VASCULAR PLANT COMMUNITIES AND FLORA OF THE SEVEN LAKES NATURE PRESERVE IN MICHIGAN'S EASTERN UPPER PENINSULA

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ABSTRACT

The Seven Lakes Nature Preserve comprises nearly 2,400 hectares of aquatic, wetland, and upland habitats in southeastern Alger and northeastern Schoolcraft counties in the eastern Upper Peninsula of Michigan. The preserve was obtained and protected by the J.A. Woollam Foundation and has undergone several expansions. In an area of Michigan with relatively limited development and few roads, the natural communities of Seven Lakes are highly intact, and many of its habitats have recovered since the historic logging era. Botanical surveys were conducted in 2016, 2017, 2020, 2021, and 2022 with the goals of describing the natural communities and ecosystem processes and of producing a comprehensive floristic inventory. The post-glacial natural history of the region and a description of climate and soils are provided. A floristic quality assessment was performed, yielding a Total Floristic Quality Index of 99.9, a Total Mean C of 4.5 and a Native Mean C of 5.3. Within the upland forests, shrubby and forested wetlands, and open wetlands, eleven plant communities are described following the classification system proposed by the Michigan Natural Features Inventory. The floristic affinities of rare or otherwise noteworthy taxa are discussed, as are potential threats to the ecosystem. Four-hundred ninety-three species and four hybrids were observed during our surveys, 147 species are represented by specimen vouchers and 440 are recorded as photo vouchers on iNaturalist. Sixteen new species records for Alger County are reported.

KEYWORDS: Floristic Inventory, Great Lakes, Floristic Quality Assessment, Natural Communities

INTRODUCTION

The Seven Lakes Nature Preserve (Seven Lakes) (Figure 1) comprises nearly 2,400 hectares of aquatic, wetland, and upland habitats in southeastern Alger and northeastern Schoolcraft counties in the eastern Upper Peninsula of Michigan. In an area of Michigan with relatively limited development and few roads, the natural communities of Seven Lakes are highly intact, and many of its habitats have recovered since the historic logging era. Botanical surveys were conducted in

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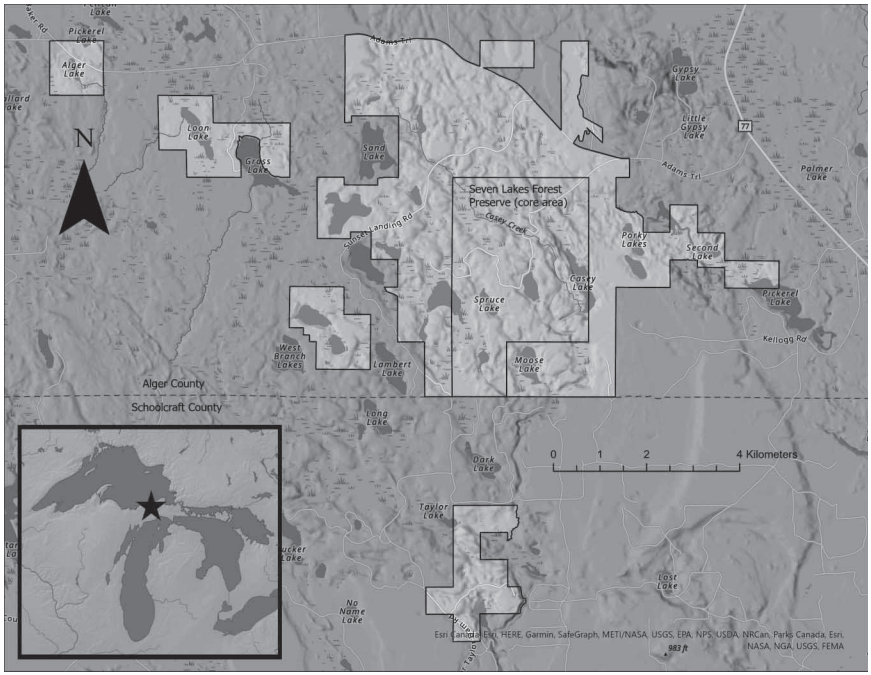

FIGURE 1. Map of the Seven Lakes Nature Preserve in southeastern Alger and northeastern Schoolcraft Counties, Michigan. All areas of the Nature Preserve are in lighter shading. The Seven Lakes Forest Preserve (core area) is indicated. The other tracts on the map outside the core area are known collectively as Seven Lakes Forest Reserve.

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Southeastern Alger and northeastern Schoolcraft counties in the northeastern Upper Peninsula of Michigan have been understudied by ecologists until recent years. Situated nearby well-known places such as Pictured Rocks National Lakeshore to the north and west, Seney National Wildlife Refuge to the south, and Tahquamenon Falls State Park to the east, Seven Lakes and the area directly adjacent to the preserve consists of sparsely visited privately owned timberland. A private conservation organization, the J.A. Woollam Foundation, has taken great interest in this area and currently owns Seven Lakes. Founded in 2000, the mission of the J.A. Woollam Foundation is to help protect undeveloped land and the plants and animals that occur there. They support land trusts and conservation groups with similar interests. Beginning in 2016, the J.A. Woollam Foundation contracted Biophilia, LLC to conduct multi-taxa ecological surveys of the property which is divided into two management units. The Seven Lakes Forest Preserve is the core of the property and is exempt from timber harvest; it comprises 557 hectares. Beyond the core area is the Seven Lakes Forest Reserve, comprising 1,786 hectares, which is subject to occasional timber harvest outside

of wetland buffer zones. The property and survey area consists of one large parcel, and four smaller parcels to the south and west.

The climate in Alger and Schoolcraft counties is categorized as Dfb = warm summer humid continental climate by the Köppen–Geiger Classification system (Kottek et al. 2006). According to the Midwestern Regional Climate Center (MRCC), monthly average temperature (1981–2010) at the nearest station with long-term weather data, Munising, Michigan (45 km to the WSW of Seven Lakes), ranges from –7.8°C (17.9°F) in January to 18.2°C (64.8°F) in July, with an annual average of 6.4°C (42.0°F) (MRCC 2021). The average growing season is 140 days near Lake Superior and fewer than 100 days inland. Average yearly precipitation is between 81 and 86 cm, and annual snowfall is as high as 457 cm in the highlands near Lake Superior (Albert 1995). Situated between 270 and 300 meters in elevation, Seven Lakes is higher than the surrounding lacustrine-influenced terrain of the eastern Upper Peninsula and around 100 meters higher in elevation than Lake Superior. Seven Lakes is in a unique geographic position, sitting at the headwaters of the Fox River in the Lake Michigan watershed, yet much closer to Lake Superior, which is only 8 to 18 kilometers away. Although snowfall amounts are not measured for this exact location, they are reported to be among the highest in the region by local residents (John Herman, personal communication). The lacustrine influenced temperature moderation and precipitation, including snow lingering long into spring, forms a unique mesic climate.

The entire area comprising Seven Lakes is underlain by 500-million-year-old Cambrian age sandstone, which is not directly exposed at the surface but comes close along the Fox River in the southern portion of the preserve near the Alger-Schoolcraft County border. The bedrock is overlain by a variety of glacial deposits, which may be up to 65 meters thick, and which were deposited during the Wisconsin glaciation at the end of the Pleistocene epoch 9,000–12,000 years ago (LaBerge 1994). Coarse-textured glacial till caps some of the higher morainal ridges, while pitted outwash dominates much of the lower portions of Seven Lakes. The pitted outwash plains contain many kettle lakes, bogs, and other wetlands. Peat deposits in bogs are several meters deep in places and can occupy just a few hectares, while others are tens of hectares in size. Poorly to extensively drained sands surround the wetlands, and podzols are the dominant soil type in the area. Soils in the upland forests have a well-developed O horizon with leaf litter thickness measurements of 10 cm or more in the upland forest. Non-native earthworms, which have depleted much of the topsoil regionally, are in low abundance.

The development of the current ecosystems at what is now Seven Lakes has been a dynamic process with many changes in community type since the retreat of the last glaciers around 9,000 years ago. Boreal forest zone conifers such as *Picea* spp., *Larix laricina*, *Pinus banksiana*, and *Abies balsamea* were among the first trees to arrive after the ice sheets melted. *Pinus strobus*, *Acer* spp., *Quercus rubra*, and *Tsuga canadensis* arrived around six to seven thousand years ago, and *Fagus grandifolia* was the last dominant tree species to arrive, approximately 4,000 years ago. The latter species is close to its western range limit. The community composition became relatively stable around 3,000 to 4,000 years

ago when the current dominant natural communities were established (Davis 1983).

