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IN THIS ISSUE

Derek Anderson and Julie Fox present the latest in a long line of floristic studies published in The Michigan Botanist, in this case a flora of Interstate State Park, Wisconsin's oldest state park, which is situated in the tension zone along the St. Croix River in northwestern Wisconsin. The authors take into account previous collections at the park as well as their own collections to provide a complete list of the park's vascular flora as currently known. This is supplemented with a geological and human history of the area, along with a description of the various plant communities that occur in the park. This paper can be considered a companion piece to an earlier flora of Amnicon Falls State Park, which lies some 150 km to the northeast, near Lake Superior, authored by Paul Hlina, Derek Anderson, and Donald Davidson (The Michigan Botanist 47: 121–146). Indeed, the article in this issue provides a comparison of the floras of the two state parks and discusses how the differences arise from their differing geographical settings and floristic regions.

The second article in this issue is a collaborative effort by the members of a field botany course, co-authored by their teacher, Jordan Marshall. The authors studied three forest fragments in relatively close proximity to assess how the differences in species composition in canopy, midstory, and understory strata, as well as in certain factors such as species richness, canopy closure, leaf litter depth, and incidence of non-native species, are related to the different management histories and levels of protection of the three study sites.

Neil Harriman completes his series of reviews of the field guides written by Steve Chadde on various regions of the Midwest, including floras of the states of Wisconsin and Minnesota and of the Upper Peninsula of Michigan, as well as a guide to the ferns and fern allies of the north central United States. His earlier survey of six of Chadde's wetland floras of various states of the Great Lakes region, as well as one for the entire region, appeared in the previous issue of The Michigan Botanist (52: 109–114).

The editor has provided a catalogue of floristic articles from throughout the whole 53 years of The Michigan Botanist from its inception to date in order to make this rich resource readily available to current readers and researchers. The issue is rounded out with two book reviews.

Michael Huft

FLORA OF INTERSTATE STATE PARK, POLK COUNTY, WISCONSIN

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ABSTRACT

The vascular plants and plant communities observed at Interstate State Park, located in Polk County, on the south side of the city of St. Croix Falls in northwestern Wisconsin are presented. The most commonly encountered plant communities were mesic and dry-mesic hardwood forest. The vascular plant list includes 652 taxa from 118 families, including 35 ferns and fern allies, nine gymnosperms, and 608 angiosperms. Fifty-nine county records were discovered in the course of the survey as well as two species listed as Threatened, and five as Special Concern, by the State of Wisconsin. These data are presented to document floral composition and to provide a base for future research activities within the park and the region.

KEYWORDS: Interstate State Park, flora of Wisconsin, St. Croix River

INTRODUCTION

Interstate State Park (the Park) is located in Polk County, on the south side of the city of St. Croix Falls in northwestern Wisconsin, approximately 70 kilometers (45 miles) northeast of St. Paul–Minneapolis, Minnesota. Formed in 1900, it is Wisconsin's oldest state park and is approximately 538 hectares (1330 acres) in area. There are three State Natural Areas within the boundary of the Park. The St. Croix National Scenic Riverway borders the Park to the west, the western terminus of the Ice Age National Scenic Trail is in the Park, and the Park is also a unit of the Ice Age National Scientific Reserve. The main features attracting the public to the Park are glacial potholes and scenic basalt cliffs that form The Dalles of the St. Croix River. This project was undertaken to document the flora of this Park and of the greater region, since these data are generally lacking and incomplete for northwestern Wisconsin.

The Park is primarily forested, and the most common forest types are mesic forest, dry-mesic forest, floodplain forest, and oak woodlands, following the classification of natural communities established by the Wisconsin Department of Natural Resources (2012b). The site is also situated in the middle of the tension zone. This zone roughly follows the border separating the northern hardwoods province and the prairie-forest province, and as a result, contains species from both (Curtis 1959). Compiling information on the range limits of 182

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TABLE 1: Collection contributions by major collectors at Interstate State Park, showing for each total collections and collections of the four largest plant families at the Park.

		Plant Families				
Collector	Total	Asteraceae	Poaceae	Cyperaceae	Rosaceae	Other
Anderson, Derek S.	722	73	83	70	31	465
Cochrane, Theodore S.	63	8	10	4	0	41
Fassett, Norman C.	84	15	12	8	2	47
Patman, Jacqueline	98	8	11	11	7	61
Pohl, Richard W.	187	21	22	7	13	124

plants, Curtis created maps identifiying this zone where a greater number of northern and southern species reach the edges of their range (Curtis 1959; Anderson 2005). Several uncommon habitats such as cliffs (dry and moist), forest seeps, bedrock glades, sedge meadows and emergent aquatic communities add to an already diverse flora.

The Park has a long history of botanizing, but until this survey, there had not been any exhaustive documentation of the flora. Richard Pohl conducted one of the more intensive surveys of the Park in 1936. Other noteworthy collecting trips were made by Norman Fassett in 1927 and 1934, Jacqueline Patman in 1959, and Theodore Cochrane in 1972 (Robert W. Freckman Herbarium 2015, Wisconsin State Herbarium 2015). A comparison of the contributions by past collectors with those of the authors is presented in Table 1.

A review of online databases of Wisconsin herbaria revealed a number of species that had been collected in the past and deposited in the state's herbaria but that were not relocated during this study. These species are indicated in Appendix I by the citation of collector and collection number, year of collection, and herbarium acronym.

Early public land survey records (Haight 1847–1848, Jenkins 1847, Whitcher 1847) indicate that the tree composition in the area of the Park in the mid-1800s is similar to that of today. Surveyors characterized the Park as being "very broken," since it "abounds with traprock [basalt]" (Haight 1847–1848). Other surveyors described the landscape in and around the Park as hilly and stony. They noted that the trees typical in the area of this rocky region of the Park included linden, birch, white oak, elm, hickory, pine, and butternut (presumably *Tilia americana, Betula* sp., *Quercus alba* and/or *Q. macrocarpa, Ulmus* sp., *Carya cordiformis, Pinus strobus,* and *Juglans cinerea*, respectively). The understory in these rocky areas also included hazel and prickly ash (presumably *Corylus* sp., and *Zanthoxylum americanum*). Interestingly, the notes that describe section 36 in Township 34N, Range 19W mention prairie, which is consistent with the extensive bedrock glade community seen in the vicinity today.

The section line notes for the area near the St. Croix River indicate the presence of such species as white maple, black ash, willow, elm and linden (presumably *Acer saccharinum, Fraxinus nigra, Salix* sp., *Ulmus* sp., and *Tilia americana*, respectively), which confirms the wetter nature of this area. The notes also reveal that in upland areas beyond the basalt exposures, species indicative of a mesic forest became common, including sugar maple, linden, white walnut, white ash, pine, elm and oak (presumed to be *Acer saccharum, Tilia americana, Juglans cinerea, Fraxinus americana, Pinus strobus, Ulmus* sp., and *Quercus rubra*, respectively), and, in the understory, ironwood (*Ostrya virginiana*) and prickly ash.

The climate of the region is continental. Based on weather data from St. Croix Falls, the mean annual precipitation is 77.7 cm, and August is the month with the greatest mean monthly precipitation (11.9 cm). The mean annual temperature for the area is 7° C; July is the hottest month (mean 28.9° C), and January is the coldest (mean –17.6° C). The length of the frost-free growing season ranges from 117 days to 172 days with an average of 144 days per year (Midwestern Regional Climate Center 2015).

Development within the Park includes a contact station, a nature interpretive center, two campgrounds, a swimming beach, a boat landing, approximately 14.4 kilometers of hiking trails, and 20.9 kilometers of winter recreation trails (Wisconsin Department of Natural Resources 2012a). The most disturbed areas of the Park are a gas pipeline right-of-way and the Silverbrook Mansion site on the south end of the Park. Although most of the infrastructure of the mansion is gone, foundation remnants and trout ponds that were created by the berming of springs remain. Other portions of the Park continue to recover from logging, mining, grazing, and agricultural activities that took place around the turn of the twentieth century.

Geology

The complex landscape of the Park is the result of geological events spanning a billion years. Evidence of lava flows, faulting, flooding, glaciation, and erosion can be seen in the Park. The geologic events of the past have directly and indirectly impacted the landscape and plant communities as they exist in the Park today.

Late in the Precambrian, about 1.1 billion years ago, tectonic forces began to pull the North American continent apart. Outpourings of lava, called fissure flows, continued for millions of years, completely burying the pre-existing landscape in this area beneath thousands of feet of Keweenawan basalt. Eight individual basalt flows have been mapped in the area (Cordua 1989). The weight of the lava and accumulated sediment at the surface resulted in the Lake Superior syncline, a down-warping of the earth's surface. The northeast–southwest axis of the syncline lies west of the Park; as a result, the lava flows in this area dip toward the west. Faulting also occurred in many places within the syncline.

Toward the end of Precambrian time, a long period of erosion began that lasted a few hundred million years and wore deep valleys into the Keweenawan sediments and the rocks below. Then, starting in the Late Cambrian, this region was submerged under a shallow sea. Hundreds of feet of sediments reburied the Keweenawan rocks under layers of sedimentary rock. Where sea cliffs stood at the edge of the sea, boulders fell into the wave zone where the surf tumbled, broke, and ground them smooth, resulting in a conglomerate rock layer at the base of the much thicker overlying sandstone (Mickelson et al. 2011). Ravines containing examples of basal conglomerate are evidence of the ancient exhumed landscape of this area.

Eventually the area rose above sea level, followed by another long period of erosion lasting over 300 million years. Gradual erosion ended two million years ago when the Ice Age began in Wisconsin. During the Pleistocene, several episodes of glacial and interglacial periods altered the landscape, each advance leaving little evidence of earlier glaciations.

The most recent glacial episode was the Wisconsin Glaciation, which began about 100,000 years ago. The best record of late Wisconsin ice cover is preserved on bedrock surfaces as striations, which indicate the direction of ice flow. Johnson (2000) interpreted the striations at the tops of Observation Rock and Eagle Peak as having been formed by the Superior Lobe during the last glaciation. The Superior Lobe was one of six major lobes of ice that advanced over Wisconsin during the Wisconsin Glaciation. This lobe of ice deepened the Lake Superior basin as the ice advanced along the Lake Superior syncline, and is thus named after Lake Superior (Johnson 2000).

Extensive erosion of the St. Croix River gorge and the formation of the potholes occurred very late during the retreat of the Superior Lobe. The retreating ice exposed the Lake Superior basin. Melt water filled the basin to form glacial Lake Duluth at the ice margin. Glacier ice blocked drainage of the melt water to other outlets. As a result, glacial Lake Duluth eventually overflowed, flooding the Bois Brule–St. Croix valley. At the Park, torrents of glacial melt water filled the valley to an elevation of at least 274 meters (900 feet), as is evident at Eagle Peak by rock eroded by the river (Mickelson et al. 2011).

The rapidly flowing river repeatedly ripped away pieces of the highly fractured basalt. Continued cutting of the gorge resulted in the deep, narrow formation known as The Dalles of the St. Croix. Lake o' the Dalles is another feature of the torrential flow of the river. It is a plunge pool basin formed at the base of cascading water as the glacial St. Croix River tumbled over the bluffs of Summit Rock.

The rushing melt water also formed glacial potholes in the bedrock 6–21 m (20–70 ft) above the present level of the river (Figure 1). In the fast-flowing current of the river, recurring eddies moved debris in a circular motion on the riverbed. Over time, the spinning debris drilled holes into the bedrock. Rocks caught in the swirling water were worn to a smooth, spherical shape. These rocks are called grindstones.

Land History

Little is known about the earliest inhabitants of the area now preserved in the Park. Settlers tell of finding stone spear points and axes and other prehistoric tools about the Park (Pond 1937). Archeological surveys have not identified any definite village or campsite dating to prehistoric times. In 1936, an important archeological discovery provided evidence of prehistoric mammals inhabiting this area. A number of large bones were uncovered by Civilian Conservation Corps workmen while digging in peat not far from Lake o' the Dalles. The bones were identified as *Bison occidentalis*, an extinct species of bison. Based on bone

FIGURE 1. A glacial pothole carved into the basalt bedrock along the St. Croix River. Photograph by Derek Anderson, October 1, 2010.

dating, *B. occidentalis* persisted in the region for about 4,000 years, with the greatest presence between ca. 8,000–7,000 calibrated years B.P. (Hawley et al. 2013). Over 1400 bison, deer, and elk bones were recovered from the excavation site, as well as one copper tool.

The first European to record travel from Lake Superior to the Mississippi River via the Bois Brule–St. Croix portage was Daniel Greysolon, Sieur du Lhut, in 1679 (du Lhut is the namesake of Duluth, Minnesota). It was the French, during this early period of exploration, who named this river the *St. Croix,* or Holy Cross river, and described the river gorge as the *Dalles*—a word to describe rivers with steep walls and fast-flowing water. Du Lhut claimed the region for France and offered gifts to the Dakota Indians, the first historic inhabitants of the St. Croix Valley (McMahon and Karamanski 2009).

The river became a regular route for missionaries, fur traders, and other voyagers. Ojibwa Indians began migrating into the valley in the seventeenth century and became involved in the fur trade. McMahon and Karamanski (2009) discussed the eventual and mounting tension and violence between the Ojibwa and Dakota that escalated into an epic battle fought here at the Dalles of the St. Croix around 1770. Combined war parties of Fox and Dakota Indians met Ojibwa warriors in combat on the portage trail around the St. Croix Falls. After a fierce battle with heavy losses on all sides, the Ojibwa emerged victorious. An uneasy boundary between the Ojibwa and Dakota was established, yet skirmishes continued for the next several decades.

By the mid-1800s, the fur trade had diminished and the logging industry began in earnest due to the rising market for lumber in the Mississippi River Valley and beyond. For more than a half century, the St. Croix River was used to transport pine logs to mills and markets downstream. The most spectacular event of the logging days occurred in the Dalles in the spring of 1886. More than 150 million feet of pine were stacked in a logjam that extended three miles upstream of the 90-degree bend in the river known as the "Elbow of the St. Croix." By 1914, the last log drive had reached the mills and the logging boom was over. Other business ventures such as copper mining, traprock excavation and blasting, and construction of the hydroelectric dam at the "falls" of Taylors Falls and St. Croix Falls had also begun by the 1890s (St. Croix Falls Area History, compiled by Knudson, unpublished).

Local citizens became concerned about preserving the scenic beauty of the river gorge. In the mid-1890s, George Hazzard of Taylors Falls, Minnesota, began encouraging citizens of that community to lobby their legislators to create a state park on the Minnesota side of the Dalles. As a result, Minnesota Interstate State Park was established in 1895. Harry Baker of St. Croix Falls, Wisconsin, was doing the same in his community. After five years of numerous trips to Madison, and fundraisers by local businessmen to support the lobbying efforts, the legislators finally agreed to set aside funds to purchase land on the Wisconsin side of the Dalles of the St. Croix River. On September 20, 1900, the State of Wisconsin acquired the first parcel of land here, officially establishing Interstate State Park as Wisconsin's oldest state park (Baker, unpublished letter 1961).

Approximately 30 hectares (a little more than 72 acres) of land was purchased in 1900, mostly from within the city limits of St. Croix Falls. In 1907 and 1908, more than 200 additional hectares (500 acres) were purchased. These purchases included what are now the Dalles of the St. Croix and the Lake o' the Dalles areas. Over the next several years lands were acquired bit by bit from several adjacent landowners, thereby providing protection for the more sensitive areas of the Park (Interstate State Park acquisition files, unpublished).

Despite land acquisition, little development took place within the Park until the 1930s and the creation of the Civilian Conservation Corps (CCC). In the summer of 1935 the barracks of CCC Camp Interstate were constructed not far from Lake o' the Dalles. In November, 1935, CCC Company 633 arrived from Grafton, Illinois, to begin work in the Park. Development projects included extension and improvement of the park road; construction of stone buildings, shelters, and other structures; and construction of 16 kilometers (10 miles) of hiking trails (Pond 1937). Late in 1937 Camp Interstate was abandoned until the following year when CCC Company 4610 arrived to continue the work until they were disbanded in 1940. Many of the stone structures and nine miles of the hiking trails built by the CCC are still in use today.

Additional land acquisitions included approximately 100 hectares (240 acres) purchased in Osceola Township from the Riegel family in 1964 and about 80 hectares (196 acres) purchased from the Mills family in 1970, the latter of which nowconstitutes the Silverbrook area (Interstate State Park acquisition files, unpublished).

Significant to further protection of the natural and cultural resources of the Park was the passage of two acts of Congress. In 1968 the Upper St. Croix River was one of eight original rivers protected by the National Wild and Scenic Rivers Act. In 1972 that act was amended to include the Lower St. Croix. In 1971 another act of Congress created the Ice Age National Scientific Reserve, established to preserve Wisconsin's glacial heritage. Interstate State Park is one of nine units of the Reserve. As a result, federal funding was received to aid in new development at the Park. In 1982 a new park entrance and office, a maintenance building, and the Ice Age Interpretive Center were completed.

METHODS

Study Area

Interstate State Park is a 538 hectare park located along the east edge of the St. Croix River, south of St. Croix Falls in Polk County, Wisconsin (Figure 2). This area was well known throughout history and was often referred to as the "Falls of the St. Croix". The actual falls were a series of rapids where the St. Croix River dropped about 12 meters (40 feet) in elevation over the course of 9.6 kilometers (6 miles). Today, most of these rapids are hidden underwater because of a hydroelectric dam that was completed in 1906.

There are a number of places within the Park referenced by nicknames used to describe the different features and places. Eagle Peak, a basalt exposure, is 274 meters (900 feet) above sea level. It is one of the highest points in the Park. Geographically, it is located in the center of the Park. Summit Rock, another basalt rock feature, is 250 meters (830 feet) above sea level. It is the highest point in the Park located along the St. Croix River gorge (the area described as the Dalles). Observation Rock is a third basalt feature nicknamed for the panoramic view it provides of the St. Croix River Valley. It is found on the last 1.5 kilometers (ca 1 mile) of the Ice Age Trail.

The lakes observed within the Park are connected to the St. Croix River. Lake o' the Dalles is a spring fed lake centrally located within the Park, just south of Summit Rock. A small stream flows from this lake along a former river channel to the St. Croix River. Folsom Lake is on the southern boundary of the Park and is backwater slough.

Also found at the southern end of the Park is an area referred to as the Silverbrook Mansion. When it was in private ownership, the estate developed the area. A downhill ski slope was cleared, and several trout ponds were created by berming natural springs near the home site. The mansion was razed in 1974, and now only foundational ruins remain.

Data for this flora project were collected during the growing seasons of 2011 to 2013. Seven hundred twenty-two voucher specimens representing 612 taxa were collected, identified, and deposited in the Robert W. Freckmann Herbarium of the University of Wisconsin–Stevens Point in Stevens Point, Wisconsin (UWSP). These are listed in Appendix I. An additional 40 taxa that were previously documented at the Park and represented by collections at UWSP or the Wisconsin State Herbarium of the University of Wisconsin–Madison (WIS) but not located during the present survey are also included in this list. The following sources were used for plant identification: Fassett (1951, 1978), Gleason and Cronquist (1998), Holmgren (1998), Hipp (2008), Crow and Hellquist (2000), Smith (2008), and Voss and Reznicek (2012). Nomenclature follows Reznicek et al. (2011) for the ferns and fern allies and Voss and Reznicek (2012) for the seed plants. Six taxa not included in Voss and Reznicek (2012) follow the nomenclature of the Flora of North America (1993+). These are *Antennaria plantaginifolia, Delphinium carolinianum, Phemeranthus rugospermus, Rubus alumnus, Tradescantia occidentalis,* and *Vernonia fasciculata*.

General species composition was noted for plant communities in the Park. We visited each community throughout the Park recording the dominant plants in each stratum (canopy, understory and ground layers) if present. This information was used to describe the basic composition of the plant communities. The nomenclature for the plant communities follows that used by the Wisconsin DNR Natural Heritage Inventory (Wisconsin Department of Natural Resources 2012b). One or two visits were made to the Park each week during the growing season. An extra effort was placed on visiting forested communities in the spring to capture ephemerals, while later-season survey effort was focused on wetlands and other more open communities. Meander surveys to locate rare species (Goff et al. 1982) were undertaken in the more uncommon communities of the Park.

A list of target species to search for while conducting surveys was compiled from several re-

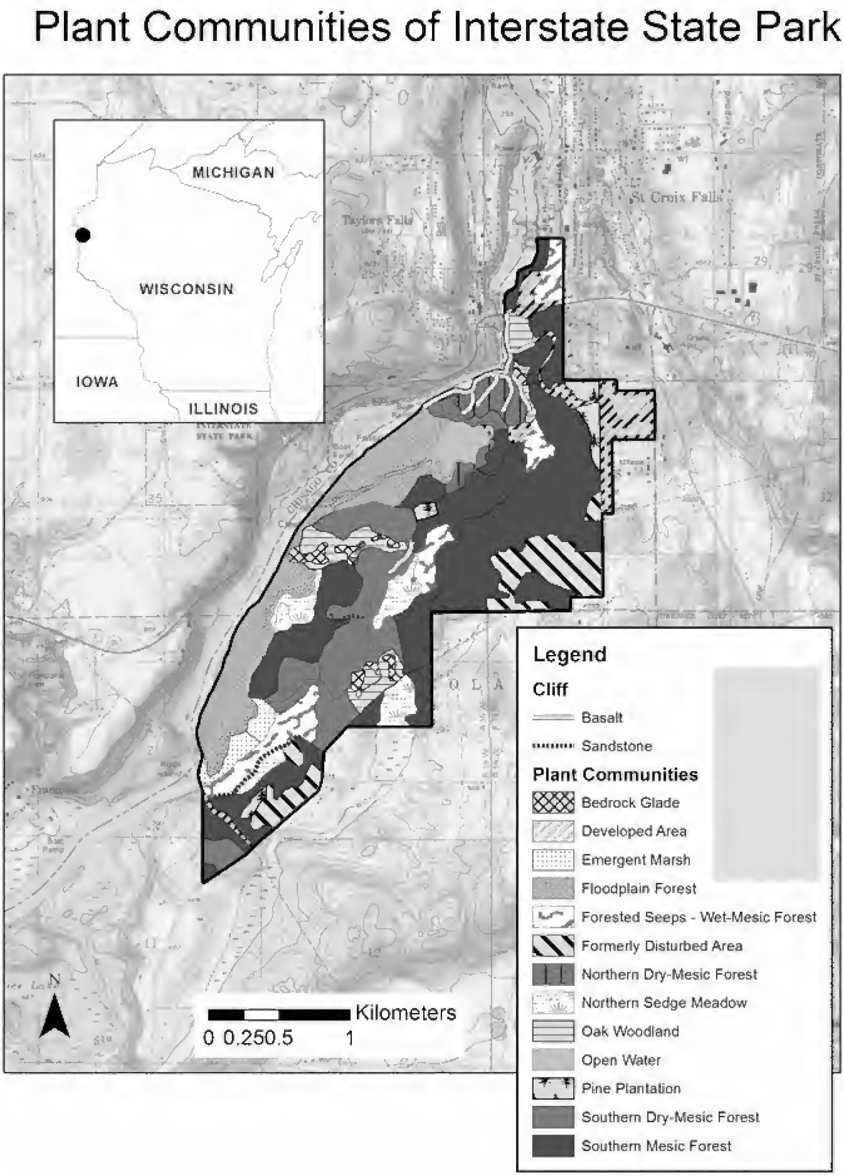

FIGURE 2. Map of the major plant communities of Interstate State Park.

sources. These included databases of previous collections from the Park housed at Wisconsin herbaria (Robert W. Freckmann Herbarium 2015; Wisconsin State Herbarium 2015) and previously prepared flora checklists on file at the Park (Crawford 1987, unpublished; Delaney 2000, unpublished). These unpublished checklists were based on observation rather than the collection of specimens preserved in an herbarium. Effort was placed on surveying plant communities that would likely provide habitat for the species on these lists.

