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THE VASCULAR FLORA AND COMMUNITY STRUCTURE OF LITTLE CALUMET HEADWATERS NATURE PRESERVE, LAPORTE COUNTY, INDIANA

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ABSTRACT

Little Calumet Headwaters Nature Preserve is a 108-acre tract of woodland and wetland areas that comprise the headwaters of the Little Calumet River in northwestern Indiana. The preserve, consisting of upland hardwood forests, groundwater seeps, and wetland complex, is an area of high diversity due to its topographical variation. A floristic inventory, plot sampling, and seed bank analysis were used to determine the structure and composition of the plant communities. The flora consists of 298 species (27 exotic) representing 188 genera and 84 families. Dominant vegetation of the forest includes *Liriodendron tulipifera*, *Prunus serotina*, *Packera aurea* and *Podophyllum peltatum*. Each groundwater seep contains similar plant communities with variant species that depend on water flow and topography. They include species such as *Symplocarpus foetidus*, *Impatiens capensis*, and *Caltha palustris* and lack an extensive woody overstory except for occasional *Salix* spp. or *Cornus* spp. The wetland complex contains three distinct areas: an open fen dominated by *Leersia oryzoides* and *Cornus* spp.; a marsh dominated by *Typha latifolia* and *Carex lasiocarpa*; and a shrub-carr portion dominated by *Symplocarpus foetidus*, *Cornus alternifolia*, and *Salix nigra*. A wetland seed bank study resulted in a total of 46 species representing 33 genera and 22 families. A similarity of 71.7% was determined between the seed bank samples and the above-ground vegetation. The entire preserve has a high floristic quality index (FQI) of 70.1 and average mean coefficient of conservatism of 4.1. The high FQI value is influenced by property size and the number of communities in the preserve.

Keywords: LaPorte County, flora, plant community, seed bank, wetland

INTRODUCTION

Little Calumet Headwaters Nature Preserve (LCHNP) is a 108-acre tract of woodland and wetlands that comprise the headwaters of the Little Calumet River in northwestern Indiana. The hill and valley topography of the Northwestern Moraine Natural Region (Jackson 1997) was historically covered with mesic forests consisting of *Fagus grandifolia*, *Acer saccharum*, *Populus deltoides*,

Quercus rubra, *Carya ovata*, and *Prunus serotina* (Post 1997). Fens, bogs, savannas, marshes, spring seeps, and swamps were also commonly found in the low areas between these hills and contained a high diversity of species including diverse grass and sedge species typical of wet communities (Homoya et al. 1985). LCHNP was recently purchased by the LaPorte County Park Foundation because of the site's ecological diversity and its potential to be a high quality natural habitat. However, given its location in LaPorte County and its proximity to Red Mill County Park, the preserve is at risk of many disturbances resulting from rapid suburban growth. Disturbances such as deer overcrowding, exotic species invasion, eutrophication, and woody encroachment are noticeable in the preserve and could become more prevalent if a management scheme is not developed and implemented for the ecosystem.

Extensive floristic inventories are valuable because they document the diversity of an ecosystem and reveal species of special concern or interest due to their rarity or unique attributes. Floras have also been valuable in researching ecological theory and applied biology (e.g. plant dispersal, species distributions, municipal planning, weed control, etc.) and recently have shown potential for applications in comparative floristic studies (Palmer & Wade 1995). There are, nevertheless, shortcomings in floristic comparisons and as a result, many authors have noted the importance of including supplemental information to floristic inventories. The usefulness of a flora increases with supplemental components such as site delineation, methodology, and collected specimens (Lawrence 1951; Davis & Heywood 1973; Wilken et al. 1989; Palmer & Wade 1995). A floristic checklist with these additional components becomes even more applicable when it is upheld by community descriptions, statistical analysis, and a basic foundation of ecological information on the abiotic environment. This study attempts to provide a flora with these additional components because a thorough, vouchered floristic checklist has not previously been completed for LCHNP or any known area of similar location and topography.

Species in the soil seed bank should be included in the determination of vegetative diversity (Major & Pyott 1966; Díaz-Villa et al. 2003) because the seed bank not only indicates former environmental conditions, but also implies future evolutionary and ecological trends of an ecosystem (Levin 1990; Aparicio et al. 2002; Díaz-Villa et al. 2003). Due to the large number of groundwater seeps in LCHNP along with an interest in previous community structure and how each community may change with time, an initial seed bank study was conducted to provide insights into past and potential future community structure and composition. Past research leads to the conclusion that wetland ecosystems and their seed bank composition in the northern Midwest have not been studied in detail. Many attempts to describe the seed bank have depended upon germination methods (Roberts 1981; Parker & Leck 1985; Gross 1990). A readily recognized problem of this method is an underestimation of the seed bank due to the specific germination requirements of each species. However, germination is justified as a reasonable technique for identifying the germinable portion of the seed bank (Major & Pyott 1966; Thompson & Grime 1979; Roberts 1981; Parker & Leck 1985; Gross 1990).

Hydrological considerations of wetlands are also important in understanding

these vegetative communities because seasonal variations in hydrological regime (e.g. standing water or no standing water) have been shown to have a major impact on seed germination and the establishment and distribution of wetland species (Champness & Morris 1948; van der Valk 1981; Parker & Leck 1985; Schneider & Sharitz 1986; Leck & Brock 2000).

The major objective of this study is to develop a complete floristic inventory by collecting and identifying all of the vascular plant species present in the preserve and noting any exotic, rare, threatened, or endangered species. In addition, this study examines the distribution of vegetation to indicate what species are dominant in each habitat within the preserve. Comparisons of the wetland communities and their seed banks along with hydrological and chemical analyses provide further insight to the community. This report provides a preliminary description of these habitats and how the sampled seed bank relates to the above-ground vegetation. These insights into LCHNP will provide a comparison study for similar habitats and will also yield a floristic checklist and initial seed bank study for habitat types that have not been previously studied in detail in northern Indiana.

SITE DESCRIPTION

History

In the original 1830 land survey notes for sections 3 and 4, a section line runs directly through the research site. *Fagus grandifolia*, *Acer saccharum*, *Juglans* spp., and *Carya* spp. all ten inches in diameter or greater were present at the site during this time. The area was also reported as being “lame” which most likely referred to poor farming land due to the topography. In later publications, the study site was depicted as a land of “. . . rolling terrain with occasionally rugged bluffs and wide lowlands . . .” that was covered in both mesic forest and wetland species contributing to a great diversity of plants (LaPorte Herald Argus 1933). In later years, area residents described the site as being the locality of “125 springs which are legendarily scattered throughout the grounds” (Michigan City Historical Society 1977).

Gladys Bull Nicewarner recounted the history of Little Calumet Nature Preserve and the closely surrounding areas in a letter written in 1973 (Nicewarner 1973). LaPorte County was originally acquired from the Potawatamie Indians in 1826. The land was of value because it contained some of the finest hardwood forests in the state together with many springs, creeks, and rivers that resulted in a productive area for water-powered saw mills. LCHNP was the site of a timber mill that was in operation from 1833 until the early 1950s. The presence of the mill eventually led to the harvesting of local trees and conversion of the land to agricultural and grazing fields. Around 1876, the mill was additionally used as a feed mill and a cider press which likely contributed to the present establishment of *Malus domestica* in localized areas throughout the preserve. The land ultimately became unusable as a source of timber and the property was sold to the Girl Scouts in 1956. The mill was deconstructed in the 1960s for safety reasons

and the remaining forest was converted into a campground with paths, cabins, shelters, and other structures constructed throughout the property (Nicewarner 1973). In 1999, the property was purchased by the LaPorte County Park Foundation and management of the property was allocated to the LaPorte County Parks Department (Bacone pers. comm.).

Physical Characteristics and Topography

LCHNP is located in northwestern LaPorte County and is adjacent to Red Mill County Park, a recreational area situated on the preserve's western boundary (N 1/2, NW 1/4 of Sec. 3, T36N, R4W; E 1/2, NE 1/4 of Sec. 4, T36N, R4W; SE 1/4, SE 1/4 of Sec. 34, T37N, R4W, LaPorte West and Westville Quadrangles, 510832 E 4605787 N UTM Zone 16 NAD83 Datum). This entire complex, composing 160-acres and containing 23 acres of wetlands and open water, is bordered on the south edge by the Penn Central Railroad, on the north edge by Division Road, and on the eastern side by forested residential properties (Figure 1) (LaPorte County Parks Department 2004). There are two drainage pipes underneath the slope of the railroad that drain agricultural fields located to the south of the property. This water runs directly into a few groundwater seep wetlands and then into the dammed pond. This shallow pond is currently serving as a catchment basin for siltation from hillside and agricultural runoff. This siltation has resulted in terrestrialization of the pond by plants such as *Typha angustifolia*, *Typha latifolia*, *Nuphar advena* and other emergent and aquatic species (Mitsch & Gosselink 2000).

The arrangement of the wooded areas is complex due to the ridge and valley topography of the region and results in microhabitats that tend to support a high diversity of plant species (Stonehouse et al. 2003). On the north side of the pond, the landscape consists of a forested area that gently slopes to the south toward

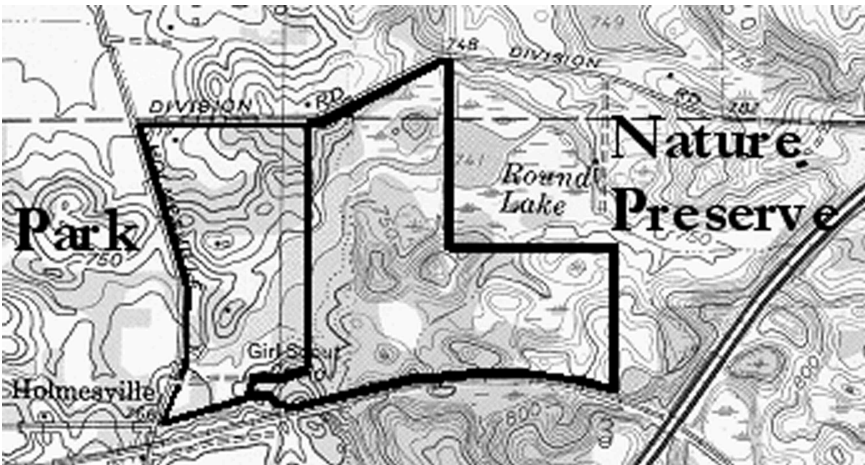


FIGURE 1. Topographic map of Little Calumet Headwaters Nature Preserve and adjacent Red Mill County Park (LaPorte County Parks Department 2004).

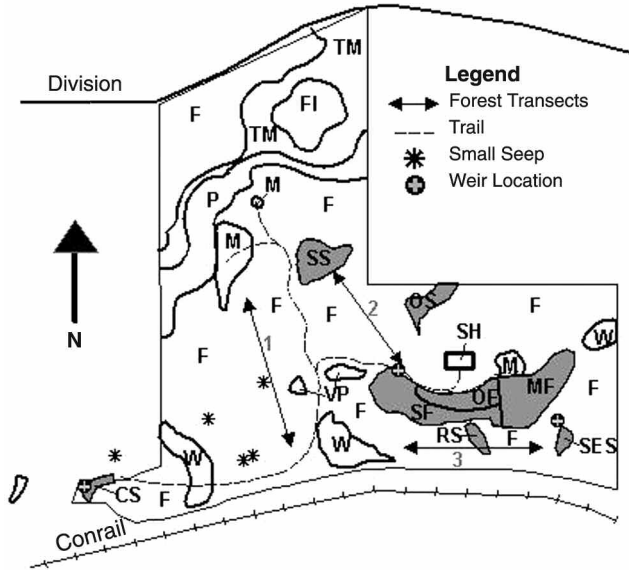


FIGURE 2. Map of Little Calumet Headwaters Nature Preserve, LaPorte County, Indiana (CS = craft seep; F = forested areas; FI = forested island; M = open meadow; MF = marsh fen; OF = open fen; OS = outlet seep; P = pond; RS = railroad seep; SES = SE seep; SF = shrub-carr fen; SH = shelter house; SS = Saxifrage seep; TM = *Typha* spp. floating mat; W = wetland; VP = vernal pool). Forest transects 1, 2, and 3 show the location of the 200-meter forest transects utilized for woody and herbaceous species sampling.

the pond. The terrain to the south of the pond is composed of three forested ridges; one on the west side of the preserve near the pond, a second oriented southeast through the center of the property from the pond to the wetland complex, and a third located parallel to the railroad that runs east and west on the south side of the preserve (Figure 2). Throughout the wooded areas there are remnant buildings, trails, and campsites that were once a part of the Girl Scout Camp (Nicewarner 1973).

Small groundwater wetlands are located throughout the preserve in lowland spots such as valleys and depressions (Figure 2). The springs originate on forested slopes and drain through rivulets, creeks, and wetlands until the water drains into the pond. In one area, water drains out of separate seepage locations on the south ridge slope and forms two groundwater seeps that then drain into a wetland complex where much of the water remains. This, along with additional groundwater seepage within the wetland complex, forms a wet area where many sedges and wetland species thrive (Figure 3). During the study it was seen that the smaller groundwater seeps are seasonally saturated with water, whereas the larger seeps tend to receive less water in the dry months, but still sustain some water flow year round. The wetland complex contains standing water year round, but the volume decreases during the dry months. This wetland complex can be visually divided into three distinct communities: an open fen area with



FIGURE 3. Photograph of a seepage wetland containing *Caltha palustris* at Little Calumet Headwaters Nature Preserve, LaPorte County, Indiana. Photo taken by Dr. Paul Rothrock 2004.

few shrubs, a marsh area dominated by *Carex lasiocarpa* and *Typha latifolia* containing no shrubs, and a shrub-carr portion that is overgrown with shrub species. There are also dry meadows and a few wet meadow areas that are moist year round due to topographic location, but there is no visible water flow through these areas (Figure 2).