Over the past few thousand years, the primary community-level altering disturbance forces have been fire and windthrow. Fire has been a community-altering force in the region's low elevation pine-dominated systems, which receive more frequent and extensive burns (Zhang et al. 1999). Red and jack pine-dominated areas within a few tens of kilometers to the east between northern Luce County and Whitefish Point and to the south in Seney National Wildlife Refuge were known to experience large fires (Zhang et al. 1999; Anderson 1982). An analysis of original land survey notes revealed that fire was a rare occurrence in the higher terrain northern hardwood forests of the Luce District, which includes this area with stand-replacing fires only occurring every 2,600 years (Zhang et al. 1999). However, old fire scars were found to be common in several parts of Seven Lakes, and it is suspected to be from the great cutover era in the late 1800s and early 1900s. A nearby post great-cutover fire occurred a few kilometers to the west at the Kingston Plains, which burned everything, including the organic soil. Much of the area is still covered in open stump barrens dominated by lichens, grasses, and bracken fern (Barrett 1997). Most areas with old fire-scarred stumps at Seven Lakes are now under a canopy of maple and beech and are unlikely to burn under current conditions. The abundance of old sawed white pine stumps in the area suggests that white pine was far more common, and perhaps fire did occur here more often in the distant past; but without trees with pyrogenic characteristics such as pines, fire is less likely. This process of mesophication, in which forest structure and leaf litter composition change to make fire less likely, has been documented elsewhere in eastern North America and is related to habitat fragmentation and a shift from the widespread use of fire by indigenous peoples towards a policy of fire suppression (Nowacki and Abrams 2008). Large areas of blowdown from wind events have been observed elsewhere in the region (Woods 2004). We have not seen evidence of such events at Seven Lakes. However, high winds have had some impact, particularly among American beech trees, which had their tops blown off after becoming weakened by beech scale (*Cryptococcus fagisuga*).

MATERIALS AND METHODS

Surveys

Initial survey work began as part of an all-taxon biological inventory in fall 2016 (October 7–10) and continued throughout the 2017 growing season (May 7–11, June 10–13, August 10–13, August 31–September 1, and October 15–16). The initial survey focused on the core area (Seven Lakes Forest Preserve). More intensive surveys started in 2020 and included areas outside the core area and parts of the core area that were not previously surveyed (May 3–4, May 21–24, June 18–21, July 17–20, August 12–16, September 21–25, October 16–19, 2020, and April 30–May 3, May 11–14, June 28–July 5, August 2–8, September 25–28, November 6–8, 2021). Follow-up surveys were conducted in 2022 (June 2–4, August 4–6, October 13–16) and targeted species that were listed from previous surveys, but not documented. The goals of the surveys were to describe the natural communities based on the system developed by the Michigan Natural Features Inventory (Cohen et al. 2015) and to catalog all taxa, including the flora, as completely as possible. Surveys for plants were mostly intuitive meander searches in all habitats present on the property during the appropriate survey periods for all vascular plant taxa. Surveys were primarily conducted by the first author, Ryne Rutherford.

Significant assistance was provided by the second author, Dr. Susan Fawcett, and Dr. Bruce Baldwin during the 2017, 2020, and 2022 seasons. Voucher specimens were collected for new county records and underrepresented taxa. Voucher specimens collected by Ryne Rutherford were deposited at the University of Michigan Herbarium (MICH), and those collected by Susan Fawcett were deposited at the University of Michigan Biological Station Herbarium (UMBS). A project was created in the free global online biodiversity database, iNaturalist, to document the flora with photo vouchers (iNaturalist 2023). The project targets all taxa that could be photographed or identified with microscopy, but the relevant subset can be retrieved by querying 'tracheophyta'.

Floristic Quality Assessment (FQA)

A Floristic Quality Assessment was performed with the Universal FQA Online Calculator (Freyman et al. 2016) using the most recent Michigan database (Reznicek et al. 2014), which assigns each species a coefficient of conservatism (C), a wetness coefficient (W), and categories for physiognomy (e.g., tree, shrub etc.) and duration (e.g., annual, perennial, etc.). Floristic Quality Assessments are increasingly employed by conservationists, land managers, government agencies, and researchers. The Floristic Quality Assessment was developed in the Chicago region (Swink and Wilhelm 1979) as a simple, quantitative, repeatable metric to assess the integrity of remnant native habitats. Within a given region, each species is assigned a coefficient of conservatism (C, or C-value) on a scale of 0 to 10, which corresponds to its tolerance of anthropogenic disturbance (lower coefficients) and/or fidelity to a particular habitat (higher coefficients). For example, all non-native species are automatically assigned a 0, along with some native species that are well-adapted to human disturbance and are without strict habitat requirements (e.g., *Lobelia inflata*), while a species with strict habitat requirements that is intolerant of habitat degradation would be assigned a 10 (e.g., *Kalmia polifolia*) (Reznicek et al. 2014; Slaughter et al. 2015). The Total Mean C is the average of the C-values of all species in the survey, while Native Mean C excludes all non-native species. The Total or Native Floristic Quality Index (FQI) is the Total Mean C, or Native Mean C, respectively, in each case multiplied by the square root of the number of species in the study area—all species for the Native FQI and native species only for the Native FQI. The Adjusted FQI (defined as the Mean C of native plants divided by 10 multiplied by the square-root of the number of native plants divided by the square root of the number of all plants multiplied by 100) was developed to diminish the influence of species richness and to better reflect the impacts of disturbance on species composition (Miller and Wardrop 2006). Coefficients of wetness (W) are widely used for wetland delineation, and species are assigned a number on a five-point scale: Upland (UPL; W= 5); Facultative Upland (FACU; W= 3); Facultative (FAC; W= 0); Facultative Wetland (FACW; W= –3); and Obligate Wetland (OBL; W= –5). Mean Wetness is the average W for all species, and Native Mean Wetness excludes non-native species. The FQI metrics were designed to operate at a variety of scales using various sampling approaches and has been proven to be a robust and forgiving measure of habitat integrity under a variety of conditions (Spyreas 2016, 2019). The Universal FQA Calculator (Freyman et al. 2016) has facilitated this approach by automating calculations and enabling data sharing. This allows for standardized comparisons between sites and the potential to perform large-scale meta-analyses with data from more than 15,000 FQAs now publicly available.

RESULTS

Natural Plant Communities

The descriptions below of the communities found at Seven Lakes include the dominant plant species for both upland and wetland natural communities. The plant communities recognized here follow the Michigan Natural Features Inventory community classification (Cohen et al. 2015). Photos of a selection of natural communities are shown in Figure 2 and selection of vascular plants observed is pictured in Figure 3. A species list is provided in Appendix 1.

