary and depend greatly on physical and biological site factors (i.e. soil type). In addition to information in Appendix B, the control of non-native plant species, including the use of fire, is addressed in the discussion of management options in this report.

The following is a list of the non-native invasive plant species that most negatively affect native plants, animals, and plant communities within the park and measures should be taken to manage populations for the future.

Giant reed (*Phragmites australis*)
Garlic mustard (*Alliaria petiolata*)
Morrow's honeysuckle (*Lonicera morrowii*)
Multiflora rose (*Rosa multiflora*)
Black locust (*Robinia pseudoacacia*)*
Spotted knap-weed (*Centaurea maculosa*)
Oriental bittersweet (*Celastrus orbiculatus*)
European alder (*Alnus glutinosa*)

* Black locust (*Robinia pseudoacacia*) is native to Eastern North American. However, the northern limit of its native range is in central Pennsylvania and Ohio, considerably south of Erie County, PA (Huntley, in Burns and Honkala, 1990). Because of this, and its ability to drastically alter ecosystem structure and composition (especially in sand barren and oak savannah community types), it is considered an invasive plant species and site planning should address removal and control options for this species park-wide.

Vertebrates

Bioblitz participants recorded several avian species of special concern status in July 2004 (Gross in Bioblitz at Erie Bluffs State Park). Jean Stull Cunningham and Toby Cunningham collected additional records and information. The diverse habitat types of Erie Bluffs provide foraging grounds for Bald Eagles and Northern Harriers and are breeding sites for Red-headed Woodpeckers and several forest interior bird species (Acadian Flycatcher, Mourning Warbler, Blue-headed Vireo). As noted previously, the bluff face supports what may possibly be the largest colony of Bank Swallows in PA (over 3000 nesting holes recorded at Bioblitz). These nesting holes play an important role in the natural disturbance regime of the bluffs and provide nest holes for other bird species (Kingfishers). The interior forest habitat also provides habitat for several species of bats such as the eastern red bat, the big brown and little brown bats, and the eastern pipistrelle. Other mammal species benefit from the large interior forest habitat. Jim Hart, wildlife biologist for The Nature Conservancy, noted the absence of species such as the Norway rat and house mouse in records from the 2004 Erie Bluffs Bioblitz. The absence of these species, ubiquitous in more urbanized areas, indicates a high degree of site quality (Ropski in Bioblitz at Erie Bluffs State Park).

Erie Bluffs does not appear to be a hotspot for herpetifaunal diversity, although the ephemeral pools and ruts along the road on the west side of Duck Run have fairly high amphibian abundance. Two significant findings are the four-toed salamander, which is considered relatively rare, and the large numbers of gray tree frogs. The four-toed salamander is presently under consideration by the PA Biological Survey as a potential species of concern or as a watch list species (Meret in Bioblitz at Erie Bluffs State Park).

Invertebrates

Aquatic invertebrates

A total of 23 invertebrate taxa were identified from spring sampling of ephemeral pools at Erie Bluffs State Park. A list of the invertebrates recorded at the 2004 BioBlitz can be found in Appendix A. The most abundant invertebrate group in numbers was the clam shrimp (ostracods) (42 percent of total). Ostracods are common inhabitants of seasonal pools that produce eggs that can survive drying for many years. Other common inhabitants of seasonal pools, copepods, use a similar strategy to survive. However, none were found in survey efforts.

The taxa collected in the seasonal pools of Erie Bluffs State Park indicated that much of the area remains saturated for long periods of time during the year due to the influence of groundwater seepage. This is supported by the prevalence of *Caecitodea* (Crustacea: Isopoda: Asellidae), a group of isopods that typically inhabit permanent waterbodies and are not physically adapted for weathering a drying phase. In periods of drying, isopods will burrow deep into the moist substrate (Smith 2001). The most abundant freshwater snail in the study area, *Aplexa elongata* (lance aplexa), inhabits a variety of temporary environments, including seepage wetlands, ditches, and occasionally permanent waterbodies (Jokinen 1992). They are often abundant when encountered. Another notable find was *Gyraulus circumstriatus* (disk gyro). This species inhabits ephemeral waterbodies as well as lakes and ponds. It is somewhat rarer than the two other species of *Gyraulus* found in this study. The rarest species located in this study was *Stagnicola caperata* (wrinkled pondsnail), located in pool 10. This species is typically associated with seasonal pools and shallow ephemeral environments. It was found in a very small wetland environment that obviously dries on a frequent basis. This and other snail species survive the drying period by producing a mucous epiphragm, or by burrowing into the moist sediment.

Aeshna tuberculifera (black tipped darner) was collected from pool 9. Previous researchers have reported this species from ephemeral wetlands and it undoubtedly uses these habitats in order to exploit the relatively predator-free environment found there. Odonates cannot survive a complete drying phase, although some species produce eggs resistant to desiccation. *Aeshna tuberculifera* is typically found in semi-permanent seasonal pools (Colburn 2004) because it requires a long period of development.

Isopods and amphipods (also found in this study) typically only survive in wetland environments that remain saturated through the year, are flooded regularly, or have a perennial water source (Colburn 2004).

The aquatic invertebrate composition of the forested pools indicate that they are saturated for much of the year and do not experience the drying out phase typical of vernal pool ecosystems. Water filling these wetlands may arise from a deep aquifer or may arise from subsurface groundwater flow south of the forested areas on Erie Bluffs property. Reduction in subsurface water flow due to increased water use, changes in impervious surface area due to road building and development activities, and changes in site hydrology within the watershed may decrease habitat quality for this group of species requiring relatively predator-free habitats.

Insects

Carabidae

Bioblitz results for Carabidae (ground beetles) were quite as expected; many species but nothing exciting, rare, out of range, or significant beyond probable county records for some of the species (in the context of a state-wide survey of ground beetles now ongoing at CMNH with WRCP funding). Ground beetles captured from the fall 2004 Erie Bluffs Bioblitz were similarly unsurprising, with one exception, *Maronetus imperfectus* (see following discussion). All species taken are common throughout Pennsylvania in the proper habitat. The following species had not previously been recorded for Erie County in the CMNH database of Pennsylvania Carabidae, but are known from counties nearby.

Acupalpus indistinctus
Agonum cupripenne
Agonum ferreum
Agonum fidele
Agonum melanarium
Agonum placidum
Amara exarata
Amphasia interstitialis
Bembidion bifossulatum cheyennense
Bembidion cordatum
Bembidion impotens
Bembidion inaequale
Bembidion obscurellum
Bembidion petrosum
Bembidion simplex
Calathus opaculus Cymindis limbatus
Cymindis platicollis
Dicaelus elongatus
Dyschirius politus
Harpalus compar
Maronetus imperfectus
Notiophilus aeneus
Ophonus puncticeps
Oxypselaphus pusillus
Patrobus longicornis
Pterostichus femoralis
Pterostichus luctuosus
Pterostichus melanarius
Pterostichus tristis
Sphaeroderus canadensis canadensis
Synuchus impunctatus
Xestonotus lugubris

The following is a discussion of two carabid species: one unexpected and possibly unusual, and the other an introduced species from Europe.

Maronetus imperfectus (G. H. Horn)

This species is characteristic of the northern portion of the Allegheny Plateau and was not previously known north of the southeastern corner of Ohio and a few counties in southwestern Pennsylvania. It is common from western Virginia through all of West Virginia, and extends into southeastern Ohio, southwestern Pennsylvania and western Maryland. It is replaced by a number of other *Maronetus* species throughout the southern Appalachians. It is one of the tiniest members of the snail-eating carabids of the tribe Cychrini. Unlike its larger relatives that are active ground foragers and tree climbers, it is a creature of the leaf litter and upper soil layers, where it burrows in search of small snails.

The six specimens from Erie County (four from Station 5 mixed hemlock forest, two from Station 6 secondary ravine forest) extend the known range at least one hundred miles north of its previously-known occurrence. It also suggests that it could be found much further north in Ohio than previously suspected, and it may even have expanded its range into the southwestern corner of New York State. The capture of six individuals at two of the most mesic sites at Erie Bluffs suggest the species may require such habitats and that a significant population may exist there.

Ophonus puncticeps (Stephens)

There was a time when a record of this species from northwestern Pennsylvania was exciting as this European introduction spread to the west. Now it has been known from the area (and from northeastern Ohio) for about twenty years. It is almost certain that it has spread west and south well beyond Ohio and Pennsylvania by this time, but there are in fact no published records as yet. The species belongs to a largely herbivorous tribe of Carabidae and is a specialist in seeds of *Daucus*

carota (Queen Anne's lace), also an introduced European species. One specimen was taken during the Bioblitz, but it has at times been taken in huge numbers in this part of Pennsylvania and adjacent Ohio in the fall when the Queen Anne's lace sets seed. Dozens of adults may be found in one flower head. The adult beetles bury seeds in an underground chamber, where they lay their eggs and take care of their larvae.

Tipulidae

Species of crane flies (Diptera: Tipulidae) captured so far in this survey are those commonly encountered in hardwood forest habitats. Species of *Pedicia* are indicators of clean, rapid, streams in the area (Duck Run), and species of *Tipula (Yamatotipula), T. (Nippotipula)* indicate the availability of semiaquatic habitats. The capture of the snow crane fly (*Chionea scita*) at Station 4 (wet woodland in light trap) in November was interesting. Snow crane flies are usually found after fresh snowfall and the larvae of this genus are believed to live inside the nests of small rodents.

Nephrotoma alterna (Walker)

This was the only species, out of all crane flies found in this survey, that was recorded in the 2000 Pennsylvania tipulid survey conducted by CMNH and ANSP investigators (Young, C., and J. Gelhaus. Crane *Flies of Pennsylvania: Preliminary Checklist and Database* – a WRCP-funded effort). This is due to the infrequent collecting in the study area.

Macrolepidoptera

Virtually all species of Lepidoptera captured to date are entirely expected during this time period in mixed forest habitats in Pennsylvania. The absence of a species in any given sample does not mean that the species does not occur at that site, or during that time of the year, as there are almost countless variables that influence whether or not a particular species is captured in a given type of trap at different times of the year. The majority of the loopers (Geometridae) taken were polyphagous species feeding on a wide range of woody plants. Most of the owlet moths (Noctuidae) were agricultural pests, common woodland species (mostly polyphagous), or dead-leaf feeders *always* associated with forest understory settings in late successional or mature forest conditions. The abundance of agricultural pest noctuids at most sites, and especially at the dune sites immediately adjacent to corn and soybean fields, was also expected and included virtually all of the major agricultural pest taxa:

Agrotis ipsilon (black cutworm)
Anticarsia gemmatalis (velvet bean looper)
Helicoverpa zea (corn earworm)
Peridroma saucia (glassy cutworm)
Plathypena scabra (green cloverworm)
Pseudaletia unipuncta (armyworm)
Spodoptera ornithogalli (yellow-striped armyworm)

Two introduced species are worth comment. *Noctua pronuba* (large yellow underwing) is a European species of noctuid moth (called by some the pronuba cutworm) and was taken at several sites during the Bioblitz (fields, lakeshore, and ravine habitats). The species was recently introduced in the New World from Europe by way of Canada and appeared in the Pittsburgh area only in 1996. It is now becoming much more abundant and becoming a serious agricultural pest as it frequently is in Europe. Another introduced moth, a single fresh male of *Rhizedra lutosa* (Hübner), was taken during the fall survey at Site 1 (the disturbed forest setting overlooking the

lake). This is a large sedentary noctuid moth dependent on common reed, *Phragmites australis*, on which it is thought to be monophagous as a rhizome borer. It originally occurred in the western Palearctic (Europe) but was known from Ohio as early as 1967. The species was first documented in Pennsylvania by CMNH along the Susquehanna River as part of an EPA funded characterization of floodplain habitats (study in collaboration with The Nature Conservancy and WPC), although it must have been established in *Phragmites* habitats in the state for years, perhaps as early as the 1960s.

A small geometrid moth, *Eupithecia mutata mutata*, common in adjacent Ontario and New York, was recorded during the Bioblitz (lakeshore and wetland habitats). The obscure species appears not to have been previously documented in the CMNH collections from western Pennsylvania, and its occurrence here is therefore worth emphasizing. It is not rare northward, however, nor in any sense thought to be a species of special concern for conservation.

The larch lappet moth, *Tolype laricis*, was taken at Stations 5 and 6 (hemlock forest and Duck Run forest) (Lasiocampidae). This is one of three species of *Tolype* in Pennsylvania, one of which was also taken in large numbers at all fall stations (*Tolype velleda). Tolype velleda* feeds as a larva on woody rosaceous plants (*Prunus* and relatives), but *T. laricis* larvae feed only conifers (almost certainly hemlock at these sites). The third species in the state is listed as being of special concern (*Tolype notialis*) and is not known from, but it is often confused with, *T. laricis*. This also feeds solely on conifers, and may indeed be indistinct from that species. The two species are not known to be sympatric anywhere, with *T. laricis* northern, and *T. notialis* southern from central Pennsylvania to peninsular Florida. Certainly *T. laricis* at Erie Bluffs is abundant and by no means would be considered a population of special concern.

Mecoptera

One other insect capture during these surveys is notable. A single specimen of *Merope tuber* was taken at Site 1 (bluff top and face) during the fall survey. 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. Discovering the life history and larval stages of this species is often referred to as the "Holy Grail" of North American entomology. Nobody knows where the larva lives, how and upon what it feeds, or even what it may look like. The presence of a single specimen during this survey suggests that a population of the sedentary species is present, but nothing further can be said about its conservation status there. The species is almost always found in wet habitats in understory, most often along streams and ravines with wet mossy slopes or otherwise continuously wet soils. The species would have been expected at Stations 4, 5, and especially 6 (wet ravine forest) but not where it was actually taken at Station 1. It would not be expected at Station 2 (dune) or Station 3 (oak forest).

Discussion

Although no species of insect known at the time of the report (studies are ongoing) at Erie Bluffs is genuinely of special concern, the hemlock-associated, wet forest sites are expected to contain additional disjunct taxa or population(s) of species with forest-restricted habits. They most likely merit greatest concern for protection based on preliminary insect occurrence data alone. However, all conclusions are preliminary, given limited data at the present time. Insect composition of the dune habitat and open lakeshore suggest that these open habitats contribute greatly to overall species richness of the park, even without attention to possible dune relicts or other special taxa with limiting associations with the lake shore.

An established pest species (*Rhizedra lutosa*) was recorded from Station 1 during the fall survey, and the unusual earwigfly, *Merope tuber*, was taken at that station as well. As discussed above, the pest borer is restricted to *Phragmites*, and adjacency to the lakeshore may explain its presence at Station 1. The earwigfly (*Merope tuber)* was expected to have been present (based on numerous other collections by these investigators) in forested situations (such as Stations 5 and 6), so its unique occurrence at Station 1 during the fall survey may be unusual.

HABITAT QUALITY

Habitat quality was evaluated and described for areas sharing similar ecological attributes and site history. These areas are presented in Figure 11 below.

The non-forested areas on the Erie Bluffs property are predominantly agricultural and currently planted in corn and soybeans (Figure 11, pt. 1). Since transfer of the property from WPC to DCNR, Presque Isle State Park has administered agricultural activities in accordance to the lease. Continued agricultural activity represents a significant threat to the quality of the black oak woodland and sand barrens community on the Relict Dune landform. Continued use of agricultural herbicides directly harms populations of rare plants and potentially harms animal species. The effects of spraying were observed on field visits, and WPC ecologists suspect that proper care was not taken by the lessee to avoid the natural plant communities of the dune landform when spraying.

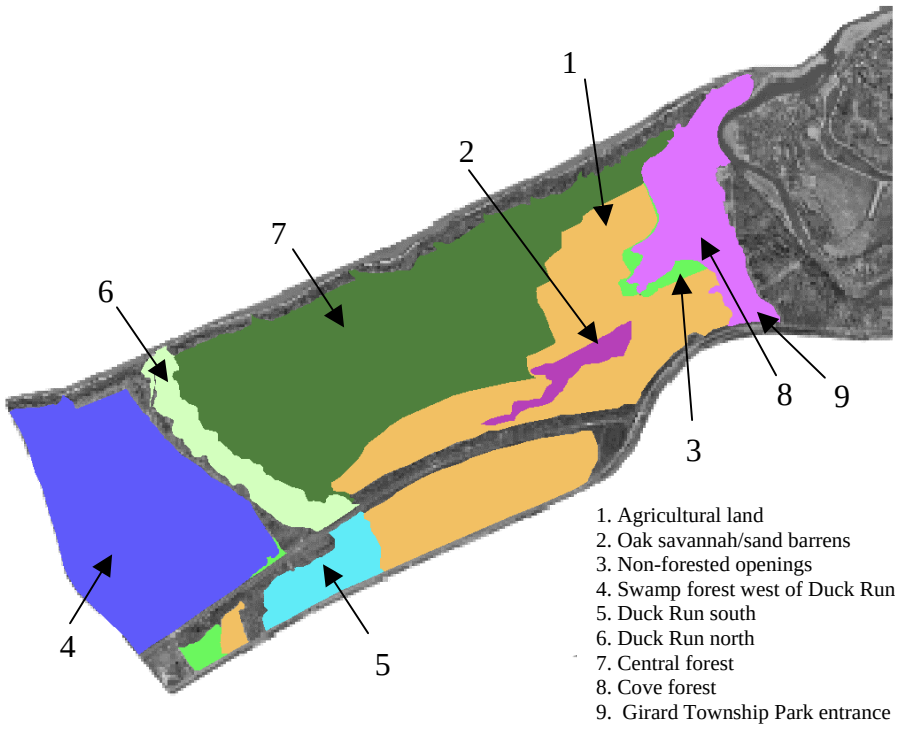


Figure 11. Regions of Eire Bluffs State Park sharing similar ecological attributes and history, Erie County, PA.

The oak savannah/sand barrens are a relatively small community patch (Figure 11, pt. 2). Invasive plant species and herbicides used in the surrounding agricultural fields further threaten sandbarren and oak savannah species. At least one third of the relict dune landform and several acres of forest located northeast of the agricultural fields are dominated by young black locust (*Robinia pseudoacacia*) trees, which are an early colonizer of pastureland. In the open areas, the native northern dewberry, and non-native plants such as spotted knapweed, sweet vernal grass,

orchard grass, and quack grass, have colonized much of the open sand barrens community and outcompete native sand barren species.

Other non-forested areas at Erie Bluffs described as successional herbaceous openings include recently abandoned agricultural sites and sites where periodic disturbance from ATV use or where periodic mowing has kept the site open (Figure 11, pt. 3).

Although the swamp forest west of Duck Run (Figure 11, pt. 4) is relatively young due to clear-cutting in the 1950s, and drainage appears to have been altered, this area is of relatively high quality. Poor access limits overuse by ATVs, the major factor contributing to ecosystem degradation in the Duck Run area. There is a substantial population of pumpkin ash (*Fraxinus profunda*), and the area has a high number of seepage wetland pools that are significant for amphibian conservation on the site (Maret in Bioblitz at Erie Bluffs; results of ephemeral pool sampling). Swamp red oak (*Quercus shumardii*), another tree species with a limited distribution in PA, is found along the Lake Erie coast. Hemlocks may have been more abundant historically in this area. However, there is little hemlock regeneration due to in part to the overbrowsing by deer. Without proper management, this species may never re-establish. There are few significant occurrences of non-native plant species in this area, most likely due to the high watertable and low-light levels beneath the canopy. The primary feature compromising site quality of this area is the utility lines along the east border between the swamp forest, the Duck Run escarpment, and along the top of the bluff face. These fragmenting features may limit wildlife movement and function as corridors for non-native and opportunistic native plant species.

The moderately sloping forested banks of Duck Run, south of the rail road tracks (Figure 11, pt. 5), appear to have sustained several different episodes of selective logging based on the presence of logging roads and the number of stumps in various stages of decomposition. Soil moisture is high and there are many seeps that flow into Duck Run. An upland area of even-aged younger tuliptrees, just north of Rt. 5, suggests the area was clearcut some time in the past 50 years. While non-native plant species are prevalent along Rt. 5, the railroad, and the utility lines that fragment this area, the interior hemlock-northern hardwood forest is of good quality, containing several large trees. However, because this area is effectively isolated from the rest of the site by the railroad line to the north and agricultural fields to the west, there is little potential to enhance habitat quality for species requiring interior forest conditions. The only corridor linking this area to the contiguous forest area to the north is a culvert through which Duck Run flows. Because the property south of the park is actively farmed, the forests in this area are directly impacted by agricultural runoff. The lack of forest canopy, agricultural runoff, and drainage from septic systems greatly affect the water quality of Duck Run (Campbell 2004, pers.com). A wetland situated south of Rt. 5, within the Duck Run watershed, filters agricultural runoff and sustains the palustrine seeps and ravines found in Erie Bluffs State Park. Since there was water in the swamp forest and ravine seeps observed throughout the summer of 2004, it is likely that this wetland may feed these areas in addition to the Duck Run watershed. More work is required to delineate the “groundwatershed” for this and other areas of the park.

The forested Duck Run floodplain and associated slopes to the north of the railroad tracks (Figure 11, pt. 6) contain some of the tallest trees (primarily tuliptrees, red oaks, and hemlocks)

on the property. Probably the most significant threat to site quality in this area has been uncontrolled ATV use. Much of the ATV damage has occurred in the last 10 years (Fuhrman 2004, Campbell 2004, pers.com) and has probably resulted in the loss of dozens of cubic feet of sediment along the Duck Run channel (Campbell 2004, pers.com). This abuse may have led to substantial changes in the natural meander pattern of Duck Run (Campbell 2004, Clemente 2004, pers.com). ATV use has significantly reduced the herbaceous ground cover and greatly impacted woody plant regeneration in areas of extremely high use.

The palustrine and upland forests of the central forest area (Figure 11, pt. 7) occur primarily on the Warren III lake plain, slump ravines, and escarpment tops, and represent part of the large contiguous forest area on the Erie Bluffs Property. However, the several small openings within the area reduce the quality of interior forest habitat. Since these areas were logged, early successional shrub and woody vine species have dominated. It is not clear at this time why these areas have remained shrub-dominated and not succeeded to forest as have other areas within the section. At the eastern end of this area, a narrow stand of black locust along the bluff's escarpment top functions as the only corridor between the cove forest and the central forest area.

There is a substantial ravine seep in the cove forest area just to the east of the agricultural fields (Figure 11, pt. 8), which is similar to the ravines found in the central forest area. Water from this seep flows into Elk Creek. Outside of the ravine slopes of the central forest section, the cove forest possibly contains the largest intact stand of "older-growth" trees on the Erie Bluffs site. However, it is relatively isolated from the rest of the Erie Bluffs forests by the agricultural fields. The slopes of the Elk Creek ravine are extremely steep and appear to be fairly unstable due to the many seeps. Garlic mustard is prevalent on the edge of this area, and development of the Elk Creek Access parking area has greatly altered the composition and structure of the cove forest adjacent to the Elk Creek floodplain.

The quality of the habitats of the Girard Township Park (Figure 11, pt. 9) are not completely known as WPC survey efforts were concentrated in the section of Erie Bluffs owned by the State. However, this area will represent the most highly developed area on the park property once this area is transferred to the State. The developed recreation area includes a substantial amount of paved surface in the form of roads and parking lots and represents a fragmenting feature, separating the forests of Erie Bluffs and Elk Creek. Rustic bathroom facilities and garbage dumpsters take away from the site's aesthetic quality. While the parking lot is vacant most of the time, it is full during certain seasons, especially during steelhead migration from Lake Erie into Elk Creek. Water, flowing from the seepages on the cove forest slopes, flows beneath the road through culverts and through a ditch next to the parking lot, and eventually to Elk Creek. Oil and other substances from parked vehicles are carried by runoff directly into Elk Creek from this area. Much of this area is maintained as lawn and mowed often throughout the summer season.

SIGNIFICANT FOREST AREAS

Using accurate tree dimension measurements associated with select coring of trees can be an essential tool for educational purposes and to help conserve or preserve special areas of interest. Over the course of two years, 65.8 acres of significant forest area, representing mature forest communities, were assessed at Erie Bluffs State Park by Dale Luthringer of Cook Forest State

Park, and WPC ecologists. Luthringer documented at least eight trees that are ranked near the top of the list as some of the tallest documented tree specimens in either Erie County, Pennsylvania, or the Northeastern United States. The oldest tree documented is an Eastern hemlock on the escarpment top, determined to be 170 years old. Older specimens may still be found. The entire Erie Bluffs area has experienced some type of logging activity (excluding the steep cliffs), prior to the property transfer dating as far back as the early to mid-1800s. Several select trees and stands appear be 125 to 170 years of age. There are most likely specimens of Eastern hemlock, American beech, sugar maple, butternut, northern red oak, and cucumber trees well over 150 years old.

Erie Bluffs State Park ranks 7th out of 21 sites thus far documented by the Eastern Native Tree Society in Pennsylvania and currently stands in the top 1/3 of documented tall tree sites in the state (Table 5). It is interesting to note that the average heights of the ten tallest different tree species at Erie Bluffs surpasses those found in other well known natural areas such as Hemlocks, Heart's Content, Alan Seeger, Tionesta, Detweiler Run, and Bear Meadows.

Table 5. Ranking of areas evaluated by the Eastern Native Tree Society in terms of trees less than or equal to 12 feet CBH and 100 feet high

Site	# Species	# Trees	% of Total
Allegheny River Islands Wilderness Area	9	2	9
Anders Run Natural Area	2	4	4
Clarion River	1	2	2
Cook Forest State Park	6	37	37
Delaware Water Gap National Recreation Area	2	2	2
Detweiler Run Natural Area	1	1	1
Erie Bluffs	**4**	**6**	**6**
Fairmont Park	2	3	3
Glenwood Park	1	1	1
Heart's Content Natural Area	1	6	6
Hemlocks Natural Area	1	1	1
Lake Erie Community Park	2	2	2
Ridgway	1	1	1
Scott Community Park	3	5	5
Sisters of St. Francis	6	8	8
Spencer Estate	1	1	1
Tionesta Scenic & Research Natural Area	1	1	1
Valley Forge Park	1	1	1
Walnut Creek Gorge	2	5	5
Wintergreen Gorge	2	4	4

The most significant area for older growth trees is the Lake Erie escarpment forest on the escarpment tops of the Lake Erie Bluffs (Figure 12). This site is composed of several communities, some that exist in a perpetual successional state due to severe weather and erosion associated with the park's close proximity to Lake Erie and highly erodible soils. Most of the species along the escarpment are early successional in nature and not significant in terms of age. The oldest trees are those on the top edge of the cliff that were left following various logging

operations throughout the early to late 1800s. These include an Eastern hemlock approximately 170 years old and a northern red oak that is approximately 125 years old.