Geology and Soils

The Valparaiso Moraine is the terminal position of the Lake Michigan Lobe of the Wisconsin Ice Sheet in which the retreat of glacial ice left behind thick glacial deposits. The eastern portion of the moraine, where the preserve is located, tends to be hilly in comparison to the flat plains of the western portion of the moraine (Hall 1989). Prevalent soil types determined from the LaPorte County Soil Survey include Tracy Sandy Loams, Riddles Loams, Fluvaquents, Histosols, and Aquolls. These soils are underlain by Elsworth Shale bedrock and are dependent on topographic position within the study site. Bottomland and depressional areas make up a large portion of the preserve and are dominated by organic, mucky soils with high water holding capacities (e.g. Histosols, Aquolls, Adrian Mucks, Fluvaquents) (Furr 1982). The plant species present in these areas are characteristic of fen and wetland communities in the Midwest. The upland forested areas are dominated by well-drained loam and sandy loam soils (Tracy Sandy Loams and Riddles Loams) with vegetation typical of a beech-maple habitat (Furr 1982).

METHODS

Floristic Inventory

During the 2004 growing season, monthly and bi-monthly forays were conducted at the study site. In early spring and early summer, plant collection took place two to three times per month, while in late summer and early fall, when the growing season slowed, forays were lessened to one to two times per month. The study site was divided topographically along valleys, ridges, trails, and wetland boundaries to keep track of the areas that had previously been searched for plants. This assured that each section was checked thoroughly and no area went unnoticed. During each outing, care was taken to walk a different route each time in order to cover the entire area and increase the chances of encountering new or rare species in the preserve. Voucher specimens of each species were collected and have been deposited in the Morton Arboretum Herbarium (MOR), Lisle, Illinois. On many occasions, multiple voucher specimens of a particular species were collected when identification of the species was not immediately recognized. Species designations for both scientific and common names followed the USDA plant database which utilizes the most recent nomenclature (Natural Resources Conservation Service 2005). Synonym nomenclature included in the checklist was taken from "Plants of the Chicago Region" which was used for plant identification (Swink & Wilhelm 1994). Species status listings from the Indiana Department of Natural Resources, Division of Nature Preserves were utilized to check for state listed species (Division of Nature Preserves 2004). Species identifications, especially for difficult taxonomic groups, were carefully checked by one of the authors (Dr. Paul Rothrock, Taylor University, Upland, Indiana).

Community Sampling

Woody and herbaceous forest plots were sampled along the same 200 meter transects throughout each of the three wooded areas to the south of the pond (Figure 2). The composition of tree species was sampled with eight 100m² circular sampling plots placed every 25 meters. Woody plants with heights greater than 2 meters were considered to be trees. All trees with a diameter of less than 7.6 centimeters (3 inches) were recorded as having a diameter of 6.4 centimeters (2.5 inches). Aerial percent cover of each herbaceous species was measured by sampling every 20 paces along the woody 200 meter transects with a 0.25m² rectangular frame.

Twenty herbaceous and ten shrub sample quadrats were sampled with random stratified sampling plots in five groundwater seeps (e.g. craft seep, outlet seep, railroad seep, southeast seep, and Saxifrage seep) and three visually distinct areas located in the wetland complex (e.g. open fen, marsh, and shrub-carr) (Figure 2). Individual grids composed of 5 × 5 meter square plots were laid out to cover the entire area of each wetland. Sample quadrats within each grid were then chosen using a random number table. Herbaceous and shrub aerial cover was measured randomly in each plot with a 0.25m² frame and a 1m² frame respectively. In all eight wetlands, ten shrub quadrats were sampled except in the

shrub-carr portion of the wetland complex in which 20 quadrats were sampled due to the high number of shrub individuals. In the marsh area and craft seep no shrub quadrats were sampled because there were no shrubs or very few shrubs present in these communities. Due to resource limitations and time constraints, only a representative portion of the wetland areas were sampled for community structure and plots were not marked for resampling purposes (Figure 2). Open meadows comprised a small portion of the preserve and therefore were not quantitatively sampled (Figure 2). Areas that were not included in the quantitative analysis were surveyed extensively throughout the growing season for the floristic checklist.

Seed Bank Comparison

Five soil samples, approximately 710 cm³ in volume were taken in April of 2004 in each of the eight wetlands except in the craft seep and the shrub-carr area where ten soil cores were sampled due to the large size of each area. The samples were collected at random distances along the length of a transect spanning across the center of each wetland. An approximate amount of soil in the top 20 centimeters of the profile was sampled with a trowel because root structures inhibited coring a specific volume and depth. Each soil sample was germinated under greenhouse conditions, keeping the soil moist but not waterlogged. Although the limitation of the germination technique has been acknowledged, it is a suitable technique for this preliminary seed bank study because the purpose was to see what species were present and if they differed from the above-ground vegetation. Seedlings were identified and carefully removed from the soil, making sure to extract the entire root mass with minimal loss of soil. Rhizomatous plants were noted and clipped to their base to avoid losing soil volume from pulling extensive root systems. Seedlings that could not be identified were transplanted to separate pots and grown to maturity for identification. When possible, species from the genera *Scirpus* and *Carex* were removed as seedlings and identified according to achene casings.

Hydrology

A preliminary hydrological study was undertaken to understand temporal change of water flow in the preserve area. Temporary V-notched weirs were built for three streams in the preserve, the first located in the southeast corner of the property, the second in the center of the property flowing out of the wetland complex, and the third in the far southwest corner (Figure 2). Water flow was measured in June 2004, August 2004, and April 2005. The weir in the southwest corner of the study site worked only during the first sampling period due to erosion and difficulty inserting the weir. The weir positioned in the stream at the center of the property failed to work during the April 2005 sampling for the same reasons. Depth measurements at the same location in these streams were used to estimate water volume changes. Discharge tables and discharge rate equations were utilized to determine water volume at each site and to estimate the amount of water flowing in the preserve throughout the year (Grant & Dawson 1995).

Soil and Water Chemistry

Bulked soil samples were gathered from seven forested locations all depicting characteristic soil formations from Midwestern forests. Five samples of the top 10 centimeters of soil were collected at each of the seven locations with a trowel and combined for chemical analysis. Each location represented a different ridge or valley within the preserve. Standard chemical parameters of all samples were analyzed by A & L Great Lake Laboratories, Inc. of Fort Wayne, Indiana.

Surface water samples were collected and tested for chemical composition on site in July 2004 and again on April 2005 to check if seasonal variability was present. Reported chemical values are from the July 2004 sampling period because no significant seasonal difference was found between the two sampling periods. Conductivity, pH, and temperature were sampled employing a Eutech/Oakton PC 10 Meter (Eutech Instruments Pte Ltd. 1999). LaMotte Water Pollution Kit 1 was used to determine dissolved oxygen, hardness, and alkalinity (Reen 2001). Each sample was collected from the water surface and stored in a plastic bottle for immediate processing in the field. Only one water chemistry sample was taken at the wetland complex and was assumed to be similar for the three areas within the complex because of the interconnected hydrology of the area through stream networks and localized flow.

Statistical Analysis

There is a realization that a great number of diversity and similarity indices could be applied to this data set, however, due to low numbers of sample plots in each community, the resulting statistical analyses would not be representative of the entire sample area. Furthermore, Squiers and Wistendahl (1977) argue that many indices assume that comparisons between populations occur in sites of the same size, which is not possible unless comparing the same site over a period of time. The calculation of average number of species and average frequency per sample therefore aids in eliminating the problem of comparing areas of different sizes. These two numbers indicate the richness and evenness of a community without utilizing an obscure mathematical equation that is "uninterpretable in terms of the real situation" such as those seen in many diversity indices (Squiers & Wistendahl 1977).

Descriptive statistics were calculated on three forested areas, five groundwater seeps, and three areas of the wetland complex. Calculations included average number of species per plot, importance values, and relative cover and frequency for each species. Woody and herbaceous species were analyzed independently from one another because each life form was sampled separately in the field. Importance values of tree species were determined using relative frequency, relative density, and relative cover. Importance values of herbaceous species were determined using relative cover and relative frequency and considered only if the resulting value was distinctly higher than other species importance values. Relative density was not used in the determination of importance for herbaceous species because herb density was quite low, with only two to three plants per quadrat. The focus of community structure for herbaceous species is relative cover and frequency rather than importance values because of the low number of samples taken and potential inaccuracy of the resulting data. Seed bank data was

given presence and absence values in relation to the data from the above-ground vegetation. From this, percent similarity was calculated to determine if the below-ground seed bank samples correlated strongly with the above-ground vegetation. The percent composition of each species germinated relative to the total number of plants germinated was also determined for the sampled seed bank.

Principal Coordinate Analysis (PCOORDA) was utilized to distinguish vegetation and seed bank differences among the eight chosen wetland areas within the preserve. In prior studies, multivariate ordination analysis has been used to determine site differences among vegetation or seed banks in many habitats (Henderson et al. 1988; Smith et al. 2002; Price & Weltzin 2003; Hölzel & Otte 2004). Relative cover and frequency data were used for the above-ground vegetation analysis and presence and absence data developed the matrix for the seed bank analysis. PCOORDA was applied to the above-ground vegetation data in three combinations: relative cover; frequency; and relative cover and frequency included in the same matrix. Linear transformation and double-centering was conducted on the data set to eliminate the effects of varying scales used during sampling. The Euclidean distance-squared distance measure was then utilized for this analysis. The results from these three trials resulted in extremely similar graphs, so the last of the three trials was chosen for interpretation. The NTSYS-pc software was utilized to conduct the PCOORDA (Exeter Software 1997). After generation of the original PCOORDA, eigenvector distances were reviewed to determine excessive effects of weighting on rare species in the sites. Past research suggests that eigenvector values explain what specific species are having the greatest impact in defining certain axes (Nichols 1977). Through examination of the eigenvector values, it was found that the analysis gave more weight to rare species, therefore species of low cover and frequency were removed from the dataset. Above-ground species that had less than 10% total cover or had less than 5% total frequency were considered rare and removed from the data. For the seed bank data, species with less than five seedlings germinated were also considered rare in the communities and removed from the data set (Gauch 1982; Price & Weltzin 2003). Comparison of the original PCOORDA and the analysis with the removal of rare species showed little difference between the two methods, consequently the original data set was chosen for interpretation. Differences between sites and species with the highest correlations to each axis were determined through eigenvector analysis.

Floristic Quality Assessment (FQA) was applied to the plant inventory list to acquire information on the natural quality of the site as a whole (Wilhelm & Masters 2001). Swink and Wilhelm (1994) suggest four applications for FQA: 1) natural area identification, 2) quality comparisons among sites, 3) long-term monitoring of natural quality, and 4) monitoring community restoration. FQA was used in this study not only to determine the natural quality of the entire preserve, but to also aid in future monitoring efforts after property management or restoration of the preserve (Wilhelm 1977, 1978; Wilhelm & Ladd 1988; Swink & Wilhelm 1994; Rothrock 1997; Taft 1997). The use of FQA for comparisons between sites must be conducted carefully because the analysis is heavily dependent on site size and species diversity. The coefficient of conservatism assigned to each species only reflects the ecological role the species has in the

community without consideration of its distribution or abundance in the community (Swink & Wilhelm 1994; Rothrock & Homoya 2005). Due to this effect, the coefficient of conservatism should be considered when comparing sites of differing size.

RESULTS

Floristic Inventory

The floristic inventory of LCHNP resulted in 298 species of vascular plants representing 188 genera and 84 families (Appendix). The five families with the greatest number of species are the Cyperaceae (39), Asteraceae (29), Poaceae (17), Rosaceae (15), and Ranunculaceae (12). LCHNP has a floristic quality index (FQI) of 70.1 and average mean coefficient of conservatism of 4.1. The high FQI value results from the study site's size and the broad range of habitats rather than an unusually high species quality. An FQI above 45 or a coefficient of conservatism above 4.5 suggests that the area has natural area potential (Swink & Wilhelm 1994). The average mean coefficient of conservatism suggests that LCHNP has some remnant natural quality and deserves a more extensive survey of community structure and species of concern or interest (Swink & Wilhelm 1994). If both FQI and the coefficient of conservatism are considered, LCHNP is a remnant community with natural area potential.

Carex scabrata and *Juncus articulatus* are listed as endangered, *Habenaria hyperborea*, *Salix eriocephala*, and *Chrysosplenium americanum* are all recorded as threatened and *Diervilla lonicera* and *Eriophorum angustifolium* are cataloged as rare by the Indiana Heritage Program (Division of Nature Preserves 2004) (Figures 4 and 5). No species are listed on the federal endangered, threatened, and rare species list. Species previously noted by Thomas Post, but not located during collection included *Acer rubrum*, *Corylus americana*, *Pedicularis canadensis*, *Lythrum salicaria*, and *Vaccinium corymbosum*. All of these species are typical of northern Indiana forest communities and were found on a forested island surrounded by the pond on the property which could not be accessed during collection (Figure 2).

Of the 298 species collected, 27 species (9.3%) are exotic, all of which have a very low abundance throughout the preserve. Most of these species are found in meadow and wetland communities (11 species and 7 species respectively); however a few exotics with patchy distribution are present in the wooded areas. These species include *Glechoma hederacea*, *Malus domestica*, *Berberis thunbergii*, and *Rosa multiflora* and do not appear to have severely invaded any wooded habitats. *Vinca minor*, *Morus alba*, and *Elaeagnus angustifolia* are all present on the exterior edges of the preserve and need to be monitored to prevent future invasion. The wetland communities contain a variety of exotic species that are also low in abundance such as *Typha angustifolia* located in both the wetland complex and groundwater seeps. Adventive species exclusive to groundwater seepage areas are *Dipsacus fullonum*, *Ranunculus repens*, and *Rorippa nasturtium-aquaticum*, while *Dianthus armeria*, *Elaeagnus umbellata*, and



FIGURE 4. Photograph of endangered species, *Carex scabrata*, classified by the Indiana Division of Nature Preserves (Division of Nature Preserves 2004). Photo taken by Dr. Paul Rothrock 2004

Mentha spicata are located primarily in the wetland complex. Open dry meadow species include *Trifolium pratense*, *Digitaria ischaemum*, *Phalaris arundinacea*, *Poa compressa*, *Schedonorus phoenix*, *Galium mollugo*, *Daucus carota*, *Hieracium piloselloides*, *Leucanthemum vulgare*, *Cerastium fontanum*, and *Elaeagnus angustifolia*. *Veronica serpyllifolia*, *Phalaris arundinacea*, *Poa annua*, and *Medicago lupulina* can be found scattered along trails and paths throughout the study site, but as mentioned previously, are not found in high quantities. One plant of *Lythrum salicaria* was also noted in the forested island



FIGURE 5. Photograph of rare species, *Eriophorum angustifolium*, classified by the Indiana Division of Nature Preserves (Division of Nature Preserves 2004). Photo taken by Dr. Paul Rothrock 2004

area on the far north side of the property by Thomas Post, Division of Nature Preserves, but it was not collected.