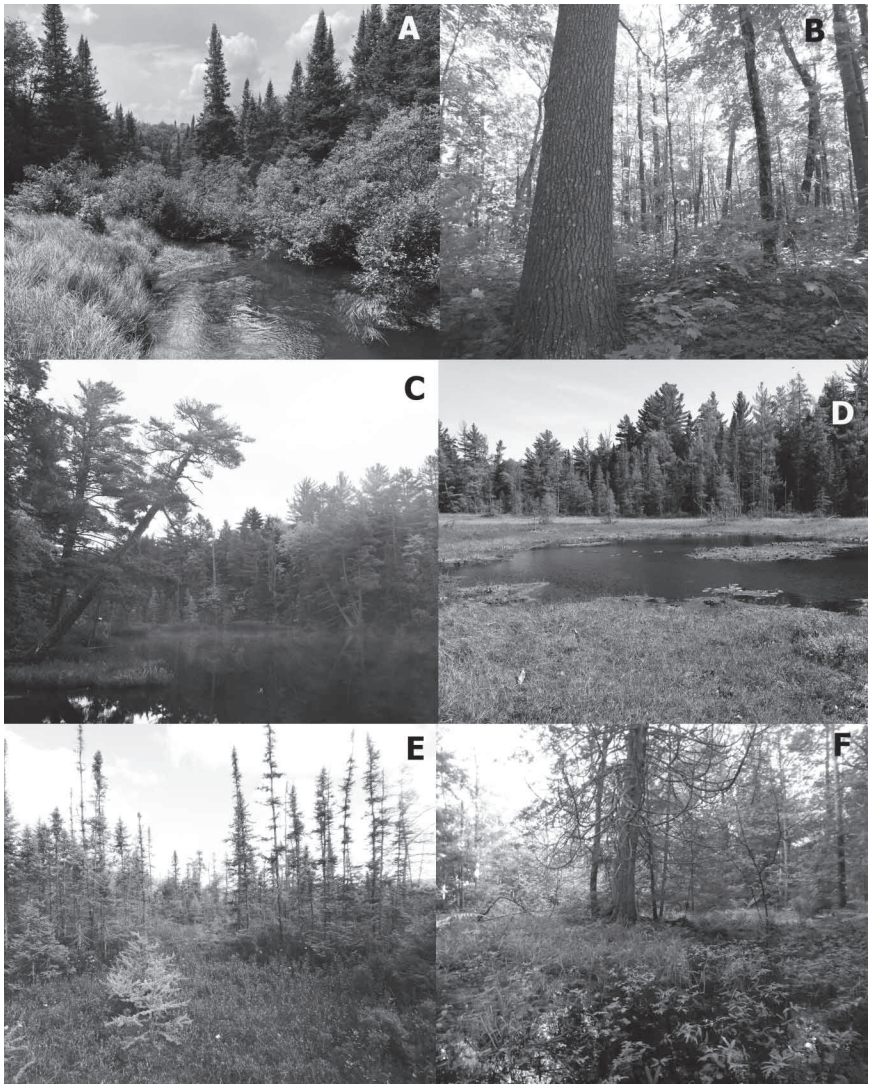

FIGURE 2. Representative habitats of the Seven Lakes Nature Preserve A. Northern shrub thicket along the Fox River. B. Supercanopy white pine in a mesic northern forest. C. Dry-mesic northern forest along the shores of Gopher Lake. D. A pool in an open bog. E. Black spruce and tamarack in a poor conifer swamp. F. Rich conifer swamp with northern white cedar. All photos by R. D. Rutherford.

Forest Group

Forest covers most of Seven Lakes and the rest of the region. It is especially prevalent on the glacial moraines, sandy ridges, and upland areas of the pitted outwash plain. The forest types are strongly tied to the water-holding capacity of the soils and proximity to the water table. American beavers (*Castor canadensis*) have an impact on the forest composition near the water, with deciduous trees felled at higher frequency leading to conifer dominance around waterways. The high snow cover makes this area poor habitat for overwintering deer. Our camera trap study from our all-taxon biodiversity inventory shows that white-tailed deer (*Odocoileus virginianus*) are mostly absent at Seven Lakes between January and March, contributing to minimal observed impacts of browsing. The presence of wolves (*Canis lycaon*) may also prevent large concentrations of yarding deer, lessening impacts on species subject to winter browse.

Mesic Northern Forest

Mesic northern forest is the dominant forest type and has been since the original land surveys in the 1800s (Albert 1995, Zhang et al. 1999). The hilly uplands underlain by coarse-textured glacial till are covered mostly by this forest type, which occurs on over 50% of the land area in the region. This forest type reaches its finest development on the areas of higher terrain with more nutrient-rich fine-textured glacial till. The mesic northern forest in this area has a well-stratified canopy structure. *Acer saccharum* is the dominant tree, with *Betula alleghaniensis* and *Prunus serotina* in lower abundance. Few *Pinus strobus* trees remain in this forest type, but evidence from old stumps suggests it was prevalent prior to historical logging. Relict supercanopy *Pinus strobus* is rare but persists in a few small areas (Figure 2). Although the ground flora is usually more depauperate at Seven Lakes than at Pictured Rocks National Lakeshore to the north and the more calcium-rich mesic northern forests associated with the Niagara Escarpment to the south, some areas of rich ground flora occur on the caps of fine-textured moraines. Species of ground flora characteristic of this forest type include *Streptopus lanceolatus*, *Prunus serotina*, *Lysimachia borealis* (syn. *Trientalis borealis*), *Claytonia caroliniana*, *Erythronium americanum*, *Hepatica americana*, *Carex gracillima*, *C. deweyana*, *C. arctata*, *C. intumescens*, *Maianthemum racemosum*, *Dryopteris intermedia*, *Oxalis acetosella*, *Fallopia cilinodis*, *Aralia nudicaulis*, *Spinulum annotinum*, *Huperzia lucidula*, *Dendrolycopodium dendroideum* and *Polygonatum pubescens*. Areas with sandier soil contain mesic northern forest supporting more *Acer rubrum*, *Fagus grandifolia*, and *Ostrya virginiana*. *Acer pensylvanicum* occurs sporadically here and is near its northwesternmost range limit. *Tsuga canadensis* increases in abundance near lakeshores and streams, particularly on the east and north-facing slopes which have lower evapotranspiration than west and south-facing slopes. Old-growth stands, likely several hundred years old, occur on steep slopes along streams and around lakeshores. It is worth noting that other tree species common in this forest type elsewhere in the Upper Peninsula, such as *Fraxinus* spp., *Tilia americana*, and *Quercus rubra*, were not observed occurring naturally at Seven Lakes, although oaks have been planted on the airstrip.

Dry-Mesic Northern Forest

Dry-mesic northern forest occurs in a few pockets where the soil is slightly poorer and more acidic. Historically abundant in the Upper Peninsula, but now much less common after the great cutover circa 1900, this white pine-dominated forest type occurs along the eastern and northern (west and south-facing) shorelines of several lakes (Figure 2). Only a few hectares of this forest type were found in the study area. *Diervilla lonicera*, *Epigaea repens*, *Gaultheria procumbens*, *Cypripedium acaule*, *Clintonia borealis*, and *Maianthemum canadense* were strongly associated with this forest type.

Dry Northern Forest

Dry northern forest dominated by *Pinus resinosa* is found in small areas of low glacial outwash plain with sandy ridges close to the water table. This open forest type occurs on sandy uplands and is surrounded by poor conifer swamp and bog communities. Although some individuals of *Pinus resinosa* appear to be planted, old stumps suggest some of the area was dominated by that species historically. The few deciduous trees present include *Prunus pensylvanica* and *Acer rubrum*. *Picea glauca* and *Picea mariana* are also present. *Vaccinium angustifolium*, *V. myrtilloides*, *Coptis trifolia*, *Lycopodium clavatum* (Figure 3), and *Gaultheria procumbens* are common in the understory.

Forested and Shrub Wetland Groups

Although forested wetlands cover far less acreage than upland forests, significant areas of these community types are present at Seven Lakes, usually in low-lying areas of sandy pitted outwash plain near rivers and lakes and in isolated kettle depressions where they are associated with open bogs.

Northern Shrub Thicket

Northern shrub thicket occurs abundantly along the floodplains of streams (Figure 2). The short canopy of northern shrub thicket is almost entirely composed of *Alnus incana* and contains nutrient-rich soils shaped by fluctuating water levels and beaver activity. The rich ground flora in the floodplains includes *Calamagrostis canadensis*, *Onoclea sensibilis*, *Rubus strigosus*, *Clematis virginiana*, *Scutellaria galericulata*, *Prunus virginiana*, *Impatiens capensis*, *Thalictrum dasycarpum*, *Osmunda spectabilis*, *Glyceria canadensis*, *Solidago rugosa*, *Viburnum cassinoides*, *Symphyotrichum lateriflorum*, *Ludwigia palustris*, *Caltha palustris* (Figure 3), and *Juncus canadensis*.