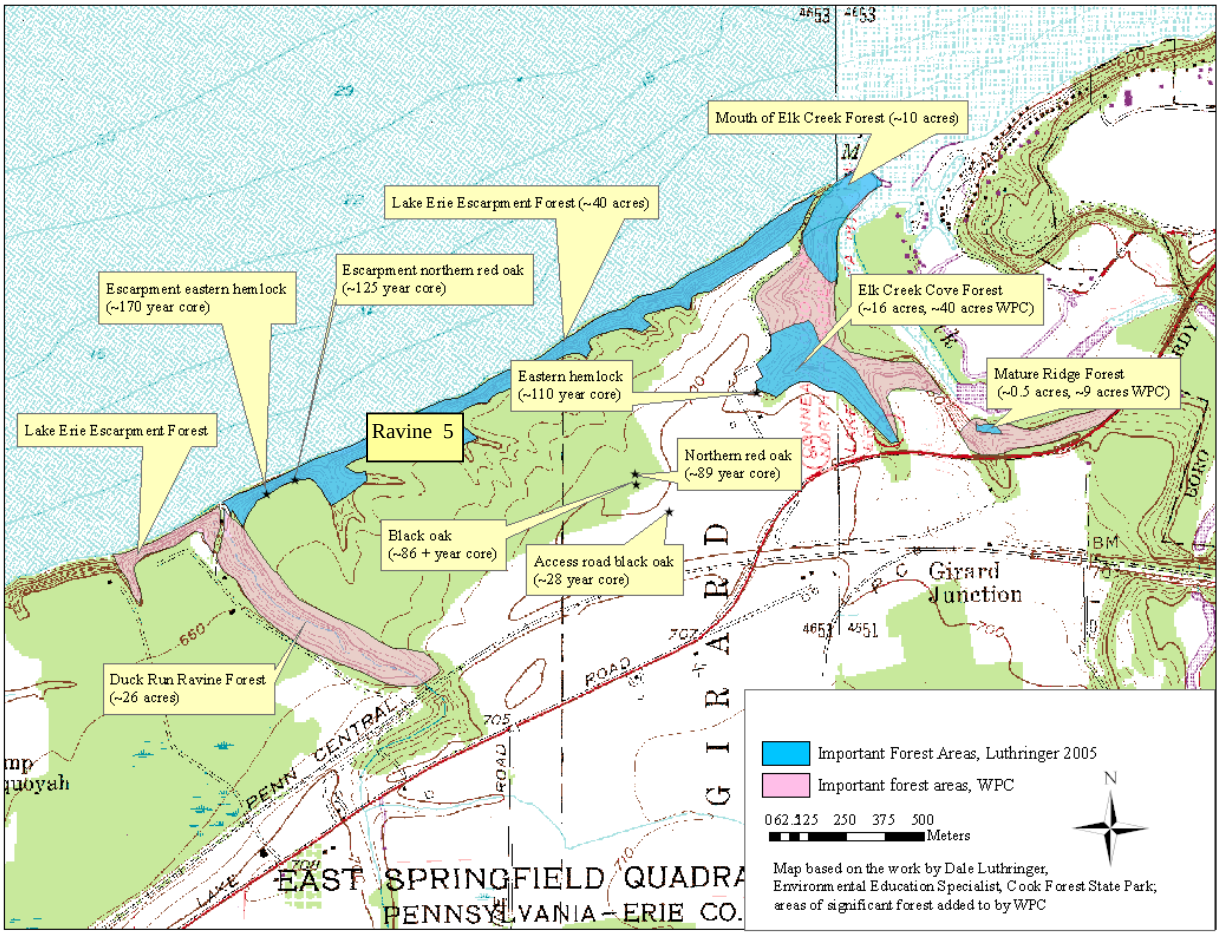


Figure 12. Significant forest areas based on the work by Dale Luthringer from Cook Forest State Park, and WPC ecologists.

The second tallest documented sassafras in the state (5.1 feet CBH x 98.4 feet high) (CBH is Circumference Breast Height) is located on the western end of this area near ravine number five, east of Duck Run. To date, this particular tree has been documented by members of the Eastern Native Tree Society as the third tallest documented sassafras in the entire Northeastern United States (Table 5). The second tallest sassafras in the Northeastern US, which happens to be the tallest sassafras found in Pennsylvania (4.3 feet CBH x 100.5 feet high), is located in Wintergreen Gorge. The mouth of ravine number five is home to one of the largest documented forest-grown single stem white ash in Erie County, and measures 12.3 feet CBH x 116feet high (42 00.914N x 80 23.637W, Table 6). Other significant trees at Erie Bluffs are found in Table 6.

Table 6. The following is a list of the most significant big trees found to date at Erie Bluffs, documented by Dale Luthringer, an Environmental Education Specialist for Cook Forest State Park.

Species	CBH	Height	Site	Comments
Juglans cinerea	5.8	104.6	Lower slopes Elk Creek	tallest documented Pennsylvania, 2nd tallest NE US
Populus deltoides	8.5	125.4	Mouth Elk Creek	tallest documented Pennsylvania
Quercus rubra	9.7	123.4	Duck Run	tallest documented Erie County
Sassafras albidum	5.1	98.4	Slump Ravine 6	2nd tallest documented Pennsylvania
Liriodendron tulipifera	8.4	140.3	Duck Run	3rd tallest documented tulip stand Erie County
Liriodendron tulipifera	12.7	105.1+	Slump Ravine 5	
Liriodendron tulipifera	14.7	111.1+	Central Forest between field edge and ravine 5	
Fraxinus americana	12.3	116	Slump Ravine 6	possibly largest forest grown single stem Erie County

The Duck Run Ravine is home to several of the park's tallest trees. The tallest tree at Erie Bluffs State Park is a tuliptree that measured 8.4 feet CBH x 140.3 feet tall. There are a number of tuliptrees in this ravine that make it into the upper 130 feet height class. Although the Erie Bluffs tuliptree is not the tallest in the state, the site currently is the 3rd tallest ranking ravine in terms of large trees in Erie County, behind Wintergreen Gorge on the campus Penn State Behrend and Lake Erie Community Park (Table 13). The tallest concentration of northern red oaks at Erie Bluffs is also located in this area (42 00.744N x 80 23.846W) with the tallest reaching 9.7 feet CBH x 123.4 feet tall. This is currently the tallest documented northern red oak in Erie County.

The second most significant forest stand in terms of mature older growth trees is situated in the cove forest slopes west of Elk Creek. Luthringer surveyed roughly 15.6 acres of mature forest consisting of the finest sugar maple and American beech within the park (Elk Creek slope). The tallest documented cottonwood in the state (8.5 feet CBH x 125.4 feet high) is also located here (42 1.237N x 80 22.509W), due west of the Elk Creek Access parking lot by no more than 30 yards.

Luthringer determined that the forests near the mouth of Elk Creek, located on a flat area due west of the mouth of creek, were also significant. This mature forest consists mainly of tuliptree, bitternut hickory, and sugar maple, with a scattering of Eastern hemlock. This stand is approximately 10 acres and is immediately adjacent to the cove forest slopes described above. It is also home to the tallest documented butternut in the state at 5.8 feet CBH x 104.6 feet high (42 1.353N x 80 22.538W).

A very small patch of mature forest (0.4acres) lies along a finger-like ridge and ravine that drains into Elk Creek about 2600 feet southeast from the main Elk Creek Access parking lot. The oldest cucumbertrees on the property are found on this steep "finger." One cliff-edge-cucumbertree in particular may be upwards of 200 years old. It appears that this small patch, situated in the middle of what is a much larger (approximately 9 acre) patch of cove forest between the Elk Creek Access area, was left unharvested due to inaccessibility. Large red and black oaks are also found along the escarpment top and upper slope of the cove forest.

Additionally, there are large trees found on the flat just west of the Rt. 5 bridge that crosses Elk Creek. A downed black walnut probably exceeded 15 feet CBH and may have represented one of the largest single stem forest-grown black walnut trees in the state. A heavily leaning sycamore measured 14.7 feet CBH x 96.4 feet high. These two trees would most likely have exceeded 200 years of age.

SITE SENSITIVITY

Landscape Sensitivity Based on Rare Species and Community Elements

WPC ecologists first identified the Erie Bluffs area as part of the exceptionally significant Lake Plain Shoreline Biodiversity Area (BDA) in the Erie County Natural Heritage Inventory based on the high number of rare plant species and plant community elements (Kline 1993). A BDA is used by PNHP to identify sites of high natural value that include several populations of rare plants and animals and rare naturally occurring plant communities. PNHP field methodology includes mapping and documentation of each population of rare plant, animal, or natural community (i.e. occurrence). The occupied area is referred to as the "core area," or the population's area. Following core area mapping, the "supporting landscapes" were determined based on PNHP conservation planning specifications for each element. Conservation planning specifications are guidelines for identifying the area of landscape important in the support of the element. They may incorporate physical factors (i.e. slope, aspect, hydrology) and biological factors (plant community composition, species interaction) and are based on scientific literature, expert judgment, or specifications provided by jurisdictional agencies. The two areas together, referred to as "conservation-planning polygons," were identified and mapped for each rare species and community element found at Erie Bluffs State Park. Conservation-planning polygons are an important tool for conservation, planning, and restoration purposes.

For occurrences of rare plants and communities at Erie Bluffs, conservation planning polygons included the area occupied by the element (core area) and a minimum buffer of 200 meters minus non-supporting habitat (i.e. for terrestrial plant species, Lake Erie) if habitat requirements were not known. The supporting area may often be extensive because of the large dispersal distances or foraging territories of a species, or to maintain the level of water quality and quantity required for a species or community. For example, the supporting landscape area for plant and community elements in Duck Run was extended to the boundary of the watershed, south of the park, for protection of water quality.

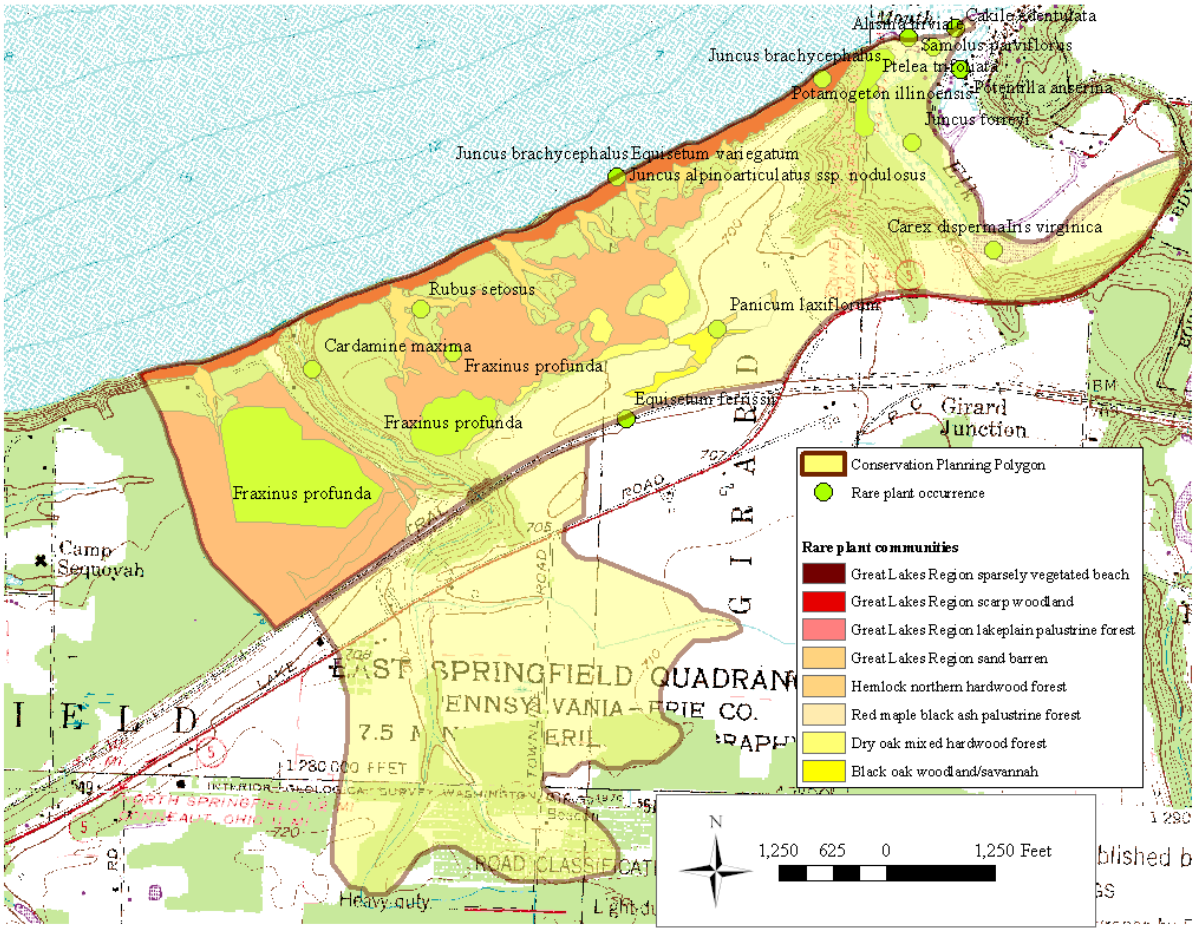


Figure 13. Aggregated conservation planning polygons for rare species and community elements at Erie Bluffs State Park, Erie County, PA (Base map: USGS 7.5-minute quadrangles Fairview, PA, Fairview SW, PA Springfield PA).

Maintenance of water quantity and quality within the supporting landscape is essential to protecting habitat quality for certain species, such as seepage wetland obligates of the Great Lakes Region palustrine forest community.

The aggregated conservation planning polygons for all species and community elements are presented in Figure 13. For palustrine and scarp seep communities, and species found in those communities, the community patch, plus adjacent upland areas, were used to represent the conservation-planning polygon. Because of this, nearly the entire Erie Bluffs site falls within the aggregated conservation-planning polygon for all elements of concern.

Conservation

While areas identified as core areas should be managed for the preservation of critical habitat for the protection of that species, supporting natural landscape designation, while important to the viability of an element or its habitat, may be able to support conversion of limited portions of the area for moderately disruptive uses (i.e. small-scale, low impact infrastructure, certain types of active recreation, or sustainable forestry) without detriment to the resource. All activities taking

place within the supporting area should be evaluated to determine the direct and indirect impacts to the element of concern. This designation would apply to areas that do not contain elements or habitat but support large-scale landscape processes necessary for the viability of an element or its habitat, areas that provide habitat for prey species for an animal species of concern, or areas that are important to limit development that would decrease water quality, critical to wetlands and aquatic systems down-slope. It is important to understand the value of maintaining the hydrologic character of the site for conserving these communities and the species within. Maintaining habitat buffers should also be a part of conservation planning for supporting landscapes.

Landscape Sensitivity Based on Soils and Physiography

Hydrology

The quantity and quality of water are important factors influencing plant species distribution and community composition at Erie Bluffs State Park. However, hydrology of the site, especially the extent of the recharge zone for the slump ravines and palustrine forests, remains largely unknown. Maintaining groundwater quantity and quality was an important factor when determining the conservation planning polygons and therefore the watershed boundary was used to determine the extent of the supporting landscape area. Activities that significantly alter the drainage pattern of groundwater inputs to the scarp seep communities, or reduce the quality or quantity of water to the palustrine seepage wetlands of the lake plain community, may negatively affect plant populations and habitat quality. For example, saturated soil conditions are necessary to sustain the red maple-black ash palustrine forest community. Figure 14 below depicts plant community types described as “palustrine” (wetland), or possessing seeps or saturated soils at the time of field inventory. In these systems, a potential result of decreased groundwater flow is the invasion of terrestrial plant species formerly limited by their intolerance to saturated soils. For species like pumpkin ash, which is limited to the flats of former glacial lake beds, altering drainage may result in its replacement in the forest canopy.

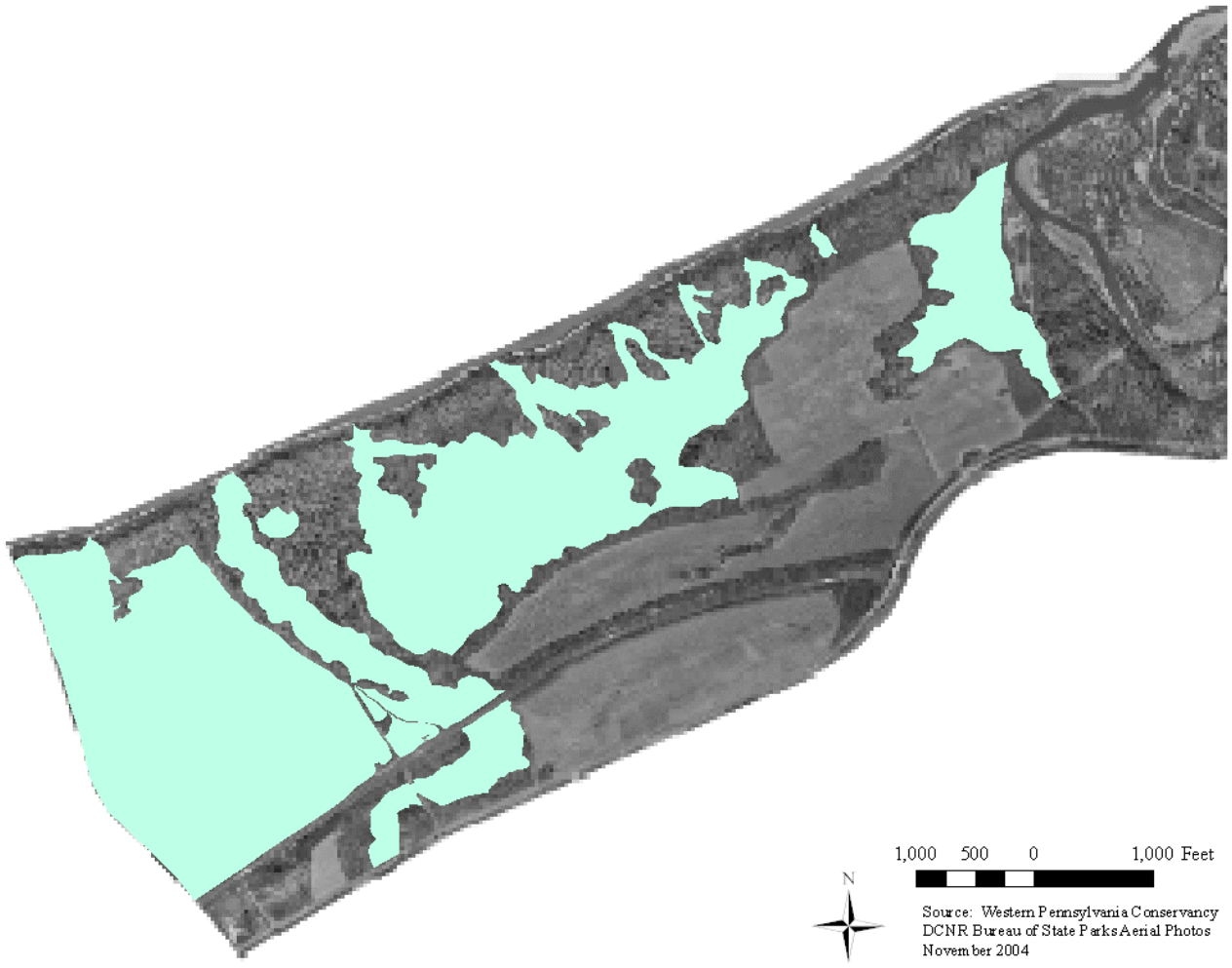


Figure 14. Plant community types at Erie Bluffs State Park occurring on saturated soils or where seeps are present.

While figure 14 depicts communities in areas of saturated soils, this map does not account for the "recharge zone" (upslope areas that contribute water to these systems via subsurface groundwater flow). The conservation planning polygons for rare species depicted in Figure 13 account for this. However, a better delineation of the "ground-watershed" is needed to adequately protect the palustrine forests and slump ravine communities. In these areas any development and recreation planning activities should be evaluated for their impact on the quality and quantity of groundwater and surface flow. Conservation, recreation, and development planning should plan for maintenance of the hydrologic character for each of the slump ravines, which are important inputs to Lake Erie.

Steep slopes

A map depicting areas with slopes greater than 25 percent at Erie Bluffs State Park was created from the DCNR shapefile with 2 feet interval topographic lines (Jeff Johns, Bureau of State Parks) (Figure 15). This map depicts slopes that characterize the slump ravines, Lake Erie bluff face, and the ravine slopes of Duck Run and Elk Creek. Because of their steepness, these areas should be of highest conservation priority, and activities within limited to those that do not interfere with slope stability. There are very few activities that are compatible with site protection, and therefore, all activities should be limited to those that ensure or enhance slope stability and protection. Considerable attention should be paid to enhancing slope stability and plant community quality on degraded areas, such as those along the slopes of Duck Run.

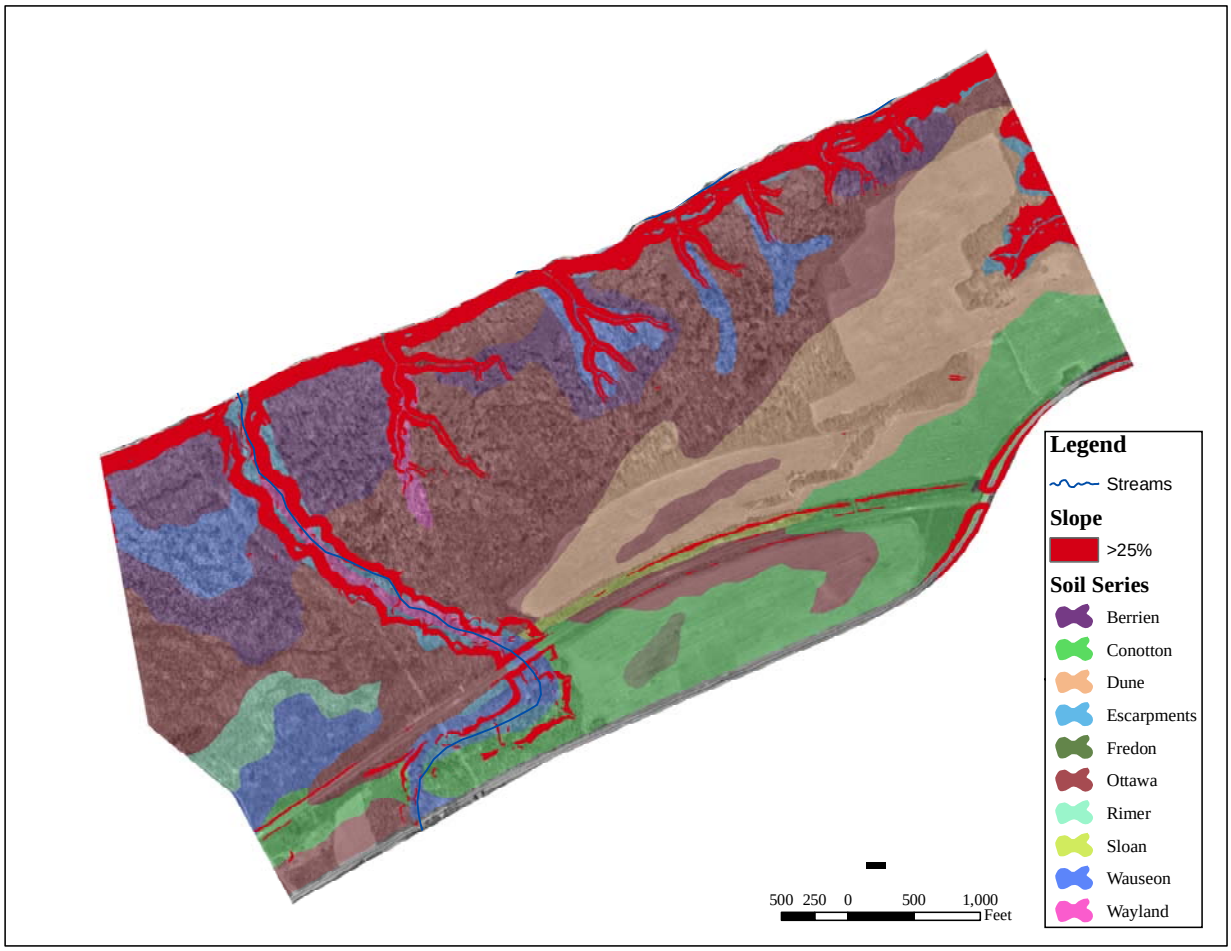


Figure 15. Map depicting areas of high slope (greater than 25 percent slope) at Erie Bluffs State Park. Source: Erie County Soil Survey (Taylor 1960); Topographic contour intervals AutoCad data layer DCNR Bureau of State Parks 2004. Map created by WPC.

Soil Suitability

Sites at Erie Bluffs were evaluated for conservation need based on soil limitation ratings for development activities (Erie County Pennsylvania Soil Interpretations Manual, PA Department of Environmental Resources 1972), a companion to the Soil Survey for Erie County Pennsylvania (Taylor 1960). Soil limitations for certain activities were summarized and presented in Figures 16 and 17. Soils rated as "severe" indicate areas with soil types that are not conducive to development and therefore should be managed as conservation areas. Activities considered in this analysis (buildings with and without basements) were chosen because they represent the greatest impact to the system. The combination of the steep slopes of the bluffs and ravines, high water table, and perennially saturated soils of the lake plain landform limit the potential for development activity over much of the Erie Bluffs site. Soils of the dune and beach ridge landforms have not been rated for building potential and therefore need to be evaluated as to their limitations. Additionally, no hydrologic assessments have been conducted at the site to determine the path of the flow of precipitation and runoff after it enters the upper sandy upper soil horizons.