Biogeographical commentary in floras can serve as a valuable baseline in terms of climate change and the future shift of plant localities. For many species in this study Indiana approximates the northern or southern limit of current distribution (Flora of North America Committee 1993+; Natural Resource Conser-

vation Service 2004). For eight species LaPorte County, in particular, seems very close to the southern edge of their range and for five species it appears to be their northern edge (Table 1). Comparing the current distribution of a species to its distribution in the future can indicate important floristic shifts due to global climate change.

Community Descriptions

Mesic Forest: Wooded communities cover ridge tops, uplands, and slopes of LCHNP (Figure 2). A total of 21 tree species were located in the wooded sample sites, with a density of approximately 1,561 stems per hectare. *Malus domestica* is the only exotic species, while *Pinus resinosa*, *Pinus sylvestris* and *Pinus strobus* (listed as rare in Indiana) are all considered to have been planted at the site by previous owners and therefore are not included as natural members of the community in the study. Dominant tree species vary among each forest section in the study site, but overall *Liriodendron tulipifera*, *Prunus serotina*, and *Acer saccharum* are abundant in the overstory (Figure 6). The stems are a mixture of large individuals, such as *Liriodendron tulipifera* and *Prunus serotina* defining the upper canopy and smaller individuals of recent establishment filling the gaps left behind by tree falls. *Acer saccharum* and *Fagus grandifolia* seedlings generally grow into these canopy openings. Individuals that were smaller in stature were greater in number and had higher frequency values than the larger, overstory species with high relative cover but lower frequency values. The presence of *Liriodendron tulipifera*, *Prunus serotina*, *Fraxinus americana*, and *Populus deltoides* in the upper canopy most likely resulted from initial or secondary logging of the site. *Ulmus americana* and *Crataegus pruinosa* are both present along forest edges due to shade intolerance and an affinity to disturbance (Burns & Honkala 1990). One individual of *Diervilla lonicera*, a state rare species, is located along a fencerow dividing a path and the railroad tracks. Other shrub species noted in the forested areas are *Lindera benzoin*, *Rosa multiflora*, and *Viburnum acerifolium*. *Lindera benzoin* is so high in abundance in some areas that it formed thickets, in contrast to the other two species which were only found in the western edge of the woods near the pond.

Spring ephemerals are sparse throughout the forest sites and tend to become denser along the edge slopes of wetland communities. A total of 48 herbaceous species were found in the forested areas with an average of 3.5 species per plot, which suggests a low richness of species in the forest. No exotic or state listed species were found in the forest herbaceous layer. Abundant herbaceous species in the ground layer include *Packera aurea*, *Podophyllum peltatum*, *Arisaema triphyllum*, *Parthenocissus quinquefolia*, *Galium circaezans*, and *Viola sororia* (RIV = 13.6, 11.9, 9.5, 7.1, 6.4, and 6.0 respectively). Each sample site consists of similar species with varying relative cover values and a few diverging species at lower relative cover percentages (Figure 7). Relative cover suggests species dominance, with the higher relative cover values indicating dominance of a specific species. Frequency values suggest the evenness of species distribution with higher frequencies indicative of even distribution of a species throughout the site. In the overall forest community, *Packera aurea* (20.6), *Podophyllum peltatum* (19.6), *Arisaema triflorum* (11.8), *Galium circaezans* (5.1), and *Partheno-*

TABLE 1. Biogeographical outline of species collected at LCHNP that were found to be in the far northern or southern portions of their continental distributions (Flora of North America Committee 1993+; Natural Resources Conservation Service 2004). Species were considered to be in the northern portion of their range if their distribution was predominantly south of northern Indiana. Alternately, species were considered to be in the far southern portion of their range if the majority of their distribution was located to the north of northern Indiana.

Species Name	Southern Edge of Range	Northern Edge of Range
<i>Carex lasiocarpa</i>	*	
<i>Carex tonsa</i>	*	
<i>Chrysosplenium americanum</i>	*	
<i>Diervilla lonicera</i>	*	
<i>Eriophorum angustifolium</i>	*	
<i>Platanthera huronensis</i>	*	
<i>Juncus articulatus</i>	*	
<i>Liriodendron tulipifera</i>		*
<i>Maianthemum canadense</i>	*	
<i>Panicum rigidulum</i>		*
<i>Sabatia angularis</i>		*
<i>Trillium recurvatum</i>		*
<i>Vernonia gigantea</i>		*

cissus quinquefolia (4.7) have the highest relative cover. These values are considered small and suggest that no species are highly dominant in the community. The evenness of species is also low as indicated by the frequency values (0.15–0.33) (Table 2). Together, these values can be interpreted as the total forest community having a low diversity of species. Table 2 also lists the relative cover and frequency of abundant herbaceous species located in the three separate sampled forest areas. *Packera aurea* is typically found in calcareous wetland

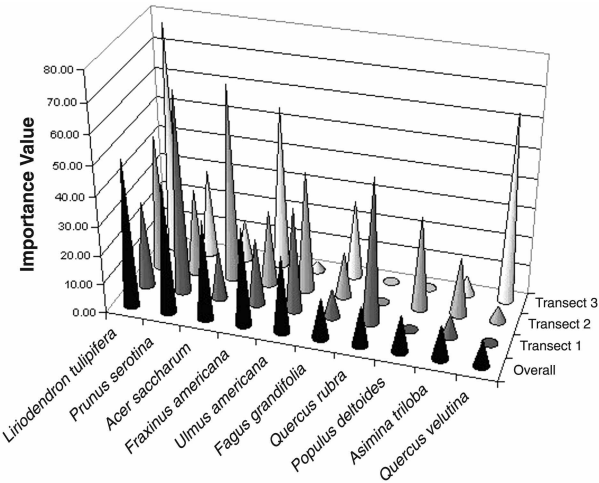


FIGURE 6. Composition of the forest community in Little Calumet Headwaters Nature Preserve. 6. Dominant tree species: the dominant species are those that have an importance value of 20 or higher at one or more sites. See figure 2 for transect locations.

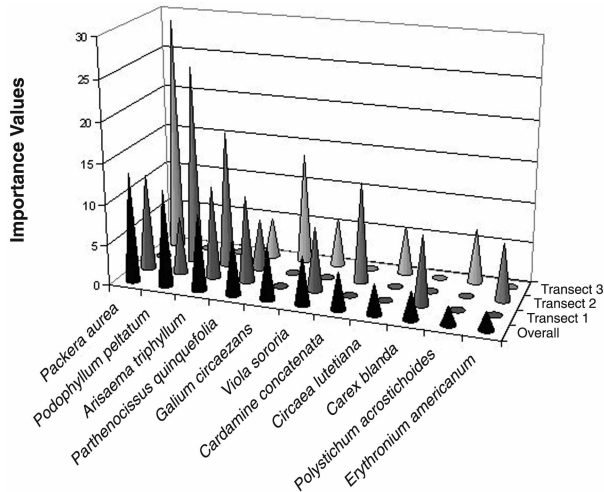


FIGURE 7. Dominant herbaceous species: the dominant species are those with importance values of 5 and above at one or more sites. See figure 2 for transect locations.

habitats and wet meadows (Swink & Wilhelm 1994), however in this site, the species is widely distributed both in wet communities and mesic woodlands. The FQI for woody and herbaceous forest species is 30.3 with a mean C value of 4.4 which suggests that the area is a remnant community with some disturbance but contains enough quality to be considered of marginal natural area potential (Swink & Wilhelm 1994).

Soil analysis from the forest community results in typical values for north-western Indiana forests of the Valparaiso Moraine region (Furr 1982; Kite pers. comm.) (Table 3). Soil pH ranges from 5.3 to 6.1, which is slightly acidic, but typical for woodlands of this type. Percent organic matter is relatively low (2.0% to 4.9%) because deposition of organic material is low in less mature forest communities. This result could also possibly suggest that decomposition rates in the wooded areas are high. The glacial till left by the Wisconsin glaciation originally came from dolomitic parent material rich in calcium and magnesium. Not surprisingly, then, our soil samples showed high levels of magnesium (65–170 ppm) when compared to the average concentrations across northern Indiana. On the other hand, they had very low to medium concentrations of calcium (250–850 ppm). This may be the result of differential leaching of calcium from the sandy loam soils (Furr 1982). Cation exchange capacity of LCHNP soils ranged from 3.2 to 8.1 meq/100g, a range characteristic for the soil type of this area (Foth 1990). Potassium levels were also moderate and typical of northern Indiana soils. Underlying the glacial till of LCHNP is parent bedrock of Ellsworth shale; it is buried too deeply to affect the chemistry of local soils.

Groundwater Seep Wetlands: Within the wooded habitats are many isolated wetlands originating from groundwater springs along forested slopes (Figure 2).

TABLE 2. Ranked percent relative cover (RC) of the most abundant herbaceous species among three sample sites. All forest sample sites are combined and include frequency estimates for Little Calumet Headwaters Nature Preserve. See figure 4 for the importance values of each species below.

Species	All Forested Areas	
	% RC	Frequency
<i>Packera aurea</i>	20.6	0.23
<i>Podophyllum peltatum</i>	19.6	0.15
<i>Arisaema triphyllum</i>	11.8	0.25
<i>Galium circaezans</i>	5.1	0.27
<i>Parthenocissus quinquefolia</i>	4.7	0.33
<i>Cardamine concatenata</i>	4.5	0.16
<i>Polystichum acrosticoides</i>	3.5	0.05
<i>Viola sororia</i>	3.3	0.30
<i>Carex blanda</i>	2.5	0.15
<i>Circaea lutetiana</i>	2.3	0.18
<i>Erythronium americanum</i>	0.8	0.13

Total # spp. = 48

Average # spp. per plot = 3.5

These seeps differ in size and water flow, but typically are not over 4 hectares in size. Smaller seeps (less than 0.4–0.8 hectares) experience water flow during spring and early summer, but then dry completely during late summer, fall, and winter (Figure 2). Larger seeps, such as the craft seep, sustain water flow throughout the year but the volume of water lessens during the dry season (late summer through winter). Stream systems connecting wetland areas also experience a seasonal change in the volume of water flow throughout the year. Discharge rates decrease slightly into the dry season and increase to normal volume during the growing season. Streams near the shrub-carr area of the wetland complex and southeast seep showed a reduction in flow from early summer to late summer (6.0 gal/min and 5.8 gal/min to 0.7 gal/min and 0.5 gal/min respectively). The craft seep weir measurement was taken one time due to difficulty installing equipment. This measurement, taken on June 15, 2004, resulted in a flow rate of 28.5 gallons per minute. Depth measurements of 7.0 cm and 4.8 cm were taken on August 3, 2004 and April 17, 2005 respectively and are interpreted as a reduction in water discharge rates during the dry season as seen in the other two streams sampled. Water chemistry analysis in the groundwater seeps and wetland complex resulted in typical chemical values for Midwestern wetlands and

TABLE 3. Bulk soil analysis from seven upland forest sites in Little Calumet Headwaters Nature Preserve.

Location	Organic Matter (%)	pH	K (ppm)	Mg (ppm)	Ca++ (ppm)	CEC (meg/100g)
A	2.6	5.8	110	170	800	8.1
B	4.9	5.6	55	165	750	7.7
C	2.5	5.5	96	125	500	6.2
D	3.7	5.7	70	150	750	7.6
E	2.7	5.3	83	65	250	3.2
F	3.1	6.1	73	145	850	6.8
G	2.0	5.9	50	85	65	5.3

TABLE 4. Water chemistry at five sites in Little Calumet Headwaters Nature Preserve, LaPorte County, Indiana sampled on July 18, 2004.

Location	Temp. (°C)	pH	Conductivity (µS)	Alkalinity (mg/l)	Dissolved Oxygen (mg/l)	Hardness (mg/l)
Fen	21.4	7.4	750	390	5.2	400
Craft Seep	14.7	8.1	840	N/A	7.5	320
SE Seep	19.0	8.2	826	370	6.6	360
Outlet Seep	18.6	7.9	628	273	2.2	332
Pond	25.7	7.7	608	232	9.6	225

do not have a significant seasonal variation in values (Table 4) (Stewart et. al. 1993; Amon et. al. 2002). Conductivity and alkalinity for the wetland areas range from 608–826 µS and 232–390 mg/l respectively. Dissolved oxygen levels range from 2.2–7.5 mg/l, which is typical when compared to past studies in Indiana fen habitats that resulted in a mean of 7.3 mg/l (Stewart et. al. 1993). pH and hardness values were also typical of wetlands in the area with pH ranging from 7.4 to 8.2 and hardness 225–400 mg/l.

The five groundwater seeps consist of many similar species, but also have a slight variation in species composition (Table 5). 49 total herbaceous species were recorded with an average of 4.6 species per sample plot indicating moderate species richness. *Symplocarpus foetidus* (33.3%), *Carex bromoides* (7.9%), *Caltha palustris* (7.8%), *Impatiens capensis* (7.5%), and *Leersia oryzoides* (3.9%) have the highest percent relative cover out of five seep areas sampled. All of these species are uneven in distribution (frequency = 0.16–0.37) except *Symplocarpus foetidus* that has a moderately even distribution (frequency = 0.65). *Symplocarpus foetidus* is by far the most dominant species in all five groundwater seepage areas according to relative cover estimates and has a relative importance value of 23.6 (the next highest RIV is *Impatiens capensis* at 7.7). *Caltha palustris* is present in abundance at all groundwater seeps sampled except the outlet seep and therefore shows large cover values for the total seepage habitats. The overall relative cover for *Carex bromoides* can be attributed to its high relative cover value in the SE seep, which is the only seep that contains this species in abundance. *Impatiens capensis* and *Leersia oryzoides* are present in only two of the five seepage wetlands, but are in such high abundance in those communities that their overall relative cover for all seeps is also high.