Poor Conifer Swamp

Poor conifer swamp is prevalent on acidic peat in association with lake edges and open bog margins. *Picea mariana* and smaller amounts of *Larix laricina* form the canopy, which varies from closed to partially open (Figure 2). *Sphagnum* moss covers the soggy ground from which a variety of shrubs emerge, such as *Rhododendron groenlandicum*, *Viburnum cassinoides*, and *Vaccinium myrtilloides*. The ground flora is similar to that of open bogs and includes *Sarrace-*

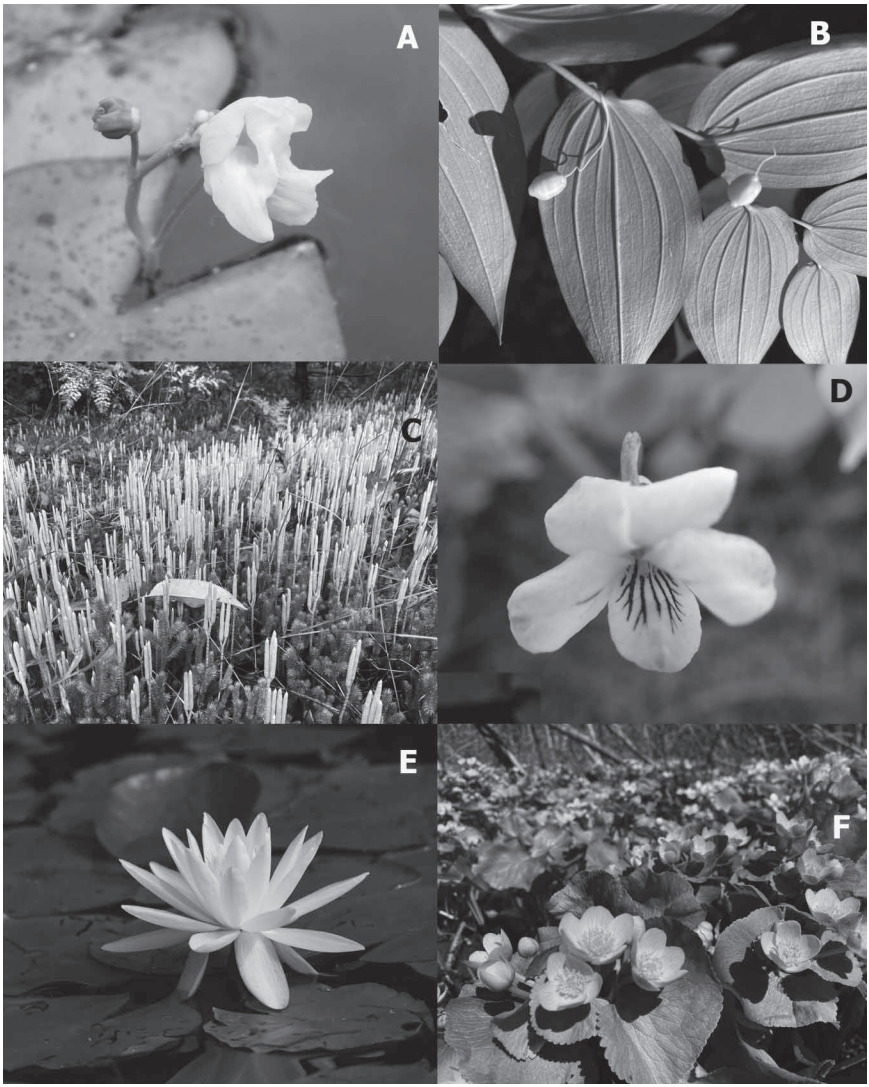

FIGURE 3. Vascular plants of the Seven Lakes Nature Preserve. A. *Utricularia purpurea*. B. *Streptopus amplexifolius*. C. *Lycopodium clavatum*. D. *Viola blanda*. E. *Nymphaea odorata*. F. *Caltha palustris*. All photos by R. D. Rutherford except B. and D by S. Fawcett.

nia purpurea, *Osmundastrum cinnamomeum*, and *Eriophorum vaginatum*. Sedges are abundant in the understory, among which *Carex pauciflora*, *C. limosa*, *C. trisperma*, and *C. buxbaumii* are the most common.

Rich Conifer Swamp

Rich conifer swamp occurs where the water table meets the surface in areas of groundwater flow. This community type is much more nutrient-rich and less acidic than other community types at Seven Lakes. A few stands of sizeable *Thuja occidentalis* remain in narrow bands along spring-fed streams (Figure 2). Common species in this community include *Matteuccia struthiopteris*, *Lysimachia borealis*, *Chrysosplenium americanum*, *Carex canescens*, *C. scabrata*, *Scutellaria galericulata*, *S. lateriflora*, *Mentha canadensis*, and *Streptopus lanceolatus*. One small patch of *Streptopus amplexifolius* (Figure 3) was also discovered.

Open Wetlands—Marsh, Fen, and Bog Groups

Although open wetlands at Seven Lakes generally cover small areas, they host high levels of biodiversity and are home to many specialized wetland species. Hydroperiod, nutrient availability and pH are among the more important factors that dictate the occurrence of these community types.

Northern Wet Meadow

Northern wet meadow often occurs along flowages that were once occupied by standing water resulting from beaver activity. Thick organic soils developed during decades of sediment deposition. A few excellent examples of this community are present at Seven Lakes, where they are dominated by *Carex lasiocarpa*, *Calamagrostis canadensis*, *Solidago canadensis*, *Symphyotrichum lateriflorum*, *Iris versicolor*, *Epilobium leptophyllum*, *Lysimachia terrestris*, *L. thyrsiflora*, *Verbena hastata*, *Spiraea alba*, *Glyceria canadensis*, *Scirpus cyperinus* and *Palustricodon aparinoides* (syn. *Campanula aparinoides*). *Viola blanda* (Figure 3) was often encountered along the upland margins. *Cirsium palustre* is a noteworthy non-native that is common in wet meadows here. Due to the abundant late summer flowers, this plant community is important for pollinators such as bumble bees (*Bombus*) and flower flies (Family Syrphidae). It is presumed that natural succession will eventually shift towards forested wetlands, but the process is slow, and it is likely that these wet meadows will stay open for a long time.

Emergent Marsh

Emergent marsh is a tall, graminoid-dominated aquatic community characterized by vegetation that emerges from the water. Small patches occur along the margins of lakes and stream flowages. Plants common in emergent marsh include *Typha latifolia*, *Schoenoplectus tabernaemontani*, *Carex lasiocarpa*, *Persicaria amphibia*, *Nuphar variegata, Rosa palustris*, and *Myrica gale*. A varia-

tion of this community occurs on mucky peat at Moose Lake where the following species occur along with the previous listed species *Eleocharis flavescens*, *E. ovata*, *E. quinqueflora*, *E. palustris*, *Schoenoplectus subterminalis* and *Nymphaea odorata* (Figure 3).

Submergent Marsh

Submergent marsh is well represented at Seven Lakes. This plant community is composed of aquatic plants and forms the structure and base of the aquatic food web that supports waterfowl, aquatic insects, fish, turtles, and amphibians. Most of the lakes sampled are circumneutral to acidic with deep organic muck bottoms. Aquatic plants in the lakes include *Brasenia schreberi*, *Nuphar variegata*, *Nymphaea odorata*, *Najas flexilis*, *Persicaria amphibia*, *Myriophyllum sibiricum*, *M. heterophyllum*, *Elodea canadensis*, *Ceratophyllum demersum*, *Bidens beckii*, *Schoenoplectus tabernaemontani*, *Equisetum fluviatile*, *Potamogeton alpinus*, *P. friesii*, *P. epihydrus*, *P. pusillus*, *P. zosteriformis*, *P. natans*, *P. robbinsii*, and *P. praelongus*, *P. obtusifolius*, and *P. amplifolius*. A freshwater sponge (*Spongilla lacustris*) is found in a few places and is a good indicator of water quality. A different community of submergent plants occurs at Triangle Lake, which is acidic and with a sandy bottom. Rare plants such as *Utricularia purpurea* (Figure 3) and state special concern *Potamogeton confervoides* occur here in abundance. The remoteness of the lakes and lack of public boat access have kept them free of aquatic invasive plants.

Poor Fen

Poor fen is a bog-like community that develops on acidic peat soil with minimal to moderate influence of groundwater. The plant community contains a flora similar to that of bogs, but with the addition of several species that are less tolerant of highly acidic bog conditions. *Arethusa bulbosa*, *Oclemena nemoralis*, *Carex utriculata*, *C. lasiocarpa*, *C. trisperma*, *C. utriculata, C. oligosperma*, *Dulichium arundinaceum*, and *Menyanthes trifoliata* were all noted in this habitat. Examples of this community occur around flowages and outflows of lakes and are often adjacent to other wetland types.