The map of native plant communities was created using ESRI ArcGIS 9.3 software. Plant community boundaries were drawn using US Geologic Survey topographic quadrangle maps (1:24,000), the 2008 Farm Service Agency's National Agriculture Imagery Program (NAIP) color and color infrared aerial images of Minnesota, and notes collected during ground surveys.

RESULTS

A total of 652 vascular plant taxa representing 366 genera and 118 families were documented from the Park (see Appendix I). Ferns and fern allies were represented by 35 taxa, gymnosperms by 9 taxa, and angiosperms by 608 taxa. Of the angiosperms, 184 taxa were monocots and 424 were dicots. The predominant plant families were Asteraceae with 68 taxa, Poaceae with 67 taxa, Cyperaceae with 57 taxa, and Rosaceae with 33 taxa. These totals include two rare species listed as Threatened and five species listed as Special Concern by the Wisconsin Department of Natural Resources, Bureau of Endangered Resources (Wisconsin Department of Natural Resources 2011c) (Table 2). In addition, three of the species were previously tracked by the Bureau of Endangered Resources, but were removed from the state's endangered species list during the course of the survey. These are *Carex assiniboinensis, Juglans cinerea,* and *Taxus canadensis*. Ninety-four of the species are introduced, some of which are ecologically invasive.

When comparing the species we collected with species previously documented by collections in the State's herbaria (UWSP, WIS), we identified 59 species not previously reported from Polk County (Table 3). These include 25 species that are introduced and naturalized in the state of Wisconsin.

TABLE 2: Documented rare plant species at Interstate State Park (Wisconsin Department of Natural Resources 2012c). Species indicated as a "New Record" were not previously known from the Park. "Not Actively Tracked" indicates species that were formerly tracked by the Bureau of Endangered Resources at the start of this survey but are no longer included in the department's database.

Species	New Record	State Status
Besseya bullii		Threatened
Carex assiniboinensis		Not Actively Tracked
Carex backii	X	Special Concern
Cystopteris laurentiana	X	Special Concern
Dryopteris fragrans		Special Concern
Juglans cinerea		Not Actively Tracked
Opuntia fragilis		Threatened
Panax quinquefolius	X	Special Concern
Phemeranthus rugospermus		Special Concern
Taxus canadensis	X	Special Concern

TABLE 3: New Polk County Records (an asterisk indicates introduced species).

Species
Abies balsamea
*Acer ginnala
Actaea pachypoda
*Alliaria petiolata
Anemone cylindrica
*Berberis thunbergii
Carex backii
Carex buxbaumii
Carex haydenii
Carex hirtifolia
Carex lurida
Carex muhlenbergii
Carex radiata
Carex stricta
Carex typhina
*Convallaria majalis
Cystopteris laurentiana
*Dianthus armeria
Dicentra cucullaria
Dichanthelium linearifolium
*Draba verna
*Elaeagnus angustifolia
Fragaria vesca
*Galinsoga quadriradiata
Gaylussacia baccata
*Gypsophila muralis
*Hieracium caespitosum
Hierochloë hirta
Hypoxis hirusta
Impatiens pallida
*Iris pseudacorus
Lactuca biennis
Liparis liliifolia
*Malus pumila
*Matricaria discoidea
*Medicago lupulina
Menispermum canadense
Mertensia virginica
Oxalis dillenii
Panax quinquefolius
Poa annua
Prunus pumila
Quercus alba
Ranunculus hispidus var. nitidus
*Robinia pseudoacacia
*Rumex crispus
Salix petiolaris
*Salix ×rubens
*Sedum acre
*Sorbus aucuparia
*Stellaria media
*Tanacetum vulgare
Tsuga canadensis
*Ulmus pumila
Vaccinium myrtilloides
*Veronica officinalis
*Veronica verna
*Vicia cracca
Zannichellia palustris

PLANT COMMUNITIES

The location of the Park within the tension zone described by Curtis (1959) makes it difficult to distinguish plant communities with southern and with northern affinities (in particular, the forests) from each other. The following descriptions of plant communities within the Park indicate, among other things, the dominant species observed in each community. The map in Figure 2 highlights the major plant communities found within the Park, generated on the basis of a field survey and the examination of aerial photographs.

Southern Mesic Forest

Southern mesic forest, together with southern dry-mesic forest, comprises the majority of the acreage of the Park. These two communities grade into one another with changes in topography, slope aspect, and soil composition. The southern mesic forest is most commonly encountered in the eastern half of the Park. It is found on gentle to steep slopes, and there is little or no influence from the underlying bedrock on its composition. The southern mesic forests within the Park

FIGURE 3. Typical forest community on south-facing slopes and ridge tops that lack bedrock near the surface. The forest is dominated by red oak (*Quercus rubra*) and basswood (*Tilia americana*). Sugar maple (*Acer saccharum*) is common in the understory, and there is a diverse ground layer. Photograph by Derek Anderson, May 10, 2012.

are dominated by *Acer saccharum*. Occasionally *Quercus rubra*, *Tilia americana*, *Carya cordiformis*, *Fraxinus americana*, and *F. pennsylvanica* are canopy co-dominants. The understory is dominated by *Acer saccharum* and *Ostrya virginiana*. The ground layer is diverse and consists of *Trillium grandiflorum, T. cernuum*, *Hepatica americana, H. acutiloba*, *Hydrophyllum virginianum*, *Adiantum pedatum*, *Athyrium filix-femina*, *Caulophyllum thalictroides*, and many other spring ephemerals.

Southern Dry-Mesic Forest

As noted above, southern dry-mesic forests in the Park are often found in close association with southern mesic forest. Dry-mesic forest often occurs near ridge tops with moderate to well-drained soils (Figure 3) and on south-facing slopes. It also occurs near oak woodland communities where bedrock outcrops are more prevalent. The canopy is dominated by *Quercus rubra* and *Tilia americana*. The understory is often dominated by *Acer saccharum*. The ground layer is usually diverse. The more common ground species observed include *Geranium maculatum*, *Aralia nudicaulis*, *Hylodesmum glutinosum*, and *Arisaema triphyllum*.

FIGURE 4. The floodplain forest along the St. Croix River in early spring. The forest is dominated by silver maple (*Acer saccharinum*); hackberry (*Celtis occidentalis*) and cottonwood (*Populus deltoides*) are also present. Water begins to pool in old channels as the snow and ice begin to melt. The water in this area of the Park can easily rise an additional 3 to 6 meters (10 to 20 feet) as spring rain and seasonal snowmelt occurs in the greater watershed. Photograph by Derek Anderson, April 2, 2011.

Floodplain Forest

A well-developed example of floodplain forest in northern Wisconsin can be observed on the western edge of the Park. This riparian zone is dominated by *Acer saccharinum*, and *Populus deltoides*, *Celtis occidentalis*, and *Acer negundo* are occasional co-dominants (Figure 4). Spring floods inundate the area for several weeks each year, and there are several natural, well-developed channels throughout the area of this community. Species common in the herbaceous layer include *Viola sororia*, *Laportea canadensis*, *Matteuccia struthiopteris*, and *Rudbeckia laciniata*. *Lobelia cardinalis* is one of the more striking species observed in this community in late summer, especially along the seasonal water channels. As these channels dry out over the course of the summer, they are dominated by *Eleocharis acicularis, E. obtusa, E. ovata, Cyperus erythrorhizos, C. odoratus*, and *C. strigosus*.

Forested Seeps (with Southern Wet-Mesic Forest Inclusions)

A number of forested seeps can be found along the steep slopes above the St. Croix River. This is especially true in the southern reaches of the Park where the more porous sandstone facilitates the movement of groundwater. The seepage

FIGURE 5. A forested seep located along the slopes above the St. Croix River. The canopy is patchy and dominated by black ash (*Fraxinus nigra*). The ground layer is dominated by skunk cabbage (*Symplocarpus foetidus*). Photograph by Derek Anderson, May 12, 2012.

zones in these areas underlie a patchy canopy dominated by *Fraxinus nigra*, with *Ulmus americana* and *Betula allegheniensis* as occasional co-dominants. Slight rises in the topography surrounding the seepage areas tend to support *Acer saccharum* and *Tilia americana*. In the areas of ground water seepage, *Symplocarpus foetidus* is dominant (Figure 5), and there is a continuous cover in the ground layer. Other species present in the seeps include *Impatiens capensis*, *Hydrocotyle americana*, *Viola sororia*, *Poa palustris*, *Packera aurea*, and *Micranthes pensylvanica*. Many of these seeps feed small streams that eventually reach the St. Croix River.

Dry and Moist Cliffs

There are several cliffs throughout the Park, which are composed of one of two basic lithologies, basalt or sandstone. The many exposures of these cliffs provide a full spectrum of moisture conditions. Several of these cliffs are directly exposed to the sun, whereas others are completely shaded by well-developed forest canopies (for example, some of the largest individuals of *Pinus strobus* in the Park can be found growing from the cliffs). Several of the cliffs are wet from groundwater seepage. The most prominent area occupied by this plant community is the Dalles of the St. Croix River. Basalt cliffs rise 30 meters (100 feet) above the river. Smaller basalt cliffs of 5–15 meters (15–50 feet) can be found a few hundred meters from the St. Croix River and along abandoned

FIGURE 6. The state special concern fragrant fern (*Dryopteris fragrans*) has long been documented in the area of the Park. It is typically found growing from the cracks of basalt near the St. Croix River. Photograph by Derek Anderson, 2007.

river channels, such as in the area of Meadow Valley. At the bases of some of these cliffs are large talus slopes and fields where the basalt has weathered from the cliffs. The sandstone cliffs are most prominent in the southern region of the Park west of the Silverbrook Mansion and are not readily accessible by trail.

Vegetation is sparse on these cliffs, and both types of cliffs tend to be dominated by a wide variety of pteridophytes. The most common of these include *Polypodium virginianum*, *Woodsia ilvensis*, and *Cystopteris fragilis*. Three ferns that are rare in the state of Wisconsin, *Dryopteris fragrans* (Figure 6), *Cystopteris laurentiana*, and *Woodsia oregana*, are found in this community. *Woodsia oregana* had been previously documented at the Park but was not relocated during the course of this survey. Herbaceous species that are also found along these cliffs include *Aquilegia canadensis*, *Campanula rotundifolia*, *Corydalis aurea*, and *Capnoides sempervirens*.

Northern Dry-Mesic Forest

This community occupies a fairly small portion of the overall acreage of the Park. It is associated with draws and ravines of the basalt cliffs along the St. Croix River. The canopy is dominated by *Pinus strobus* with occasional *P. resinosa*, *Quercus rubra* and *Q. ellipsoidalis*. The shrub layer contains *Vaccinium angustifolium*, and the ground layer contains *Maianthemum canadense*, *Aralia nudicaulis*, *Cornus canadensis*, and *Trientalis borealis*.

Oak Woodland

The oak woodland plant community is found between the bedrock glades and the dry-mesic forests throughout the Park. It is also found as an inclusion within the mesic forests where large portions of bedrock are exposed. Typically, this community has an interrupted or patchy canopy, dominated by *Quercus macrocarpa, Q. alba,* and *Q. ellipsoidalis*. *Juniperus virginiana* is an associate in some stands. Shrubs are sparse, but include *Corylus americana*, *C. cornuta*, *Rhus typhina*, *R. glabra*, and *Zanthoxylum americanum*. The ground layer includes *Elymus hystrix, Andropogon gerardii*, *Solidago* spp., *Toxicodendron rydbergii*, and *Galium boreale*. This community also provides habitat for the state Threatened *Besseya bullii* (Figure 7).

FIGURE 7. Kitten tails (*Besseya bullii*) in an oak woodland near a transition between woodland and bedrock glade. This species is listed as threatened in Wisconsin. Photograph by Derek Anderson, June 2, 2013.

FIGURE 8. One of several bedrock glades found throughout the Park. Lichen and moss covered basalt is in the foreground. Prairie vegetation and oak woodlands with *Quercus macrocarpa, Q. ellipsoidalis,* and *Q. alba* surround the exposed bedrock. Photograph by Derek Anderson, July 23, 2011.

Bedrock Glade

The bedrock glade community in the Park is found where basalt bedrock is exposed or is near the surface. These sites tend to be dry, and they support a unique assemblage of plants adapted to xeric conditions, such as *Selaginella rupestris*, lichens, and mosses. Where soil has developed and accumulated, prairie, savanna, and barrens species can be observed (Figure 8). These species include *Schizachyrium scoparium*, *Andropogon gerardii*, *Sorghastrum nutans*, *Coreopsis palmata*, *Lespedeza capitata*, *Liatris aspera*, and *Quercus ellipsoidalis*. *Opuntia fragilis* (Figure 9) and *Phemeranthus rugospermus* are two rare species that are found within this community. Bedrock glades are found throughout the Park; the largest areas are west of Eagle Peak and in the southern reaches of the Park. Smaller inclusions of this community occasionally occur within mesic forests where basalt bedrock is exposed.

Northern Sedge Meadow

There are a number of sedge meadows throughout the Park, the largest approaching five hectares (12 acres) in area. The majority of the sedge meadow communities in the Park are dominated by *Phalaris arundinacea.* Closer examination reveals a few diverse, intact remnants of native vegetation within the

FIGURE 9. The brittle prickly pear cactus (*Opuntia fragilis*) is listed as threatened in Wisconsin. This species is restricted to areas of bedrock glade habitat within the Park. Photograph by Derek Anderson June 28, 2011.

larger context of *Phalaris arundinacea*. These remnants tend to be dominated by *Carex lacustris*, although a few are dominated by *Carex stricta*. Other graminoids found in this community include *Glyceria canadensis, G. striata*, *Poa palustris*, *Calamagrostis canadensis*, and several species of *Carex* and *Scirpus*. Several forbs are also present, including *Doellingeria umbellata*, *Eutrochium maculatum*, *Epilobium ciliatum, E. leptophyllum*, *Asclepias incarnata*, and *Campanula aparinoides*.

Emergent Marsh and Submergent Aquatic

Aquatic communities are found in a few locations within the Park. A large emergent marsh is present in the backwaters of the St. Croix River, in the area of Folsom Lake. This backwater is inundated most of the year with 15–100 cm (6–40 inches) of water (Figure 10). In drought years mud flats become exposed. The emergent marsh is dominated by *Bolboschoenus fluviatilis*, and lesser amounts of *Sagittaria latifolia* and *S. rigida* are present.

Submerged aquatic communities are present in the areas of Folsom Lake and of Lake o' the Dalles. In these bodies of water, *Potamogeton nodosus* and *P. pusillus* are common. *Elodea canadensis*, *E. nuttallii*, and *Ceratophyllum demersum* are present in pockets within these lakes. *Zannichellia palustris* is found in water channels running through the emergent marsh in Folsom Lake. This is a new discovery for the Park and for Polk County. *Potamogeton crispus*, an invasive non-native species, occurs in both Lake o' the Dalles and Folsom Lake.

FIGURE 10. The north end of the river backwater named Folsom Lake. River bulrush (*Bolboschoenus fluviatilis*) dominates in the right center area of the photograph. The open water contains long-leaved pondweed (*Potamogeton nodosus*) and slender pondweed (*P. pusillus*). Photograph by Derek Anderson, July 27, 2012.

DISCUSSION

The forest flora at the Park has been affected by about 100 years of secondary successional regeneration of forest in northwestern Wisconsin. The diverse flora of the site is also influenced by its location in the tension zone and by such abiotic factors as bedrock, topography, and groundwater seepage. The high diversity of plant species found in the Park becomes evident when comparing this site with Amnicon Falls State Park, approximately 150 km northeast, which was the subject of a previous floristic study. Hlina et al. (2008) identified a total of 400 taxa at Amnicon Falls State Park. The two parks share 297 species in common. One hundred three of the species at Amnicon Falls State Park have not been documented at Interstate State Park. These include several species with cooler climate (or northern) affinities, including *Carex castanea, C. ormostachya, Halenia deflexa, Petasites frigidus* var. *sagittatus, Rubus parviflorus, Shepherdia canadensis,* and *Sparganium angustifolium*. In contrast, Interstate State Park has 355 species that were not documented at Amnicon Falls State Park. Several of these species, including *Boechera canadensis, Carex blanda, Ludwigia polycarpa, Ranunculus fascicularis, Staphylea trifolia,* and *Trillium flexipes*, have not been documented north of the tension zone described by Curtis (1959).

A total of 163 species were documented for the Park for the first time and, of those, 59 were also newly documented for Polk County. It is evident from these numbers that gaps still remain in our knowledge of plant distributions within the state, particularly in those regions located the farthest from the state's universities. The myth of a well-catalogued flora is not unique to the Park, and, as Ertter (2000) points out, there are several examples to the contrary throughout North America. Although many new species records were discovered for the Park and for Polk County, 40 taxa previously collected from the Park were not relocated during this three-year study. There is no evident correlation between the individual taxa and the inability to relocate them within the Park (such as the disappearance of northern species that may have been lost to a changing climate or the loss of a given community). Instead, they may actually no longer be found within the Park, or they may have been simply overlooked.

The diverse landscape of the Park supports several rare species (Table 2). One of these species, *Besseya bullii* (Figure 7), was rediscovered during the course of the survey. An older collection of the species from 1959 did not include a specific location in the Park. As a result, it is uncertain whether the new record is from the same population as the older collection. Another species of particular interest is the fern, *Dryopteris fragrans* (Figure 6), which was first collected at the "Falls of St. Croix" by Charles Parry in 1848. According to correspondence between Parry and Dr. John Torrey, this was the first time the species was documented within the limits of the United States. Parry (1852) indicated that the plant was "quite abundant." This species now appears to be quite rare in the Park. Between 2011 and 2013, only a few small populations were discovered on the extensive cliffs. Iltis and Judziewicz (1994) did not locate this species during their rare plant survey of the St. Croix National Scenic Riverway. They noted that extensive collections were made dating back to 1861 and that over-collecting at this site had likely contributed to the decline.

In addition to rare species, other surprise discoveries were made during the course of this survey. One was of a lone eastern hemlock (*Tsuga canadensis*) discovered in a mesic hardwood forest in the north end of the Park in the region that was first acquired in 1900. The tree was growing a few meters from a long-abandoned hiking trail. This hemlock tree had a diameter at breast height of 17.5 cm (6.8 in.). By comparing this measurement to the average diameters of trees in Michigan as documented by Burns and Honkala (1990), we conclude that this tree is most likely between forty and sixty years old. Its origins remain a bit of a mystery, since the nearest known site is approximately one hundred kilometers to the east.

Invasive species are another factor that impacts the diversity and abundance of native plant species in forests. Many of the non-native species in the Park are not particularly invasive and are restricted to previously disturbed land, such as the gas pipeline right-of-way, roadways, trails, and campgrounds. However, one of the more aggressively invasive species discovered at the Park in the course of the survey was garlic mustard (*Alliaria petiolata*). This species should be monitored and managed, particularly since Knight et al. (2009) found that the presence of white-tailed deer can lead to a significant divergence in plant community structure, and to an increase in the relative cover of garlic mustard. In addition, the non-native honeysuckles, *Lonicera tatarica* and *L. ×bella*, and common buckthorn, *Rhamnus cathartica*, were observed in populations ranging from scattered individuals to dense patches throughout the Park. Management activities have been directed toward these species when funding allows. *Phalaris arundinacea* has become a dominant species in several larger wetlands that were likely sedge meadows prior to the invasion.

As similarly reported in an earlier floristic study of Amnicon Falls State Park (Hlina et al. 2008), Interstate State Park has become a refuge for white-tailed deer (*Odoceoileus virginianus*), despite a large portion of the Park being open to hunting. Evidence of deer browse and winter deer yards can be observed throughout. The white-tailed deer appear to be impacting the forests within the Park, as reported in a number of studies examining such impacts (Graham 1954; Stoeckeler et al. 1957; Beals et al. 1960; Alverson et al. 1988; Balgooyen and Waller 1995; Mudrak et al. 2009). It appears that some woody species such as *Thuja occidentalis* and *Taxus canadensis* are not regenerating. Impacts are not restricted to woody species, however; the herbaceous layer in these forests has also been impacted in plant communities of northern Wisconsin with high deer populations (Rooney et al. 2004; Holmes et al. 2008).

The documentation of the flora at Interstate State Park sets the stage for future research and management activities at the Park. Follow-up activities could include: 1) monitoring and removal of invasive plant populations; 2) monitoring rare plant populations; 3) monitoring impacts of the white-tailed deer population on plant species and communities; 4) assessing comparisons of phenological shifts in certain species over time; and 5) using the results of this study as a baseline for future floristic work in the Park and the surrounding area.

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APPENDIX I: INTERSTATE STATE PARK FLORA LIST

The following list is organized alphabetically, first by family, then by genus, and finally by species, in each major group of plants. Non-native species are indicated with an asterisk. All collections in the course of this survey were made by Anderson and are deposited in the Robert W. Freckmann Herbarium at the University of Wisconsin–Stevens Point (UWSP). The name of each species is followed by a common name and, in parentheses, Anderson's collection numbers. This list also contains forty species collected in the past but not relocated during the course of our study. Each of these species is followed by a common name, the collector's name in italics, their collection number, year of collection and the herbarium acronym. Nomenclature follows Reznicek et al. (2011) for the ferns and fern allies and Voss and Reznicek (2012) for the seed plants. Six taxa not included in Voss and Reznicek (2012) follow the nomenclature of the Flora of North America (1993+). These are *Antennaria plantaginifolia, Delphinium carolinianum, Phemeranthus rugospermus, Rubus alumnus, Tradescantia occidentalis,* and *Vernonia fasciculata* as they are not known to occur in Michigan.