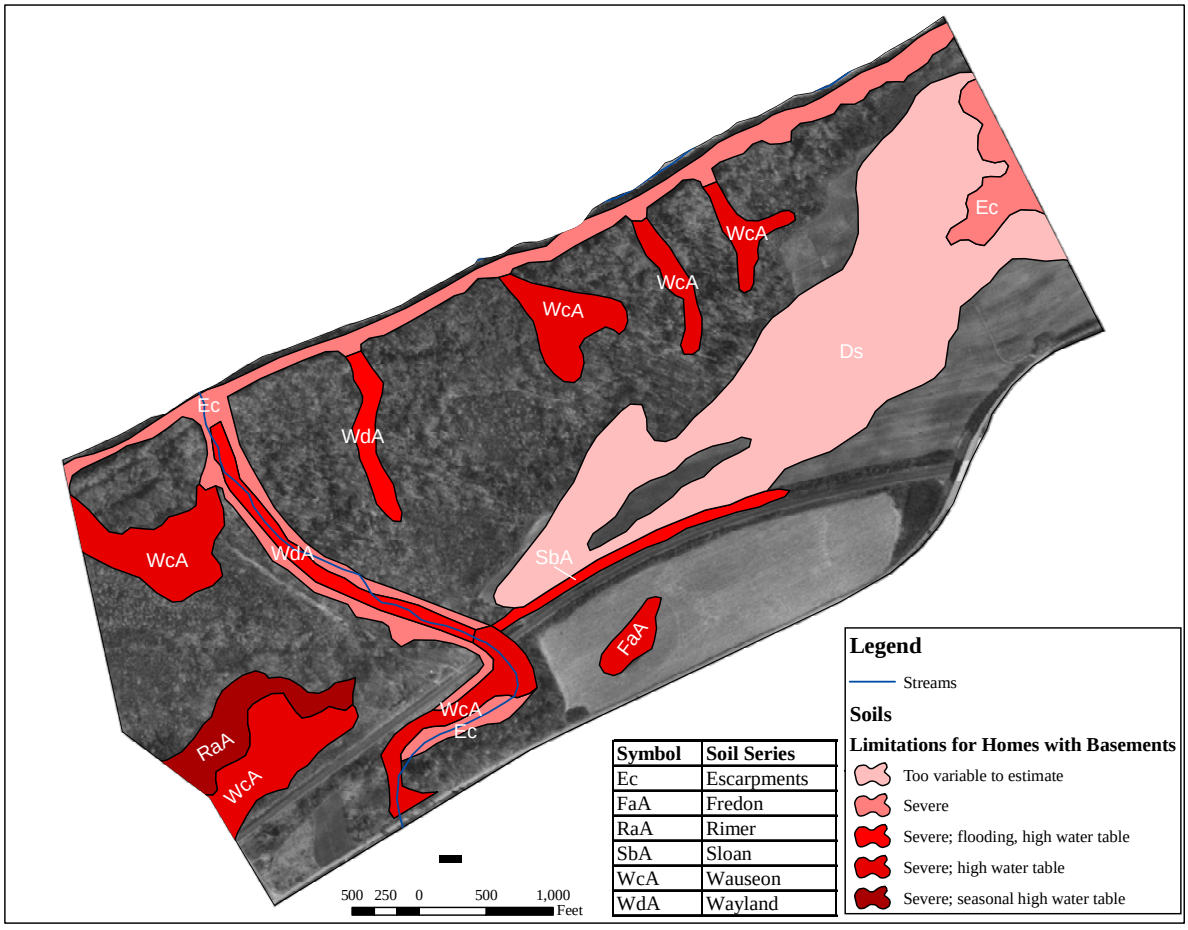
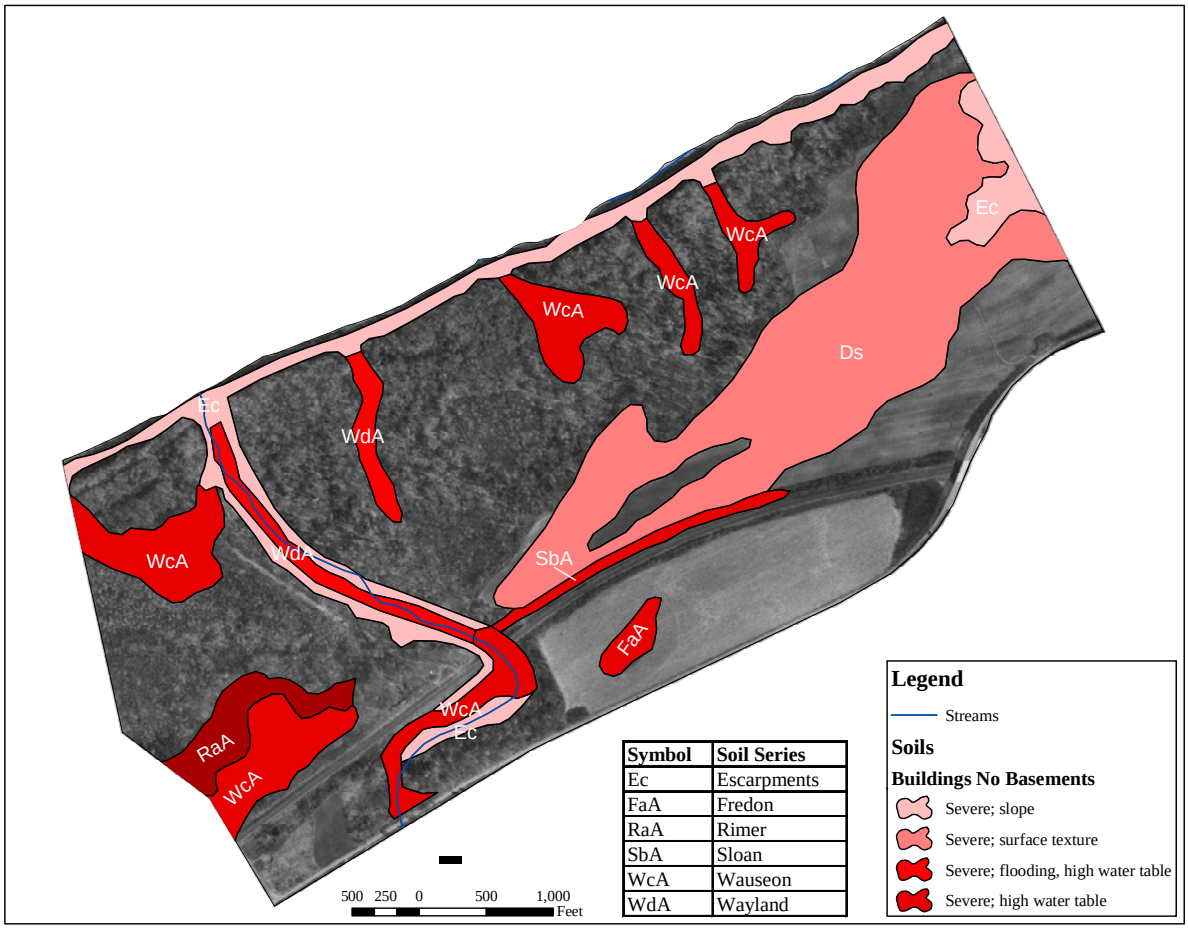


Figure 16. Soil series and limitation rating for development (buildings with basements) of areas at Erie Bluffs State Park.



Symbol	Soil Series
Ec	Escarpments
FaA	Fredon
RaA	Rimer
SbA	Sloan
WcA	Wauseon
WdA	Wayland

Figure 17. Soil series and limitation rating for development (buildings with out basements) of areas at Erie Bluffs State Park.

RESTORATION OPPORTUNITIES

While Erie Bluffs State Park has been described as having one of the last remaining tracts of forested land along the Lake Erie coast of Pennsylvania, fragmentation from power lines and roads, the high amount of forest edge relative to interior, and the number of recently clear-cut patches within the forest of the central forest region, compromise the overall quality of the site. Years of abuse from off-road vehicles have further impacted site quality. It is difficult to determine the impact of a highly developed zone of recreation to an ecosystem already heavily fragmented by agriculture. However, increases in impervious surfaces and permanent fragmentation of the forests by structures, transportation, and parking lots will further reduce the habitat quality of sites not currently under active agriculture.

Restoration of these degraded sites to their native habitats will provide critical buffers to protect occurrences of rare plant and animal species and patches of naturally occurring high quality native communities, enhance interior forest habitat, and protect slope stability and water quality. The Erie Bluffs site presents an opportunity for restoration of a rare naturally occurring complex of sand barren, mesic hardwood forests and oak savannah communities. Mike Campbell and students from Mercyhurst College have been investigating the efficacy of different restoration methods in the Duck Run ravine (Campbell 2004, pers.com).

Two major types of restoration opportunities exist at Erie Bluffs: (1) enhancing habitat quality by improving degraded sites, and (2) re-establishment of native habitat types in areas that are currently farmed. Within these major categories, specific opportunities are depicted in Figure 18. Table 7 lists the sites, categories, and general restoration strategies. Specific management options addressing activities for restoration categories are addressed in the following section.

- Restoration of areas degraded or destroyed by ATVs
- Restoration of native habitats modified by invasion of aggressive native and non-native species (restoration of degraded sand barrens and sites dominated by black locust)
- Re-creation of sand barren oak savannah community complex on sites that are currently farmed in order to increase patch size, connectivity and enhancement of corridors
- Re-forestation of clearcut areas
- Restoration of weedy, successional habitat patches
- Restoration of degraded sand barren sites

Enhancing habitat quality by improving degraded sites

Participants in the 2004 BioBlitz at Erie Bluffs recorded several species of neotropical migratory birds in the central forests of the park. These species require unfragmented interior forest landscape with at least a 100-meter buffer from the forest edge. Therefore, the successional woodland patches resulting from clearcutting within the forests between Elk Creek and Duck Run area should be a focus of restoration activities to increase interior forest habitat. Restoration activities should focus on removal of grape (*Vitis spp*.), black berries (*Rubus spp*.) and sumac (*Rhus typhina*) in order to facilitate recruitment of forest trees. Increasing the percent of Eastern hemlock would add a conifer component to the forest canopy. While restoring forests to increase the overall area of core forest is recommended, these open, successional patches may present

Table 7. Restoration areas by numbered patch. Patch number corresponds to map depicting current plant community.

Numbered patch	Restoration category	Current plant community	Restoration goal	Restoration Method
21	Patches compromised by black locust	Black locust forest with honeysuckle understory	Black oak savannah/sand barren complex	Use of herbicide, cutting, use of prescribed fire in restoration, transplant native species, such as black oak seedlings from adjacent community patches on dune
81	Patches compromised by black locust	Black locust forest	Northern hardwood forest	Use of herbicide, cut black locust, multiflora rose and honeysuckle. Allow red maple and sugar maple to establish naturally
94, 103	Patches compromised by black locust	Black locust forest	Sugar maple basswood forest	Use of herbicide, cut black locust, multiflora rose and honeysuckle. Allow red maple and sugar maple to establish naturally
103	Patches compromised by black locust	Black locust forest	Black oak savannah/sand barren complex	Use of herbicide, cutting, use of prescribed fire in restoration, plant black oak seedlings from adjacent community patches on dune
42, 50, 44, 47, 49, 105,106	Patches with significant ATV damage	Hemlock – northern hardwood forest/ Northern hardwood forest	Hemlock – northern hardwood forest/Northern hardwood forest	Control erosion, eliminate ATV use, control deer to facilitate establishment of woody species
114	Patches with significant ATV damage	Sugar maple-basswood forest	Sugar maple-basswood forest	Control erosion, eliminate ATV use, control deer to facilitate establishment of woody species
108, 109, 110	Patches with significant ATV damage	Great Lakes Region lake plain palustrine forest (and shrubland)	Great Lakes Region lake plain palustrine forest	Control erosion, eliminate ATV use, control deer to facilitate establishment of woody species
100, 111	Patches with significant ATV damage	Dirt road	Northern hardwood forest	Eliminate ATV use, allow native species to establish
15	Reforestation of clearcut areas	Early successional woodland	Northern hardwoods forest	Remove areas of thick grape vine, blackberries; plant seedling tree from nearby forest patches
28, 30, 34, 35, 36	Reforestation of clearcut areas	Early successional woodland	Sugar maple-basswood forest	Remove areas of thick grape vine, blackberries; plant seedling tree from nearby forest patches
74, 75, 98,	Reforestation of clearcut areas	Early successional woodland	Great Lakes Region lake plain palustrine forest	Remove areas of thick grape vine, blackberries; plant seedling tree from nearby forest patches

68, 69, 87, 115, 128	Restoration of weedy successional habitats	Early successional woodland	Northern hardwoods forest	Control invasive species using herbicide; increase buffer area
86. 90	Restoration of weedy successional habitats	Early successional woodland	Black oak woodland savannah/sand barren complex	Control invasive species using herbicide; increase buffer area (see re-creation of black oak savannah)
115	Restoration of weedy successional habitats	Successional herbaceous opening	Northern hardwoods forest	Control invasive species using herbicide; plant seedling tree from nearby forest patches
97	Restoration of weedy successional habitats	Tuliptree beech maple	Great Lakes Region lake plain palustrine forest	Control invasive species using herbicide; plant seedling tree from nearby forest patches
101	Restoration of weedy successional habitats	Early successional woodland	Sugar maple basswood forest	Control invasive species using herbicide; plant seedling tree from nearby forest patches
20,22, 67, 121	Restoration of degraded sand barrens	Sand barren (degraded)	Great Lakes Region sand barren	Use of herbicide, cutting, use of prescribed fire in restoration, transplant native species, such as black oak seedlings from adjacent community patches on dune
113	Re-creation of black oak savannah/sand barren complex	Row crops	Black oak savannah/sand barren complex	Use of herbicide, cutting, use of prescribed fire in restoration, transplant native species, such as black oak seedlings from adjacent community patches on dune
12	Re-creation of black oak savannah/sand barren complex	Early successional woodland	Black oak savannah/sand barren complex	Use of herbicide, cutting, use of prescribed fire in restoration, transplant native species, such as black oak seedlings from adjacent community patches on dune

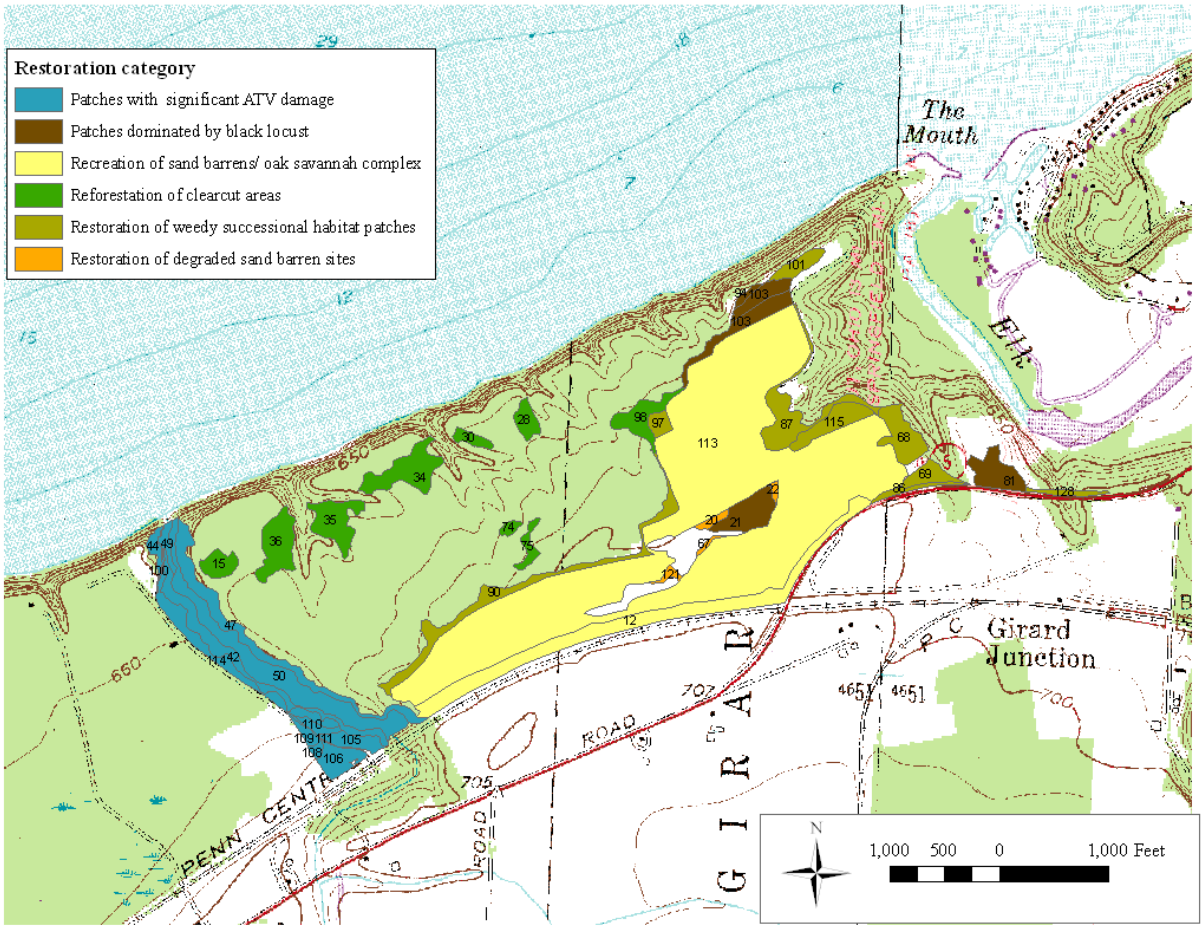


Figure 18. Map of potential restoration areas at Erie Bluffs State Park, Erie County, PA. Patch number corresponds to map depicting current plant community.

opportunities for game species (white-tail deer, grouse, etc.) that require edge habitats and could be retained depending on management goals for this area. ATV use has also reduced the habitat quality along the slopes and floodplains of Duck Run. The northern portion of the Duck Run floodplain has received the most significant damage from ATVs at Erie Bluffs. Allowing vegetation to re-establish will reduce erosion and sedimentation and improve overall water quality.

For the dune ecosystem and forests along the edge of the agricultural fields, the establishment of aggressive non-native and opportunistic native plant species has compromised habitat quality for some of the last remaining sandbarrens and oak savannah community types in Pennsylvania. At least one third of the relict dune landform, and several acres of forest located northeast of the agricultural fields, are dominated by young black locust trees; a species native to the southern Appalachians, but probably not native to the Lake Erie Basin. The native northern dewberry and non-native plants such as bush honeysuckle, multiflora rose, spotted knapweed, sweet vernal grass, orchard grass and quack grass are also significant threats to the sand barrens. These species have been the primary concern of ecosystem management activities at the Cleveland

Museum of Natural History's Kingsville Sand Barrens Natural Area, situated along the Lake Erie coastline of northeastern Ohio. There, land managers have had great success restoring the black oak savannah community through a combination of conservative management activities such as hand-pulling, mowing, employing herbicides, and prescribed burning. In recent years, they have observed a return of native species such as lupine (*Lupinus perennis*), bug-on-a-stick moss (*Buxbaumia aphylla*), racemed milkwort (*Polygala polygama*), and Bicknell's geranium (*Geranium bicknellii*), following removal of black locust and non-native invaders. While such a recovery may not occur immediately at Erie Bluffs, restoration of this community type would provide the necessary habitat for the successful introduction of sand barrens and oak savannah species. A list of plant and animal species found at North Kingsville Sand Barrens Preserve can be found in Appendix E.

Re-establishment native habitat types on sites that are currently farmed or are developed
Although the oak savannah and sand barren communities of the dune ridge at Erie Bluffs are unique to Pennsylvania, they are very small. These community patches are essentially isolated from the rest of the site; in particular, the older-growth mixed oak hardwoods community type of the beach ridge, north of the agricultural fields. Creation of a functional oak savannah corridor linking the communities on the dune with the oak forest would provide an opportunity to restore natural patterns of plant and animal dispersal for similar ecosystems based upon shared soil types. As habitat patch size increases, populations increase and core areas are better buffered, thereby increasing the resiliency and viability of plant communities. The "dune sand" soil type of the agricultural areas at Erie Bluffs is similar to that of the sand barren and oak savannah community type of the relict dune, suggesting that re-establishment of these two natural community types in areas now farmed would be possible (Campbell 2004, Bissell 2004, pers.com). Recovery of the black oak savannah plant community in the farmed areas will increase patch size of this rare community type, increase habitat for rare species found only in these habitats, and reconnect this habitat with oak types in other areas of the site. Restoring areas severely altered by human activities through joint efforts of park planners and conservation scientists would enhance the viability of the site.

In addition to the need for restoration of the sand barren and oak savannah communities, there is a need for increased forest cover within the Duck Run watershed south of the Erie Bluffs property, south to Middle Road, Springfield Township. The lack of forest canopy, and the presence of agricultural runoff and drainage from septic systems, greatly affects the water quality of Duck Run (Campbell 2004, pers.com). It is possible that an increase in forest cover in the watershed south of Rt. 5 may improve the potential for Duck Run to provide cold-water stream habitat for native brook trout (Campbell 2004, pers.com).

While there is an acknowledged desire to maintain public access to the mouth of Elk Creek, restoration projects within the Girard Township Park could work to reduce the "ecological footprint" of the developed area. This would increase the water quality of Elk Creek and improve habitat value to wildlife species at the mouth of the river. Day-lighting the streams flowing from Elk Creek cove forest seeps, and restoring their natural meandering pattern, would improve water quality. Decreasing the amount of impervious surface area through a reduction in size of the parking lot, or by replacing asphalt with more porous materials, would also substantially improve the aquatic habitat of Elk Creek. Improving the rustic bathroom facilities would reduce

the impact of leaching from the pit toilets into the creek system. Creating a more sustainable planting plan for the maintained "lawn" areas, including the use of native grasses or re-establishing forests would increase the protective cover for wildlife and reduce maintenance costs over the long term. A plan for the restoration of the upper parking lot should call for a reduced impervious surface area and restoration of native forest habitat, which is currently dominated by black locust.

SITE MANAGEMENT OPTIONS

The overall objectives for the ecological management of Erie Bluffs State Park should focus on maintaining and enhancing populations of rare species and elements, maintaining and enhancing ecological viability by increasing patch size and site connectivity through restoration, maintaining the relationship of site hydrology and ecosystem (habitat) character and function, and controlling non-native invasive species.

OVERALL PROPERTY MANAGEMENT OPTIONS

The following general management options are provided as holistic perspectives for Erie Bluffs management.

1. Develop an ecological park management plan that will address the protection, restoration and maintenance of biodiversity resources;
2. Designate the forested area and relict dune areas of Erie Bluffs State Park as State Park Natural Areas or Native Plant Sanctuaries;
3. Develop a hydrologic overview and model of the site to incorporate into the management plan; and
4. Establish ecoregional objectives for the management of biodiversity resources through joint "sister preserve" relationships between Erie Bluffs State Park and other managed areas along the Lake Erie coast (e.g. North Kingsville Sand Barren Preserve of the Cleveland Museum of Natural History).

SPECIFIC SITE MANAGEMENT OPTIONS

The following is a discussion of site-based management options based on the WPC assessment and should present management options consistent with maintaining and enhancing the high ecological quality of the entire Erie Bluffs State Park site.

1. Bluff Face and Escarpment Top

The bluff face supports the greatest number of species and community elements of concern and supports older growth Eastern hemlock, sugar maple, and red oak trees. In addition, its steep, highly erodible slopes make it one of the most sensitive sites on the property.

The escarpment tops, while relatively stable compared to the actively eroding bluff face itself, should be considered sensitive because of the rapid rate of bluff recession, and the potential for accelerated slumping and associated changes in the site's hydrologic regime caused by increased development and recreational use. The extensive root systems of the overstory trees may contribute to the stability of the escarpment tops. Removing some or any of the large trees along the escarpment top may accelerate erosion.

Although the bluff face seeps are not as extensive or voluminous as those in the ravines, the presence of these discharges is important in terms of natural community and rare plant species maintenance. Therefore, both the quantity and quality of the groundwater that maintains the seeps is a conservation and planning concern. The quality and quantity of groundwater seepage is linked to aspects of recharge maintenance within the seep watersheds. These are areas that are

most effectively protected through the protection of natural vegetation and soils in the upper reaches of watershed recharge zones.

Specific management options for this area include:

(1) Develop a recreational hiking trail plan to direct traffic along, but set back from, the escarpment top. Control access to the edge of the bluff and limit access to a few designated areas.
(2) Limit access to the bluff face itself to prevent increased erosion from increased recreation.
(3) Monitor invasive species on the bluff face. More work is needed to determine the impact of these non-native plants on native plant populations and methods of non-native plant control on the bluff face. Care should be taken in project planning and implementation as activities to remove invasive exotic plants may actually increase the rate of bluff erosion slumping.
(4) Establish recharge zone mapping within the park management plan and link to the decision-making process for immediate and future site management.

2. Slump Ravines and Seeps

The slump ravines of Erie Bluffs State Park contain probably the best example of what this entire property looked like before recent extensive harvesting occurred. Because of the many seeps on the ravine slopes, soils are saturated and are relatively unstable. Several plant species of special concern occur where the slump ravines meet the more open bluff face, and the hemlock forests of the ravines support Acadian Flycatchers and other locally rare species such as Mourning Warblers and Blue-headed Vireos.

Changes in surface and groundwater hydrology due to increased impervious surface area may affect quality and character of the slump ravines and the many seepages wetlands, and result in considerable changes to slope stability, erosion, and bluff recession, as this water eventually makes its way to Lake Erie.

Specific management options for this area include:

(1) Develop a recreational hiking trail plan to direct traffic along margins of the slump ravines as needed, but designed in a way as to not encourage erosion or seep damage.
(2) Limit access to steep slopes to prevent additional impact from increased recreation.
(3) Protect/manage area for forest quality and contiguity.
(4) A hydrologic assessment of the entire property should be conducted in order to better understand both surface and groundwater systems for use in decision-making relative to site development. Issues include: (a) the immediate up-slope area in the vicinity of the slump slopes and seeps, and (b) areas well to the south, but still in the watersheds of the seeps and slump ravines. Issues are largely those of quality, quantity changes, recharge areas and directional flow.
(5) Monitor and control non-native invasive species such as garlic mustard *(Alliaria petiolata)* that may threaten native species.