Bog

Bogs are nutrient-poor acidic peatlands that lack influence from groundwater and that are fed mostly from rain and snow. This highly specialized plant community (Figure 2) occurs in scattered, isolated pockets in kettle depressions throughout the area. Many of the lakes in this area are in transition towards becoming bogs. Highly specialized plants such as *Sarracenia purpurea*, *Andromeda glaucophylla*, *Chamaedaphne calyculata*, *Kalmia polifolia*, *Carex pauciflora*, *Carex oligosperma*, *Eriophorum virginicum*, *Vaccinium oxycoccos*, *Rhynchospora alba*, *Xyris montana*, and *Lycopodiella inundata* occur in this community. This is a highly specialized, low pH community containing many species that range further north. Some specialist animals include the bog copper butterfly (*Lycaena epixanthe*), which is common in the kettle bogs at Seven Lakes, and the uncommon and state special concern incurvate emerald dragon-

fly (*Somatochlora incurvata*). A unique mobile variant of this community that we referred to as "log bogs" occurs on top of old logs in several of the lakes.

Human-modified Communities

Human-modified communities occupy relatively little land area at Seven Lakes but contain species that would likely not occur in the area under natural conditions. The most striking anthropogenic feature is an old airstrip that is in the process of being reforested and contains a mix of native and non-native open country plants. This area was once mesic northern forest but was cleared and leveled to create a private airfield and has suffered from soil compaction and sandy blowouts. Fortunately, much has been done to restore it. The area has been planted with native tree species that include *Acer rubrum*, *Populus tremuloides*, *Pinus strobus*, *P. banksiana*, *P. resinosa*, *Quercus rubra*, and *Quercus macrocarpa*. While the last-named species is not native locally, it may fare well in this location under a warmer climate. Nearly all the trees appear to be doing well, and there have been some signs of natural regeneration. In 2020 and 2021, we observed young jack pine seedlings establishing in open sandy blowout areas, a good sign of recovery. Additional non-native taxa were associated with roadsides, two-tracks, and the periphery of the cabins at the north end of Gopher Lake. A spreading patch of non-native *Betula pendula* occurs around the cabins, but it appears unlikely to succeed in invading the adjacent forest.

Floristic Inventory

Two-hundred ninety-nine species were found on the initial all-taxon biological inventory (Rutherford 2018). That number increased to 462 after surveys in 2020 and 2021 and now stands at 493 and four hybrids after follow-up surveys in 2022. One-hundred forty-seven species are represented by specimen vouchers and 440 are represented by photo vouchers. The richness observed at Seven Lakes includes more than half of the species documented for Alger County (MICHIGAN FLORA ONLINE 2011), which is notable considering that Seven Lakes lacks Great Lakes shoreline and calcareous habitats, which contribute much to the floristic diversity of the region.

The Seven Lakes iNaturalist project (iNaturalist 2023) includes 1048 observations of vascular plants, representing georeferenced observations of 440 species. iNaturalist observations are especially useful for non-destructive documentation of rare and sensitive species (e.g., *Streptopus amplexifolius*) and may complement, but do not replace, herbarium collections. Continuing survey efforts at Seven Lakes will prioritize the collection of voucher specimens.

Forty-six species are provisionally included on the basis of observations alone and are not represented by specimens or photos in the iNaturalist project (indicated with an asterisk in Appendix 1) and are therefore in need of further verification. Many of these were seen during the first years of the study and were not relocated in subsequent years. Taxonomy follows MICHIGAN FLORA ONLINE (2011) with some exceptions, in which case the synonyms used in Michigan Flora are provided in the Appendix.

TABLE 1. Results of the Floristic Quality Assessment, counts of species richness, physiognomy, and duration, and mean coefficients of wetness.

Conservatism-based Metrics		Physiognomy	
Total Mean C	4.5	Tree	32 (6.5%)
Native Mean C	5.3	Shrub	59 (12%)
Total FQI	99.9	Vine	5 (1%)
Native FQI	108.5	Forb	259 (52.5%)
Adjusted FQI	48.9	Grass	34 (6.9%)
% C Value 0	17.6%	Sedge	67 (13.6%)
% C Value 1-3	19.1%	Rush	5 (1%)
% C Value 4-6	39.4%	Ferns/Lycophytes	32 (6.5%)
% C Value 7-10	23.9%		
Native Tree Mean C	4.1		
Native Shrub Mean C	5.3		
Native Herbaceous Mean C	5.4		
Species Richness		Duration	
Total Species	493	Annual	37 (7.5%)
Native Species	419 (85%)	Perennial	438 (88.8%)
Non-native Species	74 (15%)	Biennial	18 (3.7%)
		Native Annual	18 (3.7%)
Species Wetness		Native Perennial	393 (79.9%)
Mean Wetness	–0.8	Native Biennial	8 (1.6%)
Native Mean Wetness	–1.6		

Floristic Quality Assessment

Excluding hybrids, 493 species were included in a Floristic Quality Assessment. Of these, 85% are native. The Total Mean C was 4.5, and the Native Mean C was 5.3 (Table 1). The Total FQI was 99.9, and the Native FQI was 108.5. The Total Mean Wetness was –0.8 and Native Mean Wetness was –1.6, reflecting a large proportion of wetland species. Thirty-six percent of species were given a wetness coefficient of –5, indicative of obligate wetland species. The mature forest and wetland ecosystems subject to infrequent disturbance at Seven Lakes are dominated by perennials (88.8% of species). More than half of the species diversity was represented by forbs (52.5%). The summarized results of the Floristic Quality Assessment, including data reflecting physiognomy, growth habit, and mean coefficients of wetness are presented in Table 1, and the complete dataset, downloadable in spreadsheet form, is available online (Universal FQA Calculator 2023).

County Records

Sixteen species representing new county records for Alger County were vouchered and verified. These are *Acer platanoides*, *Anemone quinquefolia*, *Betula pendula, Epipactis helleborine, Erucastrum gallicum*, *Galium trifidum*, *Hemerocallis fulva, Hydrocotyle americana*, *Hylotelephium telephium, Leersia oryzoides*, *Malus domestica, Muscari botryoides*, *Pinus sylvestris*, *Potamogeton*

pusillus, *Rhinanthus minor,* and *Thelypteris palustris*. No new county records were collected from Schoolcraft County.

DISCUSSION

Like other floras in the northern Great Lakes/Laurentian latitudinal belt, the plants at Seven Lakes are a mix of the eastern deciduous floristic province to the south and the boreal forest to the north. Much of the flora here ranges eastward to the Atlantic coast and south along the Appalachian chain. Some species with that distribution pattern reach their western range limit in the central Upper Peninsula (e.g., *Acer pensylvanicum*, *Fagus grandifolia*, *Medeola virginiana*). A species of poor fens and bogs, *Oclemena nemoralis*, is also predominantly northeastern in distribution and is near its western range limit.

A few other species are predominantly western in distribution and are disjunct in the Laurentian-Great Lakes region (e.g., *Streptopus amplexifolius*, *Erythranthe geyeri*, *Polygonum douglasii*, *Vaccinium membranaceum*, *V. ovalifolium*, *Goodyera oblongifolia*, *and Osmorhiza berteroi*) (Marquis and Voss 1981). Many more western disjuncts are present at Pictured Rocks National Lakeshore, the Keweenaw Peninsula and the western Upper Peninsula (Read 1975). At Seven Lakes, regionally rare western bilberries (*Vaccinium membranaceum* and *V. ovalifolium*) occur in abundance under a canopy of mature eastern hemlock resulting in a distinct botanical association that occurs only in the vicinity of Pictured Rocks National Lakeshore. Although many wide-ranging boreal plants are common at Seven Lakes, few are rare regionally, with *Amelanchier bartramiana* representing such an exception.

Several southern species strongly associated with mesic northern forest such as *Fraxinus* spp., *Tilia americana*, *Ostrya virginiana*, and *Quercus* spp., *Trillium grandiflorum*, *Sanguinaria canadensis*, and *Caulophyllum thalictroides* do not occur naturally at Seven Lakes. These species are all common in deciduous forests associated with the calcareous formations to the south near the Niagara Escarpment and on top of cliffs at Pictured Rocks National Lakeshore, which is capped with calcareous rock, resulting in a rich flora (Read 1975). The deciduous forests at Seven Lakes seem to be calcium limited, leading to lower floristic diversity.