The shrub species for all five groundwater seeps are low to medium in richness and evenness. Shrub cover in the four groundwater seeps (the craft seep is not included due to virtually no presence of shrub species) is dominated by *Lindera benzoin* (33.7%), *Cornus racemosa* (17.7%), and *Cornus sericea* (15.3%) all with a frequency of less than 0.50 (Table 6). A total of 15 shrub species are located in these groundwater seeps with an average of 1.4 species per plot. Individual seepage wetlands are dominated by one of these three species and the most abundant shrub has a relatively high frequency and therefore it is evenly distributed (Table 6). The few shrubs that are present in the craft seep are *Cornus* spp. The FQI value of these seeps is 31.6 with a mean C of 4.1, indicating

TABLE 5. Ranked percent relative cover (RC) and corresponding frequency values of the five dominant herbaceous species for five groundwater seeps individually and combined at Little Calumet Headwaters Nature Preserve.

All Seeps			Craft Seep		
Species	% RC	Frequency	Species	% RC	Frequency
<i>Symplocarpus foetidus</i>	33.3	0.65	<i>Symplocarpus foetidus</i>	32.0	0.45
<i>Carex bromoides</i>	7.9	0.16	<i>Impatiens capensis</i>	14.1	0.55
<i>Caltha palustris</i>	7.8	0.33	<i>Caltha palustris</i>	13.7	0.15
<i>Impatiens capensis</i>	7.5	0.37	<i>Cardamine pensylvanica</i>	3.4	0.50
<i>Leersia oryzoides</i>	3.9	0.22	<i>Symphyotrichum puniceum</i>	5.2	0.25
Total # spp. = 49			Total # spp. = 18		
Average # spp. per plot = 4.6			Average # spp. per plot = 3.8		
Outlet Seep			Railroad Seep		
Species	% RC	Frequency	Species	% RC	Frequency
<i>Symplocarpus foetidus</i>	13.9	0.45	<i>Symplocarpus foetidus</i>	45.5	0.75
<i>Leersia oryzoides</i>	11.9	0.55	<i>Caltha palustris</i>	6.1	0.25
<i>Carex stipata</i>	11.7	0.20	<i>Pilea fontana</i>	6.1	0.45
<i>Ranunculus hispidus</i>	7.9	0.40	<i>Equisetum arvense</i>	5.5	0.45
<i>Amphicarpaea bracteata</i>	6.9	0.30	<i>Galium aparine</i>	5.2	0.40
Total # spp. = 21			Total # spp. = 21		
Average # spp. per plot = 4.5			Average # spp. per plot = 4.6		
Saxifrage Seep			SE Seep		
Species	% RC	Frequency	Species	% RC	Frequency
<i>Symplocarpus foetidus</i>	43.3	0.80	<i>Symplocarpus foetidus</i>	27.4	0.80
<i>Saxifraga pensylvanica</i>	14.0	0.50	<i>Carex bromoides</i>	25.7	0.45
<i>Impatiens capensis</i>	9.3	0.50	<i>Eupatorium maculatum</i>	8.8	0.35
<i>Laportea canadensis</i>	7.3	0.30	<i>Leersia oryzoides</i>	8.4	0.35
<i>Leersia oryzoides</i>	5.3	0.40	<i>Caltha palustris</i>	5.9	0.50
Total # spp. = 22			Total # spp. = 21		
Average # spp. per plot = 4.9			Average # spp. per plot = 5.2		

that the seeps have experienced minimal disturbance and have the potential to be quality remnant natural areas (Swink & Wilhelm 1994).

Wetland Complex: The wetland complex located in the center of the study site is interesting because it is composed of three visually distinct areas: a marsh area; an open fen area; and a shrub-carr area (Figure 2). Each area has species common to the others, but may have different dominant species or contain species unique to that site. The total number of species in the wetland complex is 44 with an average of 5.1 species per plot suggesting moderate species richness. The five most dominant species for the overall wetland complex are *Carex lasiocarpa* (16.3%), *Leersia oryzoides* (12.1%), *Symplocarpus foetidus* (11.2%), *Carex stricta* (6.8%), and *Impatiens capensis* (6.0%) (Table 7). Frequency, also indicative of species evenness, ranges from 0.23 to 0.38 (Table 7). The most dominant species, *Carex lasiocarpa*, is only present in the marsh area, but has such a high cover (51.4%) and frequency (0.95) that it is on average considered the most

TABLE 6. Ranked percent relative cover (RC) and corresponding frequency values of dominant shrub species for five groundwater seeps individually and combined at Little Calumet Headwaters Nature Preserve. The craft seep had low shrub abundance throughout the site and therefore was not sampled.

Species	All Seeps		Outlet Seep		Railroad Seep		Saxifrage Seep		SE Seep	
	% RC	Freq	% RC	Freq	% RC	Freq	% RC	Freq	% RC	Freq.
<i>Lindera benzoin</i>	33.7	0.45	63.5	0.90	4.7	0.10	39.5	0.50	21.3	0.30
<i>Cornus racemosa</i>	17.7	0.23			81.2	0.70			17.3	0.20
<i>Cornus sericea</i>	15.3	0.20	23.3	0.20			40.5	0.50	4.0	0.10
<i>Salix nigra</i>	4.9	0.05							18.2	0.20
<i>Zanthoxylum americanum</i>	4.1	0.08	12.8	0.30						
<i>Fagus grandifolia</i>	3.4	0.05			14.1	0.20				
<i>Cornus alternifolia</i>	3.0	0.05							10.7	0.20
Total # spp.	15		4		3		4		11	
Average # spp. per plot	1.4		1.5		1.0		1.4		1.7	

dominant species of the entire complex. *Leersia oryzoides* is also only present in one of the three areas (open fen) and ranked second most dominant species for the same reasons (RC = 29.9% and frequency = 0.60). *Symplocarpus foetidus*, *Carex stricta*, and *Impatiens capensis* are all present in two of the three wetland communities and have low to moderate relative cover and frequency values (Table 7). These three wetland species can be considered as the most dominant species of the entire wetland complex because both *Carex lasiocarpa* and *Leersia oryzoides* are not present in the majority of the wetland complex study area.

The overall wetland complex consists of 18 shrub species averaging 1.7 species per square-meter plot. This indicates moderate species richness in the woody shrub strata. Dominant shrub species, based upon percent relative cover values, include *Salix nigra* (16.1%), *Cornus alternifolia* (12.8%), *Toxicodendron vernix* (9.6%), *Lindera benzoin* (9.3%), *Salix discolor* (8.6%), *Asimina triloba* (8.0%), and *Cornus sericea* (7.3%) (Table 8). These shrub species all have very low frequency values (0.07–0.23) due to their patchy distribution throughout the wetland and concentration of cover in the shrub-carr portion of the complex. The high relative cover percentages of *Cornus alternifolia*, *Toxicodendron vernix*, *Lindera benzoin*, and *Asimina triloba* result from their presence in only one of the sites in which the abundance of each species is relatively greater than the other shrub species in the area. *Salix nigra*, *Salix discolor*, and *Cornus sericea* are located in both the open fen and shrub-carr portions of the wetland complex and have moderate to high abundance (Table 8). Note that the marsh area is not included in the shrub analysis because there were no shrubs present at that location. The FQI value of the three wetland areas combined is 31.7 with a mean C of 4.2 suggesting that the area has remnant natural area potential, but has undergone some disturbance in the past (Swink & Wilhelm 1994).

Seed Bank Analysis: 46 species (1, 835 seedlings total) were germinated out of the collected seed bank samples representing 22 families and 33 genera. Percent

TABLE 7. Ranked percent relative cover (RC) and corresponding frequency values of the five dominant herbaceous species for three fen areas individually and combined at Little Calumet Headwaters Nature Preserve.

All Fen Areas			Open Fen		
Species	% RC	Frequency	Species	% RC	Frequency
<i>Carex lasiocarpa</i>	16.3	0.33	<i>Leersia oryzoides</i>	29.9	0.60
<i>Leersia oryzoides</i>	12.1	0.28	<i>Symplocarpus foetidus</i>	13.9	0.55
<i>Symplocarpus foetidus</i>	11.2	0.38	<i>Carex stricta</i>	8.6	0.20
<i>Carex stricta</i>	6.8	0.23	<i>Agrimonia parviflora</i>	7.7	0.45
<i>Impatiens capensis</i>	6.0	0.38	<i>Equisetum arvense</i>	5.6	0.45
Total # spp. = 44			Total # spp. = 30		
Average # spp. per plot = 5.1			Average # spp. per plot = 5.6		
Shrub-carr			Marsh		
Species	% RC	Frequency	Species	% RC	Frequency
<i>Symplocarpus foetidus</i>	17.7	0.55	<i>Carex lasiocarpa</i>	51.4	0.95
<i>Carex stricta</i>	11.0	0.50	<i>Typha latifolia</i>	9.8	0.50
<i>Impatiens capensis</i>	10.6	0.50	<i>Thelypteris palustris</i>	8.0	0.40
<i>Equisetum arvense</i>	10.0	0.55	<i>Impatiens capensis</i>	6.7	0.45
<i>Symphotrichum puniceum</i>	5.9	0.40	<i>Sagittaria latifolia</i>	3.8	0.30
Total # spp. = 29			Total # spp. = 19		
Average # spp. per plot = 6.0			Average # spp. per plot = 3.9		

similarity between the sampled seed bank and above-ground vegetation is 71.7% with 33 of the 46 species present in both above and below ground populations. Eight species composed greater than 5% of the total number of plants germinated (i.e. greater than 100 seedlings germinated) in the seed bank samples all of which were present in the above-ground vegetation. These species include *Carex hystericina* (15.4%), *Juncus effusus* (15.2%), and *Glyceria striata* (13.7%) and all have less than 1% relative cover in the above-ground vegetation (Figure 8). Species germinated from seed bank samples but not present in the above-ground vegetation determined from the floristic inventory, all had a percent composition of less than 2.0% (Figure 9). Species in the germinated seed bank samples are typical for each wetland community, with many species being pioneer or early successional species and therefore absent from the above-ground vegetation. Species not present in the seed bank samples, but abundant in the above-ground vegetation tend to reproduce through other means (i.e. vegetatively). No exotic species or state listed species were germinated from the sampled soil.

Principal Coordinate Analysis (PCOORDA): Principal Coordinate Analysis (PCOORDA) for the above-ground vegetation sample plots revealed distinct differences in the structure and composition of the wetland complex areas versus groundwater seeps (Figure 10). A two-axis PCOORDA was utilized to analyze the differences between sites, with axis one accounting for 20.7 percent and axis two explaining 19.1 percent of the total variation for the wetland above-ground vegetation. Species identified by the analysis as being particularly important in accounting for the separation among sites include *Agrimonia parviflora*, *Carex*

TABLE 8. Ranked percent relative cover (RC) and corresponding frequency values of dominant shrub species for three fen areas individually and combined at Little Calumet Headwaters Nature Preserve. The marsh area has a low abundance of shrub species throughout the site and therefore was not sampled.

Species	All Fen Areas		Open Fen		Shrub-carr	
	% RC	Frequency	% RC	Frequency	% RC	Frequency
<i>Salix nigra</i>	16.1	0.17	14.8	0.20	16.7	0.15
<i>Cornus alternifolia</i>	12.8	0.17			19.1	0.25
<i>Toxicodendron vernix</i>	9.6	0.17			14.3	0.25
<i>Lindera benzoin</i>	9.3	0.07	28.5	0.20		
<i>Salix discolor</i>	8.6	0.13	1.6	0.10	11.9	0.15
<i>Asimina triloba</i>	8.0	0.17			11.9	0.25
<i>Cornus sericea</i>	7.3	0.23	18.0	0.30	2.1	0.20
<i>Cornus florida</i>	5.9	0.10	18.0	0.30		
<i>Cornus racemosa</i>	4.8	0.07			7.2	0.10
<i>Carpinus caroliniana</i>	3.7	0.05			5.6	0.05
<i>Salix eriocephala</i>	3.7	0.10	3.3	0.10	3.7	0.10
Total # spp.	18		9		13	
Average # spp. per plot	1.7		1.6		1.7	

bromoides, and *C. lasiocarpa*. The marsh area of the wetland dominated by *Typha latifolia* and *C. lasiocarpa* is more similar vegetatively to the groundwater seep wetlands than to the other two portions of the wetland complex. This is both due to the dominance of a few species that are also found in the groundwater seep wetlands and the lower diversity of the site compared to the remaining wetland complex. This analysis also indicates that although the groundwater seeps have a slight variation in above-ground species composition, all five areas are vegetatively similar to one another. The three portions of the wetland complex

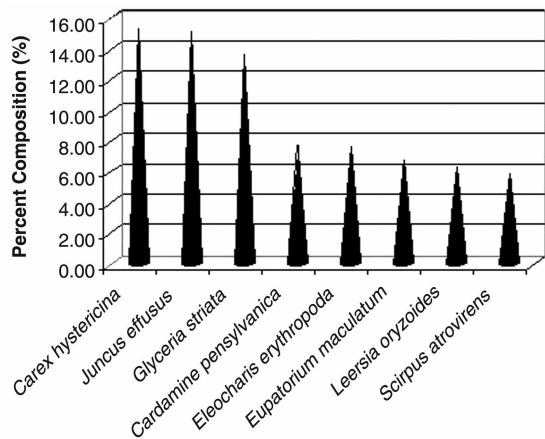


FIGURE 8. Percent composition of the eight most abundant species in Little Calumet Headwater Nature Preserve germinated from the seed bank.