PTERIDOPHYTES

ASPLENIACEAE (Spleenwort Family)
Asplenium rhizophyllum L., walking fern (1576)

ATHYRIACEAE (Lady Fern Family)
Athyrium filix-femina (L.) Roth, common lady fern (1498)

CYSTOPTERIDACEAE (Brittle Fern Family)
Cystopteris bulbifera (L.) Bernh., bladder fern (1839, 1842)
Cystopteris fragilis (L.) Bernh., brittle bladder fern (1555)
Cystopteris laurentiana (Weath.) Blasdell, Laurentian bladder fern (1554)
Cystopteris tenuis (Michx.) Desv., MacKay's brittle fern (1618)
Gymnocarpium dryopteris (L.) Newman, oak fern (1586)

DENNSTAEDTIACEAE (Bracken Fern Family)
Pteridium aquilinum (L.) Kuhn. var. *latiusculum* (Desv.) A. Heller, bracken fern (1647)

DRYOPTERIDACEAE (Wood Fern Family)
Dryopteris carthusiana (Vill.) H. P. Fuchs, spinulose wood fern (1532)
Dryopteris cristata (L.) A. Gray, crested shield fern (1522)
Dryopteris fragrans (L.) Schott, fragrant fern (1553)

EQUISETACEAE (Horsetail Family)
Equisetum arvense L., field horsetail (1720, 1721)
Equisetum hyemale L., common scouring rush (1531, 1624)
Equisetum pratense Ehrh., meadow horsetail (1961)
Equisetum scirpoides Michx., dwarf scouring rush (1620)
Equisetum sylvaticum L., wood horsetail (2226)
Equisetum ×ferrissii Clute, Ferris' horsetail; *Fassett* 15557, 1927 (WIS)

LYCOPODIACEAE (Club-Moss Family)
Dendrolycopodium obscurum (L.) A. Haines, princess'-pine (1934)
Diphasiastrum digitatum (A. Braun) Holub, southern ground-cedar (1443, 1935)
Huperzia lucidula (Michx.) Trevis., shining club moss (1933)

ONOCLEACEAE (Ostrich Fern Family)
Matteuccia struthiopteris (L.) Todaro, ostrich fern (1958)
Onoclea sensibilis L., sensitive fern (1869)

OPHIOGLOSSACEAE (Adder's-Tongue Family)
Botrypus virginianus (L.) Michx., rattlesnake fern (1598)
Sceptridium dissectum (Spreng.) Lyon, cut-leaved grape fern (810, 1468, 1936)

OSMUNDACEAE (Royal Fern Family)
Osmunda cinnamomea L., cinnamon fern (1612)
Osmunda claytoniana L., interrupted fern (1611)
Osmunda regalis L., royal fern (1672, 1676)

POLYPODIACEAE (Polypody Fern Family)
Polypodium virginianum L., common polypody fern (1641)

PTERIDACEAE (Maidenhair Fern Family)
Adiantum pedatum L., maidenhair fern (1575)

SELAGINELLACEAE (Spikemoss Family)
Selaginella rupestris (L.) Spring, rock spikemoss (1473)

THELYPTERIDACEAE (Marsh Fern Family)
Phegopteris connectilis (L.) Slosson, northern beech fern; *Fassett* 15506, 1927, (WIS)
Thelypteris palustris Schott var. *pubescens* (Lawson) Fernald (1870)

WOODSIACEAE (Woodsia Fern Family)
Woodsia ilvensis (L.) R. Br., rusty cliff fern (1971)
Woodsia obtusa (Spreng.) Torr., blunt-lobed cliff fern (1523)
Woodsia oregana D. C. Eaton subsp. *cathcartiana* (B. L. Rob.) Windham, Oregon cliff fern, *Tyrone* 4143, 1938 (WIS)

GYMNOSPERMS

CUPRESSACEAE (Cypress Family)
Juniperus communis L., common juniper (1748)

Juniperus virginiana L., eastern red-cedar (1743)
Thuja occidentalis L., northern white cedar (1719)

PINACEAE (Pine Family)
Abies balsamea (L.) Mill., balsam fir (2138)
Picea glauca (Moench) Voss, white spruce (1938)
Pinus resinosa Aiton, red pine (1986)
Pinus strobus L., white pine (1977)
Tsuga canadensis (L.) Carrière, eastern hemlock (2139, 2140)

TAXACEAE (Yew Family)
Taxus canadensis Marshall, American yew (1441)

DICOTYLEDONS

ADOXACEAE (Moschatel Family)
Sambucus canadensis L., American elderberry (1804)
Sambucus racemosa L., red-berried elder (1473)
Viburnum lentago L., nannyberry (1565, 1573)
Viburnum rafinesquianum Schult., downy arrow-wood (1584)
Viburnum trilobum Marshall, American cranberry bush (1984)

AMARANTHACEAE (Amaranth Family)
Amaranthus retroflexus L., rough pigweed (2051)
Amaranthus tuberculatus (Moq.) J. D. Sauer, rough-fruited amaranth (2245)
Chenopodium album L., common lamb's quarters (1983)
Chenopodium simplex (Torr.) Raf., maple-leaved goosefoot (1774)

ANACARDIACEAE (Cashew Family)
Rhus glabra L., smooth sumac (2000)
Rhus typhina L., staghorn sumac (2030)
Rhus ×pulvinata Green, hybrid sumac; *Patman* s.n., 1959 (WIS)
Toxicodendron rydbergii (Rydb.) Greene, western poison ivy (2127)

APIACEAE (Parsley Family)
Angelica atropurpurea L., purple-stem angelica (1764)
Cicuta maculata L., water hemlock (1707)
Cryptotaenia canadensis (L.) DC., honewort (1596, 1648)
Osmorhiza claytonii (Michx.) C. B. Clarke, bland sweet cicely (1621)
Osmorhiza longistylis (Torr.) DC., anise-root (1528)
Sanicula marilandica L., black snakeroot (1604, 1619)
Sanicula odorata (Raf.) Pryer & Phillippe, clustered black snakeroot (1599)
Zizia aurea (L.) W. D. J. Koch, golden alexanders (1546)

APOCYNACEAE (Dogbane and Milkweed Family)
Apocynum androsaemifolium L., spreading dogbane (1640)
Apocynum cannabinum L., Indian-hemp (2009)
Asclepias exaltata L., poke milkweed (1791)
Asclepias incarnata L., swamp milkweed (1750)
Asclepias syriaca L., common milkweed (2020)
Asclepias tuberosa L., butterfly weed (1776)
Asclepias verticillata L., whorled milkweed (2070)

AQUIFOLIACEAE (Holly Family)
Ilex verticillata (L.) A. Gray, winterberry (1671)

ARALIACEAE (Ginseng Family)
Aralia nudicaulis L., wild sarsaparilla (1510)
Aralia racemosa L., American spikenard (1809)
Hydrocotyle americana L., marsh pennywort (1841)
Panax quinquefolius L., American ginseng (1990)

ARISTOLOCHIACEAE (Birthwort Family)

Asarum canadense L., wild ginger (1457)

ASTERACEAE (Sunflower Family)

Achillea millefolium L., yarrow (1710)
Ageratina altissima (L.) R. M. King & H. Rob., white snakeroot (1901)
Ambrosia artemisiifolia L., common ragweed (1813)
Antennaria neglecta Greene, field pussy-toes (1480, 1488)
Antennaria plantaginifolia (L.) Hook., plantain pussy-toes (1469)
**Arctium minus* (Hill) Berhn., common burdock (2028)
Artemisia campestris L. subsp. *caudata* (Michx.) H. M. Hall & Clem, field wormwood (1899)
Artemisia ludoviciana Nutt. subsp. *ludoviciana*, white sage (1854)
Artemisia serrata Nutt., saw-toothed sagebrush (1867)
Bidens cernua L., nodding beggar-ticks (2116)
Bidens comosa (A. Gray) Wiegand, straw-stem beggar-ticks (2113)
Bidens connata Willd., purple-stem beggar-ticks; *Koch* 7158, 1971 (UWSP)
Bidens frondosa L., common beggar-ticks (2112)
**Centaurea stoebe* L., spotted knapweed (1897)
**Cirsium arvense* (L.) Scop., Canada thistle (2071)
Cirsium discolor (Willd.) Spreng., field thistle (2075)
Cirsium muticum Michx., swamp thistle (1887)
**Cirsium vulgare* (Savi) Ten., bull thistle (2050)
Conyza canadensis (L.) Cronquist, Canadian horseweed (1843)
Coreopsis palmata Nutt., prairie coreopsis (1775)
**Crepis tectorum* L., hawk's beard (1635)
Doellingeria umbellata (Mill.) Nees, flat-topped aster (1871)
Erechtites hieraciifolius (L.) DC., American burnweed (2059)
Erigeron philadelphicus L., common fleabane (1614, 2006)
Erigeron strigosus Willd., daisy fleabane (2189)
Eupatorium perfoliatum L., boneset (1860)
Eurybia macrophylla (L.) Cass., big-leaved aster (1824)
Euthamia graminifolia (L.) Nutt., grass-leaved goldenrod (2076)
Eutrochium maculatum (L.) E. E. Lamont, spotted Joe-Pye weed (1825)
Eutrochium purpureum (L.) E. E. Lamont, purple-node Joe-Pye weed (1429)
**Galinsoga quadriradiata* Cav., common quickweed (1928)
Gnaphalium uliginosum L., marsh cudweed (2115)
Helenium autumnale L., common sneezeweed (1922)
Helianthus giganteus L., giant sunflower; *Pohl* 560, 1936 (WIS)
Helianthus pauciflorus Nutt., stiff sunflower (1434)
Helianthus strumosus L., woodland sunflower (1821, 1915)
Helianthus tuberosus L., Jerusalum-artichoke (2033)
Heliopsis helianthoides (L.) Sweet, ox-eye (1755)
**Hieracium aurantiacum* L. orange hawkweed (1605)
**Hieracium caespitosum* Durmot., yellow king-devil (1663)
Hieracium umbellatum L., northern hawkweed (1919, 2069)
Lactuca biennis (Moench) Fernald, tall blue lettuce (2233)
Lactuca canadensis L., Canada lettuce (2065)
**Leucanthemum vulgare* Lam., ox-eye daisy (1715)
Liatris aspera Michx., rough blazing star (1855)
**Matricaria discoidea* DC., pineapple-weed (2012)
Packera aurea (L.) A. Löve & D. Löve, golden ragwort (1627)
Prenanthes alba L., white-lettuce (2141)
Rudbeckia hirta L. var. *pulcherrima* Farw., black-eyed Susan (1757)
Rudbeckia laciniata L., cut-leaved coneflower (1828)
Solidago canadensis L., Canada goldenrod (2052)
Solidago flexicaulis L., zig-zag goldenrod (1918)
Solidago gigantea Aiton, giant goldenrod (1820)

Solidago hispida Willd. var. *hispida*, hairy goldenrod (1435)
Solidago juncea Aiton, early goldenrod (1436)
Solidago nemoralis Aiton, gray goldenrod (1856)
Symphyotrichum laeve (L.) A. Löve & D. Löve, smooth aster; *Sayre* s.n., 1937 (WIS)
Symphyotrichum lanceolatum (Willd.) G. L. Nesom, panicled aster (2053, 2077)
Symphyotrichum novae-angliae (L.) G. L. Nesom, New England aster (1879)
Symphyotrichum oolentangiense (Riddell) G. L. Nesom, sky-blue aster (1929)
Symphyotrichum puniceum (L.) A. Löve & D. Löve, swamp aster (2064)
Symphyotrichum sericeum (Vent.) G. L. Nesom, silky aster (2126)
Symphyotrichum urophyllum (DC.) G. L. Nesom, arrow-leaved aster (1917, 1932)
**Tanacetum vulgare* L., common tansy (2049)
**Taraxacum officinale* F. H. Wigg., common dandelion (1954)
**Tragopogon dubius* Scop., goat's beard (1592, 1609)
Vernonia fasciculata Michx., ironweed (1851, 1852)
Xanthium strumarium L., common cocklebur (2107)

BALSAMINACEAE (Touch-Me-Not Family)
Impatiens capensis Meerb., orange jewelweed (1859)
Impatiens pallida Nutt., yellow jewelweed (1878)

BERBERIDACEAE (Barberry Family)
**Berberis thunbergii* DC., Japanese barberry (1654)
Caulophyllum thalictroides (L.) Michx., blue cohosh (1693)

BETULACEAE (Birch Family)
Alnus incana (L.) Moench subsp. *rugosa* (Du Roi) R. T. Clausen, speckled alder (1682)
Betula alleghaniensis Britton, yellow birch (1477)
Betula papyrifera Marshall, paper birch (1795)
Carpinus caroliniana Walter, American hornbeam (1941)
Corylus americana Walter, American hazelnut (1937)
Corylus cornuta Marshall subsp. *cornuta*, beaked hazelnut (1940)
Ostrya virginiana (Mill.) K. Koch, ironwood (1763)

BORAGINACEAE (Borage Family)
Hackelia deflexa (Wahlenb.) Opiz var. *americana* (A. Gray) Fernald and I. M. Johnst., cliff stickseed (1792)
Hackelia virginiana (L.) I. M. Johnst., beggar's-lice (1752)
Hydrophyllum virginianum L., Virginia waterleaf (1533)
Mertensia virginica (L.) Pers. ex Link, Virginia bluebells (1967)

BRASSICACEAE (Mustard Family)
**Alliaria petiolata* (M. Bieb.) Cavara & Grande, garlic mustard (1481)
Arabidopsis lyrata (L.) O'Kane & Al-Shehbaz, sand cress (1474, 1497)
**Barbarea vulgaris* Aiton, yellow rocket (1517)
**Berteroa incana* (L.) DC., hoary-alyssum (2001)
Boechera canadensis (L.) Al-Shehbaz (1652, 1653)
Boechera grahamii (Lehmann) Windham & Al-Shebaz (1513, 1534)
**Capsella bursa-pastoris* (L.) Medik., shepherd's-purse (1560)
Cardamine bulbosa (Muhl.) Britton, Sterns & Poggenb., spring cress (1559)
Cardamine parviflora L. var. *arenicola* (Britton) O. E. Schulz, dry-land bitter-cress (1494)
Cardamine pensylvanica Willd., Pennsylvania bitter-cress (1527)
**Draba verna* L., spring whitlow grass (1496)
**Erysimum cheiranthoides* L., worm-seed mustard (1798)
**Hesperis matronalis* L., dame's rocket (1995)
**Lepidium densiflorum* Schrad., prairie pepper-weed (2247)
**Nasturtium officinale* R. Br., watercress (1610)
Rorippa palustris (L.) Besser subsp. *palustris*, marsh cress (2015)
Sisymbrium altissimum L., tall tumble mustard; *Patman* s.n., 1959 (WIS)
Turritis glabra L., tower mustard (1651)

CACTACEAE (Cactus Family)
Opuntia fragilis (Nutt.) Haw., brittle prickly pear (1738)

CAMPANULACEAE (Bellflower Family)
Campanula aparinoides Pursh, marsh bell flower (1758)
**Campanula rapunculoides* L., European bell flower (1891)
Campanula rotundifolia L., harebell (1630)
Lobelia cardinalis L., cardinal flower (1836)
Lobelia inflata L., Indian tobacco (1872, 1895)
Lobelia siphilitica L., great blue lobelia (1428)

CANNABACEAE (Hemp Family)
Humulus lupulus L., common hops (1868)
Celtis occidentalis L., hackberry (1681)

CAPRIFOLIACEAE (Honeysuckle Family)
Lonicera dioica L., red honeysuckle (1970)
**Lonicera tatarica* L., Tatarian honeysuckle (1536, 1563)
**Lonicera ×bella* Zabel, showy honeysuckle (1978)
Symphoricarpos albus (L.) S. F. Blake, snowberry (1639)
Triosteum aurantiacum E. P. Bicknell, early horse gentian (1507)

CARYOPHYLLACEAE (Pink Family)
**Cerastium fontanum* Baumg., common chickweed (1666)
**Dianthus armeria* L., Deptford pink (1823)
**Gypsophila muralis* L., cushion baby's breath (2013)
Moehringia lateriflora (L.) Fenzl, sandwort (1495)
**Myosoton aquaticum* (L.) Moench, giant chickweed (1543, 2183)
**Saponaria officinalis* L., bouncing-bet (2043)
Silene antirrhina L., sleepy catchfly (2186)
**Silene latifolia* Poir, bladder campion (1646)
Stellaria longifolia Willd., long-leaved stichwort (1594)
**Stellaria media* (L.) Vill., common chickweed (2184)

CELASTRACEAE (Bittersweet Family)
Celastrus scandens L., American bittersweet (1862)

CERATOPHYLLACEAE (Hornwort Family)
Ceratophyllum demersum L., coon's tail (1803,1908)

CISTACEAE (Rock-Rose Family)
Crocanthemum bicknellii (Fernald) Janch., hoary frostweed (2230)
Lechea intermedia Britton, intermediate pinweed (1814)

CONVOLVULACEAE (Morning Glory Family)
Calystegia sepium (L.) R. Br., hedge bindweed (1754)
Cuscuta gronovii Roem. & Schult. var. *gronovii*, common dodder (1877)

CORNACEAE (Dogwood Family)
Cornus alternifolia L.f., pagoda dogwood (1617)
Cornus amomum Mill. (blue-fruited dogwood); *Pohl* 550, 1936 (WIS)
Cornus canadensis L., bunchberry (1582)
Cornus foemina Mill. subsp. *racemosa* (Lam.) J. S. Wilson, gray dogwood (1667, 1670)
Cornus rugosa Lam., round-leaved dogwood (1648)
Cornus sericea L., red osier dogwood (1762)

CRASSULACEAE (Sedum Family)
**Sedum acre* L., gold-moss stonecrop (1686)

CUCURBITACEAE (Gourd Family)
Echinocystis lobata (Michx.) Torr. & A. Gray, wild cucumber (2072)

DIERVILLACEAE (Bush-honeysuckle Family)
Diervilla lonicera Mill., northern bush-honeysuckle (1628)

ELAEAGNACEAE (Oleaster Family)
***Elaeagnus angustifolia* L., Russan olive (1987)

ERICACEAE (Heath Family)
Arctostaphylos uva-ursi (L.) Spreng., bearberry (1746, 1955)
Chimaphila umbellata (L.) W. P. C. Barton, pipsissewa (1962)
Gaylussacia baccata (Wangenh.) K. Koch, black huckleberry (1972)
Monotropa uniflora L., Indian-pipe (1893)
Pyrola elliptica Nutt., large-leaved shin-leaf (1973)
Vaccinium angustifolium Aiton, early low blueberry (1472)
Vaccinium myrtilloides Michx., velvet-leaved blueberry (1585)

EUPHORBIACEAE (Spurge Family)
Acalypha rhomboidea Raf., three-seeded mercury (1838, 1914)
Euphorbia corollata L., flowering spurge (1784)
Euphorbia cyparissias L., cypress spurge (1601)
Euphorbia glyptosperma Engelm., ridge-seeded spurge; *Pohl* 583, 1936 (WIS)
Euphorbia maculata (L.) Small, milk purslane (1927, 2074)
Euphorbia nutans Lag., nodding spurge; *Fassett* 5483, 1927 (WIS)

FABACEAE (Bean or Pea Family)
Amorpha canescens Pursh, leadplant (1745)
Amorpha fruticosa L., false indigo (1649)
Amphicarpaea bracteata (L.) Fernald, hog peanut (1921)
Apios americana Medik., common groundnut (1866)
Dalea purpurea Vent., purple prairie clover (1911)
Desmodium canadense (L.) DC., showy tick-trefoil (2191)
Hylodesmum glutinosum (Willd.) H. Ohashi & R. R. Mill, pointed tick-trefoil (1787)
Lathyrus ochroleucus Hook., white pea (1539)
Lathyrus venosus Willd., forest pea (1564)
Lespedeza capitata Michx., round-headed bush clover (1873)
**Lotus corniculatus* L., bird's-foot trefoil (1714)
**Medicago lupulina* L., black medick (1669)
**Melilotus albus* Medik., white sweet clover (1744)
**Melilotus officinalis* (L.) Pall., yellow sweet clover (1633)
**Robinia pseudoacacia* L., black locust (2192)
**Securigera varia* L., crown-vetch (1713)
**Trifolium arvense* L., rabbit's-foot clover (1778)
**Trifolium campestre* Schreb., field clover (1779)
**Trifolium hybridum* L., alsike clover (2193)
**Trifolium pratense* L., red clover (1615)
**Trifolium repens* L., white clover (1623)
Vicia americana Willd., American vetch (1580)
**Vicia cracca* L., cow vetch (1997)

FAGACEAE (Beech Family)
Quercus alba L., white oak (1709)
Quercus ellipsoidalis E. J. Hill, northern pin oak (1718)
Quercus macrocarpa Michx., bur oak (1874)
Quercus rubra L., northern red oak (1991)
Quercus ×*bebbiana* C. K. Schneid., Bebb's oak; *Fassett* 15552, 1927 (WIS)

GENTIANACEAE (Gentian Family)
Gentiana andrewsii Griseb., bottle gentian (1923, 1924)

GERANIACEAE (Geranium Family)
Geranium maculatum L., wild geranium (1524)

GROSSULARIACEAE (Gooseberry Family)
Ribes cynosbati L., prickly wild gooseberry (1504)
Ribes hirtellum Michx., swamp gooseberry (1518)

HAMAMELIDACEAE (Witch Hazel Family)
Hamamelis virginiana L., American witch hazel (2134)

HYPERICACEAE (St. John's Wort Family)
Hypericum ascyron L., giant St. John's wort (1766)
Hypericum majus (A. Gray) Britton, larger St. John's wort; *Pohl* 571, 1936 (WIS)
**Hypericum perforatum* L., common St. John's wort (1655)
Triadenum fraseri (Spach) Gleason, marsh St. John's wort (2061)

JUGLANDACEAE (Walnut Family)
Carya cordiformis (Wangenh.) K. Koch, bitternut hickory (1679)
Juglans cinerea L., butternut (1688)
Juglans nigra L., black walnut (1595)

LAMIACEAE (Mint Family)
Agastache scrophulariaefolia (Willd.) Kuntze, purple giant hyssop (1827, 1853)
**Galeopsis tetrahit* L., common hemp-nettle (2029)
**Glechoma hederacea* L., creeping Charlie (1471)
Hedeoma hispida Pursh., rough false pennyroyal (1625)
**Leonurus cardiaca* L., motherwort (1756)
Lycopus americanus W. P. C. Barton, American water-horehound (1840)
Lycopus uniflorus Michx., northern bugleweed (2036)
Mentha canadensis L., wild mint (2040)
Monarda fistulosa L., bee balm (1770)
Physostegia virginiana (L.) Benth. subsp. *virginiana*, false-dragonhead (1903)
Prunella vulgaris L., heal-all (1694)
Pycnanthemum virginianum (L.) B. L. Rob & Fernald, Virginia mountain mint (1704, 1822)
Scutellaria lateriflora L., skullcap (1425, 2035)
Scutellaria parvula Michx. var. *missouriensis* (Torr.) Goodman & C. A. Lawson, smooth small skullcap (1637)
Stachys arenicola Britton., marsh hedge-nettle (2045)
Teucrium canadense L., American germander (1767, 1896)
Trichostema brachiatum L., false-pennyroyal (1817, 2232)

LIMNANTHACEAE (Meadow-Foam Family)
Floerkea proserpinacoides Willd., false mermaid (1530)

LINDERNIACEAE (False Pimpernel Family)
Lindernia dubia (L.) Pennell, false pimpernel (2114)

MALVACEAE (Mallow Family)
**Malva neglecta* Wallr., cheeses (1785)
Tilia americana L., basswood (1780)

MENISPERMACEAE (Moonseed Family)
Menispermum canadense L., Canada moonseed (2045)

MOLLUGINACEAE (Carpetweed Family)
**Mollugo verticillata* L., carpetweed (1910)

MONTIACEAE (Blinks Family)
Claytonia virginica L., spring beauty (1460)

MYRSINACEAE (Myrsine Family)
Lysimachia ciliata L., fringed loosestrife (1742, 2027)
Lysimachia hybrida Michx., river loosestrife (2042)
Lysimachia terrestris (L.) Britton, Sterns & Poggenb., swamp loosestrife (2235)
Trientalis borealis Raf., American starflower (1538)

NYCTAGINACEAE (Four-O'clock Family)
Mirabilis nyctaginea (Michx.) MacMill., wild four-o'clock (1797)

NYMPHAEACEAE (Water-Lily Family)
Nymphaea odorata Aiton, fragrant water-lily (2047)

OLEACEAE (Olive Family)
Fraxinus americana L., white ash (2137)
Fraxinus nigra Marshall, black ash (1574)
Fraxinus pennsylvanica Marshall, green ash (1683)

ONAGRACEAE (Evening-Primrose Family)
Chamerion angustifolium (L.) Holub, fireweed (1760)
Circaea canadensis (L.) Hill subsp. *canadensis*, enchanter's nightshade (1741)
Epilobium ciliatum Raf., American willow-herb (1427, 1876, 2067, 2228)
Epilobium leptophyllum Raf., American marsh willow-herb (2066)
Ludwigia palustris (L.) Elliot, marsh purslane (1837)
Ludwigia polycarpa Short & R. Peter, false-loosestrife (2237)
Oenothera biennis L., evening-primrose (1831)
Oenothera perennis L., small sun-drops (1650, 1703, 2190)

OROBANCHACEAE (Broom-rape Family)
Agalinis tenuifolia (Vahl) Raf., common false foxglove (1920)
Aureolaria pedicularia (L.) Raf., false foxglove; *Pohl* 588, 1936 (WIS)
Pedicularis canadensis L., wood-betony (1501)
Pedicularis lanceolata Michx., swamp lousewort (1898)

OXALIDACEAE (Wood-Sorrel Family)
Oxalis dillenii Jacq., southern yellow wood-sorrel (1998)
Oxalis stricta L., common wood-sorrel (1662)
Oxalis violacea L., violet wood-sorrel (1515)

PAPAVERACEAE (Poppy Family)
Capnoides sempervirens (L.) Borkh., pale corydalis (1540)
Corydalis aurea Willd. subsp. *aurea*, golden corydalis (1556)
Dicentra cucullaria (L.) Bernh., Dutchman's breeches (1458)
Sanguinaria canadensis L., bloodroot (1447)

PENTHORACEAE (Stonecrop Family)
Penthorum sedoides L., ditch stonecrop (2025, 2236)