Only one state-listed species, *Potamogeton confervoides*, was detected at Seven Lakes. An abundance of state-listed and a few federally-listed species are present in the region, but the habitats that support those rare species (e.g., Great Lakes dunes, coastal alvars, Niagara Escarpment) are not present at Seven Lakes.

In the Floristic Quality Assessment, species with a C-value > 7 are considered to occur under conditions similar to those under which they evolved, and make up 19% of the surveyed species, while those with C-values < 3 include natives and non-natives tolerant of anthropogenic disturbance, and constitute about 27% of total species (Freyman et al. 2016). The FQI does not incorporate relative abundance of constituent species, and most non-native species as well as native

species with low C-values were in low abundance, and largely restricted to disturbed areas. A majority of non-native species in the region are dependent on anthropogenic disturbance, and, with few exceptions (discussed below), fail to establish beyond a few meters from roadsides or other human structures and clearings, a pattern described more than a hundred years ago in northern lower Michigan (Gleason and MacFarland 1914; Gleason 1918), and consistent with our findings at this site. According to Herman et al. 2001, for Michigan, an area with an FQI of 35 or greater is considered floristically important, and sites with an FQI of 50 or greater are of exceptional value for the conservation of Michigan's biodiversity, although these scores may be impacted by parcel size and habitat type (Slaughter et al. 2015). The Total FQI of 99.9 for Seven Lakes reflects its high integrity and limited history of anthropogenic disturbance, but should be interpreted with consideration of the large geographic extent of the parcel and the pooled data from a diversity of plant communities.

Non-native Species

Although several non-native species were found, only one, *Centaurea stoebe*, is included on the list of invasive species maintained by the State of Michigan (Michigan Invasive Species Program 2023). This species is widespread throughout the Great Lakes region and is documented from all counties in the Upper Peninsula. The J.A. Woollam Foundation has already made significant progress towards eradication of this species on the property. Most of the remaining non-native species are characteristic of disturbed habitats and were found in low abundance, mostly on the sandy airstrip, along roadsides, or in the vicinity of cabins. The limited number of roads in and around the Seven Lakes, the low-nutrient soils, and the cessation of broad-scale timber extraction have greatly limited opportunities for the incursion of weeds. Despite the low level of overall impact, a high proportion of the new county records were non-natives. Several were likely overlooked in previous collection efforts, but some may have arrived recently. Nearly all of them were collected from roadside patches and do not currently represent a threat to the ecosystems at Seven Lakes. These species include *Acer platanoides*, *Betula pendula, Epipactus helleborine, Erucastrum gallicum*, *Hemerocallis fulva, Hylotelephium telephium, Malus domestica, Muscari botryoides*, *Pinus sylvestris*, and *Rhinanthus minor*.

A notable invader is *Cirsium palustre*, which has successfully colonized the largely intact interior wetlands, especially wet meadows, and some conifer swamps where it thrives and may potentially compete with native species. Another invader, *Lapsana communis*, was listed as rare in the initial survey of Pictured Rocks National Lakeshore (Read 1975) but is now common along tracks and trails in mesic northern forest throughout the Upper Peninsula, including at Seven Lakes. The upland forests are generally free of invaders, although *Epipactis helleborine* was occasionally seen in minimally-disturbed upland forests.

Future Threats

The potential arrival of the hemlock woolly adelgid (*Adelges tsugae*) is concerning under future climate change scenarios (Ellison et al. 2018). Early assessments suggested that the northwesternmost populations of eastern hemlock found in the Lake Superior basin occur in an area that is too cold for the hemlock woolly adelgid, but recent climate change models show that this might not be true in the coming decades. At the time of this writing, it had recently been found in northwestern lower Michigan, about 250 kilometers to the south. At Seven Lakes, eastern hemlock is typically found within a few tens of meters of streams, lakes, and bogs but is infrequent in uplands. Perhaps the sandy soils limit it from becoming a co-dominant upland tree.

The sandy soils may be a factor in climate change scenarios for other species as well. While the moist regional climate allows for the development of mesophytic forest on potentially drought-prone sites, water stress will likely increase in the future, possibly altering the current species assemblage. During warmer and drier periods post glaciation, red oak, red maple, and white pine forest occurred where northern hardwood forest now dominates at the Sylvania Wilderness Area in the western Upper Peninsula (Davis et al. 1998). It is quite plausible that the current assemblage of sugar maple, American beech, yellow birch, eastern hemlock, and black cherry might shift to a more drought-tolerant forest type with a greater abundance of red oak, red maple, and white pine. However, the hilly topography and abundance of wetland and water interface will likely provide refuge for more moisture-loving trees in the future (McLaughlin et al. 2017).

It is unclear how the wetlands will be impacted by climate change. While some climate change-related impacts are expected, it is worth noting the resilience of peatlands to changing climates in the region. Sphagnum bogs with flora like those in the Upper Peninsula occur as far south as northern Indiana, where they are considered glacial relicts (Wilcox and Simonin 1988).

Despite the threats from climate change, local anthropogenic impacts will likely be minimized, given the shift toward full protection of much of this area. Large blocks of continuous natural cover make it more feasible for species to shift their distributions in response to changing physical and biological conditions. Beyond the boundaries of Seven Lakes, little mature forest remains, and a more aggressive timber management cycle persists, thereby increasing the regional importance of the older intact natural communities at Seven Lakes. The abundance of intact forests, lakes, wetlands, and stream corridors and the lack of roads mean that broad-scale ecosystem processes will likely continue far into the future.

CONCLUSION

In an era of accelerating climate change and biodiversity loss, it can be challenging to determine how best to prioritize limited resources for maximum conservation benefit. While we recognize the benefits of targeting small, fragmented

areas, especially for the conservation of rare species (Wintle et al. 2019) or the stewardship of natural areas near urban centers (Schwartz 2006), we applaud the vision of the J.A. Woollam Foundation in consolidating and protecting large tracts of highly intact natural communities. These habitats are irreplaceable, and the most successful restoration effort is never a substitute for preserving preexisting wildlands. We believe that the acquisition and preservation of intact natural communities, especially in areas where land is still relatively undeveloped and affordable, is a highly impactful and cost-effective use of conservation funds. It is our sincerest hope that more organizations will follow suit. This place at the headwaters of the Fox River and the undisputed solitude it provides was immortalized by Ernest Hemingway's short story, "Big Two-Hearted River" (Gibbs 1983), and that timeless wildness is still reported by all who visit. Long may it be that way.

AUTHOR CONTRIBUTIONS

RR and SF conceived this study, created the study design, and collected the specimens. RR drafted the manuscript. RR and SF edited, and revised the manuscript. SF designed the figures and conducted the analyses.

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APPENDIX 1. Checklist of the flora of the Seven Lakes Nature Preserve. Collections numbers of voucher specimens are in brackets; RDR is Ryne D. Rutherford (specimens deposited at MICH) and SF is Susan Fawcett (specimens deposited at UMBS). An asterisk (*) denotes species not represented by voucher specimens or iNaturalist observations. All voucher specimens are from Alger County except RDR 143–146, which were collected from Schoolcraft County. Nomenclature follows MICHIGAN FLORA ONLINE (2023), with some exceptions, in which case the synonyms used in the Michigan Flora are included in parentheses.

LYCOPHYTES

ISOETACEAE
Isoetes echinospora Durieu

LYCOPODIACEAE
Dendrolycopodium dendroideum (Michx.) A. Haines
Dendrolycopodium obscurum (L.) A. Haines [*RDR172*]
Diphasiastrum complanatum (L.) Holub
Diphasiastrum tristachyum (Pursh) Holub [*SF1407*]
Huperzia lucidula (Michx.) Rothm.
Lycopodiella inundata (L.) Holub
Lycopodium clavatum L. [*SF1408*]
Spinulum annotinum (L.) A. Haines

FERNS

ATHYRIACEAE
Athyrium angustum (Willd.) C. Presl (=*Athyrium filix-femina* (L.) Roth) [*SF1362*]

CYSTOPTERIDACEAE
Cystopteris fragilis (L.) Bernh.*
Gymnocarpium dryopteris (L.) Newman

DENNSTAEDTIACEAE
Pteridium aquilinum (L.) Kuhn [*RDR184*]

DRYOPTERIDACEAE
Dryopteris carthusiana (Vill.) H.P. Fuchs [*RDR144*; *RDR275*]
Dryopteris cristata (L.) A. Gray
Dryopteris intermedia (Muhl. ex Willd.) A. Gray [*RDR187*]
Dryopteris ×boottii Underw.