3. Oak Savannah, Dry Oak Forest, and Sand Barrens on Warren III Beach Ridge

The intact oak-dominated communities on the Warren III beach ridge are some of the last remaining types of their kind in Pennsylvania. However, these areas are very small and isolated,

and the establishment of aggressive non-native and opportunistic native plant species has greatly compromised their quality. Creation of a functional oak savannah corridor linking the communities on the dune with the oak forest provides an opportunity to restore natural patterns of plant and animal dispersal for similar ecosystems based upon shared soil types. Larger, more viable oak savannah patches on the Erie Bluffs landscape will providing habitat for some of the rarest plant and animal species in Pennsylvania and may make these areas suitable for reintroduction. Restoring areas severely altered by human activities would enhance the viability of the site for species habitat, and should be a concern of park planners and conservation scientists. Overlaying naturally occurring vegetation types and soil survey polygons can help determine restoration potential of the area. For example, sand barren, oak savannah, and dry oak mixed hardwood forests are found on soils classified as "Dune Sand" (Taylor 1960), indicating that other areas, now farmed, may support these communities.

Restoration of high quality oak savannah and sand barren communities relies on development of an aggressive weed management plan. Currently, at least one third of the relict dune landform, and several acres of forest located northeast of the agricultural fields, are dominated by young black locust trees, bush honeysuckle and multiflora rose. The native northern dewberry and non-native plants such as spotted knapweed, sweet vernal grass, orchard grass, and quack grass are also significant threats to the sand barrens

Specific management options for this area include:

(1) Re-route the road that currently exists on the top of the dune. This road should be re-vegetated with plants native to the dune ridge, or plants at the site should be allowed to expand and recolonize areas where they were destroyed.

(2) Create larger, more viable oak savannah patches on the Erie Bluffs landscape in areas severely altered by human activities. This would enhance the viability of the site for species habitat and should be a concern of park planners and conservation scientists. The intact sand barren, black oak savannah, and dry oak mixed hardwood forest communities that exist on the Erie Bluffs property may serve as models for use as reference communities in an active restoration program.
Note: Other viable examples of models exist in northeast Ohio portion of the Lake Erie watershed. Land managers from CMNH have had success in restoring and creating sand barren and oak savannah habitats (Bissell 2004, pers.com). In addition to rare plants and animals, restoration and plant community enhancement would create additional habitat for game species; an action heavily supported by local hunters (Wheeler 2004, pers.com).
Land managers from CMNH have had great success transplanting black oak seedlings with volunteer labor (Bissell 2005, pers.com).

(3) Control invasive plant species and aggressive native colonizers such as black locust and silver maple through a combination of conservative management activities, such as hand-pulling and mowing, and more aggressive methods such as employing herbicides and prescribed burning (Bissell 2005, pers.com). Through these activities, land managers from CMNH have enhanced and maintained populations of rare sand barrens plants and animal species such as lupine (*Lupinus perennis*), bug-on-a-stick moss (*Buxbaumia aphylla*), racemed

milkwort (*Polygala polygama*) and have seen the return of species found in the seed bank (*Geranium bicknellii*) at their preserve at North Kingsville Dunes.
(4) Cease agricultural activities in conjunction with the control of invasive exotic plants, as soon as possible, as part of a restoration plan.
(5) Protect areas of large overstory trees in the dry oak mixed hardwood forest patches to provide a diverse mosaic of oak dominated community types on dry soils.
(6) Review the need for fire as a future management tool for this habitat, and develop the management plan for the entire site relative to the decision about fire-management (e.g. fire-breaks, protection of man-made structures, etc.).

4. Lake Plain Forest East and West of Duck Run

Measures should be taken to preserve the current quality of the lake plain forests due to their high concentration of ephemeral pools, saturated wetland soils, large trees, and large pumpkin ash population. Habitat destruction from illegal ATV activity poses the greatest threat to the site. The successional woodland patches between Elk Creek and Duck Run should be restored to lake plain forest to enhance overall site contiguity. As previously mentioned, it is not clear at this time why these areas have remained shrub-dominated and not succeeded to forest. Restoration activities should focus on removal of grape, black berries and sumac in order to facilitate recruitment of forest trees. While restoring forests to increase the overall area of core forest is recommended, these open, successional patches may present opportunities for game species (white-tail deer, grouse, etc.) that require edge habitats, and maintenance of open habitats should be considered when determining management goals for this area.

Specific management options for this area include:

(1) Determine whether the seasonal pool habitats should be enhanced to provide additional or better quality habitat amphibian species.
(2) Determine deer population and the impact deer browsing has on the establishment of hemlock through monitoring and fencing efforts.
(3) Eliminate the use of ATVs throughout the area.
(4) Retain the large ruts and pools created by ATVs and the high amphibian diversity found within (Maret in Bioblitz at Erie Bluffs State Park). They may be planted or enhanced to improve the aesthetic quality of the site.
(5) Remove old structures and re-route utility line to the Fuhrman property.

5. Slopes and Seeps of Elk Creek

This site is primarily situated on the steep, wet, east facing slopes leading to the Elk Creek floodplain and its sensitivity is due to the "older-growth" trees, abundance of spring wildflowers, and high number of groundwater seeps. This area is a popular spot to look for spring wildflowers and access from the parking lot at the Elk Creek Access Area presents opportunities as well as concerns for conservation. Like other slump ravines and seeps on the Erie Bluffs property, this site should be of high conservation priority.

Restoration of sites dominated by black locust is also a priority in forested areas adjacent to forests of the Elk Creek slopes. Replacing the black locust forest with species historically native

to forests along the Lake Erie Coast would enhance core forest habitat and return native forest composition to these areas. This management activity would connect the cove forest of the Elk Creek slope with the Lake Plain forests and escarpment tops.
For the area currently managed by Girard Township, there is an acknowledged desire to maintain access to the mouth of Elk Creek. Restoration projects should focus on reducing the "ecological footprint" of the developed area to increase the water quality of Elk Creek and habitat value to wildlife species at the mouth of the river.

Specific management options for this area include:

(1) Development of a recreational hiking trail plan to direct traffic along the top of the slope and limit foot traffic on the wet slopes
(2) Limit access to steep slopes to prevent additional impact from increased recreation
(3) Protect/manage area to maintain and enhance forest quality. Any development in this area will further fragment the forest stand and decrease the habitat for interior bird species. Therefore, development must be sensitive to maintain forest interior habitat by concentrating development, limiting development to the agricultural or post agricultural areas, and limiting the footprint of development.
(4) Prior to any development activity, a thorough hydrologic assessment should be conducted to determine changes in erosion with changes in runoff and through-flow of surface water due to changes in the amount of impervious surface and water in the ravines along the Elk Creek Slope. See #4 (above) under 2. Slump Ravines and Seeps.
(5) Remove black locust trees and replace with species historically native to forests along the Lake Erie Coast
(6) Day light streams flowing from Elk Creek cove forest seeps and restore their natural meandering pattern would improve water quality
(7) Decrease impervious surface area by reducing the size of the parking lot or by replacing asphalt with more porous materials
(8) Improve the rustic bathroom facilities
(9) Creating a more sustainable planting plan for the maintained "lawn" areas, including the use of native grasses or re-establishing forests would increase the protective cover for wildlife and reduce maintenance costs over the long term

6. Duck Run Floodplain and Slopes (North and South)

The sensitivity of the Duck Run floodplain and slopes is due to the saturated soils and the steep to moderately steep slopes, in addition to the relatively low percent cover of invasive non-native plants, diverse composition of the overstory, and large, relatively old trees. The presence of hemlock and sufficient shrub layer creates ideal habitat for forest interior birds. This area is effectively isolated from the rest of the site by the railroad line to the north and agricultural fields to the west. In addition to the biological importance of the site, the upper terraces just north of the railroad tracks contain significant archeological sites (Peddler 2004, pers.com).
Despite its relatively high quality and isolation, ATVs have significantly affected plant composition, habitat quality, and may have altered the natural meander pattern of Duck Run.

The lack of forest canopy, as well as the presence of agricultural runoff and drainage from septic systems in the Duck Run watershed south of the Erie Bluffs property (south of Rt. 5 to Middle

Road, Springfield Township), has lowered water quality and the diversity of animal life within the stream.

Specific management options for this area include:

(1) Identify and protect archaeological sites.
(2) Develop a recreational hiking trail plan to direct foot traffic.
(3) Eliminate ATV activity and develop a plan for the restoration of ATV-damaged areas.
(4) Limit access on steep slopes to prevent additional impact from increased recreation.
(5) Protect/manage area for forest quality.
(6) Limit hiking, biking, and horseback riding trails to existing trails. Trails traversing steep slopes should be restored to their natural condition.
(7) Facilitate the creation of a small watershed plan for Duck Run watershed (including the area south of Rt. 5) by collaborating with adjacent landowners, watershed groups, and partner organizations. This should be a comprehensive strategy that includes a biological inventory, a hydrologic assessment, and developed management recommendations for landowners to enhance the biological quality of the watershed. This should include an assessment of corridors of connectivity between the southern portion of Duck Run and other forested areas not on the Erie Bluffs property

SUMMARY AND CONCLUSIONS

Erie Bluffs State Park is a part of the last remaining undeveloped land on the Lake Erie shoreline in northwestern Pennsylvania and is significant to the natural biodiversity of the Commonwealth. The park's diverse landscape contains a variety of landforms, habitats, and community types supporting plant and animal species that are found nowhere else in Pennsylvania. The site has been used historically as a prime hunting area for local sportspeople, and a number of scientists have studied rare plants, animals, and communities along the Lake Erie Shore (ecological studies on the property date back as far as the mid 1970s). WPC ecologists first identified the Erie Bluffs area as part of the exceptionally significant Lake Plain Shoreline Biodiversity Area (BDA) in the Erie County Natural Heritage Inventory based on the abundance of rare species and high quality rare plant communities. The site contains some of the only remaining black oak savannah and sand barren communities in Pennsylvania. Ephemeral seepage wetland pools are scattered throughout the lake plain forest community of the former glacial lake floor. Eighteen plant species of conservation concern are found on park property and there many rare plant community types. The interior forest conditions of the hemlock slump ravines are breeding sites fore several forest interior bird species. The diverse habitat types of Erie Bluffs provide foraging grounds for Bald Eagles and Northern Harriers. The bluff face supports what may possibly be the largest colony of Bank Swallows in PA. There are several trees over 100 feet tall and upwards of 150 years old. The hemlock-associated, wet forest sites contain disjunct insect species, or populations of species with forest-restricted habits. Combined, these features suggest that the site has a high natural value. Proper management and stewardship is necessary to protect its important contribution to the region's biodiversity.

The quantity and quality of water are important factors influencing plant species distribution and community composition at Erie Bluffs State Park. Further work should be done to assess the hydrology of the site, especially the extent of the recharge zone for the slump ravines and palustrine forests. Activities that significantly alter the drainage pattern of groundwater inputs to the scarp seep communities, or reduce the quality or quantity of water to the palustrine seepage wetlands of the lake plain community, may negatively affect plant populations and habitat quality.

Past and current human activity has greatly impacted the quality of the natural habitats at Erie Bluffs State Park and the public land on either side of Elk Creek. Farm fields make up nearly 150 acres of the property and have fragmented and isolated remnants of high quality habitat. Invasive non-native and opportunistic native plant species have further compromised their viability. Logging and the decline of the American chestnut have resulted in dramatic changes to the forest habitat. More recently, the site has been abused by illegal ATV activity that compromises the quality of the resource. Because of the significant threats to site quality and viability, restoration should be of utmost importance to park managers. This presents challenges for park managers, as well as incredible opportunities to improve habitat conditions for some of Pennsylvania's rarest species. Several intact, high quality sites exist on the property and nearby to guide restoration activities. These reference ecosystems provide targets and may provide sources for species re-introduction of local genotypes.

The diverse landforms and habitats of Erie Bluffs State Park, as well as the plant and animal species that inhabit the area, present a unique opportunity to highlight the management, stewardship, restoration and protection of these features to the public. The overall objectives in ecological management of Erie Bluffs State Park should focus on maintaining and enhancing populations of rare species and elements, maintaining and enhancing ecological viability by increasing patch size and site connectivity through restoration, maintaining the relationship of site hydrology and ecosystem (habitat) character and function, and controlling non-native invasive species.

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Meret, Timothy. Herpetologist PABS, Shippensburg University Dept of Biology

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Robski, Steven. Mammalogist, Gannon University, Department of Biology, Erie, PA

Gross, Douglas. Avian Ecologist, Ecology III, Inc.

Grund, Steven. Botanist, Western Pennsylvania Conservancy

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Illustrated, easy-to-read fact sheets on invasive alien plants with native ranges, plant descriptions, ecological threats, U.S. distributions & habitats, background of introductions, plant reproduction & dispersal, management approaches, alternative native plants, and other useful information. http://www.nps.gov/plants/alien/factmain.htm

APPENDIX A: SPECIES TABLES FOR EACH TAXA GROUP

This Information represents the total species count for the May 14 and 15, 2004 and the July 16 and 17, 2004 Bioblitzes. Each species record is presented in its appropriate taxonomic group. A total species count for each group is presented before each table. Some tables are more complete than others due to the need for further identification of unknowns.

The following tables represent the minimum number of species found during the Bioblitzes. In most cases, additional species will be added to these lists as experts further identify collected specimens currently listed as "unknown."

NOTATION:

(cf) In some cases (cf) may appear next to a taxon in a table. Timothy A. Pearce of the Carnegie Museum of Natural History offered the Western Pennsylvania Conservancy the following explanation:

"cf is short for confer, which I understand to be Latin for compare. I use cf to mean (1) similar to, but I am not quite sure (for whatever reason; for example, it looks like it but I didn't think they lived in this place); (2) similar to, but I am too busy to find out for sure (by getting the relevant literature, or dissecting it, or conducting a thorough taxonomic study to resolve some uncertainty); (3) similar to, but the features I need to examine are missing because it is broken or juvenile so the genitalia are immature; (4) to the next person who tries to identify this thing, start somewhere near this taxon."

† Indicates Elements that are considered to be of special concern by Pennsylvania Natural Diversity Inventory (PNDI Species of Special Concern). These Elements are also denoted using ***bold face italic print.***

^ Other Elements judged to be of possible conservation concern (Watch List species and/or species not considered species of special concern) are *formatted in Italics*

** Indicates species that are not native to Pennsylvania (Insects, Land Snails and Fungi are not included due to insufficient resources)

Table 1: PLANTS

416* taxa confirmed

FAMILY	SCIENTIFIC NAME	COMMON NAME
Aceraceae	*Acer pensylvanicum*	moosewood
Aceraceae	*Acer platanoides***	Norway maple
Aceraceae	*Acer rubrum*	red maple
Aceraceae	*Acer saccharinum*	silver maple
Aceraceae	*Acer saccharum*	sugar maple
Adiantaceae	*Adiantum pedatum*	maidenhair fern
Alismataceae	*Alisma subcordatum*	broad-leaved water-plantain
Amaranthaceae	*Amaranthus hybridus***	pigweed
Anacardiaceae	*Rhus typhina*	staghorn sumac
Anacardiaceae	*Toxicodendron radicans*	poison ivy
Apiaceae	*Cicuta maculata*	water-hemlock
Apiaceae	*Conium maculatum***	poison-hemlock
Apiaceae	*Daucus carota***	Queen Anne's-lace
Apiaceae	*Osmorhiza claytonii*	sweet-cicely
Apocynaceae	*Apocynum cannabinum*	Indian-hemp
Araceae	*Arisaema triphyllum*	Jack-in-the-pulpit
Araceae	*Symplocarpus foetidus*	skunk cabbage
Araliaceae	*Aralia nudicaulis*	wild sarsaparilla
Araliaceae	*Panax trifolius*	dwarf ginseng
Aristolochiaceae	*Asarum canadense*	wild ginger
Asclepiadaceae	*Asclepias incarnata*	swamp milkweed
Asclepiadaceae	*Asclepias syriaca*	common milkweed
Asteraceae	*Achillea millefolium*	common yarrow
Asteraceae	*Ambrosia artemisiifolia*	common ragweed
Asteraceae	*Antennaria parlinii*	Parlin's pussytoes
Asteraceae	*Antennaria plantaginifolia*	plantain pussytoes
Asteraceae	*Anthemis cotula***	Mayweed
Asteraceae	*Arctium lappa***	great burdock
Asteraceae	*Arctium minus***	common burdock
Asteraceae	*Artemisia vulgaris***	wormwood
Asteraceae	*Aster divaricatus*	white wood aster
Asteraceae	*Aster macrophyllus*	bigleaf aster
Asteraceae	*Bidens frondosa*	beggar-ticks
Asteraceae	*Centaurea maculosa***	bushy knapweed

Asteraceae	*Chrysanthemum leucanthemum***	ox-eye daisy
Asteraceae	*Cichorium intybus***	blue chicory
Asteraceae	*Cirsium arvense***	Canada thistle
Asteraceae	*Cirsium vulgare***	bull-thistle
Asteraceae	*Eupatorium fistulosum*	Joe-pye-weed
Asteraceae	*Eupatorium perfoliatum*	boneset
Asteraceae	*Eupatorium purpureum*	Joe-pye-weed
Asteraceae	*Eupatorium rugosum*	white-snakeroot
Asteraceae	*Helianthus sp.*	sunflower
Asteraceae	*Hieracium caespitosum***	king-devil
Asteraceae	*Lactuca canadensis*	wild lettuce
Asteraceae	*Lactuca serriola***	prickly lettuce
Asteraceae	*Leontodon autumnalis***	fall-dandelion
Asteraceae	*Prenanthes alba*	rattlesnake-root
Asteraceae	*Prenanthes altissima*	rattlesnake-root
Asteraceae	*Solidago altissima*	late goldenrod
Asteraceae	*Solidago caesia*	bluestem goldenrod
Asteraceae	*Solidago canadensis*	Canada goldenrod
Asteraceae	*Solidago flexicaulis*	zig-zag goldenrod
Asteraceae	*Solidago gigantea*	smooth goldenrod
Asteraceae	*Solidago juncea*	early goldenrod
Asteraceae	*Solidago rugosa*	wrinkle-leaf goldenrod
Asteraceae	*Taraxacum officinale***	common dandelion
Asteraceae	*Tragopogon dubius***	goat's beard
Asteraceae	*Tragopogon pratensis***	goat's beard
Asteraceae	*Tussilago farfara***	coltsfoot
Asteraceae	*Xanthium strumarium*	common cocklebur
Balsaminaceae	*Impatiens capensis*	jewelweed
Balsaminaceae	*Impatiens pallida*	pale jewelweed
Berberidaceae	*Berberis thunbergii***	Japanese barberry
Berberidaceae	*Berberis vulgaris***	European barberry
Berberidaceae	*Caulophyllum giganteum*	giant blue cohosh
Berberidaceae	*Caulophyllum thalictroides*	blue cohosh
Berberidaceae	*Podophyllum peltatum*	Mayapple
Betulaceae	*Alnus incana ssp. rugosa*	speckled alder
Betulaceae	*Betula alleghaniensis*	yellow birch
Betulaceae	*Betula lenta*	black birch
Betulaceae	*Carpinus caroliniana*	hornbeam

Betulaceae	*Corylus americana*	American hazelnut
Betulaceae	*Ostrya virginiana*	hop-hornbeam
Bignoniaceae	*Campsis radicans***	trumpet creeper
Brassicaceae	*Alliaria petiolata***	garlic mustard
Brassicaceae	*Arabidopsis thaliana***	wall-cress
Brassicaceae	*Arabis laevigata*	smooth rockcress
Brassicaceae	*Arabis lyrata*	lyre-leaf Rockcress
Brassicaceae	*Barbarea verna***	early winter-cress
Brassicaceae	*Brassica nigra***	black mustard
Brassicaceae	*Brassica rapa***	field mustard
Brassicaceae	***Cakile edentula*†**	***American sea-rocket***
Brassicaceae	*Cardamine bulbosa*	bittercress
Brassicaceae	*Cardamine concatenata*	cut-leaf toothwort
Brassicaceae	*Cardamine diphylla*	two-leaved toothwort
Brassicaceae	*Cardamine douglassii*	purplecress
Brassicaceae	*Cardamine hirsuta*	hairy bittercress
Brassicaceae	*Cardamine unknown hybrid*	
Brassicaceae	*Cardamine pensylvanica*	Pennsylvania bittercress
Brassicaceae	*Hesperis matronalis***	dame's-rocket
Brassicaceae	*Lepidium campestre***	fieldcress
Caesalpiniaceae	*Gleditsia triacanthos*	honey-locust
Campanulaceae	*Lobelia cardinalis*	cardinal-flower
Caprifoliaceae	*Lonicera canadensis*	fly honeysuckle
Caprifoliaceae	*Lonicera dioica*	mountain honeysuckle
Caprifoliaceae	*Lonicera japonica***	japanese honeysuckle
Caprifoliaceae	*Lonicera morrowii***	Morrow's honeysuckle
Caprifoliaceae	*Lonicera x bella*	pretty honeysuckle
Caprifoliaceae	*Sambucus canadensis*	American elderberry
Caprifoliaceae	*Sambucus racemosa var. pubens*	red-berried elder
Caprifoliaceae	*Viburnum acerifolium*	maple-leaved viburnum
Caprifoliaceae	*Viburnum dentatum*	southern arrow-wood
Caprifoliaceae	*Viburnum lantanoides*	alderleaf viburnum
Caprifoliaceae	*Viburnum recognitum*	northern arrow-wood
Caryophyllaceae	*Cerastium nutans*	nodding chickweed
Caryophyllaceae	*Dianthus armeria***	deptford pink
Caryophyllaceae	*Saponaria officinalis***	bouncing-bet
Caryophyllaceae	*Silene vulgaris***	maiden's tears
Caryophyllaceae	*Stellaria media***	common chickweed

Celastraceae	*Celastrus orbiculatus***	oriental bittersweet
Celastraceae	*Celastrus scandens*	American bittersweet
Celastraceae	*Euonymus obovatus*	running strawberry-bush
Chenopodiaceae	*Chenopodium album***	lamb's quarters
Clusiaceae	*Hypericum punctatum*	spotted St. John's-wort
Clusiaceae	*Triadenum fraseri*	marsh St. John's wort
Commelinaceae	*Commelina communis***	Asiatic dayflower
Convolvulaceae	*Calystegia sepium*	hedge bindweed
Convolvulaceae	*Convolvulus arvensis***	field bindweed
Convolvulaceae	*Ipomoea pes-caprae***	goat-foot morning-glory
Cornaceae	*Cornus alternifolia*	alternate-leaved dogwood
Cornaceae	*Cornus rugosa*	round-leaved dogwood
Cornaceae	*Cornus sericea*	red-osier dogwood
Cucurbitaceae	*Echinocystis lobata*	prickly cucumber
Cuscutaceae	*Cuscuta gronovii*	dodder
Cyperaceae	*Carex aestivalis*	summer sedge
Cyperaceae	*Carex albicans*	bellow beaked sedge
Cyperaceae	*Carex appalachica*	Appalachian sedge
Cyperaceae	*Carex blanda*	woodland sedge
Cyperaceae	*Carex brunescens*	brownish sedge
Cyperaceae	*Carex communis*	fibrous-root sedge
Cyperaceae	*Carex crinita*	fringed sedge
Cyperaceae	*Carex digitalis*	slender woodland sedge
Cyperaceae	*Carex gracillima*	graceful sedge
Cyperaceae	*Carex intumescens*	great bladder sedge
Cyperaceae	*Carex laxiflora*	loose flowered sedge
Cyperaceae	*Carex leptonervia*	finely-nerved sedge
Cyperaceae	*Carex lupulina*	hop sedge
Cyperaceae	*Carex pedunculata*	longstalk sedge
Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge
Cyperaceae	*Carex plantaginea*	plantain sedge
Cyperaceae	*Carex prasina*	drooping sedge
Cyperaceae	*Carex radiata*	small eastern star sedge
Cyperaceae	*Carex rugosperma*	umbel-like sedge
Cyperaceae	*Carex scabrata*	eastern rough sedge
Cyperaceae	*Carex stipata*	owl-fruit sedge
Cyperaceae	*Carex swanii*	swan's sedge
Cyperaceae	*Carex tribuloides*	blunt broom sedge

Cyperaceae	*Carex trisperma*	three-seeded sedge
Cyperaceae	*Carex vulpinoidea*	sedge
Cyperaceae	*Cyperus esculentus*	chufa flatsedge
Cyperaceae	*Scirpus atrovirens*	black bulrush
Cyperaceae	*Scirpus cyperinus*	wool-grass
Cyperaceae	*Scirpus hattorianus*	bulrush
Dennstaedtiaceae	*Dennstaedtia punctilobula*	hay-scented fern
Dennstaedtiaceae	*Pteridium aquilinum*	bracken fern
Dioscoreaceae	*Dioscorea quaternata*	four leaf wild yam
Dryopteridaceae	*Athyrium filix-femina*	lady fern
Dryopteridaceae	*Cystopteris fragilis*	fragile fern
Dryopteridaceae	*Deparia acrostichoides*	silvery glade fern
Dryopteridaceae	*Dryopteris carthusiana*	spinulose wood fern
Dryopteridaceae	*Dryopteris intermedia*	evergreen wood fern
Dryopteridaceae	*Dryopteris marginalis*	marginal wood fern
Dryopteridaceae	*Matteuccia struthiopteris*	ostrich fern
Dryopteridaceae	*Onoclea sensibilis*	sensitive fern
Dryopteridaceae	*Polystichum acrostichoides*	Christmas fern
Equisetaceae	*Equisetum arvense*	field horsetail
Equisetaceae	***Equisetum ferrissii**†***	***scouring-rush***
Equisetaceae	*Equisetum hyemale*	scouring-rush
Equisetaceae	***Equisetum variegatum**†***	***variegated horsetail***
Ericaceae	*Vaccinium stamineum*	deerberry
Fabaceae	*Apios americana*	ground-nut
Fabaceae	*Coronilla varia***	crown-vetch
Fabaceae	*Desmodium canadense*	showy tick-trefoil
Fabaceae	*Desmodium nudiflorum*	naked flower ticktrefoil
Fabaceae	*Lespedeza hirta*	bush-clover
Fabaceae	*Medicago lupulina***	black medic
Fabaceae	*Melilotus alba***	white sweet-clover
Fabaceae	*Melilotus officinalis***	yellow sweet-clover
Fabaceae	*Robinia pseudoacacia*	black-locust
Fabaceae	*Trifolium incarnatum***	crimson clover
Fagaceae	*Castanea dentata*	American chestnut
Fagaceae	*Fagus grandifolia*	American beech
Fagaceae	*Quercus alba*	white oak
Fagaceae	*Quercus muehlenbergii*	chinkapin oak
Fagaceae	*Quercus rubra*	northern red oak