PHRYMACEAE (Lopseed Family)
Mimulus ringens L. var. *ringens,* monkey-flower (2110)
Phryma leptostachya L., American lop-seed (1753)

PLANTAGINACEAE (Plantain Family)
Besseya bullii (Eaton) Rydb., kittentails (2142)
Chelone glabra L., turtlehead (1861)
Gratiola neglecta Torr., clammy hedge-hyssop (2111, 2118)
**Linaria vulgaris* Mill., butter and eggs (1992)
**Plantago major* L., common plantain (2129)
Plantago rugelii Decne., American plantain (1890)
Veronica beccabunga L. var. *americana* Raf., American brooklime (1607)
**Veronica officinalis* L., common speedwell (1613)
**Veronica serpyllifolia* L., thyme-leaved speedwell (1590)
**Veronica verna* L., spring speedwell (1508)
Veronicastrum virginicum (L.) Farw., culver's root (1830)

POLEMONIACEAE (Phlox Family)
Phlox divaricata L., forest phlox (1492)
Phlox pilosa L., prairie phlox (1591)

POLYGALACEAE (Milkwort Family)
Polygala sanguinea L., field milkwort (1886, 2231)

POLYGONACEAE (Buckwheat Family)
Fallopia cilinodis (Michx.) Holub, fringed bindweed (1658, 1690)
**Fallopia convolvulus* (L.) A. Löve, black-bindweed (2185)
Persicaria amphibia (L.) A. Gray, water smartweed (1912)

**Persicaria hydropiper* (L.) Delarbre (marsh-pepper knotweed); Fassett 12756, 1927 (WIS)
Persicaria pensylvanica (L.) Gómez, Pennsylvania smartweed (1863, 2194)
Persicaria punctata (Elliot) Small, dotted smartweed; *Pohl* 572, 1936 (WIS)
Persicaria sagittata (L.) H. Gross, arrow-leaved tear-thumb (1888)
Persicaria virginiana (L.) Gaert., jumpseed (1844)
Polygonum tenue Michx., pleat-leaf knotweed (1818)
**Rumex acetosella* L., sheep sorrel (1514)
Rumex altissimus A. W. Wood, pale dock (2026)
**Rumex crispus* L., curly dock (2018)
**Rumex obtusifolius* L. (bitter dock); Pohl 594, 1936 (WIS)
Rumex orbiculatus A. Gray, great water dock (2062)

PORTULACACEAE (Purslane Family)
Phemeranthus rugospermus (Holz.) Kiger, prairie fame-flower (1812)
**Portulaca oleracea* L., common purselane (2032)

PRIMULACEAE (Primrose Family)
Androsace occidentalis Pursh, rock-jasmine (1948)

RANUNCULACEAE (Buttercup Family)
Actaea pachypoda L., white baneberry (1439)
Actaea rubra (Aiton) Willd., red baneberry (1519)
Anemone canadensis L., Canada anemone (1578)
Anemone cylindrica A. Gray, thimbleweed (2182)
Anemone quinquefolia L., wood anemone (1451)
Anemone virginiana L., tall anemone (1593)
Aquilegia canadensis L., wild columbine (1509)
Caltha palustris L., marsh marigold (1452)
Clematis virginiana L., virgin's bower (1829)
Delphinium carolinianum Walter subsp. *virescens* (Nutt.) R. E. Brooks, Carolina larkspur (2181)
Enemion biternatum Raf., false rue-anemone (1953)
Hepatica acutiloba (DC.) G. Lawson, sharp-lobed hepatica (1449)
Hepatica americana (DC.) H. Hara, round-lobed hepatica (1446)
Ranunculus abortivus L., little-leaf buttercup (1535)
**Ranunculus acris* L., tall buttercup (1685)
Ranunculus fascicularis Muhl., thick-root buttercup (1448)
Ranunculus hispidus Michx. var *nitidus* (Champ.) T. Duncan, bristly buttercup (1476, 1969)
Ranunculus pensylvanicus L. f., bristly buttercup; *Fassett* 8265, 1936 (WIS)
Ranunculus recurvatus Poir. var. *recurvatus*, hooked buttercup (1519)
Thalictrum dasycarpum Fisch. & Avé-Lall., tall meadow-rue (1687)
Thalictrum dioicum L., early meadow-rue (1500)
Thalictrum thalictroides (L.) A. J. Eames & B. Boivin, rue-anemone (1445)

RHAMNACEAE (Buckthorn Family)
Ceanothus americanus L., New Jersey tea (2019)
**Rhamnus cathartica* L., common buckthorn (1989)

ROSACEAE (Rose Family)
Agrimonia gryposepala Wallr., common agrimony (1826)
Amelanchier laevis Wiegand, Allegheny serviceberry; *Pohl* 489, 1936 (WIS)
Amelanchier sanguinea (Pursh) DC., New England serviceberry (1463, 1487, 1944, 1951)
Comarum palustre L., marsh cinquefoil; *Pohl* 504, 1936 (WIS)
Drymocallis arguta (Pursh) Rydb., prairie cinquefoil (1699)
Fragaria vesca L. subsp. *americana* (Porter) Staudt, thin-leaved wild strawberry (1493)
Fragaria virginiana Mill., wild strawberry (1525)
Geum aleppicum Jacq., yellow avens (1749)
Geum canadense Jacq., white avens (1659)
Geum triflorum Pursh, prairie smoke (1700)
**Malus pumila* Mill., apple (1516)

Physocarpus opulifolius (L.) Maxim., ninebark (1629, 2145)
Potentilla argentea L., silvery cinquefoil (1661)
Potentilla norvegica L., rough cinquefoil; *Patman* s.n., 1959 (WIS)
**Potentilla recta* L., sulpher cinquefoil (1772)
Potentilla simplex Michx., common cinquefoil (1673)
Prunus americana Marshall, wild plum (1947, 1950)
Prunus nigra Aiton., Canada plum (1464)
Prunus pumila L., sand cherry (1483)
Prunus serotina Ehrh., black cherry (1572)
Prunus virginiana L. var. *virginiana*, chokecherry (1512)
Rosa acicularis Lindl., bristly rose (1632)
Rosa arkansana Porter, prairie rose; *Patman* s.n., 1959 (WIS)
Rosa blanda Aiton, smooth rose (1602)
Rubus allegheniensis Porter, common blackberry (2187)
Rubus alumnus L. H. Bailey, old field blackberry (1603)
Rubus occidentalis L., black raspberry (1668)
Rubus pubescens Raf., dwarf red raspberry (1936)
Rubus strigosus Michx., red raspberry (1660)
Rubus superioris L. H. Bailey, Superior blackberry; *Pohl* 529, 1936 (WIS)
**Sorbus aucuparia* L., Eurasian mountain-ash (1552)
Sorbus decora (Sarg.) C. K. Schneid., northern mountain-ash; *Pohl* 506, 1936 (WIS)
Spiraea alba Du Roi var. *alba*, white meadowsweet (1805)

RUBIACEAE (Madder Family)
Cephalanthus occidentalis L., buttonbush (1833)
Galium aparine L., cleavers (1505)
Galium asprellum Michx., rough bedstraw (1562)
Galium boreale L., northern bedstraw (1583)
Galium concinnum Torr. & A. Gray, pretty bedstraw (1581)
Galium obtusum Bigelow subsp. *obtusum*, blunt-leaf bedstraw (1678)
Galium triflorum Michx., sweet-scented bedstraw (1544)
Houstonia longifolia Gaertn., long-leaved bluets (1549, 1664)
Mitchella repens L., partridgeberry (1747, 1974)

RUTACEAE (Rue Family)
Zanthoxylum americanum Mill., prickly ash (1680)

SALICACEAE (Willow Family)
Populus deltoides Bartram. ex Marshall subsp. *monilifera* (Aiton) Eckenw., cottonwood (1751)
Populus grandidentata Michx., big-toothed aspen (2128)
Populus tremuloides Michx., quacking aspen (1988)
Salix discolor Muhl., pussy willow (1485, 1486, 1939)
Salix eriocephala Michx., diamond willow (2037)
Salix interior Rowlee, sandbar willow (2068)
Salix petiolaris Sm., slender willow (1484)
**Salix* ×*rubens* Schrank, hybrid crack willow (1952)

SANTALACEAE (Sandalwood Family)
Comandra umbellata (L.) Nutt., bastard toadflax (1542)

SAPINDACEAE (Soapberry Family)
**Acer ginnala* Maxim., amur maple (2008)
Acer negundo L., boxelder (1949)
Acer rubrum L. var. *rubrum*, red maple (1959)
Acer saccharinum L., silver maple (2022)
Acer saccharum Marshall var. *saccharum*, sugar maple (1964)

SAXIFRAGACEAE (Saxifrage Family)
Chrysosplenium americanum Hook., American golden saxifrage (1980)

Heuchera richardsonii R. Br., prairie alum root (1511)
Micranthes pensylvanica (L.) Haw., swamp saxifrage (1616)
Mitella diphylla L., two-leaved miterwort (1470)

SCROPHULARIACEAE (Figwort Family)
Scrophularia lanceolata Pursh, American figwort (1631)
**Verbascum thapsus* L., common mullein (2031)

SOLANACEAE (Nightshade Family)
Solanum dulcamara L., bittersweet nightshade (1716)
Solanum ptycanthum Dunal, black nightshade (1796)

STAPHYLEACEAE (Bladdernut Family)
Staphylea trifolia L., American bladdernut (1945)

THYMELAEACEAE (Mezereum Family)
Dirca palustris L., leatherwood (1942)

ULMACEAE (Elm Family)
Ulmus americana L., American elm (1943)
**Ulmus pumila* L., Siberian elm (1946)
Ulmus rubra Muhl., red elm (2023)
Ulmus thomasii Sarg., rock elm (1993)

URTICACEAE (Nettle Family)
Boehmeria cylindrica (L.) Sw., small spike false nettle (1777, 1833)
Laportea canadensis (L.) Wedd., wood nettle (1875)
Parietaria pensylvanica Muhl. ex Willd., Pennsylvania pellitory (1608)
Pilea pumila (L.) A. Gray, clearweed (1864)
Urtica dioica L. subsp. *gracilis* (Aiton) Selander, stinging nettle (1865)

VERBENACEAE (Vervain Family)
Verbena hastata L., blue vervain (1806)
Verbena urticifolia L., white vervain (1849)

VIOLACEAE (Violet Family)
Viola labradorica Schrank, American dog violet (1461)
Viola macloskeyi F. E. Lloyd subsp. *pallens* (DC.) M. S. Baker, small white violet (1454, 1956)
Viola pedatifida G. Don, prairie violet (2143)
Viola pubescens Aiton, yellow forest violet (1491)
Viola sagittata Aiton, arrow-leaved violet (1541)
Viola sororia Willd., door-yard violet (1475, 1478)

VITACEAE (Grape Family)
Parthenocissus inserta (A. Kern.) Fritsch, grape woodbine (2234)
Vitis riparia Michx., riverbank grape, frost grape (2055)

MONOCOTYLEDONS

ACORACEAE (Sweet Flag Family)
Acorus americanus (Raf.) Raf., sweet flag; *Pohl* 490, 1936 (WIS)

ALISMATACEAE (Water-Plantain Family)
Alisma triviale Pursh, northern water-plantain (2039)
Sagittaria latifolia Willd., broad-leaved arrow-head (1902)
Sagittaria rigida Pursh, stiff arrow-head (1808, 2241)

ALLIACEAE (Onion Family)
Allium canadense L., wild onion (1579)
Allium stellatum Ker Gawl., prairie onion (1811)
Allium tricoccum Aiton, wild leek (1521)

ARACEAE (Arum Family)
Arisaema triphyllum (L.) Schott subsp. *triphyllum*, Jack-in-the-pulpit (1561)
Calla palustris L., wild calla (1727)
Lemna trisulca L., forked duckweed (1957)
Lemna turionifera Landolt, Turion duckweed (1905)
Spirodela polyrrhiza (L.) Shleid., greater duckweed (1906)
Symplocarpus foetidus (L.) W. P. C. Barton, skunk cabbage (1444)

ASPARAGACEAE (Asparagus Family)
**Asparagus officinalis* L., asparagus (1577)

COMMELINACEAE (Spiderwort Family)
Tradescantia occidentalis (Britton) Smyth var. *occidentalis,* prairie spiderwort (1773)

CONVALLARIACEAE (Lily-of-the-valley Family)
Clintonia borealis (Aiton) Raf., blue-bead lily (1588)
**Convallaria majalis* L. var. *majalis*, European lily-of-the-valley (1979)
Maianthemum canadense Desf., wild lily-of-the-valley (1537)
Maianthemum racemosum (L.) Link, false Solomon's-seal (1587)
Polygonatum biflorum (Walter) Elliott, giant Solomon's-seal (1638)
Polygonatum pubescens (Willd.) Pursh, hairy Solomon's-seal (1790)
Uvularia grandiflora Sm., bellwort (1490)
Uvularia sessilifolia L., sessile bellwort (1467)

CYPERACEAE (Sedge Family)
Bolboschoenus fluviatilis (Torr.) Soják, river bulrush (1900)
Bulbostylis capillaris (L.) C. B. Clarke, hair sedge; *Fassett* 17705, 1934 (WIS)
Carex assiniboinensis W. Boott, Assiniboine sedge (1551)
Carex backii W. Boott, Rocky Mountain sedge (1976)
Carex bicknellii Britton, Bicknell's oval sedge (1636)
Carex blanda Dewey, common wood sedge (1499, 1545)
Carex brevior (Dewey) Mack. Ex Lunell, fescue sedge (1994)
Carex bromoides Willd., brome-like sedge (1453)
Carex buxbaumii Wahlenb., Buxbaum's sedge (1548)
Carex cephalophora Willd., oval-headed sedge; *Fassett* 7382, 1927 (WIS)
Carex crinita Lam. var. *crinita*, fringed sedge (1622)
Carex cristatella Britton, crested oval-sedge (1737)
Carex deweyana Schwein., Dewey's sedge (1571)
Carex emoryi Dewey, Emory's sedge; *Pohl* 484, 1936 (WIS)
Carex gracillima Schwein., graceful sedge (1506)
Carex haydenii Dewey, Hayden's sedge (1568, 2146)
Carex hirtifolia Mack., hairy sedge (1982)
Carex intumescens Rudge, greater bladder sedge (1574)
Carex lacustris Willd., lake sedge (2010)
Carex lupulina Willd., common hop sedge (804, 1732)
Carex lurida Wahlenb., shallow sedge (1769)
Carex muhlenbergii Willd., Muhlenberg's sedge (2005)
Carex normalis Mack., greater straw sedge (1567)
Carex pedunculata Willd., long-stalk sedge (1455, 1965)
Carex pellita Willd., broad-leaved woolly sedge (1600, 1708)
Carex pensylvanica Lam., Pennsylvania sedge (1450)
Carex projecta Mack., loose-headed oval sedge (1569, 1701)
Carex radiata (Wahlenb.) Small, eastern star sedge (1507)
Carex retrorsa Schwein., deflexed bottlebrush sedge (524)
Carex sprengelii Spreng., Sprengel's sedge (1503)
Carex stipata Willd. var. *stipata*, common fox sedge (1597)
Carex stricta Lam., tussock sedge (2147)
Carex tribuloides Wahlenb., awl-fruited oval sedge (1782)
Carex tuckermanii Dewey, Tuckerman's sedge (1705, 1706)

Carex typhina Michx., cattail sedge (1733, 1734, 1783, 2046)
Carex umbellata Schkuhr. ex Willd., early oak sedge (1960)
Carex vesicaria L., blister sedge (1736)
Carex vulpinoidea Michx., brown fox sedge (1735)
Cyperus bipartitus Torr., slender flat sedge (1847, 1926)
Cyperus diandrus Torr., umbrella flat sedge; *Pohl* 598, 1936 (WIS)
Cyperus erythrorhizos Muhl., red-rooted sedge (2124)
Cyperus esculentus L., yellow nut sedge (1846)
Cyperus odoratus L., flat sedge (802)
Cyperus schweinitzii Torr., Great Plains sand sedge (1794, 1857, 1894)
Cyperus squarrosus L., bearded flat sedge (2246)
Cyperus strigosus L., straw colored cyperus (1925)
Eleocharis acicularis (L.) Roem. & Schult., needle spike-rush (2123)
Eleocharis erythropoda Steud., bald spike-rush (2122)
Eleocharis intermedia Schult., matted spike-rush (2095)
Eleocharis obtusa (Willd.) Schult., blunt spike-rush (2016, 2120, 2243)
Eleocharis ovata (Roth) Roem. & Schult., oval spike-rush (2119)
Schoenoplectus tabernaemontani (C. C. Gmel.) Palla, soft stem bulrush (1807)
Scirpus atrovirens Willd., black bulrush (1765, 1845)
Scirpus cyperinus (L.) Kunth, wool-grass (2041)
Scirpus microcarpus J. Presl. & C. Presl, panicled bulrush (1644, 1645)
Scirpus pedicellatus Fernald, stalked wool-grass (1786)

DIOSCOREACEAE (Yam Family)
Dioscorea villosa L., wild-yam (1691, 1789)

HEMEROCALLIDACEAE (Day-lily Family)
**Hemerocallis fulva* (L.) L., orange day-lily (2014)

HYDROCHARITACEAE (Frog's-Bit Family)
Elodea canadensis Michx., common waterweed (1802)
Elodea nuttallii (Planch.) St. John, slender waterweed (1909)
Najas flexilis (Willd.) Rostk. Schmidt, northern water-nymph (2240)
Najas guadalupensis (Spreng.) Magnus, southern water-nymph (1800)
Vallisneria americana Michx., American eel-grass (2058)

HYPOXIDACEAE (Star-grass Family)
Hypoxis hirsuta (L.) Coville, yellow star-grass (1698, 2144)

IRIDACEAE (Iris Family)
**Iris pseudacorus* L., yellow flag (1676)
Iris virginica L., var. *shrevei* (Small) E. S. Anderson, southern blue flag (1606, 2011)
Sisyrinchium campestre E. P. Bicknell, prairie blue-eyed grass (1526)

JUNCACEAE (Rush Family)
Juncus effusus L., common rush; *Pohl* 497, 1936 (WIS)
Juncus tenuis Willd., path rush (1665, 2024)
Luzula acuminata Raf. var. *acuminata*, hairy wood rush (1462)
Luzula multiflora (Ehrh.) Lej. subsp. *multiflora*, common wood rush (1502)

LILIACEAE (Lily Family)
Erythronium albidum Nutt., white trout lily (1459)
Lilium michiganense Farw., Michigan lily (1761)

ORCHIDACEAE (Orchid Family)
Cypripedium acaule Aiton, moccasin flower (1692)
Cypripedium parviflorum Salib. var. *pubescens* (Willd.) O. W. Knight, large yellow lady's slipper (1971)
Galearis spectabilis (L.) Raf., showy orchis (1557)
Goodyera pubescens (Willd.) R. Br., downy rattlesnake-plantain (1430)
Liparis liliifolia (L.) Rich. ex Lindl., lily-leaved twayblade (1771, 2188)

Platanthera psycodes (L.) Lindl., purple fringed orchid (520)

POACEAE (Grass Family)

Agrostis perennans (Walter) Tuck. var. *perennans*, autumn bent grass (2034)
Agrostis scabra Willd., tickle grass (1730, 1731)
Andropogon gerardii Vitman, big bluestem grass (1816)
Brachyelytrum aristosum (Michx.) P. Beauv. Ex Branner & Coville, northern shorthusk (1674)
Brachyelytrum erectum (Schreb.) P. Beauv., long-awned wood grass (1432)
Bromus ciliatus L., fringed brome (534)
**Bromus inermis* Leyss., smooth brome (1697, 2002)
Bromus latiglumis (Shear) Hitchc., ear-leaved brome; *Shinners* 2858, 1940 (WIS)
Bromus pubescens L., hairy woodland brome (1696, 1810)
Calamagrostis canadensis (Michx.) P. Beauv., blue-joint grass (1832)
Cenchrus longispinus (Hack.) Fernald, sandbur (1848)
Cinna arundinacea L., common wood reed (2135, 2136, 2227)
Cinna latifolia (Gopp.) Griseb., drooping wood reed; *Fassett* 5392, 1929 (WIS)
**Dactylis glomerata* L., orchard grass (1626)
Danthonia spicata (L.) Roem. & Schult., poverty oatgrass (527, 1643, 1858)
Dichanthelium acuminatum (Sw.) Gould & C. A. Clark subsp. *fasciculatum* (Torr.) Freckmann & LeLong, western panic grass (1711)
Dichanthelium boreale (Nash) Freckmann, northern panic grass; *Freckmann* 4324, 1996 (UWSP)
Dichanthelium latifolium (L.) Harvill., broad-leaved panic grass (1656)
Dichanthelium leibergii (Vasey) Scribn., Leiberg's panic grass; *Cochrane* 5332, 1927 (WIS)
Dichanthelium linearifolium (Scribn.) Gould, linear-leaved panic grass (1712)
Dichanthelium oligosanthes (Schult.) Gould subsp. *scribnerianum* (Nash) Freckman & LeLong (1634)
Dichanthelium perlongum (Nash) Freckmann, long-stalked panic grass (1657)
Dichanthelium xanthophysum (A. Gray) Freckmann, pale panic grass; *Freckmann* 4322, 1996 (UWSP)
**Digitaria ischaemum* (Schreb.) Muhl., smooth crabgrass (2073)
Echinochloa muricata (P. Beauv.) Fernald, barnyard grass (537, 2057)
Echinochloa walteri (Pursh) A. Heller, coast barnyard grass (2108, 2117)
Elymus canadensis L., Canada wild-rye (1889)
Elymus hystrix L., bottlebrush-grass (521)
**Elymus repens* (L.) Gould, quackgrass (1717)
Elymus villosus Muhl., downy wild-rye (1819, 1852)
Elymus virginicus L. var. *virginicus*, Virginia wild-rye (1426)
Eragrostis capillaris (L.) Nees, lace grass; *Fassett* 5472, 1927 (WIS)
Eragrostis cilianensis (All.) Vignolo ex Janch., stink grass (2096)
Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb., creeping love grass (2129)
Eragrostis pectinacea (Michx.) Nees var. *pectinacea,* low love grass (2056)
Festuca subverticillata (Pers.) E. B. Alexeev, nodding fescue (526, 528, 1729)
Glyceria canadensis (Michx.) Trin., rattlesnake mannagrass (2060)
Glyceria grandis S. Watson, American mana grass; *Patman* s.n., 1959 (WIS)
Glyceria striata (Lam.) Hitchc., fowl mannagrass (529, 1675, 1724, 1725)
Hesperostipa spartea (Trin.) Barkworth, porcupine grass (1999)
Hierochloë hirta (Schrank) Borbás, hairy sweetgrass (1981)
Koeleria macrantha (Ledeb.) Schult., Junegrass (1642)
Leersia oryzoides (L.) Sw., rice cut grass (2054)
Leersia virginica Willd., white grass (1838, 1892)
Milium effusum L., American millet grass (1566, 1695)
Muhlenbergia frondosa (Poir.) Fern., common satin grass; *Shinners* 2856, 1940 (WIS)
Muhlenbergia mexicana (L.) Trin., leaft satin grass; *Shinners* 2854, 1940 (WIS)
Oryzopsis asperifolia Michx., rough-leaved rice grass (1456, 1489, 1966)
Panicum capillare L., common witch grass (2079, 2121)
Panicum philadelphicum Trin., Philadelphia panic grass (2109)

Panicum virgatum L., switchgrass (532, 535, 536)
Phalaris arundinacea L., reed canary grass (1996)
**Phleum pratense* L., subsp. *pratense*, timothy (1788)
Phragmites australis (Cav.) Trin. Ex Steud., common reed grass (2063)
Piptatherum racemosum (Sm.) Eaton, black-seeded rice grass (2094)
**Poa annua* L., annual bluegrass (2007)
**Poa compressa* L., Canada bluegrass (2003)
Poa palustris L., marsh bluegrass (1529, 1722, 1723)
**Poa pratensis* L., Kentucky bluegrass (1550)
Schizachne purpurascens (Torr.) Swallen, false melic (1482)
Schizachyrium scoparium (Michx.) Nash, little bluestem (1930)
**Setaria faberi* R. A. W. Herrm., giant foxtail (2078)
**Setaria pumila* (Poir.) Roem. & Schult. subsp. *pumila*, yellow foxtail (2038)
**Setaria viridis* (L.) P. Beauv., green foxtail (1793)
Sorghastrum nutans (L.), Nash., Indian grass (1433)
Spartina pectinata Link, prairie cord-grass (530)
Sporobolus heterolepis (A. Gray) A. Gray, prairie drop seed (2017, 2126)

POTAMOGETONACEAE (Pondweed Family)
Potamogeton crispus L., curly pondweed (1801)
Potamogeton nodosus Poir., long-leaf pondweed (1904)
Potamogeton pusillus L., slender pondweed (1799, 1907)
Zannichellia palustris L., horned-pondweed (2238, 2239)

SMILACACEAE (Catbrier Family)
Smilax ecirrhata S. Watson, upright carrion flower (1558, 1968, 1975)
Smilax hispida Raf., bristly greenbriar (1689)
Smilax lasioneura Hook., common carrion flower (1985)

TRILLIACEAE (Trillium Family)
Trillium cernuum L., nodding trillium (1589)
Trillium flexipes Raf., declined trillium (1466)
Trillium grandiflorum (Michx.) Salisb., big white trillium (1465)

TYPHACEAE (Cat-Tail Family)
Sparganium eurycarpum Englm., common bur-reed; *Pohl* 527, 1936 (WIS)
Typha angustifolia L., narrow-leaved cat-tail (1739)
Typha latifolia L., broad-leaved cat-tail (1759)
Typha ×*glauca* Godr., hybrid cat-tail (1740)

COMPARATIVE ANALYSIS OF URBAN AND RURAL FOREST FRAGMENT STRUCTURE AND DIVERSITY IN NORTHEASTERN INDIANA

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ABSTRACT

Although it was once continuously forested, the land cover in northeastern Indiana is now dominated by agriculture, and sparsely occurring forest fragments now constitute only approximately 8% of the land cover. A majority of these forest fragments are privately owned and have a history of some form of active forest management. We conducted a systematic ecological survey of understory, midstory, and overstory plant species in three forests that have differing protection and management histories to compare the effects of these different histories. Historical aerial images of each forest were compared to gauge the canopy structure and to clarify the management history for the forests. The percentage of canopy cover and the floristic quality indices (FQI) each followed expected trends, whereby the highest FQI value and percentage of canopy cover occurred in the forest with the longest history of preservation. Lower values of species richness for the understory, midstory, and overstory strata, respectively, were found in the forest that has a history of overstory management and for which there is no defined protection status. The understory species were each generally limited to one of the forests, whereas the species composition of the midstory and overstory strata were much more similar among the three forests. Measurements of forest basal area and percentage of canopy cover provide some explanation of the distribution of understory and midstory species in nonmetric multidimensional scaling ordination plots. The amount of forest protection, measured by the time since disturbance and the percentage of canopy closure, influenced the richness of the understory and the FQI of a given plot. Furthermore, the location of a forest was an important factor in the relative occurrence of non-native species, the most rural forest having no non-native species.