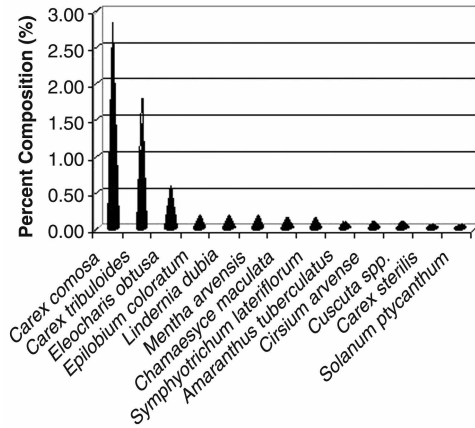


FIGURE 9. Percent composition of germinated seed bank species in Little Calumet Headwaters Nature Preserve that are absent from the above-ground vegetation.

sampled are distinct from one another and the open fen and shrub-carr portions are significantly different from the five groundwater seeps. This suggests that the three visually distinct wetland areas mentioned previously in this paper are, in fact, different in composition and structure in the above-ground vegetation according to the samples collected (Figure 2). The shrub-carr and open fen areas are shown to be extremely different in vegetative composition due to the presence of a few key species that are abundant in the wetland complex communities and absent or very uncommon in other wetland habitats (Figure 10). These species include, but are not limited to: *Carex stricta*, *Typha angustifolia*, *Lycopus americanus*, *Salix eriocephala*, *Eupatorium maculatum*, and *Salix discolor*. These wetland communities (except the marsh area) are distinctly different in composition and structure than the five groundwater seeps that are similar in above-ground vegetation to one another (Figure 10). Removal of rare species from PCORDA analysis resulted in no change in the ordination of wetland complex and seep communities. Omission of shrub cover also did not greatly alter the results of the original PCORDA analysis, which suggests that woody vegetation does not have a significant impact on the differences or similarities between the wetland areas.

PCORDA comparing the sampled seed bank among the eight wetland communities resulted in a separation of the wetland complex areas and groundwater seeps (Figure 11). This two-dimensional PCORDA analyzed the differences between the seed bank of each site, with axis one accounting for 25.9 percent and axis two explaining 18.3 percent of the total variation. *Eupatorium maculatum*, *Leersia oryzoides*, and *Pilea pumila* were recognized by the analysis as being particularly influential in the separation between sites. The open fen, marsh, and shrub-carr areas of the wetland complex show high similarity in terms of seed bank composition. The SE seep and railroad seep wetlands are also similar in seed bank composition, but are markedly different from the seed bank

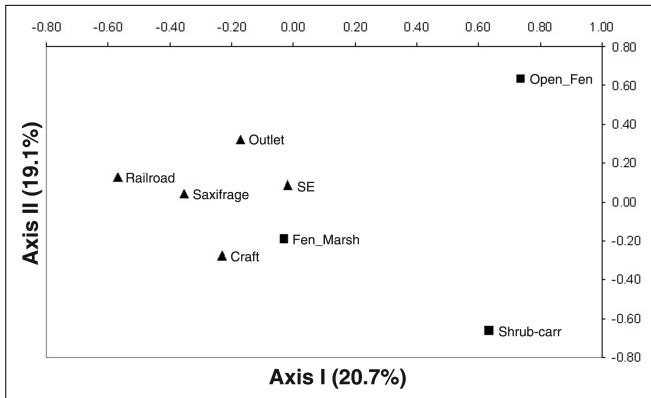


FIGURE 10. PCOORDA showing the differences in above-ground vegetation among eight wetland sites using relative cover and frequency at Little Calumet Headwaters Nature Preserve. Numbers in parentheses next to each axis represent the percent total variation explained by each axis.

samples from the craft seep, Saxifrage seep, and outlet seep wetlands. The sampled seed bank variation in the craft seep is due to the presence of rare species not found in the other seed bank areas sampled. These rare species are *Apocynum sibiricum*, *Cuscuta* spp., *Carex sterilis*, *Penthorum sedoides*, *Ranunculus hispidus*, and *Symphyotrichum lateriflorum*. The Saxifrage seep and the outlet seep varied slightly in seed bank composition due to the presence of *Persicaria hydropiperoides*, a rare species not found in the other wetland areas and also because they were lacking *Carex comosa* which is abundant in the other wetland seed bank samples. The differences among the groundwater seep seed bank samples (Figures 10 and 11) are due to varying early successional species in each seep. After initial invasion by pioneer species, which depend on site size, germination cues, and chance seeding of the area, all of the groundwater seeps became dominated by species that either do not depend fully on seed reproduction or utilize another form of reproduction entirely (Leck et al. 1989; Leck & Brock 2000). Removal of rare species from the PCOORDA analysis did not greatly affect the results, except in the craft seep, which was clustered with the railroad seep and SE seep after exclusion of rare species. This change suggests that the craft seep seed bank samples have a high proportion of species with low numbers of seedlings germinated (less than five seedlings), which has caused the seep to be significantly different from the other groundwater seeps.

DISCUSSION

LCHNP has a diverse flora due to the variety of plant communities within the preserve, none of which have been documented in previous research. This study has documented 298 species of which 270 are native to Indiana. Historical de-

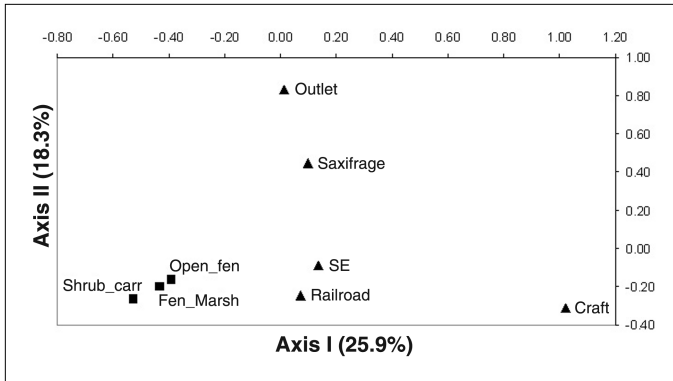


FIGURE 11. PCOORDA of variation in germinated seed bank samples among eight wetland areas utilizing presence and absence data at Little Calumet Headwaters Nature Preserve. Numbers in parentheses next to each axis represent the percent total variation explained by each axis.

scriptions of the forested areas and wetland communities correspond to the present structure and composition of the study site. The original surveyor's notes from 1830 describe the area as having *Fagus grandifolia*, *Acer saccharum*, *Carya* spp., and *Juglans* spp. all of which were found at the site in this study except *Juglans* spp. A more precise historical description of LCHNP was made by Thomas Post (1997) where all of the tree species mentioned as being historically present have been located in this research project. Homoya et al. (1985) noted the historical presence of many sedge and grass species due to the topography of the area producing low areas conducive to the formation of spring seeps and fens. The Michigan City Historical Society (1977) noted the presence of "125 springs . . . scattered throughout the grounds" however, an estimate of the number of springs encountered in this study is not that high. Further hydrological studies would give a more accurate approximation as to how many springs are in the preserve and the specific discharge rates throughout each wetland habitat.

This research provides baseline data of native and exotic species composition and community structure at LCHNP that can serve as a guide to monitor changes resulting from management implementations. The low percentage of exotic species found in this study, compared to other sites in northern Indiana, is puzzling. One possible cause is that the preserve is of larger size than many and has a noteworthy diversity of native species due to its varied topography and broad range of habitats. Another contributing factor may simply be that the preserve boundary was delineated in a manner that included the portions of the property with the highest natural quality and excluded areas with a predominance of disturbance habitat. Other floristic studies from sites of varying sizes in the region found higher percentages of exotics including Fall Creek Gorge (16.8%), Fogwell Forest (11.5%), Botany Glen (17.4%), and Neithercut Woodland (17.5%) (Tonkovich & Sargent 1997; Rothrock 1997; Stonehouse et al. 2003; Williams et al. 2005). Barker Woods Nature Preserve of LaPorte County, Indiana and Ben-

dix Woods in St. Joseph County, Indiana had a lower abundance of exotics with 8.2 and 5.0 percent respectively (Blodgett & Riemenschneider 1982; Reed 1985). Species richness of LCHNP was similar to a forested site of similar size such as Fall Creek Gorge (149 acres), which contained 346 species (Tonkovich et al. 1997). If the minor size difference between these two sites is considered, the species richness is similar for both areas. Since plant collection was only conducted during one growing season and because this was the first recorded collection at this site, species (especially rare or infrequent) may have been overlooked. Additional collections are recommended in order to obtain a more complete floristic survey of the preserve. Long-term monitoring of LCHNP would also give insight as to how to manage a property consisting of varying habitat types that is affected by urban growth. This study can also serve as a comparison flora for similar communities in northern Indiana.

Management of LCHNP is critical to sustain the diversity and natural quality of the ecosystem because of the major effects of urbanization in the area. The maintenance and preservation of original communities becomes more challenging with the fragmentation of these communities from agricultural and urban development (Ruch et al. 1998). Urbanization of the area surrounding LCHNP is having major effects on the natural quality of the preserve. Deer over browsing is a significant problem at LCHNP and may have resulted in thinning the forest ground layer herbaceous species (e.g. *Dicentra cucullaria* is completely absent at the preserve). High deer populations may have also caused the spreading and invasion of *Lindera benzoin* throughout the forested and wetland communities as a result of this herbaceous thinning. Selective cutting of this shrub species followed by herbicide application is the best management solution for this problem. Prescribed burning should not be implemented in the forested areas to decrease *Lindera benzoin* and increase herbaceous diversity because species such as *Liriodendron tulipifera* are sensitive to fire and would not recover (Reber pers. comm.).

Exotic species are not of major concern in the preserve because they have not invaded any areas, but they should be monitored to prevent future invasion. Exotic species removal would be relatively easy and cost effective at LCHNP because exotics are low in numbers and most are limited to growth in meadow and wetland areas. Proactive removal of these species will prevent expensive restoration and management of this inevitable problem in the future.

The wetland complex is beginning to become overgrown with shrubs from woody encroachment potentially due to the suppression of natural disturbance such as fire. Selective cutting of the shrub species followed by stem herbicide applications would prevent regrowth of shrub cover and would allow herbaceous species to grow. This removal of woody species then could then be followed by an introduced fire regime that follows the frequent pattern of the original natural fire regimes of the area. The marsh area is in need of management due to the low diversity and the dominance of a few plant species. Wicking of the cattail would allow growth of native species by removing the canopy and allow them to take over and thrive. The initial seed bank study revealed that utilization of the seed bank store for management or restoration purposes may not improve the overall quality of the wetland communities because the seed bank contains most of the same species currently present in the above ground vegetation. However, germi-

nation studies may not sample densely enough to reveal rare species in the seed bank that may have more specific germination requirements than more commonly found species. Further examination of the seed bank is recommended in future studies in order to fully understand the usefulness of the existing seed bank for management of the area. The pond is also in need of management because it is filling in and becoming dominated by *Typha* spp. Further research on the rate of sediment loading and *Typha* spp. encroachment is needed to fully understand what steps should be taken to manage this area properly. Careful consideration and thorough research should be performed to determine the best solution for restoring this area to its natural condition.

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APPENDIX

Catalog of Vascular Plants of Little Calumet Nature Preserve (arranged by major taxonomic group, then alphabetically by family)

Following each species is information specific to its occurrence in Little Calumet Headwaters Nature Preserve. The symbols in parentheses immediately following each common name refer to the following: E = state endangered; T = state threatened; R = state rare; * = exotic, adventive, non-indigenous, or non-native species. A coefficient of conservatism is also assigned to each native species (Rothrock 2004). Exotic or non-native species are given a coefficient of null value. C-Values: 1–3 = species widespread under many disturbance conditions; 4–7 = species show a distinct affinity to a natural community; 8–10 = species that signify stable, high-quality natural communities (Wilhelm 1988).

Frequency estimates: rare = 1–3 colonies although species may be abundant at one site; infre-

quent = occasional, not widespread, may be abundant at one site; frequent = common in suitable habitat, may be locally abundant in a few sites; abundant = in vast numbers throughout the property, not localized to a few sites (Stonehouse et al. 2003).

The characteristic habitat and collection numbers are listed following the estimate of abundance. Voucher specimens are deposited in the Morton Arboretum Herbarium (MOR) with duplicate vouchers placed in the Butler University Herbarium (BUT). Nomenclature follows the Floristic Quality Assessment Catalog of Plants for Indiana Flora by Kay Yatskievych, which utilizes the most recent nomenclature from the USDA plant database (Rothrock 2004 & Natural Resources Conservation Service 2004). Scientific names located in parentheses follow the nomenclature of Plants of the Chicago Region (Swink & Wilhelm 1994).

PTERIDOPHYTES

LYCOPODIACEAE (Club Moss Family)

Lycopodium digitatum Dill. ex A. Braun (= *Lycopodium complanatum* L. var. *flabelliforme* Fern.): Fan Clubmoss; (C = 2); frequent; mesic woods; JLA 363.

EQUISETACEAE (Horsetail Family)

Equisetum arvense L.: Field Horsetail; (C = 1); abundant; shaded mesic woods and near seepage wetlands and creeks; JLA 31.

Equisetum fluviatile L.: Water Horsetail; (C = 10); infrequent; mesic woods; PER 4206.

DENNSTAEDTIACEAE (Bracken Fern Family)

Peridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw.: Western Bracken Fern; (C = 5); infrequent; along trail; JLA 88.

DRYOPTERIDACEAE (Wood Fern Family)

Athyrium filix-femina (L.) Roth var. *angustum* (Willd.) Lawson (= *Athyrium filix-femina* (L.) Roth var. *michauxii* (Spreng.) Farw.): Subarctic Ladyfern; (C = 6); frequent; mesic woods; JLA 360.

Deparia acrostichoides (Sw.) M. Kato (= *Athyrium thelypteroides* (Michx.) Desv.): Silver False Spleenwort; (C = 8); rare; mesic woods; PER 4237.

Dryopteris carthusiana (Vill.) H.P. Fuchs (= *Dryopteris spinulosa* (O. F. Müll.) Watt): Spinulose Wood Fern; (C = 6); infrequent; seepage wetland; PER 4235.

Onoclea sensibilis L.: Sensitive Fern; (C = 4); frequent; shaded seepage wetlands; JLA 41.