Fagaceae	*Quercus velutina*	black oak
Fumariaceae	*Dicentra cucullaria*	Dutchman's-britches
Geraniaceae	*Geranium maculatum*	wood geranium
Geraniaceae	*Geranium robertianum*	herb-robert
Grossulariaceae	*Ribes americana*	American black currant
Grossulariaceae	*Ribes cynosbati*	prickly gooseberry
Hamamelidaceae	*Hamamelis virginiana*	witch-hazel
Hydrophyllaceae	*Hydrophyllum virginianum*	Virginia waterleaf
Juglandaceae	*Carya cordiformis*	bitternut hickory
Juglandaceae	*Carya glabra*	pig nut hickory
Juglandaceae	*Carya ovata*	shagbark hickory
Juglandaceae	*Juglans cinerea*	butternut
Juglandaceae	*Juglans nigra*	black walnut
Juncaceae	*Juncus articulatus*	jointed rush
Juncaceae	***Juncus brachycephalus*** †	***small-headed rush***
Juncaceae	*Juncus effusus*	common rush
Juncaceae	*Juncus tenuis*	path rush
Lamiaceae	*Clinopodium vulgare***	wild basil
Lamiaceae	*Collinsonia canadensis*	horse balm
Lamiaceae	*Leonurus cardiaca***	motherwort
Lamiaceae	*Lycopus americanus*	water-horehound
Lamiaceae	*Lycopus uniflorus*	northern bugleweed
Lamiaceae	*Mentha arvensis*	field mint
Lamiaceae	*Mentha longifolia***	horse mint
Lamiaceae	*Nepeta cataria***	catnip
Lamiaceae	*Prunella vulgaris*	heal-all
Lamiaceae	*Scutellaria lateriflora*	mad-dog skullcap
Lamiaceae	*Teucrium canadense***	wild germander
Lamiaceae	*Trichostema dichotomum*	forked bluecurls
Lauraceae	*Lindera benzoin*	spicebush
Lauraceae	*Sassafras albidum*	sassafras
Liliaceae	*Allium tricoccum*	ramp
Liliaceae	*Asparagus officinalis***	asparagus
Liliaceae	*Disporum lanuginosum*	yellow mandarin
Liliaceae	*Erythronium americanum*	yellow trout-lily
Liliaceae	*Hemerocallis fulva***	orange day-lily
Liliaceae	*Maianthemum canadense*	Canada mayflower
Liliaceae	*Medeola virginiana*	indian cucumber-root

Liliaceae	*Polygonatum biflorum*	smooth Solomon's-seal
Liliaceae	*Polygonatum pubescens*	downy Solomon's-seal
Liliaceae	*Smilacina racemosa*	false Solomon's-seal
Liliaceae	*Smilacina stellata*^	*starflower Solomon's-plume*
Liliaceae	*Trillium erectum*	purple trillium
Liliaceae	*Trillium grandiflorum*	large-flowered trillium
Liliaceae	*Trillium undulatum*	painted trillium
Liliaceae	*Uvularia perfoliata*	perfoliate bellwort
Liliaceae	*Uvularia sessifolia*	sessile leaf bellwort
Liliaceae	*Veratrum viride*	American false hellebore
Limnanthaceae	*Floerkea proserpinacoides*	false-mermaid
Lycopodiaceae	*Diphasiastrum digitatum*	deep-rooted running-pine
Lycopodiaceae	*Huperzia lucidula*	shining clubmoss
Lycopodiaceae	*Lycopodium clavatum*	common clubmoss
Lycopodiaceae	*Lycopodium dendroideum*	tree-like clubmoss
Lycopodiaceae	*Lycopodium digitatum*	fan clubmoss
Lycopodiaceae	*Lycopodium obscurum*	ground-pine
Lythraceae	*Lythrum salicaria***	purple-loosestrife
Magnoliaceae	*Liriodendron tulipifera*	tuliptree
Magnoliaceae	*Magnolia acuminata*	cucumber-tree
Malvaceae	*Abutilon theophrastii***	butter-print
Malvaceae	*Malva neglecta***	common mallow
Molluginaceae	*Mollugo verticillata***	green carpetweed
Monotropaceae	*Monotropa uniflora*	indian-pipe
Moraceae	*Morus alba***	white mulberry
Nyssaceae	*Nyssa sylvatica*	black-gum
Oleaceae	*Fraxinus americana*	white ash
Oleaceae	*Fraxinus nigra*	black ash
Oleaceae	*Fraxinus pennsylvanica*	red ash
Oleaceae	***Fraxinus profunda***†	***pumpkin ash***
Oleaceae	*Ligustrum obtusifolium***	border privet
Oleaceae	*Ligustrum vulgare***	European privet
Onagraceae	*Circaea alpina*	dwarf enchanter's-nightshade
Onagraceae	*Circaea lutetiana*	enchanter's-nightshade
Onagraceae	*Epilobium hirsutum***	hairy willow-herb
Onagraceae	*Epilobium parviflorum***	hairy willow-herb
Onagraceae	*Oenothera biennis*	evening-primrose
Onagraceae	*Oenothera fruticosa*	narrow-leaved sundrops

Ophioglossaceae	*Botrychium dissectum*	cut-leaved grape-fern
Ophioglossaceae	*Botrychium virginianum*	rattlesnake fern
Orchidaceae	*Epipactis helleborine***	bastard hellebore
Orobanchaceae	*Conopholis americana*	squaw root
Orobanchaceae	*Epifagus virginiana*	beechdrops
Osmundaceae	*Osmunda cinnamomea*	cinnamon fern
Osmundaceae	*Osmunda claytoniana*	interrupted fern
Osmundaceae	*Osmunda regalis*	royal fern
Oxalidaceae	*Oxalis stricta*	common yellow wood-sorrel
Papaveraceae	*Sanguinaria canadensis*	bloodroot
Phytolaccaceae	*Phytolacca americana*	pokeweed
Pinaceae	*Picea abies***	Norway spruce
Pinaceae	*Pinus strobus*	eastern white pine
Pinaceae	*Tsuga canadensis*	Canada hemlock
Plantaginaceae	*Plantago aristata***	bristly plantain
Plantaginaceae	*Plantago lanceolata***	English plantain
Plantaginaceae	*Plantago major***	nipple-seed plantain
Plantaginaceae	*Plantago rugelii*	Rugel's plantain
Platanaceae	*Platanus occidentalis*	sycamore
Poaceae	*Agrostis gigantea***	redtop
Poaceae	*Agrostis stolonifera var. palustris***	carpet bentgrass
Poaceae	*Andropogon virginicus*	broom-sedge
Poaceae	*Anthoxanthum odoratum***	sweet vernalgrass
Poaceae	*Arrhenatherum elatius***	tall oatgrass
Poaceae	*Cinna arundinacea*	wood reedgrass
Poaceae	*Dactylis glomerata***	orchardgrass
Poaceae	*Danthonia sp.*	poverty grass
Poaceae	*Festuca obtusa*	nodding fescue
Poaceae	*Glyceria striata*	fowl mannagrass
Poaceae	*Holcus lanatus***	velvetgrass
Poaceae	*Lolium perenne***	perennial ryegrass
Poaceae	*Panicum acuminatum*	panic grass
Poaceae	***Panicum laxiflorum*†**	***lax-flower witch grass***
Poaceae	*Phalaris arundinacea*	reed canary-grass
Poaceae	*Phleum pratense***	timothy
Poaceae	***Phragmites australis ssp. americanus*†**	***American reed***

Poaceae	*Phragmites australis ssp. australis***	common reed
Poaceae	*Poa alsodes*	grove meadow grass
Poaceae	*Poa compressa***	Canada bluegrass
Poaceae	*Poa sylvestris*	woodland bluegrass
Poaceae	*Schizachyrium scoparium*	little blue-stem
Poaceae	*Setaria faberi***	giant foxtail
Poaceae	*Setaria pumila***	yellow foxtail
Polemoniaceae	*Phlox divaricata*	wild blue phlox
Polygonaceae	*Polygonum aviculare***	knotweed
Polygonaceae	*Polygonum convolvulus*	black bindweed
Polygonaceae	*Polygonum pensylvanicum*	smartweed
Polygonaceae	*Polygonum virginianum*	jumpseed
Polygonaceae	*Rumex acetosella***	sheep sorrel
Polygonaceae	*Rumex crispus***	curly dock
Polygonaceae	*Rumex obtusifolius***	bitter dock
Polypodiaceae	*Polypodium virginianum*	common polypody
Portulacaceae	*Claytonia caroliniana*	Carolina spring beauty
Portulacaceae	*Claytonia virginica*	spring beauty
Primulaceae	*Lysimachia ciliata*	fringed loosestrife
Primulaceae	*Lysimachia nummularia***	moneywort
Primulaceae	*Trientalis borealis*	starflower
Pyrolaceae	*Chimaphila maculata*	pipsissewa
Ranunculaceae	*Actaea pachypoda*	doll's-eyes
Ranunculaceae	*Actaea rubra*^	*red baneberry*
Ranunculaceae	*Aquilegia canadensis*	wild columbine
Ranunculaceae	*Caltha palustris*	marsh-marigold
Ranunculaceae	*Cimicifuga racemosa*	black-snakeroot
Ranunculaceae	*Clematis virginiana*	virgin's-bower
Ranunculaceae	*Hepatica nobilis var. acuta*	liverleaf
Ranunculaceae	*Ranunculus abortivus*	small-flowered crowfoot
Ranunculaceae	*Ranunculus hispidus*	bristly buttercup
Ranunculaceae	*Ranunculus recurvatus*	hooked crowfoot
Ranunculaceae	*Thalictrum dioicum*	early meadow-rue
Ranunculaceae	*Thalictrum pubescens*	tall meadow-rue
Rosaceae	*Agrimonia gryposepala*	agrimony
Rosaceae	*Amelanchier arborea*	shadbush
Rosaceae	*Amelanchier laevis*	smooth serviceberry
Rosaceae	*Crataegus flabellata*	fanleaf hawthorn

Rosaceae	*Crataegus pringlei*	a hawthorn
Rosaceae	*Fragaria vesca*	sow-teat strawberry
Rosaceae	*Fragaria virginiana*	wild strawberry
Rosaceae	*Geum canadense*	white avens
Rosaceae	*Geum laciniatum*	herb-bennet
Rosaceae	*Geum virginianum*	cream-colored avens
Rosaceae	*Malus coronaria*	sweet crab-apple
Rosaceae	*Malus pumila*	common apple
Rosaceae	*Physocarpus opulifolius*	ninebark
Rosaceae	*Potentilla simplex*	common cinquefoil
Rosaceae	*Prunus pensylvanica*	pin cherry
Rosaceae	*Prunus persica***	peach
Rosaceae	*Prunus serotina*	wild black cherry
Rosaceae	*Prunus virginiana*	choke cherry
Rosaceae	*Pyrus communis*	common pear
Rosaceae	*Rosa multiflora***	multiflora rose
Rosaceae	*Rubus allegheniensis*	common blackberry
Rosaceae	*Rubus flagellaris*	prickly dewberry
Rosaceae	*Rubus idaeus var. strigosus*	red raspberry
Rosaceae	*Rubus occidentalis*	black raspberry
Rosaceae	*Rubus odoratus***	purple-flowering raspberry
Rosaceae	*Rubus pensilvanicus*	Pennsylvania blackberry
Rosaceae	*Rubus recurvicaulis (cf)*	dewberry
Rosaceae	***Rubus setosus*†**	***small bristleberry***
Rosaceae	*Sorbus aucuparia***	European mountain-ash
Rubiaceae	*Galium aparine*	bedstraw
Rubiaceae	*Galium tinctorium*	stiff marsh bedstraw
Rubiaceae	*Galium triflorum*	fragrant bedstraw
Rubiaceae	*Mitchella repens*	partridge-berry
Rutaceae	***Ptelea trifoliata*†**	***hoptree***
Salicaceae	*Populus deltoides*	eastern cottonwood
Salicaceae	*Populus grandidentata*	bigtooth aspen
Salicaceae	*Populus tremuloides*	quaking aspen
Salicaceae	*Salix amygdaloides*	peach-leaved willow
Salicaceae	*Salix discolor*	pussy willow
Salicaceae	*Salix eriocephala*	diamond willow
Salicaceae	*Salix exigua*	sandbar willow
Salicaceae	*Salix nigra*	black willow

Saxifragaceae	*Chrysosplenium americanum*	American gold saxifrage
Saxifragaceae	*Mitella diphylla*	bishop's-cap
Saxifragaceae	*Saxifraga virginiensis*	early saxifrage
Saxifragaceae	*Tiarella cordifolia*	foamflower
Scrophulariaceae	*Chaenorhinum minus***	dwarf snapdragon
Scrophulariaceae	*Chelone glabra*	turtlehead
Scrophulariaceae	*Linaria vulgaris***	butter-and-eggs
Scrophulariaceae	*Verbascum blattaria***	moth mullein
Scrophulariaceae	*Verbascum thapsus***	common mullein
Scrophulariaceae	*Veronica arvensis***	corn speedwell
Scrophulariaceae	*Veronica officinalis*	common speedwell
Smilacaceae	*Smilax rotundifolia*	catbrier
Solanaceae	*Solanum carolinense*	horse-nettle
Solanaceae	*Solanum dulcamara***	trailing nightshade
Solanaceae	*Solanum nigrum***	black nightshade
Taxaceae	*Taxus cuspidata***	Japanese yew
Thelypteridaceae	*Phegopteris hexagonoptera*	broad beech fern
Thelypteridaceae	*Thelypteris noveboracensis*	New York fern
Thymelaeaceae	*Dirca palustris*	eastern leatherwood
Tiliaceae	*Tilia americana*	basswood
Typhaceae	*Typha angustifolia***	narrow leaf cat-tail
Typhaceae	*Typha latifolia*	common cat-tail
Ulmaceae	*Ulmus americana*	American elm
Urticaceae	*Boehmeria cylindrica*	false-nettle
Urticaceae	*Laportea canadensis*	wood-nettle
Verbenaceae	*Phryma leptostachya*	lopseed
Violaceae	*Viola arvensis***	small wild pansy
Violaceae	*Viola blanda*	sweet white violet
Violaceae	*Viola canadensis*	Canada violet
Violaceae	*Viola cucullata*	marsh blue violet
Violaceae	*Viola macloskeyi*	sweet white violet
Violaceae	*Viola palmata*	early blue violet
Violaceae	*Viola pubescens*	downy yellow violet
Violaceae	*Viola rostrata*	long-spurred violet
Violaceae	*Viola rotundifolia*	round-leaved violet
Violaceae	*Viola sororia*	common blue violet
Violaceae	*Viola striata*	striped violet
Vitaceae	*Parthenocissus inserta*	Virginia creeper

Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper
Vitaceae	*Vitis aestivalis*	summer grape
Vitaceae	*Vitis labrusca*	fox grape
Vitaceae	*Vitis riparia*	frost grape

* Unidentified specimens are still held by a variety of collectors. These species will be added to the total when experts are available to identify them.

Table 2: BIRDS

94 Species confirmed

Double-crested Cormorant	Acadian Flycatcher	Northern Parula
Great Blue Heron	Willow Flycatcher	Yellow Warbler
Green Heron	Eastern Phoebe	Chestnut-sided Warbler
Turkey Vulture	Great Crested Flycatcher	Magnolia Warbler
Canada Goose	Eastern Kingbird	Black-throated Blue Warbler
Mallard	White-eyed Vireo	*Cerulean Warbler*
Bald Eagle †	Yellow-throated Vireo	American Redstart
Northern Harrier †	Blue-headed Vireo (Solitary Vireo)	Ovenbird
Cooper's Hawk	Warbling Vireo	*Louisiana Waterthrush*
Red-shouldered Hawk	Red-eyed Vireo	Mourning Warbler
Red-tailed Hawk	Blue Jay	Common Yellowthroat
Wild Turkey	American Crow	Hooded Warbler
Killdeer	Purple Martin	Wilson's Warbler
Greater Yellowlegs	Tree Swallow	Scarlet Tanager
Spotted Sandpiper	Northern Rough-winged Swallow	Eastern Towhee (Rufous-sided)
Ring-billed Gull	Bank Swallow	Chipping Sparrow
Herring Gull	Barn Swallow	Field Sparrow
Caspian Tern	Black-capped Chickadee	Vesper Sparrow
Rock Dove**	Tufted Titmouse	Song Sparrow
Mourning Dove	White-breasted Nuthatch	White-crowned Sparrow
Yellow-billed Cuckoo	Carolina Wren	Dark-eyed Junco
Eastern Screech-Owl	House Wren	Northern Cardinal
Great Horned Owl	*Eastern Bluebird*	Rose-breasted Grosbeak
Ruby-throated Hummingbird	Veery	Indigo Bunting
Belted Kingfisher	***Swainson's Thrush*** †	Red-winged Blackbird
Red-headed Woodpecker	Wood Thrush	Common Grackle
Red-bellied Woodpecker	American Robin	Brown-headed Cowbird
Downy Woodpecker	Gray Catbird	Northern Oriole (Baltimore Oriole)
Hairy Woodpecker	Brown Thrasher	House Finch**
Northern Flicker	European Starling**	American Goldfinch
Pileated Woodpecker	Cedar Waxwing	
Eastern Wood-Pewee	*Blue-winged Warbler*	

Table 3: FISH

17 taxa confirmed

SCIENTIFIC NAME	COMMON NAME
Ambloplites rupestris	rock bass
Ameirus nebulosis	brown bullhead
Aplodinotus grunniens	freshwater drum (sheepshead)
Catostomus commersonii	white sucker
Cottus bairdi	mottled sculpin
Cyprinus carpio	carp**
Dorosoma cepedianum	gizzard shad
Hypentelium nigricans	northern hog sucker
Ictalurus punctatus	channel catfish
Lepomis gibbosus	pumpkinseed sunfish
Micropterus dolomieu	small mouth bass
Micropterus salmoides	largemouth bass
Neogobius melanostomus	round goby**
Percopsis omiscomaycus	trout-perch (silver chub)
Pimephales notatus	bluntnose minnow
Rhinichthys atratulus	blacknose dace
Somotilus atromaculatus	creek chub

Table 4: MAMMALS

20 taxa confirmed

SCIENTIFIC NAME	COMMON NAME
Odocoileus virginianus	White-tailed Deer
Canis latrans	Coyote
Urocyon cinereoargenteus	Gray Fox
Vulpes vulpes	Red Fox
Procyon lotor	Northern Raccoon
Mephitis mephitis	Striped Skunk
Didelphis virginiana	Virginia Opossum
Marmota monax	Woodchuck
Sylvilagus floridanus	Eastern Cottontail
Sciurus niger	Eastern Fox Squirrel
Tamias striatus	Eastern Chipmunk
Blarina brevicauda	Northern Short-tailed Shrew
Talpidae species	Mole species
Peromyscus leucopus	White-footed Mouse
Peromyscus maniculatus	Deer Mouse
Zapus hudsonius	Meadow Jumping Mouse
Eptesicus fuscus	Big Brown Bat
Lasiurus borealis	Eastern Red Bat
Myotis lucifugus	Little Brown Bat
Pipistrellus subflavus	Eastern Pipistrelle

Table 5: HERPETIFAUNA

Combined Total of 17 Species of Herpetifauna
5 Reptile Species and 12 Amphibian Species

SCIENTIFIC NAME	COMMON NAME
REPTILES	
Chelydra serpentina	Snapping Turtle
Nerodia sipedon	Northern Water Snake
Storeria dekayi	Brown Snake
Storeria occipitomaculata	Redbelly Snake
Thamnophis sirtalis	Common Garter Snake
AMPHIBIANS	
Bufo americanus	American Toad
Ambystoma maculatum	Spotted Salamander
Desmognathus fuscus	Dusky Salamander
Desmognathus ochrophaeus	Mountain Dusky Salamander
Eurycea bislineata	Northern Two-lined Salamander
Hemidactylium scutatum	Four-toed Salamander
Plethodon cinereus	Redback Salamander
Plethodon glutinosus	Slimy Salamander
Hyla versicolor	Gray Treefrog
Rana catesbeiana	Bullfrog
Rana clamitans	Green Frog
Rana sylvatica	Wood Frog

Table 6: TERRESTRIAL AND AQUATIC INSECTS

480* total taxa confirmed
These taxa were collected by use of terrestrial traps, aquatic traps and/or hand collecting.

ORDER	FAMILY	SCIENTIFIC NAME
Coleoptera	Anobiidae	*Priobium sericius*
Coleoptera	Anthribidae	*Euparius sp.*
Coleoptera	Bostrichidae	*Lichenophanes bicornis*
Coleoptera	Buprestidae	*Dicerca divericata*
Coleoptera	Cantharidae	*Rhagonycha nigriceps*
Coleoptera	Carabidae	*Acupalpus indistinctus*
Coleoptera	Carabidae	*Agonum cupripenne*
Coleoptera	Carabidae	*Agonum extensicolle*
Coleoptera	Carabidae	*Agonum ferreum*
Coleoptera	Carabidae	*Agonum fidele*
Coleoptera	Carabidae	*Agonum melanarium*
Coleoptera	Carabidae	*Agonum placidum*
Coleoptera	Carabidae	*Amphasia sericea*
Coleoptera	Carabidae	*Anisotarsus sp.*
Coleoptera	Carabidae	*Bembidion affine*
Coleoptera	Carabidae	*Bembidion americanum*
Coleoptera	Carabidae	*Bembidion bifossulatum ssp. cheyennense*
Coleoptera	Carabidae	*Bembidion cordatum*
Coleoptera	Carabidae	*Bembidion impotens*
Coleoptera	Carabidae	*Bembidion inaequale*
Coleoptera	Carabidae	*Bembidion lacunarium*
Coleoptera	Carabidae	*Bembidion nigrum*
Coleoptera	Carabidae	*Bembidion obscurellum*
Coleoptera	Carabidae	*Bembidion patruele*
Coleoptera	Carabidae	*Bembidion petrosum*
Coleoptera	Carabidae	*Bembidion quadrimaculatum ssp. oppositum*
Coleoptera	Carabidae	*Bembidion rapidum*
Coleoptera	Carabidae	*Bembidion simplex*
Coleoptera	Carabidae	*Calathus gregarius*
Coleoptera	Carabidae	*Calosoma scrutator*
Coleoptera	Carabidae	*Chlaenius cordicollis*
Coleoptera	Carabidae	*Chlaenius emarginatus*
Coleoptera	Carabidae	*Chlaenius tricolor*

Coleoptera	Carabidae	*Cicindela punctulata ssp. punctulata*
Coleoptera	Carabidae	*Cicindela repanda ssp. repanda*
Coleoptera	Carabidae	*Cymindis limbatus*
Coleoptera	Carabidae	*Dyschirius politus*
Coleoptera	Carabidae	*Gastrellarius honestus*
Coleoptera	Carabidae	*Harpalus affinis*
Coleoptera	Carabidae	*Harpalus compar*
Coleoptera	Carabidae	*Harpalus herbivagus*
Coleoptera	Carabidae	*Harpalus pensylvanicus*
Coleoptera	Carabidae	*Lebia viridis*
Coleoptera	Carabidae	*Nebria lacustris ssp. lacustris*
Coleoptera	Carabidae	*Nebria pallipes*
Coleoptera	Carabidae	*Notiobia terminata*
Coleoptera	Carabidae	*Notiophilus aeneus*
Coleoptera	Carabidae	*Ophonus puncticeps*
Coleoptera	Carabidae	*Oxypselaphus pusillus*
Coleoptera	Carabidae	*Patrobus longicornis*
Coleoptera	Carabidae	*Platynus angustatus*
Coleoptera	Carabidae	*Platynus cincticollis*
Coleoptera	Carabidae	*Platynus decentis*
Coleoptera	Carabidae	*Platynus hypolithos*
Coleoptera	Carabidae	*Platynus tenuicollis*
Coleoptera	Carabidae	*Pterostichus adoxus*
Coleoptera	Carabidae	*Pterostichus melanarius*
Coleoptera	Carabidae	*Pterostichus mutus*
Coleoptera	Carabidae	*Pterostichus stygicus*
Coleoptera	Carabidae	*Sphaeroderus stenostomus ssp. lecontei*
Coleoptera	Carabidae	*Stenolophus comma*
Coleoptera	Carabidae	*Stenolophus lecontei*
Coleoptera	Carabidae	*Stenolophus ochropezus*
Coleoptera	Carabidae	*Synuchus impunctatus*
Coleoptera	Cerambycidae	*Brachyleptura rubrica*
Coleoptera	Cerambycidae	*Euderces picipes*
Coleoptera	Cerambycidae	*Orthosoma brunneum*
Coleoptera	Cerambycidae	*Tetraopes tetrophthalmus*
Coleoptera	Cerambycidae	*Typocerus velutinus ssp. velutinus*
Coleoptera	Chrysomelidae	*Diabrotica undecimpunctata ssp. howardi*
Coleoptera	Chrysomelidae	*Lema collaris*