KEYWORDS: Fogwell Forest Nature Preserve, Mengerson Nature Preserve, fragmentation, floristic quality index, forest management

INTRODUCTION

According to the National Land Cover Database (Fry et al. 2011), the Midwest region of the United States is dominated by agriculture with over 60% of land cover in cultivated crops, pasture land, or other open-field agricultural practices; forests account for only 20% of the land cover. Urban and suburban development has increased fairly continuously in the region for well over 60 years

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(Radeloff et al. 2005). Because there are large areas of contiguous forested land in northern Michigan, Minnesota, and Wisconsin, the percentage of land cover devoted to agricultural uses in the Midwest as a whole understates the situation in the southern part of the region, where cultivated and pastoral agricultural lands account for 80–90% of the land cover (Radeloff et al. 2005) and where forests are fragmented into relatively small woodlots. These woodlots generally have high edge-to-interior ratios, thereby increasing the area of forest subject to influence by the surrounding land matrix, which is typically agricultural, but also includes developed urban and suburban land (Brothers and Spingarn 1992; Gonzalez et al. 2010). Urbanization results in changes to the understory of forest fragments, shifting community composition away from native species toward non-native species, as well as potentially homogenizing previously distinct communities (Kühn and Klotz 2006; Dolan et al. 2011).

Much of the Central Till Plain region of Indiana was forested prior to European settlement and was dominated by flatwoods (Hedge 1997). This physiographic region covers much of the central and northeastern portions of Indiana with the southern boundary delineated by the southern reaches of the Wisconsinan ice sheet (Hedge 1997). As a result of extensive agricultural and urban development, forests now account for only 20.3% of the land cover in the entire state, the majority of which is privately owned (Woodall et al. 2009). Forest conservation efforts in Indiana have increased steadily with the inclusion of private forests in classified forest and cooperative forest management programs (IDNR 2010).

Understory and midstory plant communities are directly influenced by the structure and composition of the overstory community (Jameson 1967; Roberts 1992). Changes in the overstory by anthropogenic manipulation will alter those lower strata, which could be positive or negative depending on the community and the manipulation (Meier et al. 1995; Albrecht and McCarthy 2006). Additionally, isolation of forest fragments from other forests alters understory composition, negatively affecting a large proportion of species (McKinney and Lockwood 1999). Fragmentation impacts are long term and may persist on local or regional scales (Vellend et al. 2006). Land managers are therefore interested in quantifying the floristic integrity of a given plant community in light of forest fragmentation and anthropogenically induced disturbances (Rothrock 2004). Floristic quality assessments, as defined by Swink and Wilhelm (1994), have been applied to several different ecosystem types and, within a single ecosystem type, to those under different management strategies (e.g., Francis et al. 2000; Lopez and Fennessy 2002, Bacone et al. 2007; Rothrock et al. 2011). The need to understand the influence of forest protection and preservation on the floristic structure and composition of forest fragments is the principal reason we have undertaken this study.

The objectives of this study were 1) to quantify the understory, midstory, and overstory plant communities in three forests in northeastern Indiana with respect to species richness, diversity, and evenness, 2) to relate the composition and diversity of plant communities to characteristics of forest structure, and 3) to test the hypothesis that the management history and the characteristics of the surrounding land matrix will influence the species composition of the understory and midstory of these three forest fragments.

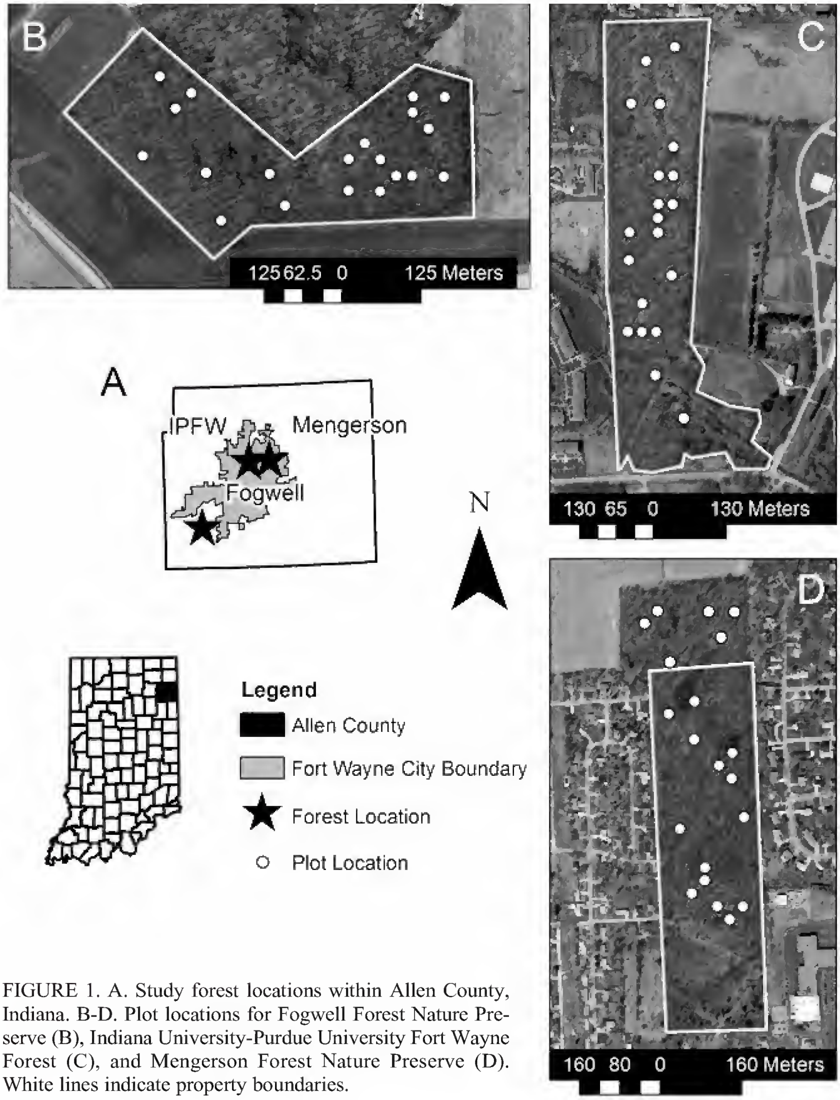

FIGURE 1. A. Study forest locations within Allen County, Indiana. B-D. Plot locations for Fogwell Forest Nature Preserve (B), Indiana University-Purdue University Fort Wayne Forest (C), and Mengerson Forest Nature Preserve (D). White lines indicate property boundaries.

MATERIALS AND METHODS

Study Sites

Three forests in Allen County, Indiana, were selected for comparison (Figure 1A). Two of them, Fogwell Forest Nature Preserve (Fogwell) (40°59′50″ N, 85°14′37″ W; Figure 1B) and Mengerson Nature Preserve (Mengerson) (41°7′35″ N, 85°4′4″ W; Figure 1D), are owned and managed by ACRES Land Trust and are designated nature preserves by the Indiana Department of Natural Resources. The third forest (IPFW) (41°7′22″ N, 85°7′18″ W; Figure 1C) is owned and managed by Indiana University-Purdue University Fort Wayne. IPFW and Mengerson are in the Auburn Morainal

Complex physiographic division, and Fogwell is in the Bluffton Till Plain physiographic division (Franzmeier et al. 2004). All three forests are located adjacent to the boundary between these two physiographic divisions, which are contained in the broader Central Till Plain Natural Region, and all three are dominated by Blount-Morley silt loam soils (NRCS 2013).

Fogwell Forest Nature Preserve is a 24.8 ha property, approximately 12.3 ha of which has a continuous forest canopy (ACRES 2008). A small housing subdivision lies to the north of Fogwell, and the remaining adjacent land consists of cultivated agricultural land and privately-owned hardwood forest. Rothrock (1997) described the forested portion of Fogwell as being donated to ACRES Land Trust in 1976, prior to which the land had been designated a classified forest in the 1930s, which placed limits on the removal of trees from the forest. The Classified Forest program in Indiana is managed by the Department of Natural Resources Division of Forestry and provides protection of privately-owned forests against large anthropogenic disturbances, while providing the land owner with a reduced tax assessment (IDNR 2015). Because of this designation, Fogwell has remained a mature closed canopy forest since the 1930s (Figure 2A).

IPFW, a forested tract of land approximately 13.8 ha in area that is adjacent to the university campus, was acquired by the university in 2004. Little documentation is available regarding its management history, but historical aerial photos indicate that the property has been continuously forested since the late 1930s (Figure 2B). However, the canopy does not appear to have been as dense or as completely closed as the canopy at Fogwell. IPFW is bounded by residential neighborhoods to the north and west, commercial properties to the west and south, and intensely managed athletic fields to the east.

Mengerson Nature Preserve is an approximately 14.4 ha forest that was donated to ACRES Land Trust in 1973 (ACRES 2008). Unlike Fogwell and IPFW, Mengerson was forested only in the northern 1/3 during the 1930s (Figure 2C). Over the subsequent decades, several species of trees have colonized the southern 2/3 of Mengerson, resulting in an early successional forest. Even now, however, the southern 1/3 of Mengerson is only sparsely forested (Figure 1D).

Methods

Within each forest, an initial grid of points with 25.25 m spacing was overlaid on aerial images, and 20 grid points were randomly selected to serve as plot center locations, using ArcMap (version 9.3.1, ESRI, Redlands, California). The spacing of the initial grid points was selected in a manner to ensure that adjacent overstory plots (defined below) did not overlap. At each plot center, understory, midstory, and overstory survey plots were established. Each understory plot consisted of two 1 m^2 quadrats diagonal from each other with sides parallel to the cardinal directions (the southwest corner of one quadrat and the northeast corner of the other were each at the plot center). Within the understory survey plots, all individual plants less than 2 m in height were identified to the finest taxonomic level possible (typically species) and counted. Each midstory survey plot consisted of a 5 * 5 m square plot with the sides parallel to the cardinal directions. All individual stems greater than 2 m in height and less than 8 cm diameter at breast height (dbh) were identified to species and counted. Overstory survey plots consisted of 500 m^2 circular plots (12.62 m radius). All overstory stems (i.e., those greater than 8 cm dbh) were measured for dbh, identified to species, and counted. Voucher specimens for each taxon identified in the understory plots were deposited in the Indiana University-Purdue University Fort Wayne Department of Biology herbarium. All surveys and data collection were conducted during September and October 2013.

At each plot center, basal area per species was assessed with a basal area 10-factor prism. Canopy cover was measured using a concave spherical densiometer following standard protocols (i.e. taking measurements 1 m above ground, averaging measurements taken facing the four cardinal directions). Litter depth was also measured in each plot at the plot center and at a point 6.3 m from the center toward each of the four midstory plot corners. Measurements of canopy cover and litter depth were compared between forests using analysis of variance (ANOVA) with a Tukey-Kramer post-hoc test. Relationships between litter depth, total overstory density (stems / 500 m^2 plot), and total midstory density (stems / 25 m^2 plot) were tested with a Spearman-Rank correlation (due to violations of normality assumptions).

Species richness (S = number of species), Shannon's diversity index ($H' = -\Sigma p_i \ln p_i$, where p_i is the proportion of the *i*th species), and Pielou's evenness index ($J' = H' / \ln S$), were calculated for each strata at the plot level. These three measures were then compared among the forests using ANOVA with a Tukey-Kramer post-hoc test. Using the coefficient of conservatism for the understory species listed by Rothrock (2004), we calculated an unweighted mean coefficient of conser-

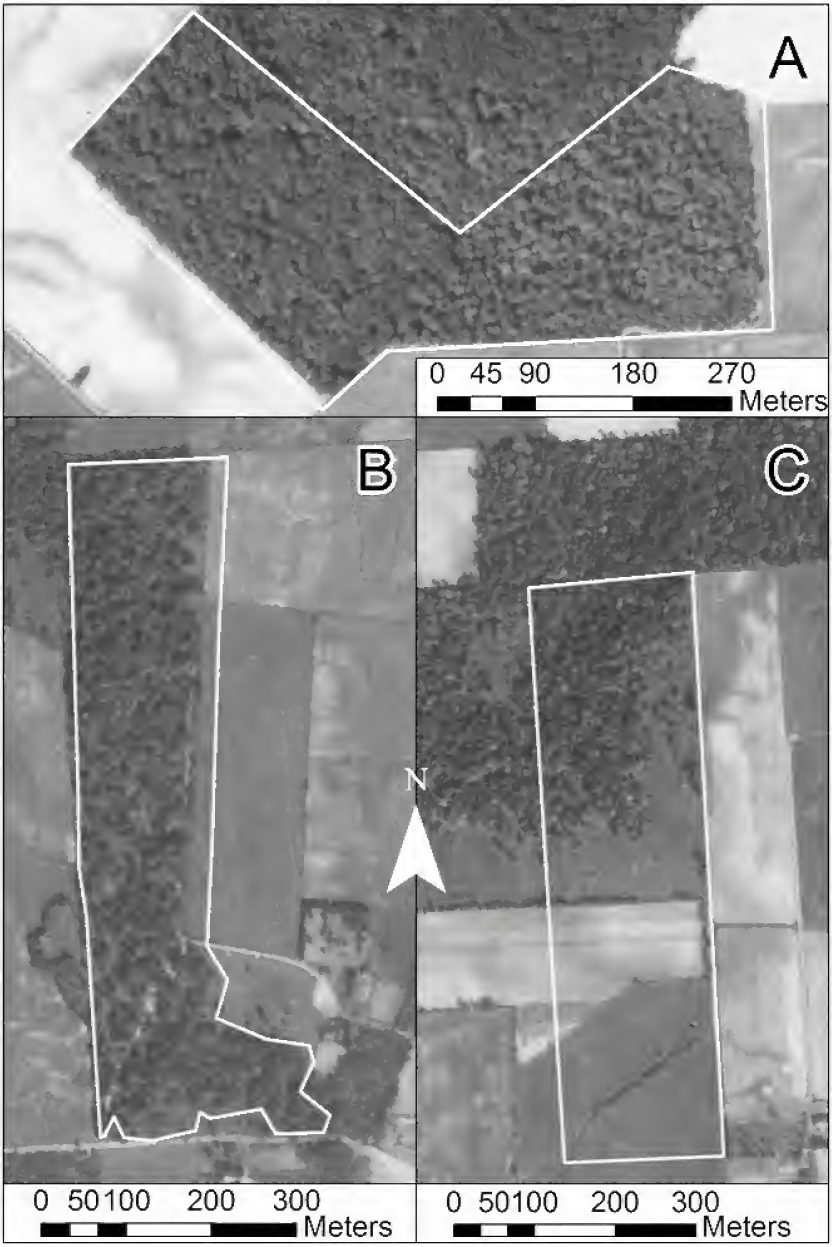

FIGURE 2. Aerial images from 1938 for (A) Fogwell (IHAPI 2013a), (B) IPFW (IHAPI 2013b), and (C) Mengerson (IHAPI 2013c) forests. White forest boundaries are from the 2013 field study. Georectification complications resulted in boundary errors on the eastern edges of Fogwell and IPFW.

vatism (C_{mean}) for each forest and the floristic quality index (FQI = C_{mean} * √number of native plant species) for each forest. Coefficient of conservatism (C-value) is a numerical value used to describe the "nativeness" of a plant species in relation to anthropogenic disturbance (Swink and Wilhelm 1994, Rothrock 2004); the greater the C-value assigned to a species, the more likely it is associated with remnant habitats similar to those existing prior to European settlement (range 1–10, 0 for non-native species). FQI provides a calculated value for the quality and natural importance of a plant community based on the C-values assigned to the species within that community (Rothrock 2004). Similarities among the forests in the understory and midstory survey plots were visualized with non-metric multidimensional scaling (NMDS) ordination using methods described by Kruskal (1964a,b). Dissimilarities were characterized using Bray-Curtis distances, which allow for a visual representation of dissimilarity in species abundances. Within the NMDS figure, species plotted closer together are less dissimilar than those farther apart. For both understory and midstory NMDS ordinations, relationships between species and forest basal area, percent canopy cover, and litter depth were visualized with vector plots associated with the ordination (cutoff α = 0.1, iterations = 1000). We selected our cutoff for the vectors in order to increase the likelihood of displaying basal area, canopy cover, and litter depth on the NMDS ordination plot. Importance values for each overstory species in each forest were calculated as the sum of the relative frequency, the relative dominance, and the relative density of that species; where relative frequency = number of plots in which a species occurred / total number of plots * 100, relative dominance = basal area of a species / total forest basal area * 100, and relative density = number of stems of a species / total number of stems * 100. All statistical analyses were conducted using R (version 3.0.2, The R Foundation for Statistical Computing) base and vegan packages.

RESULTS

In both IPFW and Mengerson, all 20 plot locations were surveyed. However, due to time constraints, only 17 plots at Fogwell were surveyed. In Mengerson, six plots were outside of the north property boundary at the time of study, but were in a section of the forest in the process of being acquired by ACRES Land Trust (Figure 1D). Canopy cover was significantly greater in Fogwell than in the other two forests (F = 5.77, df = 2,54, P = 0.005; Figure 3A). Litter depth at

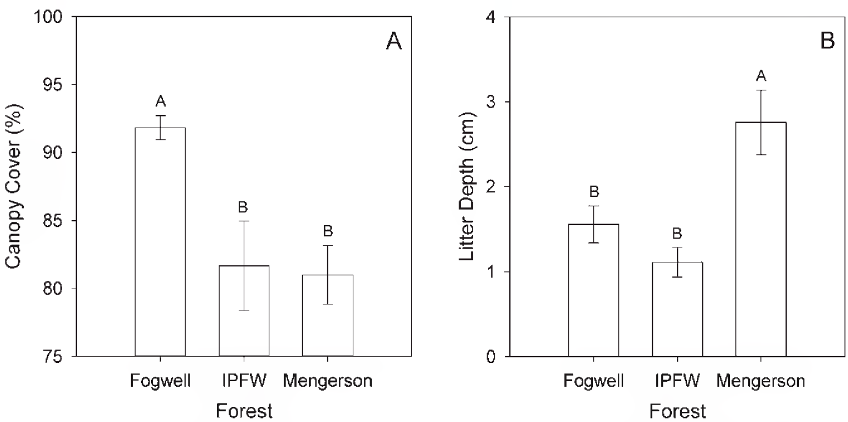

FIGURE 3. Percentage of canopy cover (A) and litter depth (B) in Fogwell, IPFW, and Mengerson forests. Bars that do not share the same letter are significantly different. Error bars represent one standard deviation about the mean.

Mengerson was significantly deeper than at the other two forests ($F = 9.76$, df = 2,54, $P < 0.001$; Figure 3B).

Understory

A total of 75 species was encountered within the understory strata of the surveyed forests (Appendix I). Fogwell and IPFW were significantly different in species richness ($F = 3.82$, df = 2,54, $P = 0.028$) (Figure 4A). However, the three forests were not significantly different in understory diversity ($F = 2.67$, df = 2,53, $P = 0.079$) (Figure 4B), which is likely related to a lack of difference in evenness between forests ($F = 1.10$, df = 2,46, $P = 0.341$). Similarly, C_{mean} was not significantly different between the forests ($F = 0.94$, df = 2,84, $P = 0.396$) (Table 1). However, Fogwell had both the greatest percentage of species with a coefficient of conservatism ≥ 5 and the highest FQI value (Table 1). The forest understories had limited overlap in species composition, sharing only 14.6% of species between Fogwell and IPFW, 14.3% between IPFW and Mengerson, and 12.5% between Fogwell and Mengerson. The limited overlap in species was visually evident in the NMDS ordination analysis (Figure 5A). The basal area, the canopy cover, and the litter depth each met the cutoff for inclusion as vectors (Figure 5B).

Midstory

A total of 16 species was encountered within the midstory strata of the surveyed forests (Appendix II). IPFW and Mengerson differed significantly in both species richness ($F = 10.23$, df = 2,54, $P < 0.001$) (Figure 4C) and in diversity ($F = 5.03$, df = 2,49, $P = 0.010$) (Figure 4D). Species evenness was not significantly different between the forests ($F = 3.07$, df = 2,48, $P = 0.056$). Midstory density (stems / 25 m^2 plot) was significantly greater in Mengerson, with 4 and 3 times more stems per plot than in Fogwell and IPFW, respectively ($F = 20.24$, df = 2,54, $P < 0.001$). Furthermore, midstory density and litter depth were positively correlated ($r = 57.00$, $P = 0.003$). However, litter depth was not correlated with either midstory species richness ($r = 0.07$, $P = 0.611$) or diversity ($r = 0.06$, $P = 0.635$). Unlike the understory strata, the midstory strata in the three forests were fairly similar in species composition, sharing 40.0% of species between Fogwell and IPFW, 31.3% between IPFW and Mengerson, and 35.7% between Fogwell and Mengerson. The similarity was visually evident in the NMDS ordination analysis (Figure 6A). Vector angle indicates relative direction of influence and vector length indicates relative strength of the influence. For example, *Acer saccharum* (ACSA3) and *Ostrya virginiana* (OSVI), both shade-tolerant species, increased in abundance as the percentage of canopy cover increased. Similarly, the shade-intolerant *Crataegus mollis* (CRMO2) decreased in abundance as the percentage of canopy cover increased (Figure 6B).