Polystichum acrostichoides (Michx.) Schott.: Christmas Fern; (C = 5); infrequent; mesic woods along trail; JLA 147.

THELYPTERIDACEAE (Thelypteris Family)

Thelypteris noveboracensis (L.) Nieuw. (= *Dryopteris noveboracensis* (L.) A. Gray): New York Fern; (C = 10); rare; slope south of open fen; PER 4236.

Thelypteris palustris var. *pubescens* Schott.: Eastern Marsh Fern; (C = 7); infrequent; marsh fen; JLA 454.

GYMNOSPERMS

CUPRESSACEAE (Cypress Family)

Juniperus virginiana L.: Eastern Redcedar; (C = 2); rare; mesic woods; JLA 457.

PINACEAE (Pine Family)

Pinus resinosa Soland.: Red Pine; (likely planted, C = NA); infrequent; mesic woods; JLA 455.

Pinus sylvestris L.: Scotch Pine; (likely planted, C = NA); infrequent; mesic woods; JLA 385.

Pinus strobus L.: Eastern White Pine; (likely planted, C = NA); one plant in mesic woods; JLA 36.

ANGIOSPERMS

ACERACEAE (Maple Family)

Acer saccharum Marshall: Sugar Maple; (C = 5); abundant; mesic woods; JLA 252.

ALISMATACEAE (Water Plantain Family)

Alisma subcordatum Raf.: American Water Plantain; (C = 2); infrequent; open wet meadow; PER 4226.

Sagittaria latifolia Willd.: Broadleaf Arrowhead; (C = 3); frequent; open fen; JLA 332.

ANACARDIACEAE (Cashew Family)

Rhus typhina L.: Staghorn Sumac; (C = 2); infrequent; edge of woods by seepage wetland; JLA 193.

Toxicodendron radicans (L.) Kuntze: Eastern Poison Ivy; (C = 1); infrequent; mesic woods along trail; JLA 456.

Toxicodendron vernix (L.) Kuntze (= *Rhus vernix* L.): Poison Sumac; (C = 10); infrequent; shrub-carr fen; JLA 247.

ANNONACEAE (Custard Apple Family)

Asimina triloba (L.) Dunal: Papaw; (C = 6); frequent; mesic woods; JLA 126.

APIACEAE (Carrot Family)

Angelica atropurpurea L.: Purplestem Angelica; (C = 6); infrequent; south side of seepage wetland; JLA 139.

Cicuta bulbifera L.: Bulblet-Bearing Water Hemlock; (C = 8); rare; seepage wetland; PER 4215.

Cicuta maculata L.: Spotted Water Hemlock; (C = 6); infrequent; open fen; JLA 333.

Cryptotaenia canadensis (L.) DC.: Canadian Honewort; (C = 3); infrequent; edge of seepage wetland; JLA 194.

Daucus carota L.: Queen Anne's Lace; (*); frequent; open meadow; JLA 328.

Osmorhiza claytonii (Michx.) C.B. Clarke: Clayton's Sweetroot; (C = 3); infrequent; mesic woods; JLA 146.

Osmorhiza longistylis (Torr.) DC.: Longstyle Sweetroot; (C = 3); rare; edge of wooded trail; JLA 107.

Sium suave Walt.: Hemlock Waterparsnip; (C = 5); infrequent; seepage wetland; PER 4234.

APOCYNACEAE (Dogbane Family)

Apocynum cannabinum L.: Indian Hemp; (C = 2); rare; open meadow; JLA 390.

Vinca minor L.: Common Periwinkle; (*); rare; road edge near Preserve boundary; JLA 254.

ARACEAE (Arum Family)

Arisaema triphyllum (L.) Schott.: Jack-In-The-Pulpit; (C = 4); frequent; mesic forest; JLA 25.

Symplocarpus foetidus (L.) Salisb. ex Nutt.: Skunk Cabbage; (C = 8); abundant; seepage wetlands and moist areas; JLA 2.

ARISTOLOCHIACEAE (Birthwort Family)

Asarum canadense L.: Canadian Wild Ginger; (C = 5); frequent; mesic forest; JLA 45.

ASCLEPIADACEAE (Milkweed Family)

Asclepias incarnata L.: Swamp Milkweed; (C = 4); infrequent; open wet meadow; JLA 289.

Asclepias syriaca L.: Common Milkweed; (C = 1); infrequent; open meadow; JLA 389.

ASTERACEAE (Aster Family)

Achillea millefolium L.: Common Yarrow; (C = 0); abundant; trail edges, open meadow; JLA 235.

Ageratina altissima (L.) King & H.E. Robins. var. *altissima* (= *Eupatorium rugosum* Houtt.): White Snakeroot; (C = 2); infrequent; mesic woods; JLA 373.

Antennaria plantaginifolia (L.) Richards.: Woman's Tobacco; (C = 3); infrequent; open meadow; JLA 55.

Bidens cernua L.: Nodding Beggartick; (C = 2); infrequent; seepage wetland; PER 4214.

Bidens tripartita L.: Threelobe Beggarticks; (C = 2); infrequent; open fen; JLA 412.

Bidens coronata (L.) Britton: Crowned Beggarticks; (C = 5); infrequent; seepage wetland; PER 4216.

Bidens frondosa L.: Devil's Beggarticks; (C = 1); rare; open wet meadow; PER 4211.

Cirsium muticum Michx.: Swamp Thistle; (C = 8); frequent; open wet meadow; PER 4209.

- Erechtites hieraciifolia* (L.) Raf.: American Burnweed; (C = 2); infrequent; open meadow; PER 4223.
- Erigeron philadelphicus* L.: Philadelphia Fleabane; (C = 3); frequent; open meadow; JLA 106.
- Eupatoriadelphus maculatus* (L.) King & H.E. Robins. (= *Eupatorium maculatum* L.): Spotted Trumpetweed; (C = 5); frequent; open fen and wet meadow; JLA 336.
- Eupatorium perfoliatum* L.: Common Boneset; (C = 4); frequent; open fen and wet meadow; JLA 349.
- Euthamia graminifolia* (L.) Nutt. var. *graminifolia* (= *Solidago graminifolia* (L.) Salisb. var. *nuttallii* (Greene) Fern.): Flat-Top Goldenrod; (C = 3); rare; open wet meadow; PER 4213.
- Helianthus giganteus* L.: Giant Sunflower; (C = 6); rare; open wet meadow; PER 4230.
- Hieracium piloselloides* Vill. (= *Hieracium florentinum* All. (F.)): Tall Hawkweed; (*); rare; open meadow; JLA 164.
- Hieracium scabrum* Michx.: Rough Hawkweed; (C = 5); infrequent; open meadow; PER 4199.
- Leucanthemum vulgare* Lam. (= *Chrysanthemum leucanthemum* L. var. *pinnatifidum* Lecoq & Lamotte): Ox-Eye Daisy; (*); frequent; open meadow; JLA 159.
- Packera aurea* (L.) A. & D. Löve (= *Senecio aureus* L.): Golden Ragwort; (C = 4); abundant; mesic woods, seepage wetlands, open fen, and open wet meadow; JLA 27.
- Rudbeckia hirta* L.: Black-Eyed Susan; (C = 2); frequent; open wet meadow; JLA 262.
- Solidago caesia* L.: Wreath Goldenrod; (C = 7); frequent; mesic woods; JLA 376.
- Solidago juncea* Aiton: Early Goldenrod; (C = 3); frequent; along trail edges; JLA 346.
- Solidago nemoralis* Aiton: Gray Goldenrod; (C = 3); rare; open field; PER 4232.
- Solidago patula* Muhl.: Roundleaf Goldenrod; (C = 8); infrequent; open wet meadow; JLA 374.
- Symphotrichum dumosum* (L.) Nesom (= *Aster dumosus* L.): Rice Button Aster; (C = 4); frequent; along wooded trail edges; JLA 387.
- Symphotrichum firmum* (Nees) Nesom (= *Aster puniceus* L. var. *firmus* (Nees) Torr. & Gray)
- Symphotrichum lateriflorum* (L.) A. & D. Löve (= *Aster lateriflorus* (L.) Britton): Calico Aster; (C = 3); infrequent; mesic woods; JLA 377.
- Symphotrichum lanceolatum* (Willd.) Nesom (= *Aster simplex* Willd.): White Panicle Aster; (C = 3); infrequent; mesic woods; JLA 375.
- Symphotrichum puniceum* (L.) A. & D. Löve (= *Aster puniceus* L.): Purplestem Aster; (C = 7); abundant; seepage wetlands and open fen; JLA 396.
- Vernonia gigantea* (Walt.) Trel. (= *Vernonia altissima* Nutt. var. *taeniotricha* S.F. Blake): Giant Ironweed; (C = 2); frequent; open fen, open wet meadow, and along trail edge; JLA 302.

BALSAMINACEAE (Touch-Me-Not Family)

- Impatiens capensis* Meerb.: Jewelweed; (C = 2); frequent; seepage wetlands and open fen; JLA 283.

BERBERIDACEAE (Barberry Family)

- Berberis thunbergii* DC.: Japanese Barberry; (*); infrequent; mesic woods; JLA 86.
- Podophyllum peltatum* L.: May Apple; (C = 3); abundant; mesic woods; JLA 24.

BETULACEAE (Birch Family)

- Carpinus caroliniana* Walter var. *virginiana* (Marshall) Fern.: American Hornbeam; (C = 5); infrequent; mesic woods; JLA 324.
- Ostrya virginiana* (Mill.) K. Koch: Hop Hornbeam; (C = 5); infrequent; mesic forest; JLA 356.

BORAGINACEAE (Borage Family)

- Hackelia virginiana* (L.) I. M. Johnston.: Beggarslice; (C = 0); frequent; mesic woods; JLA 358.

BRASSICACEAE (Mustard Family)

- Cardamine bulbosa* (Schreb. ex Muhl.) BSP.: Bulbous Bittercress; (C = 4); infrequent; mesic woods; JLA 10.
- Cardamine concatenata* (Michx.) Sw. (= *Dentaria laciniata* Willd.): Cutleaf Toothwort; (C = 4); frequent; mesic forest; JLA 6.

Cardamine pensylvanica Muhl. ex Willd: Pennsylvania Bitter Cress; (C = 2); infrequent; open fen; JLA 218.

Nasturtium officinale Ait. f. (= *Nasturtium officinale* R. Br.): Water Cress; (*); infrequent; seepage wetland; JLA 35.

CAMPANULACEAE (Bellflower Family)

Campanulastrum americanum (L.) Small (= *Campanula americana* L.): American Bellflower; (C = 4); frequent; seepage wetlands and along wooded trail; JLA 288.

Lobelia inflata L.: Indian Tobacco; (C = 3); frequent; mesic woods and along trail; JLA 300.

Lobelia siphilitica L.: Great Blue Lobelia; (C = 3); infrequent; mesic woods; JLA 353.

CAPRIFOLIACEAE (Honeysuckle Family)

Diervilla lonicera P. Mill.: Northern Bush Honeysuckle; (R, C = 9); infrequent; along wooded trail; JLA 187.

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli (= *Sambucus canadensis* L.): Common Elderberry; (C = 2); frequent; seepage wetlands; JLA 409.

Viburnum acerifolium L.: Maple-Leaf Viburnum; (C = 8); frequent; mesic woods; JLA 137.

Viburnum lentago L.: Nannyberry; (C = 5); frequent; along trail by open fen; JLA 64.

Viburnum prunifolium L.: Black Haw; (C = 4); infrequent; mesic woods; JLA 169.

CARYOPHYLLACEAE (Pink Family)

Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet (= *Cerastium vulgatum* L.): Big Chickweed; (*); infrequent; open meadow; JLA 69.

Dianthus armeria L.: Deptford Pink; (*); frequent; open fen and wet meadow; JLA 267.

CELASTRACEAE (Staff-Tree Family)

Euonymus obovatus Nutt.: Running Strawberry Bush; (C = 7); infrequent; mesic woods; JLA 135.

CERATOPHYLLACEAE (Hornwort Family)

Ceratophyllum demersum L.: Coon's Tail; (C = 1); abundant; pond; JLA 210.

CLUSIACEAE (Mangosteen Family)

Hypericum punctatum Lam.: Spotted St. John's Wort; (C = 3); infrequent; open meadow; JLA 266.

CONVOLVULACEAE (Morning-Glory Family)

Ipomoea pandurata (L.) G.F.W. Mey.: Man of the Earth; (C = 3); infrequent; open meadow; JLA 158.

CORNACEAE (Dogwood Family)

Cornus alternifolia L.f.: Alternate Leaf Dogwood; (C = 8); common; mesic woods, seepage wetlands, and open fen; JLA 127.

Cornus florida L.: Flowering Dogwood; (C = 4); frequent; mesic woods; JLA 14.

Cornus obliqua Raf.: Silky Dogwood; (C = 5); infrequent; seepage wetland; JLA 245.

Cornus racemosa Lam.: Gray Dogwood; (C = 2); frequent; open fen and wet meadow; JLA 163.

Cornus sericea L. (= *Cornus stolonifera* Michx.): Redosier Dogwood; (C = 4); frequent; mesic woods, seepage wetlands, and open fen; JLA 65.

CYPERACEAE (Sedge Family)

Carex albursina Sheldon: White Bear Sedge; (C = 7); infrequent; mesic woods; JLA 116.

Carex amphibola Steud.: Eastern Narrowleaf Sedge; (C = 8); infrequent; along trail; JLA 91.

Carex blanda Dewey: Eastern Woodland Sedge; (C = 1); infrequent; mesic woods; JLA 50.

Carex bromoides Schkuhr. ex Willd.: Bromelike Sedge; (C = 10); infrequent; seepage wetland; JLA 175.

Carex communis Bailey: Fibrousroot Sedge; (C = 8); frequent; wooded border of seepage wetlands; JLA 26.

Carex crinita Lam.: Fringed Sedge; (C = 8); infrequent; south side of open fen; JLA 184.

Carex digitalis Willd.: Slender Woodland Sedge; (C = 7); infrequent; mesic woods; JLA 81.