Coleoptera	Chrysomelidae	*Odontota dorsalis*
Coleoptera	Chrysomelidae	*Paria sp.*
Coleoptera	Cicindelidae	*Cicindela sp.*
Coleoptera	Cleridae	*Enoclarus rosmarus*
Coleoptera	Coccinellidae	*Harmonia axyridis*
Coleoptera	Curculionidae	*Apion sp.*
Coleoptera	Curculionidae	*Sitona sp.*
Coleoptera	Dytiscidae	*Copelatus sp.*
Coleoptera	Dytiscidae	*Cybister sp.*
Coleoptera	Dytiscidae	*Dytiscus fasciventris*
Coleoptera	Elateridae	*Hemicrepidius sp. 1*
Coleoptera	Elateridae	*Hemicrepidius sp. 2*
Coleoptera	Elmidae	*Optioservus sp.*
Coleoptera	Elmidae	*Stenelmis sp.*
Coleoptera	Endomychidae	*Aphorista vittata*
Coleoptera	Endomychidae	*Endomychus biguttatus*
Coleoptera	Erotylidae	*Megalodacne fasciata*
Coleoptera	Erotylidae	*Megalodacne heros*
Coleoptera	Gyrinidae	*Dineutus sp.*
Coleoptera	Haliplidae	undetermined species
Coleoptera	Helodidae	undetermined species
Coleoptera	Heteroceridae	undetermined species
Coleoptera	Histeridae	undetermined species
Coleoptera	Hydrophilidae	undetermined species
Coleoptera	Lampyridae	*Photinus pyralis*
Coleoptera	Lathridiidae	*Aphonsta vittata*
Coleoptera	Leiodidae	*undetermined species*
Coleoptera	Limnichidae	*undetermined species*
Coleoptera	Lycidae	*Calopteron reticulatum*
Coleoptera	Lycidae	*Plateros canaliculatus*
Coleoptera	Melandryidae	*undetermined species*
Coleoptera	Meloidae	*undetermined species*
Coleoptera	Mordellidae	*Falsomordellistena sp. (cf)*
Coleoptera	Mordellidae	*Mordella sp. 1*
Coleoptera	Mordellidae	*Mordella sp. 2*
Coleoptera	Mordellidae	*Tolidomordella discoidea ssp. discoidea (cf)*
Coleoptera	Nemonychidae (cf)	undetermined species
Coleoptera	Nitidulidae	*Glischrochilus fasciatus*

Coleoptera	Pedilidae	undetermined species
Coleoptera	Phalacridae	undetermined species
Coleoptera	Psephenidae	*Psephenus sp.*
Coleoptera	Ptilodactylidae	*Ptilodactyla sp.*
Coleoptera	Pyrochroidae	*Dendroides canadensis*
Coleoptera	Pyrochroidae	*Neopyrochroa flabellata*
Coleoptera	Rhysodidae	*Clinidium sculptile*
Coleoptera	Scarabaeidae	*Aphodius sp.*
Coleoptera	Scarabaeidae	*Bolboceras sp.*
Coleoptera	Scarabaeidae	*Copris sp.*
Coleoptera	Scarabaeidae	*Dialytes truncatus*
Coleoptera	Scarabaeidae	*Dialytes ulkei*
Coleoptera	Scarabaeidae	*Maladera castanea*
Coleoptera	Scarabaeidae	*Osmoderma scabra*
Coleoptera	Scarabaeidae	*Pelidnota punctata*
Coleoptera	Scarabaeidae	*Phyllophaga crenulata*
Coleoptera	Scarabaeidae	*Popillia japonica*
Coleoptera	Scarabaeidae	*Serica sp.*
Coleoptera	Scirtidae	*Prionocyphon sp.*
Coleoptera	Scolytidae	*Monarthrum mali*
Coleoptera	Scolytidae	*Xyleborinus saxeseni*
Coleoptera	Scolytidae	*Xylosandrus germanus*
Coleoptera	Silphidae	*Nicrophorus orbicollis*
Coleoptera	Silphidae	*Nicrophorus pustulatus*
Coleoptera	Silphidae	*Oiceoptoma noveboracensis*
Coleoptera	Staphylinidae	*Stenus bipunctatus*
Coleoptera	Staphylinidae	*Tachinus fimbriatus*
Coleoptera	Staphylinidae	undetermined species 1
Coleoptera	Staphylinidae	undetermined species 2
Coleoptera	Tenebrionidae	*Bolitotherus cornutus*
Coleoptera	Tenebrionidae	*Lobopoda sp.*
Coleoptera	Tenebrionidae	*Meracantha contracta*
Coleoptera	Tenebrionidae	*Neatus tenebroides*
Coleoptera	Tetratomidae	*Penthe obliquata*
Coleoptera	Trogidae	*Trox aequalis*
Coleoptera	Trogidae	*Trox variolatus*
Dictyoptera	Blattellidae	undetermined species
Diptera	Anthomyiidae	undetermined species

Diptera	Asilidae	undetermined species
Diptera	Calliphoridae	undetermined species
Diptera	Ceratopogonidae	*Probezzia sp.*
Diptera	Chironomidae	*Rheotanytarsus sp.*
Diptera	Conopidae	undetermined species
Diptera	Culicidae	*Aedes vexan*
Diptera	Culicidae	*Anopheles punctipennis*
Diptera	Culicidae	*Coquilletidia perturbans*
Diptera	Culicidae	*Culex restuans*
Diptera	Culicidae	*Nephrotoma virencenses*
Diptera	Culicidae	*Ochlerotatus trivittatus*
Diptera	Dolichopodidae	undetermined species
Diptera	Drosophilidae	undetermined species
Diptera	Ephydridae	undetermined species
Diptera	Lauxaniidae	undetermined species
Diptera	Limoniidae	*Limonia geranomyia*
Diptera	Limoniidae	*Limonia limonia*
Diptera	Lonchaeidae	undetermined species
Diptera	Muscidae	undetermined species
Diptera	Otitidae	undetermined species
Diptera	Phoridae	undetermined species
Diptera	Ptychopteridae	*Bittacomorpha sp.*
Diptera	Rhagionidae	undetermined species
Diptera	Sarcophagidae	undetermined species
Diptera	Sciomyzidae	undetermined species
Diptera	Simuliidae	*Simulium vittatum*
Diptera	Simuliidae	*Simulium tuberosum*
Diptera	Stratiomyidae	*Euparyphus sp.*
Diptera	Syrphidae	undetermined species
Diptera	Tabanidae	undetermined species
Diptera	Tachinidae	*Hystricia abrupta*
Diptera	Therevidae	undetermined species
Diptera	Tipulidae	*Dicranota sp.*
Diptera	Tipulidae	*Dolichopeza carolus*
Diptera	Tipulidae	*Elephantomyia westwoodi*
Diptera	Tipulidae	*Epiphragma fascipenne*
Diptera	Tipulidae	*Epiphragma solatrix*
Diptera	Tipulidae	*Erioptera caliptera*

Diptera	Tipulidae	*Erioptera mesocephallus*
Diptera	Tipulidae	*Erioptera septemtrionis*
Diptera	Tipulidae	*Hexatoma sp.*
Diptera	Tipulidae	*Limonia triocellata*
Diptera	Tipulidae	*Nephrotoma alterna*
Diptera	Tipulidae	*Nephrotoma virescens*
Diptera	Tipulidae	*Ormosia sp.*
Diptera	Tipulidae	*Pedicia inconstans*
Diptera	Tipulidae	*Pseudolimnophila luteipennis*
Diptera	Tipulidae	*Sialis sp.*
Diptera	Tipulidae	*Tipula beringotipula*
Diptera	Tipulidae	*Tipula borealis*
Diptera	Tipulidae	*Tipula duplex*
Diptera	Tipulidae	*Tipula entomophthorae*
Diptera	Tipulidae	*Tipula furca*
Diptera	Tipulidae	*Tipula hermannia*
Diptera	Tipulidae	*Tipula nippontipula*
Diptera	Tipulidae	*Tipula pterelachisus*
Diptera	Tipulidae	*Tipula savshenkia*
Diptera	Tipulidae	*Tipula schemelia*
Diptera	Tipulidae	*Tipula submaculata*
Diptera	Tipulidae	*Tipula tephrocephala*
Diptera	Tipulidae	*Tipula abdominalis*
Ephemeroptera	Baetidae	*Baetis sp.*
Ephemeroptera	Baetidae	*Diphetor sp.*
Ephemeroptera	Caenidae	*Caenis sp.*
Ephemeroptera	Heptageniidae	*Leucrocuta sp.*
Ephemeroptera	Heptageniidae	*Stenonema femoratum*
Ephemeroptera	Isonychiidae	*Isonychia sp.*
Ephemeroptera	Leptohyphidae	*Tricorythodes sp.*
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia sp.*
Hemiptera	Alydidae	*Alydus sp.*
Hemiptera	Aphididae	*Prociphilus tesselatus*
Hemiptera	Cercopidae	undetermined species
Hemiptera	Cicadellidae	*Graphocephala sp.*
Hemiptera	Corixidae	undetermined species
Hemiptera	Delphacidae	undetermined species
Hemiptera	Dictyopharidae	*scolops sp.*

Hemiptera	Gerridae	*Gerris sp.*
Hemiptera	Myridae	undetermined species
Hemiptera	Pentatomidae	*Banasa calva*
Hemiptera	Reduviidae	undetermined species
Hemiptera	Thyreocoridae	undetermined species
Hemiptera	Veliidae	*Rhagovelia sp.*
Heteroptera	Cydnidae	*Thyreocorinae sp.*
Heteroptera	Lygaeidae	undetermined species
Heteroptera	Miridae	undetermined species
Heteroptera	Notonectidae	undetermined species
Heteroptera	Pentatomidae	undetermined species
Homoptera	Membracidae	undetermined species
Hymenoptera	Apidae	undetermined species
Hymenoptera	Bombidae	undetermined species
Hymenoptera	Braconidae	undetermined species
Hymenoptera	Chrysididae	undetermined species
Hymenoptera	Formicidae	*Camponotus nearcticus*
Hymenoptera	Formicidae	*Camponotus noveboracensis*
Hymenoptera	Formicidae	*Formica sp.*
Hymenoptera	Halictidae	undetermined species
Hymenoptera	Ichneumonidae	undetermined species
Hymenoptera	Megachilidae	undetermined species
Hymenoptera	Mutillidae	*Dasymutilla sp. 1*
Hymenoptera	Mutillidae	*Dasymutilla sp. 2*
Hymenoptera	Siricidae	*Tremex columba*
Hymenoptera	Sphecidae	*Bembix spinolae*
Hymenoptera	Sphecidae	*Prionxy sp.*
Hymenoptera	Sphecidae	*Sphecius speciosus*
Hymenoptera	Tenthredinidae	undetermined species
Hymenoptera	Vespidae	undetermined species
Lepidoptera	Apatelodidae	*Olceclostera angelica*
Lepidoptera	Arctiidae	*Grammia arge*
Lepidoptera	Arctiidae	*Grammia virgo*
Lepidoptera	Arctiidae	*Halysidota tessellaris*
Lepidoptera	Arctiidae	*Holomelina opella*
Lepidoptera	Arctiidae	*Spilosoma virginica*
Lepidoptera	Danaidae	undetermined species
Lepidoptera	Drepanidae	*Eudeilinea herminiata*

Lepidoptera	Gelechioidea	*undetermined species*
Lepidoptera	Geometridae	*Aethalura intertexta*
Lepidoptera	Geometridae	*Anavitrinella pampinaria*
Lepidoptera	Geometridae	*Caripeta divisata*
Lepidoptera	Geometridae	*Costaconvexa centrostrigaria*
Lepidoptera	Geometridae	*Dyspteris abortivaria*
Lepidoptera	Geometridae	*Ectropis crepuscularia*
Lepidoptera	Geometridae	*Ennomos subsignaria*
Lepidoptera	Geometridae	*Epimecis hortaria*
Lepidoptera	Geometridae	*Eulithis diversilineata*
Lepidoptera	Geometridae	*Eupithecia mutata ssp. mutata*
Lepidoptera	Geometridae	*Eusarca confusaria*
Lepidoptera	Geometridae	*Heterophleps triguttaria*
Lepidoptera	Geometridae	*Homochlodes fritillaria complex, undet. female*
Lepidoptera	Geometridae	*Hydrelia inornata*
Lepidoptera	Geometridae	*Hydria prunivorata*
Lepidoptera	Geometridae	*Itame pustularia*
Lepidoptera	Geometridae	*Macaria aemulataria*
Lepidoptera	Geometridae	*Macaria fissinotata*
Lepidoptera	Geometridae	*Melanolophia canadaria ssp. Crama*
Lepidoptera	Geometridae	*Mesoleuca ruficillata*
Lepidoptera	Geometridae	*Plagodis phlogosaria*
Lepidoptera	Geometridae	*Prochoerodes lineola ssp. lineola*
Lepidoptera	Geometridae	*Prochoerodes transversata*
Lepidoptera	Geometridae	*Protoboarmia porcelaria ssp. porcelaria*
Lepidoptera	Geometridae	*Rheumaptera prunivorata*
Lepidoptera	Geometridae	*Scopula limboundata*
Lepidoptera	Geometridae	*Xanthorhoe lacustrata*
Lepidoptera	Hesperiidae	*Epargyreus clarus*
Lepidoptera	Hesperiidae	*Pholisora catullus*
Lepidoptera	Lampyridae	*Photurus sp.*
Lepidoptera	Lasiocampidae	*Malacosoma disstria*
Lepidoptera	Limacodidae	*Adoneta spinuloides*
Lepidoptera	Limacodidae	*Euclea delphinii*
Lepidoptera	Limacodidae	*Isa textula*
Lepidoptera	Limacodidae	*Lithacodes fasciola*
Lepidoptera	Limacodidae	*Prolimacodes badia*
Lepidoptera	Limacodidae	*Tortricidia flexuosa*

Lepidoptera	Limacodidae	*Tortricidia pallida*
Lepidoptera	Lycaenidae	*Celastrina neglecta*
Lepidoptera	Lycaenidae	*Cupido comyntas*
Lepidoptera	Lycaenidae	*Lycaena phlaes*
Lepidoptera	Noctuidae	*Achatodes zeae*
Lepidoptera	Noctuidae	*Acronicta americana*
Lepidoptera	Noctuidae	*Acronicta dactylina*
Lepidoptera	Noctuidae	*Acronicta hasta ssp. hasta*
Lepidoptera	Noctuidae	*Acronicta innotata*
Lepidoptera	Noctuidae	*Acronicta modica*
Lepidoptera	Noctuidae	*Acronicta morula*
Lepidoptera	Noctuidae	*Acronicta spinigera*
Lepidoptera	Noctuidae	*Agrotis ipsilon*
Lepidoptera	Noctuidae	*Allotria elonympha*
Lepidoptera	Noctuidae	*Amphipoea velata*
Lepidoptera	Noctuidae	*Anaplectoides prasina*
Lepidoptera	Noctuidae	*Anaplectoides pressus ssp. pressus*
Lepidoptera	Noctuidae	*Autographa precationis*
Lepidoptera	Noctuidae	*Baileya dormitans*
Lepidoptera	Noctuidae	*Baileya doubledayi*
Lepidoptera	Noctuidae	*Balsa labecula*
Lepidoptera	Noctuidae	*Bleptina caradrinalis*
Lepidoptera	Noctuidae	*Bomolocha madefactalis*
Lepidoptera	Noctuidae	*Bomolocha manalis*
Lepidoptera	Noctuidae	*Caenurgina crassiuscula*
Lepidoptera	Noctuidae	*Chytonix palliatricula*
Lepidoptera	Noctuidae	*Condica vecors*
Lepidoptera	Noctuidae	*Crymodes devastator*
Lepidoptera	Noctuidae	*Dyspyralis illocata*
Lepidoptera	Noctuidae	*Dyspyralis puncticosta*
Lepidoptera	Noctuidae	*Elaphria versicolor*
Lepidoptera	Noctuidae	*Eosphoropteryx thyatyroides*
Lepidoptera	Noctuidae	*Eudryas grata*
Lepidoptera	Noctuidae	*Eudryas unio*
Lepidoptera	Noctuidae	*Euxoa tessellata*
Lepidoptera	Noctuidae	*Homophoberia apicosa*
Lepidoptera	Noctuidae	*Homorthodes furfurata*
Lepidoptera	Noctuidae	*Hydraecia micacea*

Lepidoptera	Noctuidae	*Hyppa xylinoides*
Lepidoptera	Noctuidae	*Idia aemula*
Lepidoptera	Noctuidae	*Idia americalis*
Lepidoptera	Noctuidae	*Idia denticulalis*
Lepidoptera	Noctuidae	*Idia diminuendis*
Lepidoptera	Noctuidae	*Idia forbesi*
Lepidoptera	Noctuidae	*Idia julia*
Lepidoptera	Noctuidae	*Idia lubricalis ssp. lubricalis*
Lepidoptera	Noctuidae	*Idia rotundalis*
Lepidoptera	Noctuidae	*Idia scobialis*
Lepidoptera	Noctuidae	*Lacinipolia renigera*
Lepidoptera	Noctuidae	*Lascoria ambigualis*
Lepidoptera	Noctuidae	*Lithacodia muscosula*
Lepidoptera	Noctuidae	*Lithacodia musta*
Lepidoptera	Noctuidae	*Maliattha synochitis*
Lepidoptera	Noctuidae	*Marathyssa inficita*
Lepidoptera	Noctuidae	*Metalectra discalis*
Lepidoptera	Noctuidae	*Noctua pronuba*
Lepidoptera	Noctuidae	*Ochropleura implecta*
Lepidoptera	Noctuidae	*Oligia exhausta*
Lepidoptera	Noctuidae	*Oligia fractilinea*
Lepidoptera	Noctuidae	*Orthodes majuscula*
Lepidoptera	Noctuidae	*Panopoda carneicosta*
Lepidoptera	Noctuidae	*Parallelia bistriaris*
Lepidoptera	Noctuidae	*Peridroma saucia*
Lepidoptera	Noctuidae	*Phlogophora iris*
Lepidoptera	Noctuidae	*Plathypena scabra*
Lepidoptera	Noctuidae	*Protolampra brunneicollis*
Lepidoptera	Noctuidae	*Pseudaletia unipuncta*
Lepidoptera	Noctuidae	*Pseudeustrotia carneola*
Lepidoptera	Noctuidae	*Pseudeva purpurigera*
Lepidoptera	Noctuidae	*Pseudorthodes vecors*
Lepidoptera	Noctuidae	*Redectis vitrea*
Lepidoptera	Noctuidae	*Renia adspergillus*
Lepidoptera	Noctuidae	*Renia factiosalis*
Lepidoptera	Noctuidae	*Scolecocampa liburna*
Lepidoptera	Noctuidae	*Simyra insularis*
Lepidoptera	Noctuidae	*Zanclognatha jacchusalis*

Lepidoptera	Noctuidae	*Zanclognatha laevigata*
Lepidoptera	Noctuidae	*Zanclognatha lituralis*
Lepidoptera	Noctuidae	*Zanclognatha ochreipennis ssp. ochreipennis*
Lepidoptera	Noctuidae	*Zanclognatha protumnusalis*
Lepidoptera	Notodontidae	*Datana drexelii*
Lepidoptera	Notodontidae	*Datana integerrima ssp. integerrima*
Lepidoptera	Notodontidae	*Furcula cinerea*
Lepidoptera	Notodontidae	*Gluphisia septentrionis ssp. septentrionis*
Lepidoptera	Notodontidae	*Heterocampa guttivitta*
Lepidoptera	Notodontidae	*Lochmaeus bilineata*
Lepidoptera	Notodontidae	*Macrurocampa marthesia*
Lepidoptera	Notodontidae	*Nadata gibbosa*
Lepidoptera	Notodontidae	*Odontosia elegans*
Lepidoptera	Notodontidae	*Oligocentria semirufescens*
Lepidoptera	Notodontidae	*Peridea angulosa*
Lepidoptera	Notodontidae	*Peridea basitriens*
Lepidoptera	Notodontidae	*Pheosia rimosa*
Lepidoptera	Notodontidae	*Schizura ipomoeae*
Lepidoptera	Nymphalidae	*Nymphalis antiopa*
Lepidoptera	Nymphalidae	*Phyciodes tharos*
Lepidoptera	Nymphalidae	*Polygonia comma*
Lepidoptera	Nymphalidae	*Speyeria cybele*
Lepidoptera	Nymphalidae	*Vanessa atalanta*
Lepidoptera	Papilionidae	*Papilio glaucus*
Lepidoptera	Papilionidae	*Papilio polyxenes*
Lepidoptera	Papilionidae	*Papilio troilus*
Lepidoptera	Pieridae	*Colias eurytheme*
Lepidoptera	Pieridae	*Colias philodice*
Lepidoptera	Pieridae	*Pieris rapae*
Lepidoptera	Pyralidae	*Blepharomastix ranalis*
Lepidoptera	Pyralidae	*Desmia funeralis*
Lepidoptera	Pyralidae	*Euzophera ostricolorella*
Lepidoptera	Pyralidae	*Herpetogramma sp.*
Lepidoptera	Pyralidae	*Nomophila nearctica*
Lepidoptera	Pyralidae	*Ostrinia nubilalis*
Lepidoptera	Pyralidae	*Pantographa limata*
Lepidoptera	Pyralidae	*Udea rubigalis*
Lepidoptera	Pyralidae	*Vaxi auratella*

Lepidoptera	Saturniidae	*Antheraea polyphemus*
Lepidoptera	Saturniidae	*Automeris io ssp. io*
Lepidoptera	Saturniidae	*Callosamia angulifera*
Lepidoptera	Saturniidae	*Callosamia promethea*
Lepidoptera	Saturniidae	*Dryocampa rubicunda*
Lepidoptera	Sphingidae	*Amphion floridensis*
Lepidoptera	Sphingidae	*Ceratomia undulosa*
Lepidoptera	Sphingidae	*Darapsa myron*
Lepidoptera	Sphingidae	*Hemaris thysbe*
Lepidoptera	Sphingidae	*Paonias excaecatus*
Lepidoptera	Sphingidae	*Paonias myops*
Lepidoptera	Thyatiridae	*Habrosyne scripta*
Lepidoptera	Thyatiridae	*Pseudothyatira cymatophoroides*
Lepidoptera	Tortricidae	*Argyrotaenia velutinana*
Lepidoptera	Yponomeutidae	*Atteva punctella*
Lepidoptera	Yponomeutidae	*Yponomeuta multipunctella*
Mecoptera	Panorpidae	*Panorpa sp.*
Megaloptera		undetermined species
Neuroptera	Chrysopidae	undetermined species
Neuroptera	Corydalidae	*Chauliodes sp.*
Neuroptera	Myrmeleontidae	undetermined species
Odonata	Aeshnidae	*Aescha umbrosa*
Odonata	Aeshnidae	*Anax junius*
Odonata	Aeshnidae	*Boyeria vinosa*
Odonata	Aeshnidae	*Epiaeschna heros*
Odonata	Calopterygidae	*Calopteryx maculata*
Odonata	Coenagrionidae	*Argia moesta*
Odonata	Coenagrionidae	*Ischnura posita*
Odonata	Coenagrionidae	*Ischnura verticalis*
Odonata	Lestidae	*Lestes rectangularis*
Odonata	Lestidae	*Lestes unguiculatus*
Odonata	Libellulidae	*Leucorrhinia intacta*
Odonata	Libellulidae	*Libellula quadrimaculata*
Odonata	Libellulidae	*Libellula semifasciata*
Odonata	Libellulidae	*Pantala flavescens*
Odonata	Libellulidae	*Pantala hymenaea*
Odonata	Libellulidae	*Plathemis lydia*
Odonata	Libellulidae	*Sympetrum rubicundulum*

Odonata	Libellulidae	*Tramea lacerata*
Orthoptera	Acrididae	undetermined species
Orthoptera	Gryllidae	undetermined species
Orthoptera	Rhaphidophoridae	undetermined species
Orthoptera	Tetrigidae	undetermined species
Orthoptera	Tettigoniidae	undetermined species
Plecoptera	Leuctridae	*Leuctra sp.*
Plecoptera	Nemouridae	*Amphinemura sp.*
Plecoptera	Perlidae	*Perlesta sp.*
Plecoptera	Perlodidae	undetermined species
Trichoptera	Helicopsychidae	*Helicopsyche borealis*
Trichoptera	Hydriptilidae	*Leucotrichia pictipes*
Trichoptera	Hydropsychidae	*Ceratopsyche bronta*
Trichoptera	Hydropsychidae	*Cheumatopsyche sp.*
Trichoptera	Hydropsychidae	*Diplectrona sp.*
Trichoptera	Hydropsychidae	*Hydropsyche sp.*
Trichoptera	Hydropsychidae	*Parapsyche sp.*
Trichoptera	Hydroptilidae	*Hydroptila angusta*
Trichoptera	Hydroptilidae	*Hydroptila consimilis*
Trichoptera	Hydroptilidae	*Hydroptila hamata*
Trichoptera	Hydroptilidae	*Hydroptila perdita*
Trichoptera	Hydroptilidae	*Oxyethira pallida*
Trichoptera	Lepidostomatidae	*Lepidostoma sp.*
Trichoptera	Leptoceridae	*Ceraclea transversa*
Trichoptera	Limnephilidae	*Pycnopsyche sp.*
Trichoptera	Philopotamidae	*Chimarra obscura*
Trichoptera	Philopotamidae	*Wormaldia sp.*
Trichoptera	Polycentropodidae	*Polycentropus centralis*
Trichoptera	Rhyacophilidae	*Rhyacophila sp.*

* Some collected data may not be included in this count. This data will be added to the total when experts are able to identify the specimens collected. Unidentified specimens are held by a variety of collectors including the Carnegie Museum of Natural History, Doug Ebert, Joe Brancato and others.

Table 7: CHELICERATES

3* taxa confirmed

ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
Araneae	Araneidae	undetermined sp.	undetermined Arenidae
Araneae	Amaurobiidae	undetermined sp.	undetermined Amaurobiidae
Acarina		undetermined sp.	undetermined Acarina

* This table is not representative of all specimens collected by Charles Bier at the Bioblitz. All of these specimens are awaiting identification by experts when they become available.