Overstory

A total of 34 species was encountered within the overstory strata of the surveyed forests (Appendix III). The relationship of the species richness of the

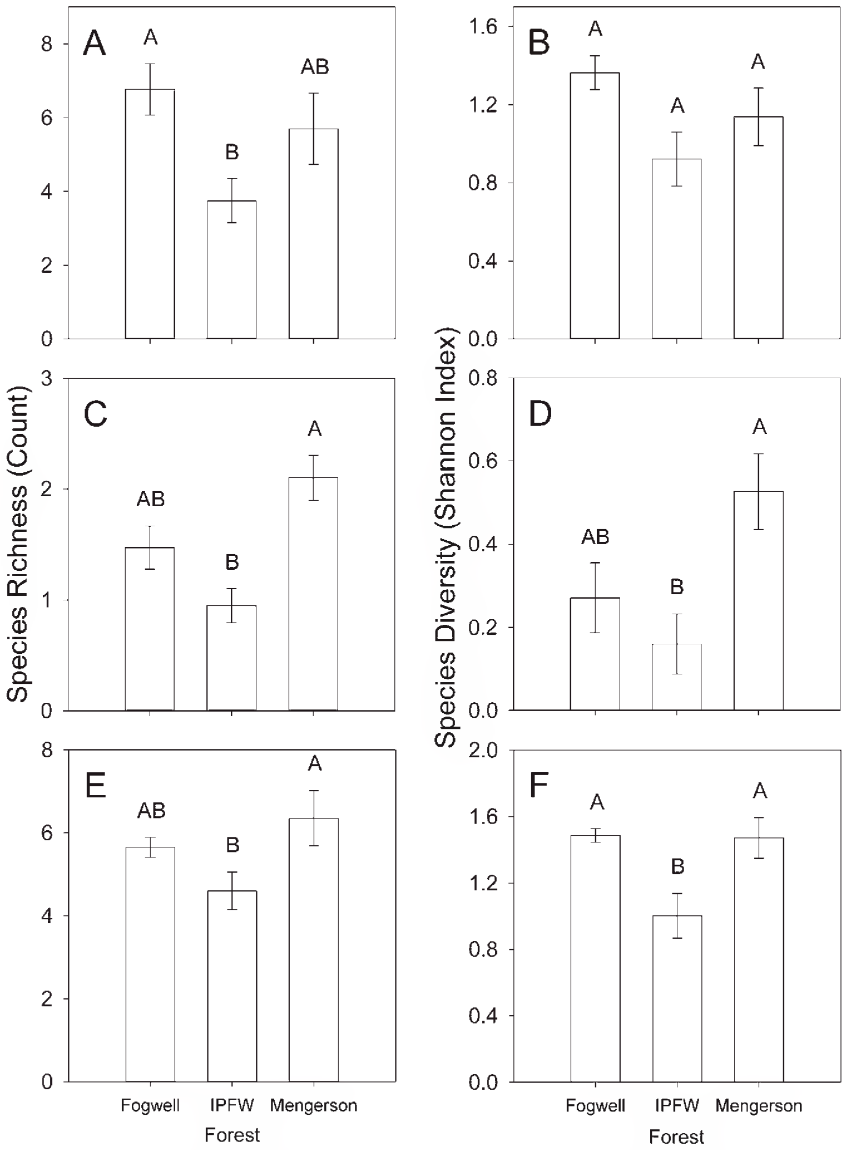

FIGURE 4. Species richness and species diversity for understory (A, B), midstory (C, D), and overstory (E, F) strata plants in Fogwell, IPFW, and Mengerson forests. Bars that do not share the same letter are significantly different. Error bars represent one standard deviation about the mean.

TABLE 1. For the understory stratum in each forest studied, the mean coefficient of conservatism (C_{mean}) (standard error in parentheses), the count of species for which the coefficient of conservatism (C) is ≥ 5 (the percentage of those species relative to all species in the midstory stratum of the forest is given in parentheses), and the floristic quality index (FQI).

Forest	C_{mean} (standard error)	Count for C ≥ 5 (percentage)	FQI
Fogwell	4.1 (0.4)	13 (41.9%)	23.4
IPFW	3.4 (0.5)	8 (28.6%)	18.6
Mengerson	3.6 (0.4)	7 (25.0%)	18.9

overstory strata of the three forests followed a pattern similar to that observed in the midstory strata. IPFW and Mengerson differed significantly from each other (F = 3.20, df = 2,54, P = 0.049) (Figure 4E). However, the overstory diversity of IPFW was significantly lower than that of Fogwell and Mengerson (F = 6.09, df = 2,54, P = 0.004) (Figure 4F). As a result, IPFW had the lowest evenness value of the three forests (F = 7.18, df = 2,54, P = 0.002). At IPFW, *A. saccharum* accounted for 62.1% of the overstory individuals. Overstory densities were not significantly different between the three forests, with an overall mean of 19.6 stems / 500 m^2 (± 8.3 stems) (F = 0.68, df = 2,54, P = 0.509). Litter depth was not correlated with overstory density (r = –0.07, P = 0.588), species richness (r = 0.07, P = 0.644), or diversity (r = 0.04, P = 0.784). As with the midstory, the overstory strata of the three forests were more similar in species composition than were the understory strata, sharing 35.7% of species between Fogwell and IPFW, 37.5% between IPFW and Mengerson, and 58.6% between Fogwell and Mengerson. A strong visual overlap can be seen in the NMDS ordination analysis between Mengerson and the other two forests, but less so between Fogwell and IPFW (Figure 7A). Basal area and percentage of canopy cover vectors were not included in the NMDS ordination analysis of pooled species due to collinearity (Figure 7B).

Acer saccharum was the most important overstory species in all three forests (Table 2). It had the greatest values for density of stems, for frequency, and for basal area. There was some overlap in the top five overstory species. *Tilia americana* occurred in all three forests, *Quercus rubra* in Fogwell and Mengerson, and *Ulmus americana* in IPFW and Mengerson (Table 2). Some species occupied high ranking positions in only one of the three forests. For example *A. saccharinum* was among the top five in Mengerson (#3), but did not occur at all in the other two forests; *Carya ovata* (#2) and *Fagus grandifolia* (#3) were both in the top five in Fogwell, but were less important in the other two forests; and *Juglans nigra* (#5) and *Ulmus rubra* (#4) were much more important in IPFW than in the other two forests (Table 2).

DISCUSSION

The three selected forests are located within close proximity of each other (each is approximately 4-16 km from the other two) and, prior to the large-scale

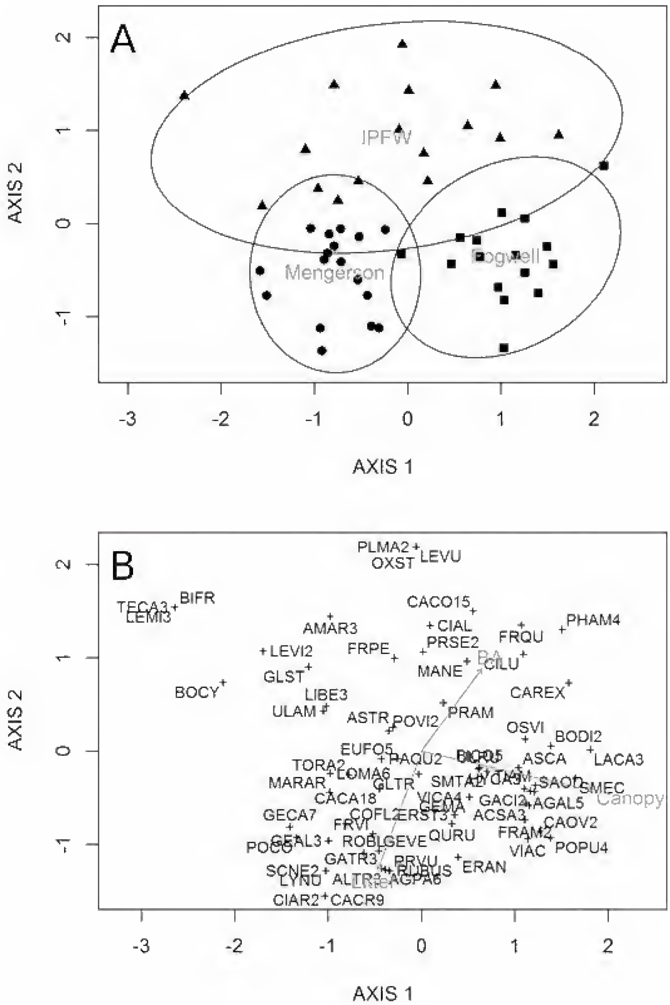

FIGURE 5. Nonmetric multidimensional scaling (NMDS) ordination of understory (final stress = 0.12) for (A) survey plots for Fogwell (squares), IPFW (triangles), and Mengerson (circles) with 95% confidence ellipses for each forest; and (B) pooled species. Direction and length of vectors (gray) for basal area (BA), percentage canopy cover (Canopy), and litter depth (Litter) indicate influence on species occurrence. Species letter codes follow USDA (2014).

conversion of forest to cultivated agricultural land and urban development, were likely connected by contiguous forested land. There have been distinct differences in the protection and management regimes of these forests. Fogwell has received protection for over 80 years, while IPFW and Mengerson have received protection for only 10 years and 40 years, respectively. IPFW has undergone

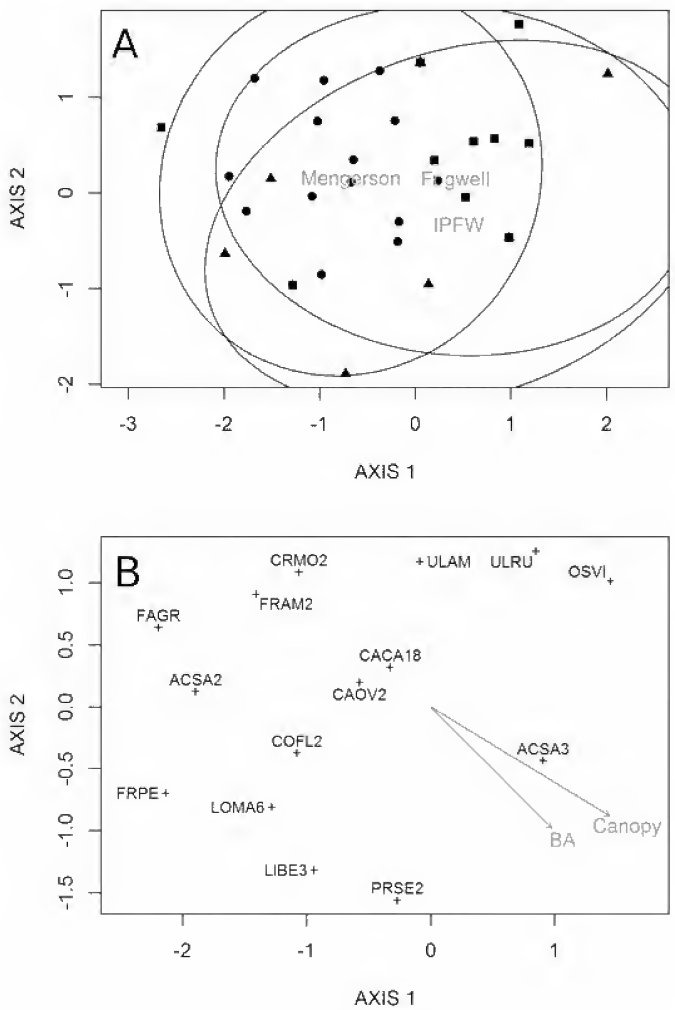

FIGURE 6. Nonmetric multidimensional scaling (NMDS) ordination of midstory (final stress = 0.08) for (A) survey plots for Fogwell (squares), IPFW (triangles), and Mengerson (circles) with 95% confidence ellipses for each forest; and (B) pooled species. Direction and length of vectors (gray) for basal area (BA) and percentage canopy cover (Canopy) indicate influence on species occurrence. Species letter codes follow USDA (2014).

decades of passive protection (i.e. without management), and the closure of its canopy likely occurred decades after that at Fogwell, but before that at Mengerson. Although Mengerson has been actively protected since the 1970s, its canopy has only recently closed, as is apparent from historical aerial imagery.

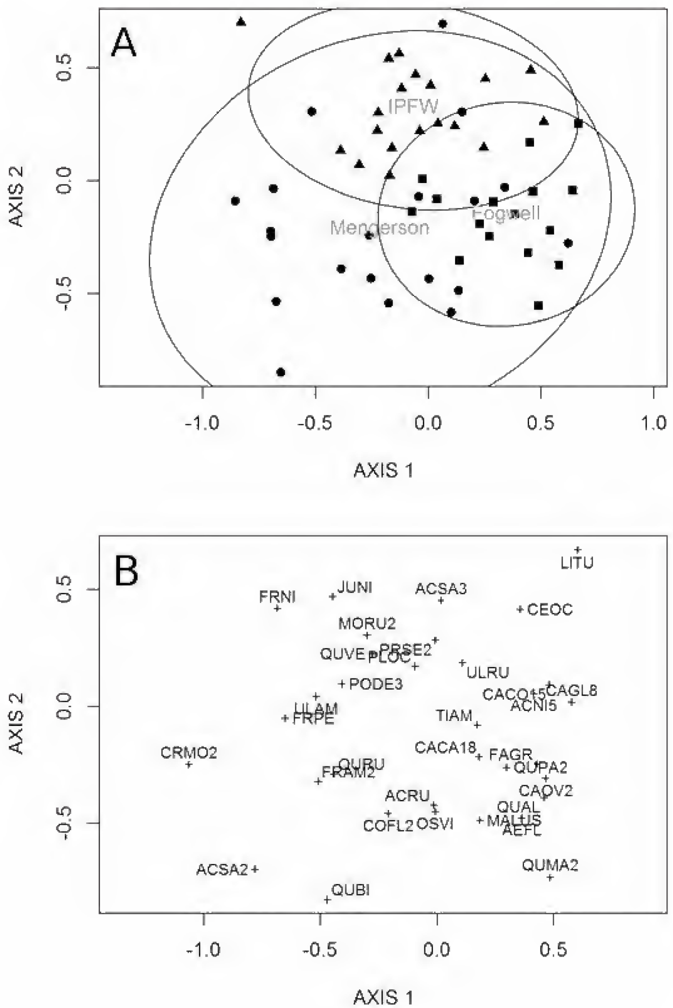

FIGURE 7. Nonmetric multidimensional scaling (NMDS) ordination of overstory (final stress = 0.22) for (A) survey plots for Fogwell (squares), IPFW (triangles), and Mengerson (circles) with 95% confidence ellipses for each forest; and (B) pooled species. Species letter codes follow USDA (2014).

The difference observed in canopy cover was expected, given the differences in the history of management at the three forests. Both IPFW and Mengerson have histories of overstory tree removal, which is evidenced by the patchy canopy visible in aerial images from the late 1930s (Figure 2). A simple visual comparison of aerial images indicates that IPFW and Mengerson are likely now at a canopy closure state similar to that of Fogwell from the 1930s to the 1950s.

TABLE 2. Importance values of the top 10 overstory species in each of the forests studied. The rank of each species within a forest is given in parentheses.

Species	Fogwell	IPFW	Mengerson
Acer saccharinum	—	—	22.7 (3)
Acer saccharum	87.6 (1)	129.0 (1)	40.1 (1)
Carya cordiformis	9.7 (8)	—	—
Carya ovata	39.6 (2)	—	20.4 (6)
Celtis occidentalis	—	9.6 (9)	—
Fagus grandifolia	37.1 (3)	—	—
Juglans nigra	6.4 (10)	21.7 (5)	12.1 (10)
Ostrya virginiana	—	—	15.9 (7)
Platanus occidentalis	—	6.6 (10)	—
Prunus serotina	—	13.2 (6)	—
Quercus alba	18.7 (6)	—	12.6 (9)
Quercus bicolor	—	—	12.7 (8)
Quercus rubra	25.0 (5)	11.0 (7)	35.5 (2)
Quercus velutina	—	10.9 (8)	—
Tilia americana	29.2 (4)	28.3 (2)	21.2 (5)
Ulmus americana	7.6 (9)	24.1 (3)	22.0 (4)
Ulmus rubra	15.7 (7)	23.5 (4)	—

Although litter depth was significantly different statistically between the three forests, of which Mengerson had the deepest litter, the numerical difference (ranging from 1.1 to 2.8 cm) may not have been biologically significant. Litter depth is a complex and dynamic relationship between addition and removal of litter (Facelli and Pickett 1991). Because of the close proximity of the three forests to each other, climate differences are likely to be very minor, resulting in little difference in rainfall or length of the growing season; decomposition rates are typically regulated by moisture and temperature (Facelli and Pickett 1991). The cause of the differences in litter depth would likely be related to differences in midstory densities, Mengerson had both the deepest litter, as well as the richest and densest midstory.

Rothrock (1997) originally calculated a C_{mean} of 5.6 for Fogwell. However, after Rothrock (2004) modified the coefficient of conservation values for Indiana specifically, C_{mean} for Fogwell was recalculated as 4.1 (Rothrock and Homoya 2005). This new value aligns exactly with our calculated C_{mean} for Fogwell (4.1). However, our calculated FQI (23.4) was less than half the value (59.3) calculated for previous surveys (Rothrock and Homoya 2005). This demonstrates the difficulty of comparing floristic survey and ecological survey studies in relation to various metrics of diversity or ecology. Rothrock (1997) conducted a floristic survey of Fogwell with the explicit intent of producing a full inventory of the preserve, which formed the basis of the calculation by Rothrock and Homoya (2005). In contrast, we conducted an ecological survey with the intent of providing a comparison between forests with different management histories and different types of surrounding development. Thus, C_{mean} for each of the three forests is based on species with moderately high to high tolerances for disturbance, using the C-values assigned by Rothrock (2004). All three forests have experienced anthropogenic disturbances related to forest management, although at different times for each forest. While using C-values to compare communities should done cautiously, comparing counts of species above or below a threshold may provide insight into forest disturbance or persistence. A C-value ≥ 5 for a given species indicates it is likely to be found in remnant areas similar to pre-settlement habitats (Rothrock 2004; Rothrock and Homoya 2005). The relatively high percentage of species in Fogwell with a C-value ≥ 5 suggests that the understory plant community has recovered or simply persisted from limited anthropogenic disturbances in the 1930s (i.e., more species are adapted to less disturbance). Inversely, the lower percentage of species at IPFW and Mengerson with a C-value ≥ 5 suggests that the recent disturbances in forest management are still evident in the understory communities, which is likely related to the later canopy closure in these forests. While C_{mean} was not significantly different between the three forests, the FQI for Fogwell was substantially greater than it was for IPFW and Mengerson. Again, the difference is related to the time that has elapsed since the most recent disturbance and to the percentage of canopy closure within the three forests, Fogwell having experienced little or no disturbance since the 1930s.

The density of the midstory is likely related to the time of canopy closure (e.g., Mengerson had the most recent canopy closure and the highest density in midstory individuals), and likely was the driver in accumulation of forest litter. Although IPFW has had some anthropogenic disturbance related to forest management, the canopy appears to have been much denser in the 1930s than the canopy at Mengerson. The greater canopy density may have been an important factor in the greater similarity in both the species observed at Fogwell and IPFW and the midstory and overstory densities in those two forests. Because active forest management has essentially stopped at IPFW and Mengerson, the overstory density in both forests has reached similar values as that of Fogwell. While the similarity in overstory species between forests is relatively high, several of the top five and top ten most important species are unique to a single forest. Those most important species are providing the physical structure of the forest. In addition to being the most important species in the overstory, *Acer saccharum* was the most frequent midstory species pooled across the three forests. Due to the ability to maintain small stature individuals for decades in the shade (Marks and Gardescu 1998), *A. saccharum* is a common midstory species in the region. Once canopy gaps form, *A. saccharum* responds and can quickly be recruited into larger size classes (Marks and Gardescu 1998), leading to inclusion in the canopy.

The location of each forest has likely been an additional factor that has influenced the development of understory communities in these forests. In other urban forests, there has been clear increase in non-native plant species (Dolan et al. 2011). Fogwell, which has the richest understory and the greatest FQI value among the forests, is a rural forest. Although there is a small subdivision to the north of Fogwell, it is not surrounded by urban and suburban development, unlike IPFW and Mengerson, each of which were lower in species richness and FQI values. We did not encounter any non-native understory species at Fogwell. In contrast, non-native species accounted for 16% of the understory individuals counted at IPFW and 26% at Mengerson. Again, this is likely related to the proximity of a forest to urban and suburban development and to the time that has elapsed since canopy closure.

While these three forests had similarities in midstory and overstory species, their importance to the region may exist more in their lack of similarity in understory species. Most of the forest fragments in northeastern Indiana and the surrounding region are small privately owned properties that have undergone a broad range of protection and use over the past century. Allowing forests to undergo canopy closure and long-term minimized anthropogenic disturbance may increase understory plant species richness and FQI, as seen in Fogwell. However, as is apparent in the case of IPFW and Mengerson, proximity to urban development may be just as important a factor as time in promoting colonization of understory communities by non-native species.

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APPENDIX I. List of understory species collected at each of the forests studied. Frequency is the number of 2 m^2 plots (out of 17 at Fogwell and 20 at each of IPFW and Mengerson) in which they were encountered. Count is the mean number of individuals (standard deviation in parentheses). Nomenclature follows ITIS (2013). An asterisk (*) indicates non-native species (USDA NRCS 2013). Collection numbers are in parentheses after each species name..

	Fogwell		IPFW		Mengerson	
Species	Frequency	Count	Frequency	Count	Frequency	Count
Acer saccharum Marsh. (1314)	7	4.7 (3.1)	1	1.0		
Ageratina altissima (L.) King & H. Rob. (1267)	2	3.0 (0.0)			1	1.0
Agrimonia parviflora Aiton (1299)					2	4.0 (1.4)
Allium tricoccum Aiton (1243)					2	7.0 (1.4)
Amelanchier arborea (F. Michx.) Fernald (1300)			2	1.0 (0.0)		
Asarum canadense- L. (1277)	12	42.2 (33.1)	3	3.7 (2.1)		
Asimina triloba (L.) Dunal (1282)			1	1.0		
Bidens connata Muhl. ex Willd. (1269)	1	1.0				
Bidens frondosa L. (1270)			1	1.0		
Boehmeria cylindrical (L.) Sw. (1329)			2	39.5 (51.6)	1	3.0
Botrychium dissectum Spreng. (1288)	1	1.0				
Carex cryptolepis Mack. (1337)					1	6.0
Carex spp. (1338)	5	2.8 (0.8)	4	7.0 (5.0)		
Carpinus caroliniana Walter (1264)	1	2.0			1	1.0
Carya cordiformis (Wangenh.) K. Koch (1253)			4	6.3 (3.9)		
Carya ovata (Mill.) K. Koch (1252)	3	1.3 (0.6)				
Cinna arudinacea L. (1283)					2	10.5 (10.5)
Circaea alpina L. (1290)			2	3.5 (0.7)		
Circaea lutetiana L. (1291)			1	3.0		
Cornus florida L. (1256)					9	4.1 (4.1)
Erigeron annuus (L.) Pers. (1271)	3	17.0 (21.9)			4	2.5 (1.0)
Erigeron strigosus Muhl. ex Willd. (1274)					2	12.5 (16.3)
Euonymus atropurpureus Jacq. (1258)	3	3.3 (2.5)				
**Euonymus fortunei* (Turcsz.) Hand.-Maz. (1257)					1	8.0
Fragaria virginiana Duchesne (1302)					4	7.5 (8.2)

(Continued on next page)

APPENDIX I. (Continued).