Carex gracilescens Steud.: Slender Looseflower Sedge; (C = 5); infrequent; open wet meadow and along wooded trail; JLA 165.

- Carex gracillima* Schwein.: Graceful Sedge; (C = 7); frequent; along wooded trail; JLA 53.
- Carex granularis* Muhl. ex Willd.: Limestone Meadow Sedge; (C = 2); frequent; mesic woods; JLA 142.
- Carex grisea* Wahlenb.: Inflated Narrowleaf Sedge; (C = 3); frequent; mesic woods and along trail; JLA 44.
- Carex hitchcockiana* Dewey: Hitchcock's Sedge; (C = 8); infrequent; mesic woods; JLA 129.
- Carex hystericina* Muhl. ex Willd.: Bottlebrush Sedge; (C = 5); frequent; open wet meadow; JLA 98.
- Carex interior* Bailey: Inland Sedge; (C = 8); infrequent; north side of open fen; JLA 66.
- Carex lasiocarpa* Ehrh. var. *americana* Fern.: American Woollyfruit Sedge; (C = 10); frequent; open fen and marsh areas; JLA 181.
- Carex laxiculmis* Schwein. var. *laxiculmis*: Spreading Sedge; (C = 7); infrequent; along wooded trail; JLA 51.
- Carex laxiflora* Lam.: Broad Looseflower Sedge; (C = 7); infrequent; mesic woods; JLA 38.
- Carex leptalea* Wahlenb.: Bristlystalked Sedge; (C = 8); infrequent; open wet meadow; JLA 103.
- Carex lurida* Wahlenb.: Shallow Sedge; (C = 4); infrequent; seepage wetland; JLA 144.
- Carex muehlenbergii* Schkuhr ex Willd. var. *muehlenbergii*: Muhlenberg's Sedge; (C = 5); infrequent; along trail in mesic woods; JLA 294.
- Carex pellita* Muhl. ex Willd.: Woolly Sedge; (C = 2); infrequent; open wet meadow; JLA 99.
- Carex pennsylvanica* Lam.: Pennsylvania Sedge; (C = 5); infrequent; slightly dry field between oak woods and fen; JLA 72.
- Carex prasina* Wahlenb.: Drooping Sedge; (C = 10); infrequent; seepage wetland; JLA 176.
- Carex rosea* Schkuhr ex Willd.: Rosy Sedge; (C = 5); frequent; mesic woods and along trail; JLA 42.
- Carex scabrata* Schwein.: Eastern Rough Sedge; (E, C = 10); infrequent; seepage wetland; JLA 138.
- Carex stipata* Muhl. ex Willd. var. *stipata*: Owlfruit Sedge; (C = 2); abundant; open fen and seepage wetlands; JLA 78.
- Carex stricta* Lam.: Upright Sedge; (C = 5); frequent; open fen and wet meadow; JLA 97.
- Carex suberecta* (Olney) Britton: Prairie Straw Sedge; (C = 5); frequent; open fen and wet meadow; JLA 180.
- Carex swanii* (Fern.) Mackenzie.: Swan's Sedge; (C = 4); infrequent; open meadow; JLA 150.
- Carex tomsa* (Fern.) Bickn. var. *tomsa*: Shaved Sedge; (C = 9); infrequent; open meadow; JLA 70.
- Carex vulpinoidea* Michx.: Fox Sedge; (C = 2); infrequent; south side of open fen; JLA 182.
- Cyperus bipartitus* Torr. (= *Cyperus rivularis* Kunth): Slender Flat Sedge; (C = 3); rare; mowed meadow; PER 4194.
- Cyperus odoratus* L. (= *Cyperus ferruginescens* Boeck.): Fragrant Flat Sedge; (C = 1); rare; open wet meadow; PER 4228.
- Eleocharis erythropoda* Steud.: Bald Spike Rush; (C = 2); infrequent; north edge of seep; JLA 141.
- Eriophorum angustifolium* Honckeny.: Tall Cotton Grass; (R, C = 10); infrequent; open fen; JLA 67.
- Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla (= *Scirpus validus* Vahl var. *creber* Fern.): Softstem Bulrush; (C = 4); frequent; open fen; JLA 178.
- Scirpus atrovirens* Willd.: Green Bulrush; (C = 4); frequent; open wet meadow; JLA 204.
- Scirpus georgianus* Harper: Georgia Bulrush; (C = 3); infrequent; along drainage ditch; JLA 392.
- Scirpus pendulus* Muhl.: (C = 4); Rufous Bulrush; infrequent; open wet meadow; JLA 227.

DIPSACACEAE (Teasel Family)

- Dipsacus fullonum* L. (= *Dipsacus sylvestris* Huds.): Fuller's Teasel; (*); infrequent; open meadow; JLA 354.

ELAEAGNACEAE (Oleaster Family)

Elaeagnus angustifolia L.: Russian Olive; (*); infrequent; open meadow and along trail; JLA 76.

Elaeagnus umbellata Thunb.: Autumn Olive; (*); infrequent; open fen; JLA 343.

ERICACEAE (Heath Family)

Vaccinium angustifolium Aiton: Lowbush Blueberry; (C = 5); infrequent; mesic woods on forested knoll; JLA 450.

Vaccinium pallidum Aiton: Blue Ridge Blueberry; (C = 5); infrequent; mesic woods on forested knoll; JLA 451.

FABACEAE (Pea Family)

Amphicarpaea bracteata (L.) Fern. var. *comosa* (L.) Fern.: American Hog Peanut; (C = 5); infrequent; stream bank; PER 4201.

Desmodium paniculatum (L.) DC.: Panicleleaf Ticktrefoil; (C = 2); frequent; open fen and wet meadow; JLA 311.

Medicago lupulina L.: Black Medick; (*); infrequent; along trail; JLA 153.

Trifolium pratense L.: Red Clover; (*); infrequent; open meadow; JLA 309.

FAGACEAE (Beech Family)

Fagus grandifolia Ehrh.: American Beech; (C = 8); frequent; mesic woods; JLA 452.

Quercus alba L.: White Oak; (C = 5); rare; mesic woods; JLA 401.

Quercus rubra L.: Northern Red Oak; (C = 4); frequent; mesic woods; JLA 381.

Quercus velutina Lam.: Black Oak; (C = 4); frequent; mesic woods; PER 4231.

GENTIANACEAE (Gentian Family)

Sabatia angularis (L.) Pursh: Rose Pink; (C = 3); infrequent; along pond shoreline; JLA 280.

GERANIACEAE (Geranium Family)

Geranium maculatum L.: Spotted Geranium; (C = 4); infrequent; mesic woods; JLA 17.

GROSSULARIACEAE (Gooseberry Family)

Ribes americanum P. Mill.: American Black Currant; (C = 5); infrequent; open fen; JLA 179.

Ribes cynosbati L.: Eastern Prickly Gooseberry; (C = 4); frequent; mesic forest; JLA 34.

HALORAGACEAE (Water-Milfoil Family)

Myriophyllum sibiricum Komarov (= *Myriophyllum exalbescens* Fern.): Shortspike Water Milfoil; (C = 7); abundant; pond; JLA 212.

HAMAMELIDACEAE (Witch-Hazel Family)

Hamamelis virginiana L.: American Witch Hazel; (C = 5); infrequent mesic woods; JLA 322.

HYDROCHARITACEAE (Frog's-Bit Family)

Elodea canadensis Michx.: Canadian Waterweed; (C = 3); frequent; pond; JLA 214.

IRIDACEAE (Iris Family)

Iris virginica L. var. *shrevei* (Small) E. S. Anderson: Shreve's Iris; (C = 5); infrequent; along pond shoreline; JLA 93.

Sisyrinchium angustifolium P. Mill.: Narrowleaf Blue-Eyed Grass; (C = 3); infrequent; open meadow and along trail; JLA 92.

JUGLANDACEAE (Walnut Family)

Carya ovata (Mill.) K. Koch: Shagbark Hickory; (C = 5); infrequent; mesic woods; JLA 394.

JUNCACEAE (Rush Family)

Juncus articulatus L.: Jointleaf Rush; (E, C = 4); rare; open fen; PER 4195.

Juncus brachycephalus (Engelm.) Buchenau: Smallhead Rush; (C = 7); infrequent; open wet meadow; PER 4240.

Juncus dudleyi Wiegand: Dudley's Rush; (C = 2); infrequent; open wet meadow; JLA 205.

Juncus effusus L.: Common Rush; (C = 3); frequent; open fen and wet meadow; JLA 222.

Juncus tenuis Willd.: Poverty Rush; (C = 0); frequent; mesic woods and open wet meadow; PER 4198.

Luzula multiflora (Retz.) Lej.: Common Wood Rush; (C = 6); frequent; mesic woods and open wet meadow; JLA 58.

LAMIACEAE (Mint Family)

Blephilia ciliata (L.) Benth.: Downy Pagoda Plant; (C = 7); infrequent; open wet meadow; JLA 260.

Blephilia hirsuta (Pursh) Benth.: Hairy Pagoda Plant; (C = 5); infrequent; mesic woods and along path; JLA 256.

Glechoma hederacea L.: Ground Ivy; (*); infrequent; mesic woods; JLA 23.

Lycopus americanus Muhl. ex W. Bart: American Water Horehound; (C = 3); frequent; open fen and wet meadow; JLA 334.

Lycopus uniflorus Michx.: Northern Bugle Weed; (C = 5); infrequent; open fen; PER 4239.

Mentha spicata L.: Spearmint; (*); infrequent; open fen; JLA 405.

Prunella vulgaris L.: Common Self Heal; (C = 1); infrequent; open meadow; JLA 275.

Scutellaria lateriflora L.: Blue Skullcap; (C = 4); infrequent; seepage wetlands; JLA 323.

LAURACEAE (Laurel Family)

Lindera benzoin (L.) Blume: Hairy Spicebush; (C = 5); abundant; mesic woods, edge of seepage wetlands and open fen; JLA 79.

Sassafras albidum (Nutt.) Nees: Sassafras; (C = 1); infrequent; mesic woods; JLA 293.

LEMNACEAE (Duckweed Family)

Lemna minor L.: Common Duckweed; (C = 3); abundant; seepage wetlands and pond; JLA 123.

Lemna trisulca L.: Star Duckweed; (C = 6); infrequent; pond; JLA 253.

Spirodela polyrhiza (L.) Schleid.: Common Duckmeat; (C = 5); infrequent; pond; JLA 217.

LENTIBULARIACEAE (Bladderwort Family)

Utricularia macrorhiza Le Conte (= *Utricularia vulgaris* L.): Common Bladderwort; (C = 5); frequent; pond; JLA 318.

LILIACEAE (Lily Family)

Allium canadense L.: Meadow Garlic; (C = 1); infrequent; open wet meadow; JLA 59.

Allium tricoccum Aiton: Wild Leek; (C = 7); infrequent; moist woods; JLA 1.

Erythronium americanum Ker Gawl.: Dogtooth Violet; (C = 5); infrequent; mesic woods; JLA 0.

Lilium michiganense Farw.: Michigan Lily; (C = 5); rare; mesic woods near stream; JLA 250.

Maianthemum canadense Desf.: Canada Mayflower; (C = 8); infrequent; mesic woods; JLA 73.

Maianthemum stellatum (L.) Link (= *Smilacina stellata* (L.) Desf.): Starry False Lily of the Valley; (C = 6); infrequent; seepage area; JLA 40.

Trillium grandiflorum (Michx.) Salisb.: White Trillium; (C = 7); infrequent; hilltop in mesic woods; JLA 21.

Trillium recurvatum L. C. Beck: Bloody Butcher; (C = 4); infrequent; mesic woods; JLA 52.

LIMNANTHACEAE (Meadow-Foam Family)

Floerkea proserpinacoides Willd.: False Mermaid Weed; (C = 5); infrequent; mesic woods; JLA 60.

LYTHRACEAE (Loosestrife Family)

Decodon verticillatus (L.) Ell. Swamp Loosestrife; (C = 8); frequent; pond and seepage wetland; LA 313.

MAGNOLIACEAE (Magnolia Family)

Liriodendron tulipifera L.: Tulip Tree; (C = 4); frequent; mesic woods; JLA 132.

MORACEAE (Mulberry Family)

Morus alba L.: White Mulberry; (*); infrequent; mesic woods; JLA 188.

NYMPHAEACEAE (Water Lily Family)

Nuphar lutea (L.) Sm. ssp. *advena* (Ait.) Kartesz & Gandhi: Yellow Pond-Lily; (C = 6); abundant; pond; JLA 166.

Nymphaea odorata Ait. ssp. *tuberosa* (Paine) Wiersma & Hellquist (= *Nymphaea tuberosa* Paine): American White Water Lily; (C = 6); abundant; pond; JLA 316.

OLEACEAE (Olive Family)

Fraxinus americana L.: White Ash; (C = 4); abundant; mesic woods; JLA 143.

Fraxinus nigra Marshall: Black Ash; (C = 7); infrequent; moist forest; PER 4204.

ONAGRACEAE (Evening Primrose Family)

Circaea lutetiana L. var. *canadensis* L. Aschers. & Magnus: Enchanter's Nightshade; (C = 2); frequent; mesic woods and trail edges; JLA 238.

Epilobium leptophyllum Raf.: Bog Willow Herb; (C = 10); infrequent; open fen; JLA 402.

Oenothera biennis L.: Common Evening Primrose; (C = 0); rare; along wooded trail; JLA 370.

ORCHIDACEAE (Orchid Family)

Cypripedium reginae Walter: Showy Lady's Slipper; (C = 10); infrequent; open fen; JLA 248.

Platanthera huronensis (Nutt.) Lindl. (= *Habenaria hyperborea* (L.) R. Br. var. *huronensis* (Nutt.) Farw.): Huron Green Orchid; (T, C = 10); rare; seepage wetland; JLA 124.

Liparis loeselii (L.) L.C. Rich.: Yellow Widelip Orchid; (C = 4); rare; open wet meadow; JLA 154.

Spiranthes cernua (L.) L.C. Rich.: Nodding Lady's Tresses; (C = 3); rare; open wet meadow; PER 4222.