Table 8: AQUATIC INVERTEBRATES

16* taxa confirmed

PHYLUM	CLASS	ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
Mollusca	***Bivalvia***	***Unionoida***	***Unionoidae***	***Potamilus alatus***	***pink heelsplitter†***
Mollusca	Bivalvia	Unionoida	Unionoidae	*Lampsilis siliquoidea*	Fatmucket
Mollusca	Bivalvia	Veneroida	Dreissenidae	*Dreissena polymorpha*	zebra mussel**
Mollusca	Bivalvia	Veneroida	Sphaeriidae	*Pisidium casertanum*	ubiquitous peaclam
Mollusca	Gastropoda	Basammatophora	Ancylidae	*Ferrissia rivularis*	creeping ancylid
Mollusca	Gastropoda	Basammatophora	Lymnaeidae	*Fossaria modicella*	rock fossaria
Mollusca	Gastropoda	Basammatophora	Physidae	*Aplexa elongata*	lance aplexa
Mollusca	Gastropoda	Basammatophora	Physidae	*Physella acuta*	European physa**
Mollusca	Gastropoda	Basammatophora	Physidae	*Physella gyrina*	tadpole physa
Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	*Elimia livescens*	liver elimia
Annelida	Hirudinea	Gnathobdellida	Hirudinidae	undetermined species	leech
Annelida	Oligochaeta			undetermined species	worm
Crustacea	Malacostraca	Amphipoda	Gammaridae	*Gammarus sp.*	shrimp or scud
Crustacea	Malacostraca	Decapoda	Cambaridae	*Carinirostris cambarus*	crayfish
Crustacea	Malacostraca	Isopoda	Asellidae	*Caecidotea sp.*	freshwater isopod
Platyhelminthes	Turbellaria			undetermined species	flat worm

* Insects are not included in this data. Some relevant collected data may not be included in this count due to the amount of time it can take to identify specimens. These data will be added to the total when experts are able to identify the specimens. Unidentified specimens are held by a variety of collectors including the Carnegie Museum of Natural History, Doug Ebert, Joe Brancato, and Ryan Evans.

Table 9: INVERTEBRATES: LAND SNAILS

35 species confirmed

FAMILY	SCIENTIFIC NAME
Arionidae	*Arion intermedius*
Arionidae	*Arion subfuscus*
Carychiidae	*Carychium exiguum*
Carychiidae	*Carychium exile ssp. exile*
Cionellidae	*Cochlicopa lubrica*
Discidae	*Anguispira alternata*
Euconulidae	*Euconulus polygyratus (cf)*
Gastrocoptidae	*Gastrocopta pentodon*
Gastrodontidae	*Striatura ferrea*
Gastrodontidae	*Striatura meridionalis*
Gastrodontidae	*Striatura milium*
Gastrodontidae	*Ventridens intertextus*
Gastrodontidae	*Zonitoides arboreus*
Gastrodontidae	*Zonitoides nitidus*
Philomycidae	*Pallifera ohioensis*
Philomycidae	*Philomycus carolinianus (cf)*
Polygyridae	*Euchemotrema sp. (cf)*
Polygyridae	*Mesodon thyroides (cf)*
Polygyridae	*Neohelix albolabris*
Polygyridae	*Stenotrema hirsutum*
Polygyridae	*Triodopsis tridentata*
Polygyridae	*Xolotrema denotata*
Punctidae	*Punctum minutissimum*
Succineidae	*Catinella sp.*
Succineidae	*Novisuccinea ovalis (cf)*
Succineidae	*Oxyloma sp.*
Valloniidae	*Vallonia costata*
Valloniidae	*Vallonia excentrica*
Vitrinidae	*Vitrina limpida*
Zonitidae	*Glyphyalinia indentata (cf)*
Zonitidae	*Glyphyalinia rhoadsi*
Zonitidae	*Glyphyalinia wheatleyi*
Zonitidae	*Mesomphix cupreus*
Zonitidae	*Mesomphix inornatus*
Zonitidae	*Paravitrea multidentata*

Table 10: FUNGI

110 total species

Identified Fungi spp. (90)	
FUNGI SPECIES	**COMMON NAME**
Agrocybe acericola	Maple Agrocybe
Aminita flavoconia	Yellow Patches
Aminita rubescens	Blusher
Arcyria denudate	Slime Mold
Armillaria mellea	Honey Mushroom
Boletinellus merulioides	Ash Tree Bolete
Boletus bicolor	Apple Bolete
Boletus rubellus	Red-Capped Bolete
Bovista pila	Tumbling Puffball
Ceratiomyxa fruticulosa	Slime Mold
Clavaria vermicularis	Worm-like Coral
Clavicorona pyxidata	Crown-tipped Coral
Clavulina amethystine	Violet Branched Coral
Clavulinopsis fusiformis	Spindel-shaped Yellow Coral
Clitocybe gibba	Funnel Cap
Collybia dryophilia	Oak Loving Collybia
Coltricia cinnamomea	Shiny Cinnamon Polyphore
Conocybe tenera	Brown Dunce Cap
Coprinus micaceus	Mica Cap
Coprinus plicatilis	Japanese Umbrella Inky
Cortinarius iodes	Viscid Violet Cort
Craterellus fallax	Black Trumpet
Cudonia lutea	Yellow Cudonia
Daedaleopsis confragosa	Thin-maze Flat Polyphore
Daldinia concentrica	Carbon Balls
Disciotis venosa	Veined Cup
Exidia glandulosa	Black Jelly Roll
Fomes fomentarius	Tinder Polyphore
Galerina autumnalis	Deadly Galerina
Gandoderma applantum	Artist’s Conk
Gandoderma tsugae	Hemlock Polyphore
Gymnoconia peckiana.	Blackberry Rust
Gymnopus dryophilus	Common Collybia
Gymnopus earleae	
Helvella macropus	Long-stalked Gray Cup
Helvella crispa	Fluted White Helleva
Humaria hemisphaerica	Brown-haired White Cup
Hydnochaete olivaceum	Brown-toothed Crust

Hygrocybe cantharellus	Golden Waxy Cap
Hygrophorus flavescens	Chanterelle Waxcap
Hygrophorus miniatus	Fading Scarlet Waxy Cap
Hypomyces cervinigenus	White Mold
Hypomyces chrysospermus	Bolete Mold
Ipex lacteus	Thick-maze Oak Polyphore
Laetiporus sulphureus	Chicken Mushroom
Lenzites betulina	Multicolor Gill Polyphore
Lycogala epidendrum	Wolf's-milk Slime
Lycoperdon perlatum	Devil's Snuffbox
Lycoperdon pyriforme	Pear-shaped Puffball
Marasmius rotula	Pinwheel Marasmius
Megacollybia platyphylla	Broad Gill
Morchella elata	Black Morel
Morchella esculenta	Yellow Morel
Morchella semilibera	Half-free Morel
Mycena galopus	White Milk Mycena
Mycena haemotopus	Bleeding Mycena
Mycena leaiana	Orange Mycena
Nectria cinnabarina	Coral Spot
Oudemansiella radicata	Rooting Collybia
Peziza badia	Pig's Ears
Phallogaster saccatus	Stink Poke
Phellinus gilvus	Mustard Yellow Polyphore
Piptoporus betulinus	Birch Polyphore
Plecotus ostreatus	Oyster Mushroom
Pluteus cervinus	Deer Mushroom
Polyporus squamosus	Dryad's Saddle
Polyporus varius	Black-footed Polyphore
Psathyrella delineate	
Pucciniastrum potentillae	Cinqufoil Rust
Puccinia podophyllum	
Russula emetica	Emetic Russula
Russula flavisiccans	None
Russula lacrocerasi	Almond Scented Russula
Russula ochroleucoides	Matt Yellow Russula
Russula variata	Variable Russula
Scutellinia scutellata	Eyelash Cup
Stemonitis splendens	Chocolate Tube Slime
Stereum ostrea	False Turkey Tail
Stereum complicatum	Crowded Parchment
Trametes elegans	
Trametes versicolor	Turkey Tail

Tremellodendron pallidum	Jellied False Coral
Trichaptum biforme	Violet Toothed Polyphore
Tubifera ferruginosa	Red Raspberry Slime
Ustilago maydis	Corn Smut
Ustulina deusta	Carbon Cushion
Wynnea Americana	Moose Antlers
Xeromphalina campanella	Golden Trumpets
Xylaria longipes	Stalked Xylaria
Xylaria polymorha	Dead Man's Fingers

Partially Identified Fungi spp. (8)

Boletus sp.	
Chanterelle sp.	Chanterelle
Collybia sp.	
Exidia sp?	Jelly Fungi
Lactarius sp.	
Mycena sp.	
Peziza sp.	
Russula sp.	

Unidentified Fungi spp. (12)

#1 --- slime mold #1
#2 --- mold #2
#3 --- cap and gills (LBM #1)
#4 --- cap and gills (LBM #2)
#5 --- cap and gills (LBM #3)
#6 --- cap and gills (LBM #4)
#7 --- cap and gills #5
#8 --- cap and gills #6
#9 --- crustose polyphore #1
#10 --- crustose polyphore #2
#11 --- crustose polyphore #3
#12 --- crustose polyphore #4

APPENDIX B: NON-NATIVE PLANT SPECIES FOUND ON THE ERIE BLUFFS PROPERTY DURING FIELD MONITORING ACTIVITIES 2004 - 2005

SCIENTIFIC NAME	COMMON NAME	National I-Rank	Management Priority	Management recommendation
Abutilon theophrasti	butter-print	Medium/Low	low	monitor
Acer platanoides	Norway maple	High/Medium	high	cutting or pulling with herbicide
Agropyron repens	quack grass	Not ranked	high	hand pulling or mowing; disking
Agrostis gigantea	redtop	Not ranked	medium	hand pulling or mowing
Agrostis stolonifera var. palustris	carpet bentgrass	Not ranked	medium	hand pulling or mowing
Alliaria petiolata	garlic mustard	High/Medium	high	hand pulling or mowing
Amaranthus hybridus	pigweed	Not ranked	medium	hand pulling or mowing
Anthemis cotula	Mayweed	Medium/Insignificant	medium	hand pulling or mowing
Anthoxanthum odoratum	sweet vernalgrass	Not ranked	high	hand pulling or mowing
Arabidopsis thaliana	wall-cress	Not ranked	low	hand pulling or mowing
Arctium lappa	great burdock	Low/Insignificant	high	hand pulling or mowing
Arctium minus	common burdock	Medium/Insignificant	high	hand pulling or mowing
Arrhenatherum elatius	tall oatgrass	Low/Insignificant	medium	hand pulling or mowing
Artemisia vulgaris	wormwood	Not ranked	low/med	hand pulling or mowing
Asparagus officinalis	asparagus	Medium/Insignificant	low	hand pulling or mowing
Barbarea verna	early winter-cress	Not ranked	medium	hand pulling or mowing
Berberis thunbergii	Japanese barberry	High/Medium	high	hand pulling or herbicide
Berberis vulgaris	European barberry	High/Medium	high	hand pulling or herbicide
Brassica nigra	black mustard	High/Low	medium	hand pulling or mowing
Brassica rapa	field mustard	Not ranked	medium	hand pulling or mowing
Calystegia sepium	hedge bindweed	Not ranked	medium	hand pulling or mowing
Campsis radicans	trumpet creeper	Not ranked	medium	hand pulling or mowing
Celastrus orbiculatus	oriental bittersweet	High/Medium	high	cutting or pulling with herbicide
Centaurea maculosa	bushy knapweed	Not ranked	high	cutting or pulling with herbicide
Chaenorhinum minus	dwarf snapdragon	Not ranked	low	monitor
Chenopodium album	lamb's quarters	Not ranked	medium	hand pulling or mowing
Chrysanthemum leucanthemum	ox-eye daisy	Not ranked	low	monitor
Cichorium intybus	blue chicory	Medium/Insignificant	low	monitor
Cirsium arvense	Canada thistle	High/Medium	med/high	hand pulling, mowing, or herbicide
Cirsium vulgare	bull-thistle	Medium/Low	med/high	hand pulling, mowing, or herbicide
Clinopodium vulgare	wild basil	Not ranked	low	monitor
Collinsonia canadensis	horse balm	Not ranked	low/med	hand pulling or mowing
Commelina communis	Asiatic dayflower	Not ranked	low/med	hand pulling or mowing
Conium maculatum	poison-hemlock	Medium/Low	med/high	hand pulling or herbicide
Convolvulus arvensis	field bindweed	Medium/Low	high	hand pulling or mowing
Coronilla varia	crown-vetch	High	high	hand pulling or herbicide
Dactylis glomerata	orchardgrass	Medium/Insignificant	med/high	hand pulling or mowing
Daucus carota	Queen Anne's-lace	Low	med/high	monitor
Dianthus armeria	deptford pink	Not ranked	low	monitor
Epilobium hirsutum	hairy willow-herb	Not ranked	low/med	hand pulling or mowing
Epilobium parviflorum	hairy willow-herb	Not ranked	low/med	hand pulling or mowing
Epipactis helleborine	bastard hellebore	Not ranked	low	hand pulling or mowing
Hemerocallis fulva	orange day-lily	Medium/Low	low	hand pulling/digging
Hesperis matronalis	dame's-rocket	Medium/Low	medium	hand pulling or herbicide
Hieracium caespitosum	king-devil	Medium/Insignificant	low	monitor
Holcus lanatus	velvetgrass	High/Medium	high	hand pulling or mowing
Ipomoea pes-caprae	goat-foot morning-glory	Not ranked	low	hand pulling or mowing
Lactuca serriola	prickly lettuce	Low/Insignificant	low	hand pulling or mowing
Leontodon autumnalis	fall-dandelion	Not ranked	low	hand pulling or mowing

Leonurus cardiaca	motherwort	Not ranked	low	hand pulling or mowing
Lepidium campestre	fieldcress	Not ranked	low	hand pulling or mowing
Ligustrum obtusifolium	border privet	Not ranked	high	cutting or pulling with herbicide
Ligustrum vulgare	European privet	High/Medium	high	cutting or pulling with herbicide
Linaria vulgaris	butter-and-eggs	High/Low	low	hand pulling or mowing
Lolium perenne	perennial ryegrass	Medium	medium	hand pulling or mowing
Lonicera japonica	japanese honeysuckle	High/Medium	high	pulling, cutting, or herbicide
Lonicera morrowii	Morrow's honeysuckle	High/Medium	high	pulling, cutting, or herbicide
Lonicera x bella	pretty honeysuckle	Not ranked	high	pulling, cutting, or herbicide
Lysimachia nummularia	moneywort	Not ranked	medium	hand pulling or mowing
Lythrum salicaria	purple-loosestrife	Not ranked	high	pulling, cutting, or herbicide
Malva neglecta	common mallow	Medium/Insignificant	low	hand pulling or mowing
Medicago lupulina	black medic	Medium/Insignificant	low	hand pulling or mowing
Melilotus alba	white sweet-clover	Not ranked	low	hand pulling or mowing
Melilotus officinalis	yellow sweet-clover	Medium/Insignificant	low	hand pulling or mowing
Mentha longifolia	horse mint	Not ranked	low	hand pulling or mowing
Mollugo verticillata	green carpetweed	Not ranked	low	hand pulling or mowing
Morus alba	white mulberry	Not ranked	medium	hand pulling or mowing
Nepeta cataria	catnip	Not ranked	low	hand pulling or mowing
Phleum pratense	timothy	Not ranked	medium	hand pulling or mowing
Phragmites australis ssp. Australis	common reed	Not ranked	high	herbicide
Picea abies	Norway spruce	Not ranked	high	cutting with herbicide
Plantago aristata	bristly plantain	Not ranked	medium	hand pulling or mowing
Plantago lanceolata	English plantain	High/Low	medium	hand pulling or mowing
Plantago major	nipple-seed plantain	Not ranked	medium	hand pulling or mowing
Poa compressa	Canada bluegrass	High/Low	medium	hand pulling or mowing
Polygonum aviculare	knotweed	Not ranked	high	herbicide
Prunus persica	peach	Insignificant	low	no treatment necessary
Pyrus communis	common pear	High/Low	low	no treatment necessary
*Robinia pseudoacacia***	black-locust	Not ranked	high	cutting with herbicide (Garlon*)
Rosa multiflora	multiflora rose	Medium/Low	high	mowing, bulldozing, herbicide
Rumex acetosella	sheep sorrel	Not ranked	low	no treatment necessary
Rumex crispus	curly dock	Not ranked	medium	hand pulling or mowing
Rumex obtusifolius	bitter dock	Not ranked	medium	hand pulling or mowing
Saponaria officinalis	bouncing-bet	Low/Insignificant	low	hand pulling or mowing
Setaria faberi	giant foxtail	Not ranked	medium	hand pulling or mowing
Setaria pumila	yellow foxtail	Not ranked	medium	hand pulling or mowing
Silene vulgaris	maiden's tears	Not ranked	medium	hand pulling or mowing
Solanum dulcamara	trailing nightshade	Not ranked	low	hand pulling or mowing
Solanum nigrum	black nightshade	Not ranked	low	hand pulling or mowing
Sorbus aucuparia	European mountain-ash	Not ranked	low	cutting with herbicide
Stellaria media	common chickweed	Not ranked	medium	hand pulling or mowing
Taraxacum officinale	common dandelion	Not ranked	medium	hand pulling, mowing, herbide
Taxus cuspidata	Japanese yew	Not ranked	medium	cutting
Teucrium canadense	wild germander	Not ranked	low	hand pulling or mowing
Tragopogon dubius	goat's beard	Not ranked	high	hand pulling or mowing
Tragopogon pratensis	goat's beard	Not ranked	high	hand pulling or mowing
Trifolium incarnatum	crimson clover	Not ranked	low	hand pulling or mowing
Tussilago farfara	coltsfoot	Not ranked	high	hand pulling or mowing
Typha angustifolia	narrow leaf cat-tail	Not ranked	high	pulling, cutting, or herbicide
Verbascum blattaria	moth mullein	Not ranked	medium	hand pulling or mowing
Verbascum thapsus	common mullein	Medium	medium	hand pulling or mowing
Veronica arvensis	corn speedwell	Not ranked	low	hand pulling or mowing
Viola arvensis	small wild pansy	Not ranked	low	hand pulling or mowing

APPENDIX C. METHODS AND RESULTS FROM VEGETATION SAMPLING AT PERMANENT SAMPLE PLOTS

Plant community composition and structure was sampled at each of these sites in June 2005 in order to correlate insect diversity and habitat structure, as well as to provide baseline data to document plant community and ecosystem change over time.

At each site, a 20 by 20 m square plot was established surrounding the insect trap station. Each point was marked permanently with a rebar, and GPS position was obtained. To characterize the vegetative composition and vertical structiore of each plot, percent cover for all plant species rooted in and hanging over the plot was recorded by canopy height class: emergent (T1), dominant canopy (T2), subcanopy (T3), tall shrub (S1), short shrub (S2), herbaceous (H), and vine (V). In addition, the diameter at breast height (dbh = 1.27 m) of all live woody plants greater than 1 cm dbh was recorded by species. Percent cover was summarized by stratum for all plant species in each plot. For all woody species over 1 cm dbh, stem density (number individuals/hectare), and relative density (number of stems of a species per ha divided by the total number of stems for all species) were calculated for all species in the plot. Basal area (cross-sectional area of the stem at dbh) was calculated for each stem and summarized for each species in the plot. Relative dominance (basal area of a give species relative to the total basal area of all species) was also calculated.

Species composition and structure variables were compared across all studied community types. Results of the vegetation composition and structure of these sties are presented in this appendix. Because only one plot was taken per community type, no statistical analyses were performed on the vegetation data alone. However, these statistics, in addition to other ecosystem variables recorded in the field (slope, aspect, soils), will be used to correlate invertebrate diversity determined for each location by researchers from the Carnegie Museum of Natural History (CMNH). These correlations are not reported in this report.

Site 1. Bluff Site

The monitoring point was located at the top of the Lake Erie Bluff Face on the edge of a sugar maple-basswood forest and Great Lakes Region scarp woodland on a steeply sloping (less than 45 percent) northwest facing (330 degree) slope. In plot 1, the emergent and dominant overstory was sparse, covering less than 35 percent of the plot (Table 1). The rather open canopy and early successional nature of plant communities on the escarpment tops facilitates the growth of a dense shrub and small tree layer, which accounted for the high stem density, but low overall basal area of the plot (Table 2). White ash (*Fraxinus americana*) and sugar maple (*Acer saccharum*) dominated the overstory layers (Table 3), but were few in number, and of characteristically short stature, compared to that of the forested sites on the Erie Bluffs property. American basswood (*Tilia americana*) was the dominant understory species. Hop-hornbeam (*Ostrya virginica*) and multiflora rose (*Rosa multiflora*) dominated the shrublayers. Also of significance were the non-native European alder (*Alnus glutinosa*) that made up nearly five percent of the shrub layer. Dominant herbaceous species included garlic mustard (*Alliaria petiolata*), sedges (*Carex sp.*), Mayapple (*Podophyllum peltatum*), and zigzag goldenrod (*Solidago flexicaulis*). European alder (*Alnus glutinosa*) and multiflora rose (*Rosa multiflora*) were more prevalent along the northern end of the plot, characterized by a more open canopy, than what was observed at the top of the escarpment. In addition, there were large patches of exposed sand, gravel and clay in the more recently eroded areas. This represents an actively eroding site remaining in a state of constant

succession, as the bluff soils continue to slough off into Lake Erie. Non-native species represent a significant threat to native community composition as they quickly colonize naturally disturbed soils.

Table 1. Summary of percent cover by stratum across permanent sample plots at Erie Bluffs State Park. Erie Bluffs State Park, Erie County, PA.

Stratum	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
Emergent	15%	---		30%	25%	
Canopy	20%	25%	75%	50%	70%	60%
Subcanopy	50%	50%	70%	30%	70%	50%
Tall shrub	35%	40%	50%	70%	20%	70%
Short Shrub	30%	50%	40%	70%	15%	60%
Herbaceous	70%	20%	10%	40%	10%	30%
Vine	---	---	---	15%	10%	15%
non-vascular	10%	5%	---	5%	1%	3%

Table 2. Summary of stem density and basal area across permanent sample plots at Erie Bluffs State Park. Erie Bluffs State Park, Erie County, PA.

Plot	Plot number	Density (stems/ha)	Basal area (m^2/ha)
1	1	1950	38.73
2	2	1275	27.46
3	3	1400	49.26
4	4	1250	29.34
5	5	525	61.16
6	6	2150	27.33

Table 3. Community composition of 20 by 20 m permanent sampling site #1 situated along the escarpment top: sugar maple – basswood community type. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Fraxinus americana	150	13.318	7.69	34.39
Acer saccharum	250	13.287	12.82	34.31
Ostrya virginiana	300	3.426	15.38	8.85
Tilia americana	375	3.406	19.23	8.79
Alnus glutinosa	700	3.325	35.90	8.59
Quercus rubra	125	1.508	6.41	3.90
Rhus typhina	25	0.396	1.28	1.02
Cornus alternifolia	25	0.059	1.28	0.15
Totals	1950	38.725	100	100

Site 2. Dune

The dune site, situated within the black oak woodland/savannah community type, was dominated by black oak (*Quercus velutina*) in the dominant canopy, subcanopy, and tall shrub layers (Table 4). Northern dewberry (*Rubus flagellaris*) co-dominated the short shrub layer with black oak (see forest quality section for discussion of *R. flagellaris* in oak savannah communities). The herbaceous layer was sparse and was dominated by non-native species common to old fields and waste areas including sweet vernal grass (*Anthoxanthum odoratum*), yarrow (*Achillea millefolium*), and Canada bluegrass (*Poa compressa*). These, especially *A. odoratum*, represent significant threats to native sand barren and oak savannah flora (Bissell 2005, pers.com.). Additionally, no black locust (*Robinia pseudoacacia)* stems were recorded in the plot. However, this species is more prevalent toward the western extent of the wooded area on the dune. This may indicate that the plot and area immediately surrounding the plot were not as disturbed as other sites. The dune site had the lowest basal area (27.42 m^2/ha, Table 2) for any of the sites, due to the lack of large canopy trees. This suggests that the soils in this site may be poor in nutrients and dry soils, or that the forests on the dune may represent some of the youngest forest stands at Erie Bluffs, since this area, or parts of this area, was cultivated as recently as the 1970s (Cunningham 1989). However, the sparse canopy of short "scrubby" trees is characteristic of these sites where periodic disturbance is required to maintain the savannah community. Regeneration of black oak is markedly greater here than in other sites at Erie Bluffs, as indicated in species percent cover in different plant community strata. This may be due to the high light availability beneath the canopy and the ability of oak roots to reach soil water, whereas at other sites, oak seedlings are shaded out by more shade-tolerant species such as red maple (*Acer rubrum*) and sugar maple (*A. saccharum)* that are able to thrive with better soil water availability.

Table 4. Community composition of 20 by 20 m permanent sampling site #2 situated on in the black oak woodland community type on the relict dune landform. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Quercus velutina	750	21.517	58.82	78.37
Prunus serotina	175	1.977	13.73	7.20
Quercus rubra	100	1.962	7.84	7.15
Fraxinus americana	100	1.282	7.84	4.67
Prunus pensylvanica	100	0.670	7.84	2.44
Rhus typhina	25	0.030	1.96	0.11
Amelanchier sp.	25	0.018	1.96	0.06
Totals	1275	27.456	100	100

Site 3. Oak forest

The third monitoring site was located in an intact stand of dry mixed oak forest on Dune Sand soils (Taylor 1960). The site, situated at an elevation above the glacial Lake Warren extent, is relatively flat, and remnant cobbles from ancient beach shores are evident in tip up mounds. Red and black oaks (*Quercus rubra, Q. velutina*) dominate the canopy (Table 5). However, plot data indicates a probable change in composition as black cherry, red maple, and sugar maple dominate the subcanopy and shrub layers. The high overall stem density (Table 2) in this plot is due to the large number of multi-stemmed witch-hazel (*Hamamelis virginiana*) clones in the tall shrub layer. While this species will never become a dominant canopy tree, it helps promote succession to a sugar maple and red maple dominated forest as it shades out oak and hickory (*Carya sp*.) seedlings in the understory, preventing their recruitment to the canopy. However, to what extent the density of witch-hazel stems significantly affects oak and hickory recruitment is not known, and may not be a factor in the poor recruitment of these species at this site. High-bush blackberry (*Rubus alleghaniensis*) comprises between 26 and 50 percent of the short shrub layer, further impacting natural recruitment of shade intolerant tree species. Although this type is, for the most part, situated on Dune Sand (DS) soils, as defined by the Erie County Soil Survey (Taylor 1966), the percent cover and species composition of the herbaceous layer suggests that these soils have a much greater soil water availability than what is found at the Dune site. The most prevalent herbaceous species in this plot is garlic mustard, covering between 13 and 35 percent of the plot. Many more water-requiring or "mesophitic" species, such as jack-in-the-pulpit (*Arisaema triphyllum*), jewel weed (*Impatiens capensis*), and black cohosh (*Cimicifuga racemosa*) are found here than at the Dune Site. Sprouts of the American chestnut (*Castanea dentata*) were found in the plot, and several large semi-decomposed stumps indicated that this species was a much larger component of the overstory of this site prior to the species' decline.