EQUISETACEAE
Equisetum arvense L.

Equisetum fluviatile L.
Equisetum pratense Ehrh.*
Equisetum sylvaticum L. [*RDR274*]
Equisetum variegatum Schleich. ex F. Weber & D. Mohr

ONOCLEACEAE
Matteuccia struthiopteris (L.) Tod.
Onoclea sensibilis L.

OPHIOGLOSSACEAE
Botrychium matricariifolium (Retz.) A.Braun ex W.D.J.Koch
Botrypus virginianus (L.) Michx.
Sceptridium multifidum (S.G. Gmel.) Rupr. [*RDR288*]

OSMUNDACEAE
Osmunda claytoniana L.
Osmunda spectabilis Willd. (=*Osmunda regalis* L.)
Osmundastrum cinnamomeum (L.) C. Presl

POLYPODIACEAE
Polypodium virginianum L.

THELYPTERIDACEAE
Phegopteris connectilis (Michx.) Watt [*SF1933A*]
Thelypteris palustris Schott [*RDR264*; *SF1924*]

GYMNOSPERMS

CUPRESSACEAE
Thuja occidentalis L.

PINACEAE
Abies balsamea (L.) Mill. [*RDR177*]
Larix laricina (Du Roi) K. Koch [*RDR167*]
Picea glauca (Moench) Voss [*RDR178*]
Picea mariana (Mill.) Britton, Sterns & Poggenb. [*RDR164*]
Pinus banksiana Lamb. [*RDR277*]
Pinus resinosa Aiton
Pinus strobus L. [*RDR182*]
Pinus sylvestris L. [*RDR306*]
Tsuga canadensis (L.) Carrière [*RDR196*]

TAXACEAE
Taxus canadensis Marshall [*RDR165*]

ANGIOSPERMS

ALISMATACEAE
Sagittaria latifolia Willd.

AMARANTHACEAE
Chenopodium album L.

AMARYLLIDACEAE
Narcissus sp. L. [*RDR228*]

ANACARDIACEAE
Toxicodendron rydbergii (Small ex Rydb.) Greene

APIACEAE
Cicuta bulbifera L.
Daucus carota L.
Heracleum maximum W. Bartram
Osmorhiza berteroi DC.*
Pastinaca sativa L.

APOCYNACEAE
Apocynum androsaemifolium L.
Asclepias incarnata L. [RDR276]
Asclepias syriaca L.
Vinca minor L. [*RDR170*]

AQUIFOLIACEAE
Ilex mucronata (L.) M. Powell, Savol. & S. Andrews
Ilex verticillata (L.) A. Gray [*RDR173*]

ARACEAE
Arisaema triphyllum (L.) Schott*
Calla palustris L.
Lemna minor L.
Lemna trisulca L.
Spirodela polyrhiza (L.) Schleid.

ARALIACEAE
Aralia hispida Vent.
Aralia nudicaulis L.
Hydrocotyle americana L. [*RDR110*]

ASPARAGACEAE (=CONVALLARIACEAE pro parte)
Muscari botryoides (L.) Mill [*RDR229*]
Maianthemum canadense Desf.
Maianthemum racemosum (L.) Link
Maianthemum trifolium (L.) Sloboda
Polygonatum pubescens (Willd.) Pursh
Hemerocallis fulva (L.) L. [*RDR260*]

ASTERACEAE
Achillea millefolium L.
Anaphalis margaritacea (L.) Benth. & Hook. f. [*RDR146*]
Antennaria howellii Greene*
Arctium minus (Hill) Bernh.
Bidens beckii Torr. ex Spreng. [*RDR246*]
Bidens cernua L.
Centaurea stoebe L. [*RDR183*; *RDR272*]
Cirsium arvense (L.) Scop.
Cirsium palustre (L.) Scop.
Cirsium vulgare (Savi) Ten.
Doellingeria umbellata (Mill.) Nees
Erigeron annuus (L.) Pers.
Erigeron canadensis L. (=*Conyza canadensis* (L.) Cronq.) [*RDR267*]
Erigeron strigosus Muhl. ex Willd.
Eupatorium perfoliatum L.
Euthamia caroliniana (L.) Greene ex Porter & Britton [*RDR133*]

Euthamia graminifolia (L.) Nutt.
Eutrochium maculatum (L.) E.E. Lamont
Hieracium aurantiacum L.
Hieracium kalmii L.
Hieracium piloselloides Vill.
Hieracium scabrum Michx.
Hypochaeris radicata L.
Lactuca biennis (Moench) Fernald
Lactuca canadensis L.
Lapsana communis L.
Leucanthemum vulgare Lam.
Oclemena nemoralis (Aiton) Greene
Pseudognaphalium macounii (Greene) Kartesz [*RDR149*; *RDR262; RDR266*]
Pseudognaphalium obtusifolium (L.) Hillard & B.L. Burtt [*SF1933*]
Solidago altissima L. [*RDR281*]
Solidago canadensis L. [*RDR175*]
Solidago hispida Muhl. ex Willd. [*RDR273*]
Solidago juncea Aiton
Solidago rugosa Mill.
Solidago uliginosa Nutt.
Sonchus arvensis L.
Sonchus asper (L.) Hill
Symphyotrichum boreale (Torr. & A. Gray) Á. Löve & D. Löve [*RDR247*]
Symphyotrichum ciliolatum (Lindl.) Á. Löve & D. Löve
Symphyotrichum lanceolatum (Willd.) G.L. Nesom [*SF1410*]
Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve*
Symphyotrichum puniceum (L.) Á. Löve & D. Löve
Tanacetum vulgare L.
Taraxacum officinale F.H. Wigg.

Balsaminaceae
Impatiens capensis Meerb.

Betulaceae
Alnus incana (L.) Moench [*RDR166*]
Betula alleghaniensis Britton [*RDR162*]
Betula papyrifera Marshall
Betula pendula Roth [*RDR154*]
Betula pumila L.
Corylus cornuta Marshall [*RDR270*]

Boraginaceae
Myosotis sylvatica Ehrh. ex Hoffm.

Brassicaceae
Barbarea vulgaris W.T. Aiton
Capsella bursa-pastoris (L.) Medik.*
Cardamine pensylvanica Muhl. ex Willd. [*RDR245*]
Erucastrum gallicum (Willd.) O.E. Schulz [*RDR127*]
Lepidium campestre (L.) W.T. Aiton
Nasturtium officinale R.Br.
Rorippa palustris (L.) Besser [*RDR 126*]

Cabombaceae
Brasenia schreberi J.F. Gmel. [*RDR299*]

Campanulaceae

Palustricodon aparinoides (Pursh) Morin (=*Campanula aparinoides* Pursh) [*RDR259*]
Lobelia inflata L. [*RDR280*]

DIERVILLACEAE
Diervilla lonicera Mill.

CAPRIFOLIACEAE
Lonicera canadensis Bartram & W. Bartram ex Marshall [*RDR296*]
Lonicera villosa (Michx.) Schult.

CARYOPHYLLACEAE
Cerastium fontanum Baumg. [*RDR294*]
Dianthus armeria L.
Saponaria officinalis L.
Silene latifolia Poir.
Silene vulgaris (Moench) Garcke
Spergularia rubra (L.) J. Presl & C. Presl
Stellaria borealis Bigelow
Stellaria media (L.) Vill.*

CERATOPHYLLACEAE
Ceratophyllum demersum L.