OXALIDACEAE (Wood Sorrel Family)

Oxalis stricta L.: Common Yellow Oxalis; (C = 0); frequent; along trail; JLA 269.

PHRYMACEAE (Lopseed Family)

Phryma leptostachya L.: American Lopseed; (C = 4); infrequent; mesic woods; JLA 282.

PLANTAGINACEAE (Plantain Family)

Plantago rugelii Dcne.: Blackseed Plantain; (C = 0); frequent; along trail; JLA 259.

POACEAE (Grass Family)

Agrostis peremans (Walt.) Tuckerman: Upland Bent Grass; (C = 2); infrequent; open wet meadow and mesic woods; PER 4233.

Cinna arundinacea L.: Sweet Wood Reed; (C = 4); infrequent; moist woods; PER 4192.

Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes: Poverty Oat Grass; (C = 3); frequent; open meadow, mesic woods, and along trail; JLA 234.

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann (= *Panicum implicatum fasciculatum*): Western Panic Grass; (C = 10); infrequent; open wet meadow; JLA 278.

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark (= *Panicum lindheimeri* Nash): Lindheimer Panic Grass; (C = 5); infrequent; open wet meadow; JLA 225.

Digitaria sanguinalis (L.) Scop.: Hairy Crab Grass; (*); infrequent; open wet meadow; PER 4227.

Elymus hystrix L. (= *Hystrix patula* Moench): Eastern Bottlebrush Grass; (C = 5); infrequent; along wooded trail; JLA 255.

Festuca subverticillata (Pers.) Alexeev (= *Festuca obtusa* Biehler): Nodding Fescue; (C = 4); frequent; mesic woods along trail; JLA 119.

Glyceria striata (Lam.) A.S. Hitchc.: Fowl Mannagrass; (C = 4); abundant; wet woods and along trail; JLA 121.

Leersia oryzoides (L.) Sw.: Rice Cut Grass; (C = 2); frequent; open fen and seepage wetlands; PER 4193.

Muhlenbergia mexicana (L.) Trin.: Mexican Muhly; (C = 4); infrequent; open wet meadow; PER 4221.

Panicum rigidulum Bosc ex Nees var. *rigidulum* (= *Panicum rigidulum* Nees): Red-top Panic Grass; (C = 4); infrequent; open wet meadow; PER 4212.

Phalaris arundinacea L.: Reed Canary Grass; (*); frequent; open wet meadows and along trail; JLA 108.

Poa annua L.: Annual Blue Grass; (*); frequent; along trails; JLA 62.

Poa compressa L.: Canada Blue Grass; (*); infrequent; along trail; JLA 326.

Schedonorus phoenix (Scop.) Holub. (= *Festuca eliator* L.): Tall Fescue ; (*); frequent; open meadow; JLA 190.

Sphenopholis intermedia (Rydb.) Rydb.: Slender Wedgescale; (C = 3); infrequent; seepage area; JLA 83.

POLEMONIACEAE (Phlox Family)

Phlox divaricata L.: Wild Blue Phlox; (C = 5); infrequent; along trail; JLA 12.

POLYGALACEAE (Milkwort Family)

Polygala sanguinea L.: Purple Milkwort; (C = 4); infrequent; open canopy along trail; JLA 284.

POLYGONACEAE (Smartweed Family)

Persicaria arifolia (L.) Haroldson (= *Polygonum arifolium* L. var. *pubescens* (Keller) Fern.): Halberd-Leaf Tear-Thumb; (C = 10); infrequent; seepage area; PER 4217.

Persicaria hydropiperoides (Michx.) Small (= *Polygonum hydropiperoides* Michx.): Swamp Smartweed; (C = 3); frequent; pond; JLA 290.

Persicaria lapathifolia (L.) S.F. Gray (= *Polygonum lapathifolium* L.): Curlytop Knotweed; (C = 0); infrequent; open wet meadow; PER 4224.

Persicaria punctata (Ell.) Small (= *Polygonum punctatum* Elliott): Dotted Smartweed; (C = 3); infrequent; mesic to wet woods; PER 4202.

Rumex orbiculatus Gray var. *borealis* Rech. f.: Greater Water Dock; (C = 7); infrequent; seepage wetland; PER 4219.

Rumex verticillatus L.: Swamp Dock; (C = 5); infrequent; along wet trail; JLA 232.

Tovara virginiana (L.) Raf. (= *Polygonum virginianum* L.): Jumpseed; (C = 3); infrequent; mesic woods; JLA 279.

PONTEDERIACEAE (Pickerelweed Family)

Heteranthera dubia (Jacq.) MacMill.: Grassleaf Mud Plantain; (C = 4); frequent; pond; JLA 215.

Pontederia cordata L.: Pickerel Weed; (C = 5); frequent; pond; JLA 263.

PORTULACACEAE (Purslane Family)

Claytonia virginica L.: Virginia Spring Beauty; (C = 2); frequent; mesic woods; JLA 8.

POTAMOGETONACEAE (Pondweed Family)

Stuckenia pectinata (L.) Boerner (= *Potamogeton pectinata* L.): Sago Pondweed; (C = 3); frequent; pond; JLA 211.

PRIMULACEAE (Primrose Family)

Lysimachia quadriflora Sims: Four-flower Yellow Loosestrife; (C = 9); infrequent; open wet meadow; JLA 261.

RANUNCULACEAE (Buttercup Family)

Actaea pachypoda Ell.: White Baneberry; (C = 7); frequent; mesic woods; JLA 359.

Anemone virginiana L.: Tall Thimbleweed; (C = 4); infrequent; edge of seepage wetland; JLA 274.

Caltha palustris L.: Yellow Marsh Marigold; (C = 7); frequent; seepage wetlands, stream banks, and open fen; JLA 9.

Enemion biternatum Raf. (= *Isopyrum biternatum* (Raf.) T. & G.): Eastern False Rue Anemone; (C = 5); frequent; mesic woods; JLA 5.

Ranunculus abortivus L.: Little-Leaf Buttercup; (C = 0); infrequent; mesic woods; JLA 128.

Ranunculus longirostris Godr. (= *Ranunculus longirostris* Godr.): Longbeak Buttercup; (C = 7); frequent; pond; JLA 209.

Ranunculus hispidus var. *nitidus* (Elliott) T. Duncan: Bristly Buttercup; (C = 5); infrequent; seepage area; JLA 174.

Ranunculus recurvatus Poir.: Blisterwort; (C = 5); frequent; moist mesic woods; JLA 136.

Ranunculus repens L.: Creeping Buttercup; (*); infrequent; seepage wetland and fen; JLA 36.

Thalictrum dioicum L.: Early Meadow Rue; (C = 7); infrequent; mesic woods; JLA 43.

Thalictrum thalictroides (L.) Eames & Boivin (= *Anemonella thalictroides* (L.) Spach): Rue Anemone; (C = 7); frequent; mesic woods; JLA 15.

ROSACEAE (Rose Family)

- Agrimonia gryposepala* Wallr.: Tall Hairy Agrimony; (C = 2); infrequent; mesic woods; JLA 304.
- Agrimonia parviflora* Aiton: Harvestslice; (C = 4); infrequent; wet woods; JLA 303.
- Agrimonia pubescens* Wallr.: Soft Agrimony; (C = 5); infrequent; mesic woods; JLA 295.
- Crataegus pruinosa* (H. Wendl.) K. Koch: Waxyfruit Hawthorne; (C = 5); frequent; open wet meadow and along trails; JLA 71.
- Fragaria virginiana* Duchesne: Virginia Strawberry; (C = 2); infrequent; open meadow; JLA 28.
- Geum canadense* Jacq.: White Avens; (C = 1); frequent; mesic forest and along trails; JLA 197.
- Malus pumila* Mill.: Paradise Apple; (*); infrequent; mesic woods and along trails; JLA 30.
- Potentilla simplex* Michx.: Common Cinquefoil; (C = 2); infrequent; open wet meadow; JLA 96.
- Prunus serotina* Ehrh.: Wild Black Cherry; (C = 1); frequent; mesic woods; JLA 173.
- Rosa multiflora* Thunb.: Multiflora Rose; (*); infrequent; mesic woods; JLA 117.
- Rosa palustris* Marshall: Swamp Rose; (C = 5); infrequent; open wet meadow; JLA 206.
- Rubus abactus* L.H. Bailey (= *Rubus pensylvanicus* Poir.): Pennsylvania Blackberry; (C = 5); infrequent; along trail; JLA 198.
- Rubus allegheniensis* Porter: Allegheny Blackberry; (C = 2); infrequent; along trails and along pond shoreline; JLA 87.
- Rubus flagellaris* Willd.: Northern Dewberry; (C = 2); infrequent; edge of open meadow; JLA 167.
- Rubus occidentalis* L.: Black Raspberry; (C = 2); infrequent; along trail; JLA 155.

RUBIACEAE (Madder Family)

- Galium aparine* L.: Sticky Willy; (C = 1); abundant; mesic woods and along trails; JLA 46.
- Galium circaezans* Michx. var. *circaezans*: Licorice Bedstraw; (C = 7); infrequent; mesic woods; JLA 131.
- Galium circaezans* Michx. var. *hypomalacum* Fern.: Licorice Bedstraw; (C = 7); infrequent; seepage wetland; JLA 251.
- Galium concinnum* T. & G.: Shining Bedstraw; (C = 5); infrequent; wooded edge; JLA 208.
- Galium mollugo* L.: False Baby's Breath; (*); infrequent; open wet meadow; JLA 223.
- Galium triflorum* Michx.: Fragrant Bedstraw; (C = 5); abundant; mesic woods; JLA 244.

RUTACEAE (Rue Family)

- Zanthoxylum americanum* P. Mill.: Common Prickly Ash; (C = 3); infrequent; open fen edge; JLA 329.

SALICACEAE (Willow Family)

- Populus deltoides* Bartr. ex Marshall: Eastern Cottonwood; (C = 1); infrequent; mesic woods; JLA 189.
- Populus grandidentata* Michx.: Big-Tooth Aspen; (C = 4); rare; mesic forest; JLA 186.
- Populus tremuloides* Michx.: Quaking Aspen; (C = 2); infrequent; open fen; JLA 341.
- Salix discolor* Muhl.: Pussy Willow; (C = 4); infrequent; open wet meadow and edge of seepage wetland; JLA 3.
- Salix eriocephala* Michx.: Missouri River Willow; (T, C = 4); rare; mowed meadow; JLA 230.
- Salix nigra* Marshall: Black Willow; (C = 3); infrequent; seepage wetland; JLA 33.

SAXIFRAGACEAE (Saxifrage Family)

- Chrysosplenium americanum* Schwein.: American Golden Saxifrage; (T, C = 10); infrequent; seepage wetland; JLA 61.
- Mitella diphylla* L.: Two-Leaf Miterwort; (C = 7); infrequent; stream bank; JLA 49.
- Penthorum sedoides* L.: Ditch Stonecrop; (C = 5); infrequent; seepage wetland; JLA 306.
- Saxifraga pensylvanica* L.: Eastern Swamp Saxifrage; (C = 10); infrequent; seepage wetland; JLA 140.

SCROPHULARIACEAE (Figwort Family)

Agalinis purpurea (L.) Pennell: Purple False Foxglove; (C = 6); infrequent; open fen; JLA 406.

Chelone glabra L.: White Turtlehead; (C = 7); rare; mesic woods; PER 4207.

Pedicularis lanceolata Michx.: Swamp Lousewort; (C = 6); infrequent; open wet meadow and seepy thicket; JLA 388.

Veronica serpyllifolia L.: Thyme-Leaf Speedwell; (*); frequent; along trails; JLA 63.

SOLANACEAE

Solanum ptycanthum Dunal (= *Solanum americanum* Mill.): West Indian Nightshade; (C = 0); infrequent; along trails.

TILIACEAE (Linden Family)

Tilia americana L. var. *americana*: American Basswood; (C = 5); frequent; mesic forest; PER 4205.

TYPHACEAE (Cat-Tail Family)

Typha angustifolia L.: Narrow-Leaf Cattail; (*); frequent; open fen, seepage areas, open wet meadow edge; JLA 273.

Typha latifolia L.: Broad-Leaf Cattail; (C = 1); frequent; open fen, seepage areas, open wet meadow edge; JLA 335.

ULMACEAE (Elm Family)

Ulmus americana L.: American Elm; (C = 5); frequent; mesic woods; JLA 368.

URTICACEAE (Nettle Family)

Boehmeria cylindrica (L.) Sw.: Smallsipike False Nettle; (C = 3); infrequent; open wet meadow; JLA 268.

Laportea canadensis (L.) Wedd.: Canadian Wood Nettle; (C = 2); infrequent; seepage wetland; JLA 286.

Pilea fontana (Lunell) Rydb.: Lesser Clearweed; (C = 5); infrequent; open wet meadow ; JLA 391.

Pilea pumila (L.) A. Gray: Canadian Clearweed; (C = 2); infrequent; seepage wetland; JLA 242.

VERBENACEAE (Vervain Family)

Verbena hastata L.: Swamp Verbena; (C = 3); infrequent; open fen and wet meadow; JLA 301.

VIOLACEAE (Violet Family)

Viola canadensis L.: Canadian White Violet; (C = 8); infrequent; mesic woods; JLA 13.

Viola cucullata Aiton: Marsh Blue Violet; (C = 9); frequent; open fen and wet meadow; JLA 68.

Viola pubescens Aiton : Downy Yellow Violet; (C = 5); frequent; mesic woods; JLA 22.

Viola rostrata Pursh.: Long-Spur Violet; (C = 8); infrequent; mesic woods; JLA 11.

Viola sororia Willd.: Common Blue Violet; (C = 1); abundant; mesic woods; JLA 16.

VITACEAE (Grape Family)

Parthenocissus quinquefolia (L.) Planch.: Virginia Creeper; (C = 2); frequent; mesic forest; JLA 196.

Parthenocissus vitacea (Knerr) A.S. Hitchc. (= *Parthenocissus inserta* (A. Kern.) C. Fritsch): Woodbine; (C = 2); infrequent; mesic forest; JLA 228.