	Fogwell		IPFW		Mengerson	
Species	Frequency	Count	Frequency	Count	Frequency	Count
Fraxinus americana L. (1240)	13	10.1 (9.1)				
Fraxinus pennsylvanica Marsh. (1238)	1	1.0	9	7.8 (12.6)		
Fraxinus quadrangulata Michx. (1293)			2	3.5 (2.1)		
Galium circaezans Michx. (1313)	11	9.7 (8.0)				
Galium triflorum Michx. (1231)					1	8.0
Geranium maculatum L. (1250)	1	1.0				
Geum aleppicum Jacq. (1341)					1	1.0
Geum canadense Jacq. (1303)					9	11.3 (11.9)
Geum vernum (Raf.) Torr. & A. Gray (1305)					2	3.0 (2.8)
Geum virginianum L. (1306)			2	1.0 (0.0)		
Gleditsia triacanthos L. (1254)			1	1.0		
Glyceria striata (Lam.) Hitchc. (1284)	1	24.0				
Hydrophyllum canadense L. (1259)	3	9.3 (11.0)				
Laportea canadensis (L.) Wedd. (1330)	6	6.8 (4.4)				
Leersia virginica Willd. (1285)			3	38.0 (36.0)		
Lemna minor L.			1	200.0		
**Leucanthemum vulgare* Lam. (1275)			1	1.0		
Lindera benzoin (L.) Blume (1246)			4	2.0 (2.0)		
**Lonicera maackii* (Rupr.) Herder (1232)			5	3.2 (3.3)	16	13.3 (12.4)
**Lysimachia nummularia* L. (1237)					1	26.0
Maianthemum racemosum ssp. *racemosum* (L.) Link (1244)					1	3.0
**Malva neglecta* Wallr. (1242)			5	5.2 (7.8)		
Menispermum canadense L. (1241)	1	7.0				
Ostrya virginiana (Mill.) K. Koch (1261)	1	1.0				
Oxalis stricta L. (1289)			1	15.0		
Parthenocissus quinquefolia (L.) Planch. (1333)	5	8.0 (2.7)	5	5.6 (9.2)	10	4.1 (3.1)
Penstemon digitalis Nutt. ex Sims (1317)					1	1.0

(Continued on next page)

APPENDIX I. (Continued).

	Fogwell		IPFW		Mengerson	
Species	Frequency	Count	Frequency	Count	Frequency	Count
Persicaria virginiana (L.) Gaertn. (1295)			1	2.0	4	6.0 (1.4)
Phlox divaricata L. (1294)					1	1.0
Phytolacca americana L. (1340)			2	1.5 (0.7)		
**Plantago major* L. (1287)			1	3.0		
**Poa compressa* L. (1286)					5	5.8 (4.4)
Polygonatum pubescens (Willd.) Pursh (1245)	3	2.0 (1.0)				
Prunella vulgaris L. (1249)					1	1.0
Prunus americana Marshall (1308)			1	3.0		
Prunus serotina Ehrh. (1307)			4	2.0 (1.4)	1	1.0
Quercus rubra L. (1339)	2	1.0 (0.0)			3	2.0 (1.7)
Rosa blanda Aiton (1311)					4	2.5 (1.0)
Rubus spp. (1312)					1	6.0
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe (1279)	11	12.2 (12.0)			2	1.5 (0.7)
Scutellaria nervosa Pursh (1248)					1	7.0
Smilax ecirrhata (Engelm. ex Kunth) S. Watson (1319)	1	1.0				
Smilax tamnoides L. (1320)	3	4.0 (4.4)	1	2.0		
Symphyotrichum praealtum (Poir.) G.L. Nesom (1268)	1	2.0				
Teucrium canadense L. (1247)			1	3.0		
Tilia americana L. (1322)	3	1.3 (0.6)				
Toxicodendron radicans (L.) Kuntze	2	6.5 (3.5)	2	3.0 (2.8)	14	11.3 (6.2)
Ulmus americana L. (1324)			1	1.0		
Ulmus rubra Muhl. (1327)	5	3.6 (2.4)	1	1.0	2	1.0 (0.0)
Viburnum acerifolium L. (1233)	1	1.0				
Viola canadensis L. (1331)	1	1.0				

APPENDIX II. List of midstory species collected at each of the forests studied. Frequency is the number of 25 m^2 plots (out of 17 at Fogwell and 20 at each of IPFW and Mengerson) in which they were encountered. Count is the mean number of individuals (standard deviation in parentheses). Nomenclature follows ITIS (2013). An asterisk (*) indicates non-native species (USDA NRCS 2013).

	Fogwell		IPFW		Mengerson	
Species	Frequency	Count	Frequency	Count	Frequency	Count
Acer saccharinum L.					2	15.0 (0.7)
Acer saccharum Marsh.	12	3.5 (2.2)	10	2.0 (0.8)		
Carpinus caroliniana Walter					1	3.0
Carya ovata (Mill.) K. Koch					2	1.0 (0.0)
Cornus florida L.					2	4.0 (2.8)
Fagus grandifolia Ehrh.	1	1.0			2	2.5 (0.7)
Fraxinus americana L.			1	1.0	2	1.0 (0.0)
Fraxinus pennsylvanica Marsh.			1	1.0		
Lindera benzoin (L.) Blume	1	2.0	1	1.0		
**Lonicera japonica* Thunb.					1	1.0
**Lonicera maacki* (Rupr.) Herder			2	3.0 (2.8)	5	5.8 (3.0)
Ostrya virginiana (Mill.) K. Koch	2	1.5 (0.7)	1	1.0	6	1.0 (0.0)
Prunus serotina Ehrh.			2	2.0 (1.4)		
Quercus macrocarpa Michx.					1	1.0
Ulmus americana L.	3	1.3 (0.6)	1	1.0	8	2.5 (2.3)
Ulmus rubra Muhl.	4	1.3 (0.5)			1	1.0

APPENDIX III. List of overstory species collected at each of the forests studied. Frequency is the number of 500 m^2 plots (out of 17 at Fogwell and 20 at each of IPFW and Mengerson) in which they were encountered. Count is the mean number of individuals (standard deviation in parentheses). Nomenclature follows ITIS (2013).

	Fogwell		IPFW		Mengerson	
Species	Frequency	Count	Frequency	Count	Frequency	Count
Acer nigrum F. Michx.	3	1.3 (0.5)	2	1.5 (0.7)		
Acer rubrum L.	1	1.0			4	2.0 (1.4)
Acer saccharinum L.					10	2.5 (1.7)
Acer saccharum Marsh.	15	4.9 (2.9)	18	14.7 (7.6)	10	6.9 (5.2)
Aesculus glabra Willd.	1	1.0			1	2.0
Carpinus caroliniana Walter	2	1.5 (0.7)			3	1.7 (0.6)
Carya cordiformis (Wangenh.) K. Koch	2	1.0 (0.0)	2	1.0 (0.0)	6	2.2 (1.5)
Carya glabra (Mill.) Sweet	1	1.0				
Carya laciniosa (Michx. f.) G. Don			1	1.0		
Carya ovata (Mill.) K. Koch	12	1.7 (0.9)				
Celtis occidentalis L.			5	2.0 (1.7)		
Cornus florida L.					6	2.8 (2.5)
Crataegus mollis Scheele					4	6.0 (6.9)
Fagus grandifolia Ehrh.	13	2.2 (2.2)	1	5.0	5	3.0 (2.8)
Fraxinus americana L.			2	1.5 (0.7)	3	5.0 (4.6)
Fraxinus nigra Marshall					1	1.0
Fraxinus pennsylvanica Marshall					4	1.7 (0.9)
Juglans nigra L.	3	1.0 (0.0)	8	2.1 (1.6)	4	2.5 (1.3)
Liriodendron tulipifera L.			1	1.0		
Malus sp.	1	2.0				
Morus rubra L.			1	1.0		
Ostrya virginiana (Mill.) K. Koch	1	1.0			8	2.5 (1.6)
Platanus occidentalis L.			3	1.3 (0.6)	1	1.0
Populus deltoides W. Bartram ex Marshall			1	5.0		
Prunus serotina Ehrh.			5	2.0 (1.7)	1	1.0
Quercus alba L.	4	1.8 (1.0)			6	1.5 (0.8)
Quercus bicolor Willd	1	1.0			6	1.8 (0.8)
Quercus macrocarpa Michx.	1	1.0			1	1.0
Quercus nigra L.					1	2.0
Quercus palustris Munchh.					4	1.5 (0.6)
Quercus rubra L.	7	1.9 (1.9)	4	2.0 (0.8)	12	3.0 (1.7)
Quercus velutina Lam.	1	4.0	5	1.6 (0.9)		
Tilia americana L.	12	1.8 (0.9)	11	2.4 (1.9)	7	4.0 (2.6)
Ulmus americana L.	3	1.7 (1.2)	11	2.8 (2.5)	10	3.8 (2.4)
Ulmus rubra Muhl.	7	1.9 (1.8)	11	2.4 (1.7)	3	2.0 (1.0)

REVIEWS OF STEVE W. CHADDE'S MISCELLANEOUS FIELD GUIDES TO THE PLANTS IN THE GREAT LAKES REGION

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Steve W. Chadde 2013. *Wisconsin Flora: An Illustrated Guide to the Vascular Plants of Wisconsin.* vi + 818 pp. ISBN 978-1490550022. Paperback. $40.99.

Mr. Chadde is a Badger, having grown up in Kenosha, Wisconsin, he tells us in the Introduction. He also comments on the fact that, despite the long history of botanical work in the state, there's never been a comprehensive flora published for the state. The nearest thing to that is the series "Preliminary Reports on the Flora of Wisconsin," which have appeared over many decades in the Transactions of the Wisconsin Academy of Sciences, Arts and Letters. The Academy has ceased publication of its Transactions, as of 2001. These preliminary reports were done under the aegis of Norman Fassett first, and then Hugh Iltis. They are all listed on pp. 777–778; Mr. Chadde has done us all a service by compiling the data, and giving the URL for finding them all online.

The keys work, the descriptions are excellent, and the illustrations are helpful. I've used them for over a year. There are some typographic errors, inevitable in a work this size, but all that I have reported to Mr. Chadde have been corrected. The core of the work, acknowledged on p. 777, is the online Wisconsin State Herbarium, which contains names, photographs, and distribution maps, but no descriptions and no keys. This is based on specimens in the herbarium of the University of Wisconsin-Madison. The website sometimes deviates from the classification adopted in Flora of North America; for example, *Symphyotrichum* is not recognized, and traditional *Aster* continues to be used, the molecular evidence to the contrary notwithstanding. This is also true for the online Freckmann Herbarium at UW-Stevens Point, which Chadde also cites as a source.

Neither of these online sources follows faithfully the Angiosperm Phylogeny Group with respect to, for example, dismemberment of the Liliaceae. Chadde adopts Liliaceae in the broad sense, and provides a listing of the genera of the segregate families in a table on p. 653; he also puts the variant family name in parentheses after each genus in the running treatment. This is very helpful to the reader. The point of the book is to allow one to put a name to a thing; it is not the place to ponder questions of phylogeny.

Sometimes, the odd introductions are mentioned in passing and are not included in the keys. In the Poaceae alone there are eleven such species—waifs that have not become established as part of the naturalized flora. Similarly treated is *Thymelaea passerina*, an introduced annual; Thymelaeaceae are treated as comprising only *Dirca palustris*, a native shrub. If the little annual shows up again, one will have to go to Gleason & Cronquist to key it out.

But elsewhere, chance introductions or escapes from cultivation are treated fully, though sometimes without a distribution map—for example, *Marrubium vulgare*, in the Lamiaceae. By contrast, *Satureja hortensis* and *Thymus pulegioides* get no further mention whatever. In the same family, *Collinsonia canadensis* is included in the keys (four times) but is neither described nor illustrated; it is said to have been extirpated in Wisconsin, and perhaps so. It's very difficult to be consistent in handling these kinds of problems; the easiest (and best, I think) solution is to include everything, with appropriate warnings to the reader.

Yet another weedy mint is treated by Chadde as *Leonurus marrubiastrum*, with the combination in *Chaiturus* given in synonymy. (It is known from only two counties in Wisconsin, having been first discovered in 1970.) Most modern manuals adopt *Chaiturus marrubiastrum*; this is not a problem, because Chadde's index is very thorough and gives every entry of a scientific name, whether adopted or not. The reader needs to be aware, Chadde is not much given to taxonomic or nomenclatural wrangles. But he has created a landmark volume in Wisconsin's botanical history.

Steve W. Chadde. 2013. *Minnesota Flora: An Illustrated Guide to the Vascular Plants of Minnesota.* vi + 781 pp. ISBN 978-1491224243. Paperback. $39.99.

A flora of Minnesota, with keys, distribution maps, and illustrations, has not existed until now. There is a rich history of botanical exploration in Minnesota, briefly summarized in the Introduction, page 1. The dichotomous keys seem to be entirely workable; they appear to be the same as those in *Wisconsin Flora*, which I know to be most useful

The manual includes something over 1900 species. A figure of 2010 species (1618 native, 392 introduced) for the state is given in Ownbey & Morley, 1991, *Vascular Plants of Minnesota: A Checklist and Atlas.* The most recent survey (available online) is Cholewa, 2011, *Comprehensively Annotated Checklist of the Flora of Minnesota*, version 2011.2, where no totals are given.

Cholewa made an effort in her checklist to follow the available treatments in *Flora of North America* and the families as recognized by the Angiosperm Phylogeny Group. Chadde has done likewise, for the most part. Hence, Aceraceae disappear into Sapindaceae, Chenopodiaceae into Amaranthaceae, and the redistribution of genera out of classical Scrophulariaceae is adhered to. He retains Liliaceae in the Cronquistian sense, but the segregate families to which the genera are assigned in APG III are clearly indicated. The reader will have no difficulty in squaring these treatments with other recent works.

The problem of treating the non-native species remains. I note the author's remark in the treatment of *Acer* that the widely cultivated *Acer ginnala* is occasionally found as an escape throughout the eastern half of Minnesota. The distribution map (all the maps are downloaded from bonap.net) shows it in a dozen or more counties; nonetheless, it is neither keyed, pictured, nor described. The same fate befell it in Smith, 2008, *Trees and Shrubs of Minnesota*. In Ownbey & Morley (see above) it is mentioned but is not granted a distribution map.

Out of idle curiosity, I looked to see how Chadde treated red mulberry, *Morus rubra*. It is shown as very scattered, in only five counties, but extending from the Canadian border south to the Iowa border. In Smith (see above) it is credited to only Houston County in extreme southeast Minnesota. Ownbey & Morley have it in two counties. Lastly, we have Nepal & Wichern, 2013, Taxonomic status of Red Mulberry (*Morus rubra*, Moraceae) at its northwestern boundary, Proceedings of the South Dakota Academy of Science 92: 19- 29, where it is concluded that the species does not occur in Minnesota – the few available specimens are said to be hybrids with *Morus alba*, including the very early records that were thought to vouch for the occurrence of red mulberry in Minnesota. The hybrid arises naturally, and is also offered in the horticultural trade. None of this is in Chadde – there's simply not room.

What *is* in Chadde is all there in one place, accessible to the reader in plain language, because he takes pains to avoid technical jargon as much as possible. One can wish the author and his book every success.

Chadde, Steve W. 2014. *Michigan Flora: Upper Peninsula*. iv + 824 pp. ISBN 978-1500566197. Paperback. $33.95.

The Upper Peninsula comprises just 15 counties, and 29% of the land area of Michigan. Even so, it harbors nearly 1900 species of vascular plants.

The book covers pteridophytes and lycophytes, gymnosperms, and angiosperms (dicots and monocots), in that order. Aside from those dividing lines, it is entirely alphabetical. The keys and descriptions are very well done; they are adopted from Voss & Reznicek, *Field Manual of Michigan Flora*, as is properly acknowledged on page 1. The treatments of pteridophytes and lycophytes rely strongly on the treatments at michiganflora.net; however, the keys and descriptions are much easier to use when one has the printed word at hand – working from a computer screen is relatively more awkward. Because the book is compiled from such exemplary sources, it follows that readers will find it very useful. The addition of line drawings for most of the species is very helpful. There are no distribution maps in Chadde's book. A county map for the UP and for the entire state is inserted on page 790.

Voss & Reznicek put monocots first, because that was standard when the original Voss work was done; Chadde puts them last. Chadde does mostly recognize the most recent Angiosperm Phylogeny Group families; hence, he leaves *Diervilla* in the Caprifoliaceae, not in its own family, but with a note to the reader. Voss & Reznicek recognize Dipsacaceae, as does Chadde, even though APG III favors submerging that family into Caprifoliaceae. V&R also accept the segregate families out of Liliaceae, such as Melanthiaceae, Trilliaceae, and Asparagaceae, whereas Chadde sticks with traditional inclusive Liliaceae, but with the other family names given in brackets.

Chadde takes some introduced species out of the keys and reduces their treatment to a note. One I noticed is *Juncus inflexus* L., introduced from Europe, not rare in wet roadside ditches in Houghton County. Omitting it from the key leaves the reader flummoxed. A much better strategy, I think, is to put it in the book along with everything else. (The running header for Juncaceae is misspelled, but easily corrected for future printings.) To the contrary, in the Hydrocharitaceae, *Hydrocharis morsus-ranae* L., introduced from Europe and known only from Chippewa County in the UP, is included in the key, with an illustration, but does not merit a detailed description. That seems to be a much better way of handling introductions that may (or may not) turn out to be mere waifs.

In Judziewicz et al., *Field Guide to Wisconsin Grasses*, the authors made an effort to track down the waifs reported for the state, to see if they are extant. Many of them are not, but if they were here once, they could very well be here again. Hence, they get the full treatment. This strikes me as a sensible way to go. (The situation changes in California. There, the place is overrun with botanists and with short-term plant introductions from both the temperate and the tropical regions of the earth. A goodly number of these are *not* treated in *The Jepson Manual*.)

Chadde's intended audience is "students of the region's flora." He is serving that cohort well, and I can only hope that his book will be stocked by merchants in the UP for sale to the hordes of summer tourists; it's a little tricky to take delivery from amazon.com when you're on vacation.

Chadde, Steve W. 2013. *Midwest Ferns: A Field Guide to the Ferns and Fern Relatives of the North Central United States.* vi + 450 pp. ISBN 978-1484161388. Paperback. $24.95.

North Central US in this book is taken to mean Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, and Ohio. The US Bureau of the Census includes in the definition these states plus the Dakotas, Nebraska, and Kansas.

The work is lavishly illustrated, with both photographs and drawings, including an illustration of the fern life cycle, perhaps for those whose grounding in Botany was more based on DNA than morphology. The illustrations of sori, leaf forms, and spores is handy to have in one place.

The author says his book is a field guide, which generally means it's meant to aid in the identification of living plants, not dried herbarium specimens. To that end, it opens not with conventional keys, but keys under nine different habitat groups: aquatic, calcareous rock, non-calcareous rock, wet forest, etc. More-or-less conventional keys begin on p. 31. The habitat keys I found difficult to use; once I decided my fern was on a near-vertical sandstone cliff face (therefore, non-calcareous), the key led me to ten parallel choices with no simple way to distinguish among them. As it happened, the fern I was trying to key out is normally a forest-floor species, and its occurrence on the cliff face was an oddity.

The descriptions of the species are very thorough. Where appropriate, each species description is accompanied by county-level range maps for the upper Midwest as well as maps showing total distribution in North America. The scientific names are fully explained or translated. The rare hybrids, some known from only one or two counties, are included.

Traditional *Lycopodium* is here treated as six genera. The key to distinguish them is quite straightforward. Because the book is a field guide, not a taxonomic treatise, there is no argument offered as to *why* all these genera should be recognized. The same taxonomic decisions are made in Michigan Flora Online, at michiganflora.net. (The ferny parts are by Robert E. Preston, for whom an obituary appeared in Michigan Botanist 52(1–2): 53–54.) Chadde's keys owe much to those online, but he improves on them by intercalating explanations of technical terms. I searched the book in vain for any acknowledgment of the online flora. In addition, it might be well to point out an online work for Wisconsin: *Pteridophytes of Wisconsin: Ferns and Fern Allies* at uwgb.edu. I was unable to find similar sites for Illinois, Indiana, Minnesota, or Ohio.

There are references, pp. 429-431, helpfully separated into "Identification Guidebooks," "Fern Culture," and "Selected Technical Reports." This is a circumstance where an *annotated* bibliography is wanted—the reader needs some guidance. I looked and looked for *Ferns and Fern Allies of Wisconsin*, edition 2, 1953. (It is quite dated, but still useful.) Chadde has it, but with Fassett as first author. No, the first author is Rolla Milton Tryon, Jr. (1916–2001), whose name somehow came to be listed last (of four).

The regularly updated websites for pteridophytes and lycophytes are very helpful and useful, but they just aren't the same as a book in hand. Chadde's bargain-priced book deserves a wide readership.

BOOK REVIEWS

Flora of North America Editorial Committee, editors. 2014 [2015]. ***Flora of North America North of Mexico. Volume 9. Magnoliophyta: Picramniaceae to Rosaceae.*** **Oxford University Press, New York, N.Y. xxiv + 713 pp. ISBN 978-0-19-534029-7. Hardback. $95.00.**

The Flora of North America (FNA), which is the first comprehensive flora project for all of North America north of Mexico and which is expected to fill 30 large volumes, is now somewhat more than half complete (this is the 18th published volume). Volume 9, for which 54 individual contributors are listed, contains treatments of four families, three of which—the Picramniaceae, the Staphyleaceae, and the Crossosomataceae—treat a mere 11 species between them and occupy only 15 pages. The remainder of the volume (645 pages) is devoted to an in-depth treatment of the Rosaceae, a large family that, on a world-wide basis, is most prominent in the north temperate region. This volume has a particularly special significance far beyond the borders of North America for those seeking to understand taxonomic relationships within the Rosaceae. This is because, although FNA contains families that are larger on a world-wide basis and that include a larger number of species in the Flora area, such as Asteraceae (2413 species), Poaceae (1373 species), and Cyperaceae (843 species), the FNA treatment of Rosaceae contains a larger percentage of its species within the Flora area (680 species of 3000, or 23%), as compared to 10% for the Asteraceae, 17% for Cyperaceae, 12% for Poaceae, nearly 20% for the Brassicaceae. More significantly, however, the Flora contains representatives of all three subfamilies and all 16 tribes of the Rosaceae, as well as 68 of the 88 genera (77%), a breadth of taxonomic diversity that cannot be said of any other large family in North America (some medium-sized families, such as Onagraceae or Boraginaceae, may approach this level of coverage).

For students of the North American flora, including that of the Great Lakes region, however, the numerous wholly new generic treatments are most welcome. Among these is a completely new treatment of the large genus *Potentilla* and its segregates by Barbara Ertter assisted by Reidar Elven, the late James Reveal, and David Murray. This has always been considered a taxonomically complex group. Ninety-eight species of *Potentilla* itself are recognized within the borders of the Flora, including *Potentilla anserina* L., which has often in recent years been segregated as the genus *Argentina* (and which here includes within *P. anserina* arctic and west coast populations often recognized as *P. egedei*). Several genera traditionally included within *Potentilla* are recognized, however. Among them are the following that include species well-known from the Great Lakes region: *Drymocallis* (including the prairie cinquefoil, *D. arguta* = *Potentilla arguta*), *Dasiphora*, which includes the widespread shrubby cinquefoil, *D. fruticosa* = *Potentilla fruticosa*, *Sibbaldiopsis* (including *S. tridentata* = *Potentilla tridentata*), and *Comarum* (including *C. palustre* = *Potentilla palustris*).