Table 5. Community composition of 20 by 20 m permanent sampling site #3 situated on in the dry mixed oak forest community type. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Quercus rubra	125	25.902	8.93	52.58
Quercus velutina	75	17.505	5.36	35.54
Acer rubrum	150	2.248	10.71	4.56
Prunus serotina	175	2.212	12.50	4.49
Hamamelis virginiana	650	0.769	46.43	1.56
Acer saccharum	25	0.358	1.79	0.73
Ostrya virginiana	100	0.202	7.14	0.41
Fraxinus americana	75	0.058	5.36	0.12
Amelanchier sp.	25	0.009	1.79	0.02
Totals	1400	49.262	100.00	100.00

Site 4. Wet woods

The canopy was dominated by very large northern red oak (*Quercus rubra*) trees, and a mix of several other forest species found in both Great Lakes Region lake plain forest and northern hardwood forest communities. There is evident pit and mound microtopography, and while there was no standing water at the time of sampling in 2005, there was substantial bare soil and significant evidence of pooled water in depressions. Spring surveys in the area resulted in documentation of several seepage wetlands throughout this area (Evans 2005, pers.com – see ephemeral wetlands sampling). The presence of pumpkin ash (*Fraxinus profunda*) in the overstory, and its location on the Lake Warren III lake plain landform, supports the designation of the Great Lakes Region lake plain forest. There was at least one confirmed pumpkin ash in the plot. However, due to the difficulty in identification of pumpkin ash without the presence of fruit, all ash species were lumped in Table 6. The shrub layers were overwhelmingly dominated by spicebush (*Lindera benzoin*) and seedling red maples (*Acer rubrum*). The red maples in the subcanopy layer, in addition to those in the shrub layers, suggest a future forest with a decidedly greater proportion of this species in the future canopy. A moderate total cover of herbaceous plants is comprised of many species. The dominant species in this plot was Mayapple (*Podophyllum peltatum*) composing 13 to 25 percent of the plot. Ferns (*Onoclea sensibilis, Dryopteris sp., Osmunda cinnamomea*), sedges (*Carex sp*.), and skunk cabbage (*Symplocarpus foetidus*) also each make up 1 to 5 percent of the plot. There are several other herbaceous species each comprising less than one percent of the plot. The high diversity of herbaceous species is due to the high soil moisture. Just east of the plot, the community type changes drastically toward a red maple-black ash palustrine forest type and large seepage-fed wetland, with saturated soils and standing water throughout the year.

Table 6. Community composition of 20 by 20 m permanent sampling site #4 situated on in the Great Lakes Region lake plain community type. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Quercus rubra	75	12.312	6.00	41.96
Betula allegheniensis	25	3.871	2.00	13.19
Acer saccharum	275	3.365	22.00	11.47
Fraxinus sp.	25	2.256	2.00	7.69
Acer rubrum	225	2.194	18.00	7.48
Lindera benzoin	350	2.153	28.00	7.34
Sassafras albidum	50	1.985	4.00	6.76
Tilia americana	150	1.129	12.00	3.85
Amelanchier sp.	75	0.076	6.00	0.26
Totals	1250	29.341	100	100

Site 5. Hemlock forest

Site five was similar to other hemlock – northern hardwood forest communities in Eastern North America, characterized by a mix of large overstory trees and very little cover of shrub and herbaceous species. Stem density of this site was lowest out of all sites due to the lack of understory tree and shrub species (Tables 5, 6). However, this plot ranked highest for total basal area, indicating a high number of large emergent, canopy and subcanopy trees, and a low number of shrubs, in comparison to other sites at Erie Bluffs State Park (Table 2). Red maple (*Acer rubrum*) and tuliptree (*Liriodendron tulipifera*) dominated the emergent layer and shared dominance with Eastern hemlock (*Tsuga canadensis*) in the canopy (Table 7). Eastern hemlock dominated the sub-canopy. However, these subcanopy trees may be suppressed individuals of the same age cohort as those in the overstory. The shrub and herbaceous layers were characteristically sparse, dominated by maple-leaved viburnum (*Viburnum acerifolium*), ground pine (*Lycopodium obscurum*), and false Solomon's seal (*Smilacina racemosa*). There was also a substantial cover of frost grape (*Vitis riparia*).

Table 7. Community composition of 20 by 20 m permanent sampling site #5 situated on in a hemlock northern hardwoods forest community type. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Liriodendron tulipifera	100	26.958	19.05	44.08
Acer rubrum	75	18.622	14.29	30.45
Tsuga canadensis	300	11.378	57.14	18.61
Betula allegheniensis	25	2.419	4.76	3.96
Sassifras albidum	25	1.779	4.76	2.91
Totals	525	61.156	100	100

Site 6: Duck Run

Site six was situated along the Duck Run Creek floodplain and lower slope of its associated west-facing ravine. The forest overstory was relatively sparse (60 percent, Table 1) and dominated by sugar maple (*Acer saccharum*) (Table 8). American beech (*Fagus grandifolia*) and white ash (*Fraxinus americana*) were also components of the overstory. Tuliptree (*Liriodendron tulipifera*), Northern red oak (*Quercus rubra*), and Eastern hemlock (*Tsuga canadensis*) were present in the overstory in other portions of the ravine, but were not found in the 20 by 20 m plot. The shrub and understory tree strata were dominated by American beech and hop-hornbeam (*Ostrya virginiana*), and are represented by the high density, but low basal area (dominance), of these two species (Table 8). Frost grape (*Vitis riparia*) vines were dense at the northwest corner of the site, in a relatively open area of the canopy. The herbaceous cover (30 percent, Table 1) was relatively dense compared with other sites at the park. Canada Mayflower (*Maianthemum canadense*), Solomon's seal (*Polygonatum pubescens*), wake-robin (*Trillium erectum*), Mayapple (*Podophyllum peltatum*), black cohosh (*Cimicifuga racemosa*) and intermediate wood fern (*Dryopteris intermedia*) were the most abundant herbaceous species.

Table 8: Community composition of 20 by 20 m permanent sampling point #6 situated on in a hemlock northern hardwoods forest community type of Duck Run. Erie Bluffs State Park, Erie County, PA.

Species	Density (stems/ha)	Dominance (m^2/ha)	Relative Density	Relative Dominance
Acer rubrum	25	0.047	1.16	0.17
Acer saccharum	600	23.964	27.91	87.70
Betula allegheniensis	75	0.077	3.49	0.28
Castanea dentata	25	0.043	1.16	0.16
Fagus grandifolia	800	0.872	37.21	3.19
Hamamelis virginiana	75	0.038	3.49	0.14
Ostrya virginiana	425	1.525	19.77	5.58
Quercus rubra	50	0.639	2.33	2.34
Tsuga canadensis	75	0.121	3.49	0.44
Totals	2150	27.326	100.00	100.00

Table 9. Vascular plant species found at permanent sample plots.

Plot 1 (Bluff)

Stratum	Species	Percent Cover
T1	*Fraxinus americana*	5-12
	Acer saccharum	1-5
T2	*Acer saccharum*	13-25
	Fraxinus americana	5-12
T3	*Tilia americana*	13-25
	Ostrya virginiana	5-12
	Quercus rubra	5-12
	Rhus typhina	1-5
	Acer saccharum	1-5
S1	*Ostrya virginiana*	13-25
	Rosa multiflora	13-25
	Quercus rubra	5-12
	Tilia americana	5-12
	Acer saccharum	1-5
	Alnus glutinosa	<1.0
	Carya cordiformis	<1.0
S2	*Rosa multiflora*	13-25
	Acer saccharum	1-5
	Alnus glutinosa	1-5
	Cornus alternifolia	1-5
	Rubus odoratus	1-5
	Carya cordiformis	<1.0
	Fraxinus americana	<1.0
	Lonicera morrowii	<1.0
	Rhus typhina	<1.0
	Ribes americana	<1.0

Plot 1 (Bluff) con't

Stratum	Species	Percent Cover
	Agrostis stolonifera	<1.0
	Arisaema triphyllum	<1.0
	Carex laxiflora	<1.0
	Carex sp.	<1.0
	Carex trisperma	<1.0
	Chelone glabra	<1.0
	Galium aparine	<1.0
	Cystopteris sp.	<1.0
H	*Equisetum arvensis*	<1.0
	Eupatorium rugosum	<1.0
	Galium circaezans	<1.0
	Geum canadensis	<1.0
	Impatiens sp.	<1.0
	Onoclea sensibilis	<1.0
	Osmorhiza longistylis	<1.0
	Phragmites australis	<1.0
	Poa alcodes	<1.0
	Polygonatum pubescens	<1.0
	Prenanthes sp.	<1.0
	Ranunculus abortivus	<1.0
	Saxifraga sp.	<1.0
	Smilacina racemosa	<1.0
	Oxalis stricta	rare
	Trillium erectum	rare
V	*Parthenocissus quinquefolia*	1-5
	Clematis sp.	<1.0

	Rubus flagellaris	<1.0
	Rubus occidentalis	<1.0
	Rubus sp.	<1.0
	Taxus sp.	rare
H	*Alliaria petiolata*	13-25
	Carex sp.	13-25
	Podophyllum peltatum	13-25
	Solidago flexicaulis	13-25
	Dryopteris intermedia	5-12
	Solidago gigantea	5-12
	Aster macrophyllum	1-5
	Dryopteris marginalis	1-5
	Polystichum acrostichoides	1-5
	Solidago canadensis	1-5
	Achillea millefolium	<1.0
	Actaea pachypoda	<1.0
	Lonicera dioica	rare

Plot 2 (Dune)

Stratum	Species	Percent Cover
T2	*Quercus velutina*	13-25
T3	*Quercus velutina*	26-50
	Fraxinus americana	1-5
	Prunus pensylvanica	1-5
S1	*Quercus velutina*	26-50
	Amelanchier arborea	1-5
	Prunus pensylvanica	1-5
S2	*Rubus flagellaris*	26-50
	Quercus velutina	13-25
	Lonicera morrowii	5-12
	Prunus serotina	5-12
	Liriodendron tulipifera	1-5
	Rhus typhina	1-5
	Acer rubrum	<1.0
	Rosa multiflora	<1.0
	Acer saccharum	<1.0
	Cornus florida	<1.0
	Fraxinus americana	<1.0
	Sassafras albidum	<1.0
	Viburnum acerifolium	rare
H	*Achillea millefolium*	1-5
	Anthoxanthum odoratum	1-5
	Fragaria virginiana	1-5
	Poa compressa	1-5
	Andropogon virginica	<1.0
	Aster sp.	<1.0

Plot 3 (Oak forest)

Stratum	Species	Percent Cover
T2	*Quercus velutina*	26-50
	Quercus rubra	26-50
T3	*Prunus serotina*	13-25
	Acer rubrum	5-12
	Acer saccharum	5-12
S1	*Acer rubrum*	13-25
	Hamamelis virginiana	13-25
	Fraxinus americana	1-5
	Amelanchier arborea	1-5
	Prunus virginianum	1-5
	Prunus serotina	1-5
	Ostrya virginiana	1-5
S2	*Rubus allegheniensis*	26-50
	Viburnum acerifolium	13-25
	Prunus serotina	13-25
	Fraxinus americana	1-5
	Hammamelis viginiana	1-5
	Acer rubrum	<1.0
	Quercus rubra	<1.0
	Rubus allegheniensis	<1.0
	Sambucus pubens	<1.0
	Castanea dentata	rare
H	*Alliaria petiolata*	13-25
	Maianthemum canadense	5-12
	Podophyllum peltatum	5-12
	Actaea pachypoda	<1.0

	Aster umbellata	<1.0
	Centaurea maculosa	<1.0
	Danthonia compressa	<1.0
	Hieracium sp	<1.0
	Hypochaeris radicata	<1.0
	Lespedeza hirta	<1.0
	Maianthemum canadense	<1.0
	Panicum sp.	<1.0
	Panicum sp. 2	<1.0
	Plantago lanceolata	<1.0
	Ambrosia artemisiifolia	<1.0
	Rumex acetosella	<1.0
	Solidago canadensis	<1.0
	Veronica officinalis	<1.0
	Aralia nudicaulis	<1.0
	Arisaema triphyllum	<1.0
	Cardamine concatenata	<1.0
	Conopholis americana	<1.0
	Cimicifuga racemosa	<1.0
	Circaea lutetiana	<1.0
	Galium cercaezans	<1.0
	Impatiens sp.	<1.0
	Ipomoea sp.	<1.0
	Phytolacca	<1.0
	Polygonatum pubescens	<1.0
	Smilacina racemosa	<1.0
	Uvularia perfoliata	<1.0
V	*Vitis riparia*	5-12
	Lonicera dioica	<1.0
	Parthenocissus quinquefolia	<1.0

Plot 4 (Wet woods)

Stratum	Species	Percent Cover
T1	*Quercus rubra*	26-50
T2	*Acer saccharum*	5-12
	Sassafras albidum	5-12
	Acer rubrum	5-12
	Quercus rubra	5-12
	Fraxinus americana	5-12
	Fraxinus profunda	5-12
	Betula allegheniensis	5-12
T3	*Acer rubrum*	1-5
	Tilia americana	1-5
	Acer saccharum	1-5
S1	*Acer rubrum*	26-50
	Lindera benzoin	26-50
	Acer saccharum	13-25
	Amelanchier arborea	1-5
	Sassafras albidum	1-5
	Tilia americana	1-5
	Quercus rubra	<1.0
S2	*Lindera benzoin*	26-50
	Acer rubrum	<1.0
	Acer saccharum	<1.0
	Euonymus obovatus	<1.0
	Fraxinus americana	<1.0
	Fraxinus sp.	<1.0
	Ligustrum obtusifolius	<1.0
	Prunus serotina	<1.0

Plot 4 (Wet woods) con't

Stratum	Species	Percent Cover
H	*Aster sp.*	<1.0
	Aster umbellata	<1.0
	Cardamine concatinata	<1.0
	Carex laxiflora	<1.0
	Carex roseus	<1.0
	Carex sp.	<1.0
	Chelone glabra	<1.0
	Circaea luctiana	<1.0
	Erythronium americanum	<1.0
	Geranium maculatum	<1.0
	Geum sp.	<1.0
	Grass sp.	<1.0
	Hepatica acutiloba	<1.0
	Impatiens capensis	<1.0
	Maianthemum canadense	<1.0
	Onoclea sensibilis	<1.0
	Panax trifolius	<1.0
	Poa alcodes	<1.0
	Polygonatum pubescens	<1.0
	Prenanthes sp.	<1.0
	Ranunculus abortivus	<1.0
	Carex sp.	<1.0
	Smilacina racemosa	<1.0
	Tiarella cordata (?)	<1.0
	Trillium erectum	<1.0
	Uvularia sessilifolia	<1.0

	Quercus rubra	<1.0
	Ribes americana	<1.0
	Ribes cynosbati	<1.0
	Rosa multiflora	<1.0
	Sambucus canadensis	<1.0
	Tilia americana	<1.0
	Viburnum recognitum	<1.0
H	*Podophyllum peltatum*	13-25
	Carex intumescens	1-5
	Dryopteris carthusiana	1-5
	Polystichum acrostichoides	1-5
	Solidago flexicaulis	1-5
	Symplocarpus foetidus	1-5
	Actaea pachypoda	<1.0
	Arisaema triphyllum	<1.0
	Aster macrophyllum	<1.0
	Veratrum viride	<1.0
V	*Vitis riparia*	5-12
	Parthenocissus quinquefolia	<1.0
	Toxicodendron radicans	<1.0

Plot 5 (Hemlock forest)

Stratum	**Species**	**Percent Cover**
T1	*Liriodendron tulipifera*	13-25
T2	*Acer rubrum*	13-25
	Liriodendron tulipifera	13-25
	Tsuga canadensis	13-25
	Betula allegheniensis	5-12
	Sassafras albidum	5-12
T3	*Tsuga canadensis*	26-50
	Acer rubrum	13-25
S1	*Tsuga canadensis*	13-25
	Acer rubrum	1-5
S2	*Viburnum acerifolium*	5-12
	Fagus grandifolia	1-5
	Acer rubrum	<1.0
	Carex sp.	<1.0
	Fraxinus americana	<1.0
	Liriodendron tulipifera	<1.0
	Prunus serotina	<1.0
	Sassafras albidum	<1.0
	Populus tremuloides	Rare
H	*Lycopodium obscurum*	5-12
	Polygonatum pubescens	5-12
	Maianthemum canadense	1-5
	Mitchella repens	1-5
	Aster divaricatus	<1.0
	Carex communis	<1.0
	Geum sp.	<1.0

	Medeola virginiana	<1.0
	Podophyllum peltatum	<1.0
	Smilacina racemosa	<1.0
	Thelypteris noveboracensis	<1.0
	Trientalis borealis	<1.0
	Trillium erectum	<1.0
V	*Vitis riparia*	5-12

Plot 6 (Duck Run)

Stratum	Species	Percent Cover
T1	---	
T2	*Acer saccharum*	26-50
	Fagus grandifolia	13-25
	Fraxinus americana	5-12
T3	*Acer saccharum*	26-50
	Fagus grandifolia	5-12
	Ostrya virginica	13-25
	Tsuga canadensis	<5
	Quercus rubra	13-25
S1	*Fagus grandifolia*	26-50
	Ostrya virginica	13-25
	Acer saccharum	13-25
	Hamamelis virginiana	<5
	Carya cordiformis	<5
	Betula allegheniensis	5-12
	Acer rubrum	<5
	Tsuga canadensis	<5
	Castanea dentata	<5
S2	*Viburnum acerifolium*	26-50
	Castanea dentata	<1.0
	Liriodendron tulipifera	<1.0
	Acer saccharum	13-25
	Euonymus obovatus	5-12
	Fagus grandifolia	<1.0
	Hamamelis virginiana	<5
	Fraxinus americana	<1.0
	Acer rubrum	<1.0
	Quercus rubra	<1.0
	Rubus occidentalis	<1.0
	Rosa multiflora	<1.0
	Cornus alternifolia	<1.0
	Tilia americana	<1.0
	Rubus alleghaniensis	<5
	Ribes sp.	<1.0
	Lindera benzoin	<5
H	*Disporum lanuginosum*	<1.0
	Maianthemum canadense	5-12
	Polygonatum pubescens	<5
	Dryopteris intermedia	<5
	Polystichum acrostichoides	<5
	Trillium erectum	<5
	Hepatica acutiloba	<1.0
	Prenanthes sp.	<1.0
	Podophyllum peltatum	<5
	Cimicifuga racemosa	<5
	Tiarella cordata	<1.0
	Aster macrophyllum	<1.0
	Mitchella repens	<1.0
	Arisaema triphyllum	<1.0
	Solidago caesia	<1.0
	Thelypteris hexagonoptera	<1.0
	Carex communis	<1.0
	Carex laxiflora	<1.0
	Viola striata	<1.0
	Actaea pachypoda	<1.0
	Unknown/non-fertile grass	Rare
	Cardamine concatenata	<1.0
	Botrychium virginianum	Rare
V	*Vitis riparia*	13-25
	Toxicodendron radicans	<1.0

APPENDIX D. CURRENT LIST OF TALLEST AND BIGGEST TREES FOUND TO DATE AT ERIE BLUFFS STATE PARK (DOCUMENTED BY DALE LUTHRINGER, ENVIRONMENTAL EDUCATION SPECIALIST FOR COOK FOREST STATE PARK)

Species	Common name	CBH (ft)	Height (ft)	Location
Acer rubrum	Red maple	12	102.7	on edge of flat due west of Overmature Finger
Acer saccharinum	Silver maple	5.1	67.9	RT5/Elk Creek bottomland forest
Acer saccharum	Sugar maple	9.3	117.1+	Elk Creek Cove, West Side of Drainage
Betula alleghaniensis	Yellow birch	5.5	92.6	N/A
Carya glabra	Bitternut hickory	5.7	93.1	Elk Creek Cove (Mouth Elk Creek)
Carya glabra	Bitternut hickory	6.7	89.2	Elk Creek Cove (Mouth Elk Creek)
Carya glabra	Pignut hickory	5	103.4	Central Forest, Dry Mixed Oak Forest Community
Fagus grandifolia	American beech	9.1	101.5+	Lake Erie Escarpment
Fagus grandifolia	American beech	6.4	108.3	Elk Creek Cove, West Side of Drainage
Fraxinus americana	White ash	12.3	116	Central Forest, Lake Erie Escarpment
Fraxinus americana	White ash	7.4	120.5	Duck Run
Juglans cinerea	Butternut	5.8	104.6	Elk Creek Cove (Mouth Elk Creek)
Juglans cinerea	Butternut	6.2	77.5	RT5/Elk Creek bottomland forest
Juglans cinerea	Butternut	6.2	81.1+	Central Forest, Lake Erie Escarpment
Juglans nigra	Black walnut	7.2	96.4	RT5/Elk Creek bottomland forest
Liriodendron tulipifera	Tuliptree	14.7	111.1+	Central Forest
Liriodendron tulipifera	Tuliptree	8.4	140.3	Duck Run
Magnolia acuminata	Cucumbertree	9.5	97.2	Overmature Finger
Ostrya virginica	Hophornbeam	4.4	64.8	Central Forest, Lake Erie Escarpment
Ostrya virginica	Hophornbeam	6.2	106.5	Central Forest, Lake Erie Escarpment
Platanus occidentalis	Sycamore	N/A	101.1	RT5/Elk bottomland forest
Populus deltoides	Eastern cottonwood	~10	99.6	RT5/Elk Creek bottomland forest
Populus deltoides	Eastern cottonwood	8.5	125.4	Elk Creek Cove, West Side of Drainage
Populus grandidentata	Bigtooth aspen	3.8	97.9	RT5/Elk Creek bottomland forest
Prunus serotina	Black cherry	7.6	105.1	Overmature Finger
Quercus rubra	Northern red oak	13.7	87.1+	Elk Creek Cove, on ridge due west of parking lot
Quercus rubra	Northern red oak	9.7	123.4	Duck Run
Quercus velutina	Black oak	7.7	91.2	Central Forest, Dry Mixed Oak Forest Community
Salix nigra	Black willow	7.9	79.4	RT5/Elk Creek bottomland forest
Sassafras albidum	Sassafras	5.8	94.5	Central Forest, Lake Erie Escarpment
Sassafras albidum	Sassafras	5.1	98.4	Central Forest, Lake Erie Escarpment
Taxus sp.	Ewe	N/A	N/A	Overmature Finger
Tsuga canadensis	Eastern hemlock	N/A	109.3	Central Forest, Lake Erie Escarpment
Vitis sp.	Grape		1.3	Elk Creek Cove (Mouth Elk Creek)

APPENDIX E. LISTS OF SPECIAL CONCERN PLANT AND ANIMAL SPECIES FOUND AT THE CLEVELAND MUSEUM OF NATURAL HISTORY'S NORTH KINGSVILLE SAND BARRENS NATURAL AREA

Animals and non-vascular plants

Common name	Scientific Name	Significance
white throated sparrow	*Zonotrichia albicollis*	Rare nester in Ohio
bug-on-a-stick (Moss)	*Buxbaumia aphylla*	
darkling beetle	*Opatrinus minimus*	
ground beetle	*Xestonotus lugubris*	
northern pygmy clubtail	*Lanthus parvulus*	
beetle	*Anisodactylus furvus*	one of two sites in Ohio
beetle	*Anisodactylus merula*	one of two sites in Ohio
beetle	*yminidis cribicollis*	only site in Ohio
beetle	*Harpalus viduus*	only site in Ohio
spider wasp	*Anoplius tenebrosus*	
sulfur-winged locust	*Arphia sulphurea*	
grasshopper	*Chortophaga viridafasiata*	
burrowing wolf spider	*Geolycosa sp.*	

SPECIAL CONCERN SPECIES OF PENNSYLVANIA AND OHIO (DOCUMENTED AT NORTH KINGSVILLE SAND BARRENS RESERVE, ASHTABULA COUNTY, OHIO, BY JAMES K. BISSELL ET. AL., CLEVELAND MUSEUM OF NATURAL HISTORY).

SPECIES	COMMON NAME	PA STATUS	OH STATUS	HABITAT WHERE FOUND at NORTH KINGSVILLE
Acer pensylvanicum	Moosewood		Endangered	Mixed *Tsuga - Betula alleghaniensis - Acer saccharinum - Magnolia - Liriodendron* forest on level swampy flats between spring channels along northern base of beach ridge

SPECIES	COMMON NAME	PA STATUS	OH STATUS	HABITAT WHERE FOUND at NORTH KINGSVILLE
Carex appalachica	Appalachian sedge		Threatened	1. *Liriodendron* - *Prunus* serotina - *Betula alleghaniensis* mature forest 2. *Sassafras* - *Quercus velutina* open woods
Carex brevior	Tufted fescue sedge		Threatened	Open, dry, grassy barren
Clintonia borealis	Blue bead-lily		Endangered	Mixed *Tsuga* - *Betula alleghaniensis* - *Acer saccharinum* - *Magnolia* - *Liriodendron* forest on level swampy flats between spring channels along northern base of beach ridge
Equisetum x *ferrissii*	Scouring-rush	Proposed Endangered		Open, low, sandy depressions
Lupinus perennis	Blue lupine		Potentially Threatened	1. Open barrens 2. *Quercus velutina* - *Sassafras* - *Prunus serotina* savannah with sand barren openings along beach ridge
Oenothera parviflora	Small-flowered evening-primrose		Threatened	Disked ground
Panicum laxiflorum	Lax-flower witchgrass	Proposed Endangered	Potentially Threatened	1. Sand barren openings with *Sassafras* - *Quercus* savannah forest 2. Open level sand barrens 3. Open *Sassafras* - *Quercus velutina* savannah with sand barren openings on beach ridge 4. Sand barrens
Panicum meridionale	Southern hairy panic grass		Threatened	Disked ground
Polygala polygama	Racemed milkwort	Tentatively Undetermined, Proposed Endangered	Threatened	*Sassafras* savannah with sand barren openings; some openings are blown out