The Rosaceae is well known to harbor a number of genera of great taxonomic complexity resulting from such processes as hybridization, apomixis, and polyploidy, prominent among them *Rubus*, *Rosa*, *Alchemilla*, and *Crataegus*. *Alchemilla* is primarily an Old World genus represented in the Flora by just 12 species, mostly arctic. The other three receive conservative treatments in the Flora, properly so, in my opinion, for a work intended to provide a floristic overview, albeit detailed and comprehensive, for the broad botanical community, rather than monographic treatments for the specialist. The large and complex genus *Rubus* is reduced to 37 species continent-wide, only two of which were described later than 1899 (1934 and 1943), but a large synonymy is provided so that the innumerable microspecies can be placed by the interested reader. The species better known as *Dalibarda repens* is here included in *Rubus* on molecular grounds, which is necessary, according to the authors, in order to preserve the monophyletic status of *Rubus*. The treatment of *Crataegus* by the long-time student of that genus, James Phipps, is the first for the entire Flora area since the work of Torrey and Gray in 1838-1843. It recognizes 169 species; and, although conservative, an important objective of the treatment is "to draw attention to the often great, but little discussed, infraspecific variation." The author's long and extensive field acquaintance with the genus has made this possible.

I have mentioned only a few of the many significant accomplishments of this magisterial volume. Readers will enjoy up-to-date and comprehensive treatments of other favorite genera, including *Geum*, *Prunus*, *Cotoneaster*, *Spiraea*, *Horkelia*, *Filipendula*, and *Sorbus*, among many others. The genus *Photinia* is treated as including only 4 introduced species, restoring the native chokeberries, which some recent authors have included here, to their more traditional placement in *Aronia*.

As is true of all the volumes of FNA, a particularly welcome feature of this volume is the often extensive commentary following the descriptions of genera, and less frequently of subgeneric taxa and species. There is no specific format for these commentaries, but authors are given free rein to discuss topics such as circumscription, taxonomic history, and broad issues of distribution, as well as explanations of and justifications for the particular taxonomic approach taken, and, in many cases, discussions of special terminology or unusual features in the keys. This is just one of many factors that will make Flora of North America a significant contribution lasting long into the future and well beyond the borders of North America.

——Michael Huft

James W. Byng. 2014. *The Flowering Plants Handbook. A practical guide to families and genera of the world.* Plant Gateway Ltd. (plantgateway.com), 619 pp. ISBN 978-0-9929993-0-8. Paperback. $56.90.

If you attempt to order the print copy of this book from the usual online outlets, you may be disappointed, temporarily. But keep trying. It is not available from the publisher's website, strangely. There is an eBook edition, which is reviewed by Neil Snow in *Systematic Botany* 40(1): 366. 2015. Snow called attention to some "printing" problems; I checked to see if these had found their way into the printed book, and found that they had not.

The book is intended to get you to family in all cases, to genus in most cases. On Cover 4, it states plainly "This plant book aims to help identify flowering plants to genus and family level anywhere in the world."

Everything follows Angiosperm Phylogeny Group III. One has first to get one's plant into one of the major categories: Asterids, Rosids, basal angiosperms, etc. Then you choose which Order you think your plant might belong to. For each Order, there is a conventional key to families. Families are given a floral formula, explained on p. 1; for larger families, this is necessarily so broad as to be of little use. For most readers, the whole point is to get to genus. And here is where problems arise, because there are no longer keys, just synopses of the included genera, accompanied by beautiful color photographs. But the descriptions are not parallel; they jump all over. I tried an unknown (from cultivation, native range unknown) in the Rosaceae, with three subfamilies. It was all I could do to decide on a subfamily, among Dryadoideae, Spiraeoideae, and Rosoideae. Within the Spiraeoideae alone, there are eight tribes and 58 genera – all this without a key. It is a daunting task, but one is assured all the genera are there, so one must persevere.

A sterner test might be Fabaceae. Forget it. The treatment is but 1.3 pages long, ending with an "advertisement" to consult Lewis et al., 2005, *Legumes of the World*. This is 577 pages of keen scholarship, elegant language, and magnificent illustrations, nearly all in full color—$140. But there's nary a key to be found in this book, either.

The treatment of Asteraceae is also scanty, 2.3 pages long. There are said to be 1600 genera and maybe 24,000 species. If the family were treated fully, one would need a wheelbarrow to carry the book(s) around. Instead, one is referred to various websites. There is no "advertisement" urging one to consult, for example, Funk et al. 2009, *Systematics, Evolution, and Biogeography of Compositae*, again beautifully written and illustrated, but without keys of any sort—$110.

The situation for Poaceae (740 genera, 11,500 species) is quite parallel to the two examples above, 2.5 pages long. You will still need Clayton & Renvoize, *Genera Graminum*, with very thorough keys—$90. And these remarks are not intended as a criticism of the author. He did the best he could, but the amazing diversity is simply too great to handle in one book. The work may be most useful for the very small and very obscure families, especially of the tropics, such as Petenaeaceae, Tapisciaceae, or Dipentodontaceae.

There are 67 pages in 7-point type of "Literature [Cited]." It's all the latest findings, mostly molecular, and therefore with no mention of the classical authors (Linnaeus, the Hookers, Asa Gray, et alii). The index is very thorough, to scientific names only. This is not a work for the neophyte.

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CATALOGUE OF FLORISTIC ARTICLES IN *THE MICHIGAN BOTANIST*

Michael Huft

The Michigan Botanist has a long history of publishing floras and floristic studies of natural areas in the Great Lakes region, including such major units as counties, national lakeshores, and state parks, but also islands in the Great Lakes and even such smaller units as individual woodlots, bogs, or defined wetlands, to name a few. These studies have covered most major groups of plants, including lichens, algae, bryophytes, and vascular plants (sometimes limited to subdivisions of the latter, such as pteridophytes or aquatic plants).

Because these articles provide a rich resource for present-day and future explorations and studies, it is useful to make available an accessible catalogue so that readers can readily find what is available and where an item of interest can be found. It is also hoped that this list will suggest further areas that need floristic work or those areas where updates would be useful.

Items are arranged by major plant group and, under Vascular Plants, by state or province. Within each category, the listing is chronological, and the volume and page citation is given at the end of each item. A very few items that deal with more than one plant group or more than one state are listed under each appropriate category.

LICHENS

Henry, Mary Lou, and Raymond E. Hampton. (1974). Macrolichens of Beaver Island, Charlevoix County, Michigan. 13: 65–67.

Wetmore, Clifford M. (1988). Lichens of Sleeping Bear National Lakeshore. 27: 111–118.

Wetmore, Clifford M. (1990). Lichens of Apostle Islands National Lakeshore, Wisconsin. 29: 65–73.

ALGAE

Andreson, Norman A. (1970). Algae in Park Lake, Clinton County, Michigan. 9: 95–107.

Andresen, N. E., and E. F. Stoermer. (1978). The diatoms of Douglas Lake—A preliminary list. 17: 49–54.

Hoagland Kyle D., and Forrest M. Begres. (1978). The diatom flora of Tiplady Bog, Michigan. 17: 55–64.

Lipsey, Louis L., Jr., and Mason G. Fenwick. (1978). Investigations on the freshwater Algae of Wisconsin. I. Plankton diatoms from High Lake (Vilas County). 17: 113–117.

Glime, Janice M., Janet F. Gereau, and Roy E. Gereau. (1980). Bryophytes of Mount Lookout, Keweenaw County, Michigan. 19: 247–250.

Anderson, Kevin, Mark Fate, Ching-Han (Eric) Hsieh, Lorenz Kim, Katy Lazarus, J. Patrick Kociolek, and Rex L. Lowe. (2013). Algal diversity in, and the description of three new diatom (Bacillariophyta) species from, Lake of the Clouds, Porcupine Mountains Wilderness State Park, Michigan USA. 52: 3–24.

BRYOPHYTES

Crum, Howard. (1964). Mosses of the Douglas Lake region of Michigan. 3: 3–12, 48–63.

Miller, Norton G. (1972). A bryophyte florula of an area near Grand Ledge, Eaton County, Michigan. 11: 3–12.
Koch, Rudy G., and Duane J. Lahti. (1973). The bryophytes of Amnicon Falls State Park, Douglas County, Wisconsin. 12: 212–216.
Hollenson, Raymond H. (1984). A checklist of the liverworts of Michigan. 23: 135–139.
Glime, Janice M., and Allison D. Slavik. (1985). A checklist of bryophytes and their critical localities in the Keweenaw Peninsula, Michigan. 24: 154–163.
Stevens, Kevin, and Elwood B. Ehrle. (1990). The Hampton Creek wetland complex in southwestern Michigan. VI. Transect survey of bryophyte populations. 29: 55–64.
Wheeler, Gerald A., Robert P. Dana, and Carmen Converse. (1991). Contribution to the vascular (and moss) flora of the Great Plains: A floristic survey of six counties in western Minnesota. 30: 75–129.
Glime, Janice M. (2002). Bryophytes of the Pictured Rocks National Lakeshore, Alger County, Michigan. 41: 31–45.
Ehrle, Elwood B. (2005). Mosses and liverworts of the Kalamazoo Nature Center, a preliminary survey. 44: 119–126.

VASCULAR PLANTS

Illinois

Moran, Robbin C. (1978). Vascular flora of the ravines along Lake Michigan in Lake County, Illinois. 17: 123–140.

Indiana

Angstmann, Julia L., Paul E. Rothrock, and Thomas W. Post. (2005). The vascular flora and community structure of little Calumet Headwaters Nature Preserve, LaPorte County, Indiana. 45: 153–192.
Namestnik, Scott, and Keith Board. (2010). The vascular flora of Sebert Property, LaPorte County, Indiana. 49: 1–40.

Michigan

Hagenah, Dale J. (1963). Pteridophytes of the Huron Mountains, Marquette County, Michigan. 2: 78–93. (See additions below in Wahla, 1984)
Crow, Garrett E. (1969). Species of vascular plants of Pennfield Bog, Calhoun County, Michigan. 8: 131–136.
Beaman, John H. (1970). A botanical inventory of Sanford Natural Area. I. The Environment. 9: 116–139. II. Checklist of vascular plants. 9:147–164.
Veldman, Lorraine Calhoun, and Daniel E. Wujek. (1971). Pteridophytes of Beaver Island, Charlevoix County, Michigan. 10: 194–196.
Wells, James R., and Paul W. Thompson. (1974). Vegetation and flora of Keweenaw County, Michigan. 13: 107–151.
Read, Robert H. (1975). Vascular plants of Pictured Rocks National Lakeshore, Alger County, Michigan. 14: 3–43.
Frye, Darlene M. (1976–1977). A botanical inventory of Sandhill Woodlot, Ingham County, Michigan. I. The vegetation. 15: 131–140. II. Checklist of vascular plants. 15: 195–204. III. Phenology study. 16: 34–38.
Haynes, Robert R., and C. Barre Hellquist. (1978). The distribution of the aquatic vascular flora of Douglas Lake, Cheboygan County, Michigan. 17: 183–191.
Beach, James H., and W. D. Stevens. (1979–1980). A study of Baker Woodlot. I. Physical and historical description. 18: 123–137. II. Description of vegetation. 19: 3–13. III. Checklist of Vascular Plants. 19: 51–69 (Stevens and Beach).
Sytsma, Kenneth J., and Richard W. Pippen. (1981–1982). The Hampton Creek wetland complex in southwestern Michigan. I. History and Physical features. 20: 137–142. II. Community classification. 20: 147–156. III. Structure and succession of tamarack forests. 21: 67–74. IV. Fen succession. 21: 105–115. V. Species of vascular plants. 21: 195–204. (See Part VI under Bryophytes, above).

Mustard, Timothy S. (1983). The vegetation of the Manistee National Forest, Oceana and Mason Counties, Michigan. I. Physical, historical, and ecological aspects. 22: 111–122. II. Checklist of vascular plants. 22: 1151–161.

Weitzman, Anna L. (1984). Sommerby Swamp, an unusual plant community in Mackinac County, Michigan. 23: 11–18.

Wahla, James. (1984). Additions to the pteridophyte flora of Marquette County, Michigan. 23: 178–179. (Updating Hagenah, 1963, above)

Kron, Kathleen A., and Beverly Scoviak Walters. (1986). A study of Red Cedar Natural Area. I. Historical background and description of the vegetation. 25: 27–34. II. Checklist of vascular plants. 25: 35–44.

Hazlett, Brian T. (1986). The vegetation and flora of the Nordhaus Dunes, Manistee national Forest, Mason County, Michigan. I. History and present vegetation. 25: 74–92. II. Catalogue of vascular plants. 25: 125–139.

Slavick, Allison D., and Robert A. Janke. (1987). The vascular flora of Isle Royale National Park. 26: 91–134.

Kron, Kathleen A. (1989). The vegetation of Indian Bowl Wet Prairie and its adjacent plant communities. I. Description of the vegetation. 28: 179–200. II. Checklist of vascular plants. 28: 201–215.

Hazlett, Brian T. (1991). The flora of Sleeping Bear Dunes National Lakeshore, Benzie and Leelanau Counties, Michigan. 30: 139–202.

Meagher, Walter L., and Stephen J. Tonsor. (1992). Checklist of the vascular flora of the Augusta Floodplain Preserve. 31: 83–98.

Forzley, Kathleen C., Thaddeus A. Grudzien, and James R. Wells. (1993). Comparative floristics of seven islands in northwestern Lake Michigan. 32: 3–21.

Hazlett, Brian T. (1993). The vascular flora of North and South Fox Islands, northern Lake Michigan. 32: 239–264.

Judziewicz, Emmet J. (1997). Vegetation and Flora of Passage Island, Isle Royale National Park, Michigan. 36: 35–62.

Judziewicz, Emmet J. (1997). Michigan's farthest north: A botanical visit to the Gull Islands, Isle Royale National Park. 36: 78–87.

Laureto, Pamela J. (1998). Vascular flora and plant community types of Seidman Park, Kent County, Michigan. 37: 67–89.

Voss, Edward G. (2001). Flora of St. Helena Island (Straits of Mackinac), Michigan. 40: 27–47.

Judziewicz, Emmet J. (2001). Flora and vegetation of the Grand Traverse Islands (Lake Michigan), Wisconsin and Michigan. 40: 81–208.

Ross, Stephen, and Robert J. Krueger. (2002). A botanical survey of the White Pine Trail State Park (Rails-to-Trails) in Mecosta County, Michigan. 41: 51–84.

Slaughter, Bradford S., and J. Dan Skean, Jr. (2003). Annotated checklist of vascular plants in the vicinity of Cedar Creek and Brewster Lake, Pierce Cedar Creek Institute, Barry County, Michigan. 42: 127–148.

McKenna, Duane D. (2004). Flora and vegetation of Kalamazoo County, Michigan. 43: 137–359.

Whately, Cathryn Elizabeth, Daniel E. Wujek, and Edwin E. Leuck II. (2005). The vascular flora of Hog Island, Charlevoix County, Michigan. 44: 29–48.

Williams, Gretchen M., Gilbert D. Starks, and Daniel E. Wujek. (2005). Annotated checklist of vascular plants of Neithercut Woodland, Clare County, Michigan. 44: 57–71.

Smith, Pamela F., and Dennis W. Woodland. (2006). Vascular plant study of Warren Dunes State Park, Berrien County, Michigan. 45: 1–58.

Springer, Joshua C., and Bruce D. Parfitt. (2010). A checklist of vascular plants of the Lapeer State Game Area, Lapeer County, Michigan, USA. 49: 41–72.

Baker, Kathleen M., and C. Elizabeth Whately. (2010). Vascular plant survey of privately owned wetlands, Pavilion Township, Kalamazoo County, Michigan. 49: 85–98.

Bassett, Tyler. (2011). Annotated checklist of the flora of the Kalamazoo Nature Center with natural community descriptions. 50: 41–104.

Minnesota

Joyal, Robert. (1971). The Marshall Bog near Itasca Park, Minnesota. 10: 78–88.

Wheeler, Gerald A., and Paul H. Glaser. (1982). Vascular plants of the Red Lake Peatland, northern Minnesota. 21: 89–93.

Wheeler, Gerald A., Robert P. Dana, and Carmen Converse. (1991). Contribution to the vascular (and moss) flora of the Great Plains: A floristic survey of six counties in western Minnesota. 30: 75–129.

Anderson, Derek, Jessica Brandt, Lynn Wright, and Donald Davidson. (2005). Ecology and floristics of Knife Island, a gull and cormorant rookery on Lake Superior, near Two Harbors, Lake County, Minnesota. 44: 95–104.

Ohio

Stuckey, Ronald L. (1975). A floristic analysis of the vascular plants of a marsh at Perry's Victory Monument, Lake Erie. 14: 144–166.

Tyrrell, Lucy E. (1987). A floristic survey of buttonbush swamps in Gahanna Woods State Nature Preserve, Franklin County, Ohio. 26: 29–38.

Whyte, Robert S., David A. Francko, and David M. Klarer. (2003). The aquatic vegetation of the old Woman Creek National Estuarine Research Reserve (Huron, Ohio): A Lake Erie coastal wetland. 42: 63–84.

Ontario

Reznicek, A. A., and P. M. Catling. (1989). Flora of Long Point, Regional Municipality of Haldimand-Norfolk, Ontario. 28: 99–175.

Morton, J. K., and Joan M. Venn. (1996). The flora of Caribou Island, Lake Superior. 35: 3–25.

Weatherbee, Ellen Elliott (In Press). The flora of Cockburn Island, Ontario, Canada.

Wisconsin

Musselman, Lytton J., Theodore S. Cochran, William E. Rice, and Marion M. Rice. (1971). The flora of Rock County, Wisconsin. 10: 147–193.

Dabydeen, Simon, and Rudy G. Koch. (1977). Vegetation and floristics of a sand spoil deposit—Barker's Island in Superior Harbor, Douglas County, Wisconsin. 16: 39–46.

Peck, James H., and W. Carl Taylor. (1980). Check list and distributions of Wisconsin ferns and fern allies. 19: 251–268.

Koch, Rudy G., Patti Younger, and Leo Bruederle. (1983). Vegetation and floristics of Wisconsin Point, Douglas County, Wisconsin. 22: 35–46.

Cochrane, Theodore S., Marion M. Rice, and William E. Rice. (1984). The flora of Rock County, Wisconsin: Supplement I. 23: 121–133.

Forzley, Kathleen C., Thaddeus A. Grudzien, and James R. Wells. (1993). Comparative floristics of seven islands in northwestern Lake Michigan. 32: 3–21.

Judziewicz, Emmet J., and Rudy G. Koch. (1993). Flora and vegetation of the Apostle Islands National Lakeshore and Madeline Island, Ashland and Bayfield Counties, Wisconsin. 32: 43–189.

Eddy, Thomas L. (2001). A vascular flora of the Norwegian Bay Wetlands on Green Lake, Green Lake County, Wisconsin. 40: 51–69.

Judziewicz, Emmet J. (2001). Flora and vegetation of the Grand Traverse Islands (Lake Michigan), Wisconsin and Michigan. 40: 81–208.

Fields, Douglas M. (2003). The vascular plants of Taylor County, Wisconsin. 42: 171–282.

Judziewicz, Emmet J. (2004). A thirty-year study of the vascular plants of "Butternut Pines," a 40-acre tract in Oconto County, Wisconsin. 43: 81–115.

Hart, Charles R. (2004). A checklist of the vascular flora of Woodland Dunes Nature Center, Manitowoc—Two Rivers, Wisconsin. 43: 361–375.

Herrick, Bradley M. (2005). The vegetation of Point Au Sable Nature Preserve, Brown County, Wisconsin, USA. 44: 49–55.

Hlina, Paul, Derek S. Anderson, and Donald W. Davidson. (2008). Flora of Amnicon Falls State Park, Douglas County, Wisconsin. 47: 121–146.

Hlina, Paul S., and Derek S. Anderson. (2011). Wetland assessment and inventory of the Pokegama Carnegie Wetland State Natural Area, Douglas County, Wisconsin. 50: 2–25.

Anderson, Derek, and Julie Fox. (2014). Flora of Interstate State Park, Polk County, Wisconsin.

CALL FOR PAPERS

We currently have articles that will fill the three remaining double issues planned during 2015. However, we will need more articles to start filling the 2016 issues, and the sooner they can be submitted the better. Please consider what you have available that can be turned into a paper for The Michigan Botanist – taxonomy, forest ecology, floristic surveys, conservation, use of plants by humans, historical studies, and many other topics. If you have any questions about the suitability of a proposed article, please feel free to contact the editor. Student-authored papers are always welcome. Short research notes and book reviews are also welcome.

We'd also like to consider some occasional special topic issues, in which several papers by different authors would explore different aspects of some area of concern. Some ideas might be Invasive Plants, or The Decline in Field Botany and Collections-Based Research, or The Role and Management of Nature Preserves or other conservation topics. Others could be a series of articles (which need not appear in a single issue, but could appear singly over time) on topics such as the history of floristics and flora writing in each of the several states and provinces that make up the Great Lakes region, or articles on the development, management, and importance of nature preserves, parks, land trusts, and similar areas in each of these states. These are just a few suggestions that come to mind. I would welcome any ideas, as well as any volunteers to take on the task (or assist in the task) of assembling authors and articles for these types of ventures.

INSTRUCTIONS TO AUTHORS

Refer to http://quod.lib.umich.edu/m/mbot/submit for more detailed instructions, especially for formatting, style conventions, literature cited, and voucher specimen requirements. Please contact the editor with any questions.

1. Create text in 12-point Times New Roman font and double space paragraphs throughout. Research articles should be organized as follows: Title, Author(s) and address(es), Abstract with up to 5 keywords, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, Literature Cited, Tables, Figure Legends, and Figures. Sections may be omitted if not relevant. All pages should be numbered.

2. For noteworthy collections, manuscripts should be formatted as follows. The title, "Noteworthy Collections," should begin each submitted manuscript, followed on the next line by the State or Province for the species reported. The next line should list the taxon of interest using the following format: Species Author(s) (Family). Common name. The rest of the manuscript should include the following named sections: (i) Significance of the Report, (ii) Previous Knowledge, (iii) Discussion, (iv) Diagnostic Characters (if desired), (v) Specimen Citations, (vi) Acknowledgements (if desired), and (vii) Literature Cited. Each of these sections is largely self-explanatory; however, the "Significance of the Report" section should be limited to a brief sentence or phrase indicating the significance of the collection(s), and this may be expanded upon in the "Discussion" section; the "Specimen Citations" section should include the relevant label data from the voucher specimen(s) including location data, collector(s), collection number, etc., as well as the Index Herbariorum acronym(s) of the herbarium or herbaria where the specimen(s) are deposited. The manuscript should end with the name and address of the author(s).

3. Non-research articles, such as book reviews, letters to the editor, notices, biographies and other general interest articles can be formatted as general text without the specific sections listed above. However, literature cited and any tables or figures should be formatted as described below.

4. Create tables either as an MS Word table or using a tab-delimited format. Each table is to be submitted as a separate file. Table captions should be placed at the top of the table. Any footnotes should appear at the bottom of the table. Please do not insert tables within the body of the text.

5. Send each figure as a separate file in a high-resolution format—eps, jpg, or tif. Figures like bar graphs that gain their meaning with color won't work—use coarse-grained cross-hatching, etc. Create figure legends as a separate text file, and the typesetter will insert them as appropriate. Please do not insert the figure in the body of the text file.

6. Citations: Please verify that all references cited in the text are present in the literature cited section and vice versa. Citations within the text should list the author's last name and publication year (e. g. Smith 1990). For works with more than 2 authors, use "et al.", and separate multiple citations with a semicolon.

7. Literature Cited: List citations alphabetically by author's last name. The first author's name is to be listed with surname first, followed by initials (e.g. Smith, E. B.), and subsequent authors are to be listed with initials first.Separate author's initials with a single space. The year of publication should appear in parentheses immediately before the title of the citation. The entire journal name or book title should be spelled out. Please put a space after the colon when citing volume number and page numbers.

8. Italicize all scientific names. Voucher specimens must be cited in floristic works and in any other study whose results depend on the identity of the plant(s). Papers citing plant records without documenting vouchers are generally not acceptable.

9. Manuscripts must be submitted electronically to the email address of the editor. All manuscripts will be reviewed by at least two referees.

CONTENTS

On the cover: The Dalles of the St. Croix River. The state of Wisconsin is on the left side of the river, and the State of Minnesota is on the right. Here, the tallest cliffs rise approximately 30 meters (100 ft) above the river. Photograph by Derek Anderson, November 8, 2013.