CORNACEAE
Cornus alternifolia L.*
Cornus canadensis L. [*RDR169*]
Cornus sericea L. [*RDR268*]

CRASSULACEAE
Hylotelephium telephium (L.) H.Ohba [*RDR230*]

CYPERACEAE
Carex arctata Boott
Carex bebbii (Olney ex L.H. Bailey) Olney ex Fernald
Carex brunnescens (Pers.) Poir. [*SF1922*]
Carex buxbaumii Wahlenb. [*RDR238*; *SF1930*]
Carex canescens L.
Carex communis L.H. Bailey
Carex comosa Boott
Carex crawfordii Fernald [*RDR150*; *RDR243*; *SF1920*]
Carex crinita Lam.
Carex cryptolepis Mack.
Carex debilis Michx.
Carex deweyana Schwein.
Carex diandra Schrank*
Carex disperma Dewey
Carex echinata Murray
Carex flava L.
Carex gracillima Schwein.
Carex gynandra Schwein.
Carex interior L.H. Bailey
Carex intumescens Rudge [*RDR271*]
Carex lacustris Willd.
Carex lasiocarpa Ehrh.
Carex leptalea Wahlenb.
Carex leptonervia (Fernald) Fernald [*RDR234*]
Carex limosa L.

Carex magellanica Lam.*
Carex michauxiana Boeckeler
Carex oligosperma Michx. [*RDR140*]
Carex pallescens L.
Carex pauciflora Lightf.
Carex peckii Howe
Carex pellita Muhl. ex Willd.
Carex projecta Mack.
Carex pseudocyperus L. [*SF1926*]
Carex retrorsa Schwein.
Carex rostrata Stokes [*SF1925*]
Carex scabrata Schwein. [*SF1363*]
Carex scoparia Schkuhr ex Willd.
Carex sterilis Willd. [*SF1921*]
Carex stipata Muhl. ex Willd.
Carex stricta Lam. [*RDR237*]
Carex tenera Dewey*
Carex tribuloides Wahlenb.
Carex trisperma Dewey [*RDR130*]
Carex utriculata Boott
Cladium mariscoides (Muhl.) Torr.
Dulichium arundinaceum (L.) Britton [*RDR134*]
Eleocharis erythropoda Steud.
Eleocharis flavescens var. olivacea (Poir.) Urb. [*RDR240*; *SF1927*]
Eleocharis intermedia Schult.
Eleocharis ovata (Roth) Roem. & Schult. [*RDR256*]
Eleocharis palustris (L.) Roem. & Schult. [*SF1928*]
Eleocharis quinqueflora (Hartmann) O.Schwarz [*RDR241*; *SF1929*]
Eriophorum angustifolium Honck.
Eriophorum tenellum Nutt.*
Eriophorum vaginatum L.
Eriophorum virginicum L. [*SF1932A*]
Rhynchospora alba (L.) Vahl
Rhynchospora capitellata (Michx.) Vahl
Schoenoplectus acutus (Muhl. ex Bigelow) Á. Löve & D. Löve
Schoenoplectus subterminalis (Torr.) Soják
Schoenoplectus tabernaemontani (C.C. Gmel.) Palla
Scirpus atrocinctus Fernald
Scirpus atrovirens Willd.
Scirpus cyperinus (L.) Kunth
Trichophorum alpinum (L.) Pers.
Trichophorum cespitosum (L.) Hartm.

Droseraeae
Drosera intermedia Hayne
Drosera rotundifolia L.

Ericaceae
Andromeda polifolia L. (=*Andromeda glaucophylla* Link)
Chamaedaphne calyculata (L.) Moench [*RDR141*]
Chimaphila umbellata (L.) W.P.C. Barton
Epigaea repens L. [*RDR190*; *RDR301*]
Gaultheria hispidula (L.) Muhl. ex Bigelow [*RDR168*; *RDR300*]
Gaultheria procumbens L. [*RDR194*]
Gaylussacia baccata (Wangenh.) K. Koch
Kalmia polifolia Wangenh.
Moneses uniflora (L.) A. Gray

Monotropa uniflora L.
Orthilia secunda (L.) House
Pyrola chlorantha Sw.
Pyrola elliptica Nutt.
Rhododendron groenlandicum (Oeder) Kron & Judd [*RDR186*]
Vaccinium angustifolium Aiton [*RDR189*]
Vaccinium macrocarpon Aiton [*RDR139*]
Vaccinium membranaceum Douglas ex Torr.
Vaccinium myrtilloides Michx. [*RDR289*]
Vaccinium ovalifolium Sm. [*RDR188*]
Vaccinium oxycoccos L.

ERIOCAULACEAE
Eriocaulon aquaticum (Hill) Druce

FABACEAE
Lathyrus sp. [*RDR227*]
Lotus corniculatus L.
Medicago lupulina L. [*RDR152*]
Medicago sativa L.
Melilotus albus Medik.
Trifolium aureum Pollich
Trifolium hybridum L.*
Trifolium pratense L.
Trifolium repens L.
Vicia americana Muhl. ex Willd.
Vicia villosa Roth*

FAGACEAE
Fagus grandifolia Ehrh. [*RDR192*]
Quercus macrocarpa Michx.
Quercus rubra L.

GROSSULARIACEAE
Ribes cynosbati L.*
Ribes glandulosum Grauer [*RDR145*; *RDR290*]
Ribes triste Pall.

HALORAGACEAE
Myriophyllum heterophyllum Michx.*
Myriophyllum sibiricum Kom.

HYDROCHARITACEAE
Elodea canadensis Michx.
Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt
Vallisneria americana Michx.*

HYPERICACEAE
Hypericum boreale (Britton) E.P. Bicknell [*RDR137*]
Hypericum canadense L.
Hypericum ellipticum Hook.
Hypericum perforatum L. [*RDR191*]
Triadenum fraseri (Spach) Gleason

IRIDACEAE
Iris versicolor L. [*RDR235*]

JUNCACEAE
Juncus articulatus L.
Juncus balticus Willd.
Juncus canadensis J. Gay ex Laharpe
Juncus effusus L.
Juncus tenuis Willd. [*RDR292*]

LAMIACEAE
Clinopodium vulgare L. [*RDR293*]
Galeopsis tetrahit L.
Lycopus americanus Muhl. ex W.P.C. Barton*
Lycopus uniflorus Michx.
Mentha canadensis L.
Prunella vulgaris L. [*RDR282*]
Scutellaria galericulata L.
Scutellaria lateriflora L.
Stachys pilosa Nutt.*

LENTIBULARIACEAE
Utricularia cornuta Michx.
Utricularia intermedia Hayne
Utricularia macrorhiza Leconte (=*Utricularia vulgaris* L.)
Utricularia purpurea Walter [*RDR298*]
Utricularia resupinata B.D. Greene ex Bigelow

LILIACEAE (=CONVALLARIACEAE pro parte)
Clintonia borealis (Aiton) Raf.
Erythronium americanum Ker Gawl.
Medeola virginiana L.
Streptopus amplexifolius (L.) DC.
Streptopus lanceolatus (Aiton) Reveal

LINDERNIACEAE
Lindernia dubia (L.) Pennell

LINNAEACEAE
Linnaea borealis L.*

MELANTHIACEAE (=TRILLIACEAE)
Trillium cernuum L.

MENYANTHACEAE
Menyanthes trifoliata L.

MOLLUGINACEAE
Mollugo verticillata L.

MONTIACEAE
Claytonia caroliniana Michx.

MYRICACEAE
Comptonia peregrina (L.) Coult [*RDR278*]
Myrica gale L. [*RDR138*]

NYMPHAEACEAE
Nuphar variegata Durand
Nymphaea odorata Aiton [*RDR239*]

ONAGRACEAE
Chamaenerion angustifolium (L.) Scop.
Circaea alpina L.
Epilobium ciliatum Raf.
Epilobium coloratum Biehler
Epilobium leptophyllum Raf.
Epilobium palustre L.
Ludwigia palustris (L.) Elliott [*RDR253*]
Oenothera biennis L.
Oenothera parviflora L. [*SF1409*; *RDR304*]
Oenothera perennis L.

ORCHIDACEAE
Arethusa bulbosa L.*
Calopogon tuberosus (L.) Britton, Sterns & Poggenb.
Corallorhiza maculata (Raf.) Raf.
Cypripedium acaule Aiton
Epipactis helleborine (L.) Crantz [*SF1923*]
Goodyera oblongifolia Raf.
Goodyera tesselata Lodd.
Platanthera aquilonis Sheviak
Platanthera clavellata (Michx.) Luer
Platanthera huronensis (Nutt.) Lindl.*
Pogonia ophioglossoides (L.) Ker Gawl.

OROBANCHACEAE
Epifagus virginiana (L.) W.P.C. Barton [*RDR174*]
Melampyrum lineare Desr.
Rhinanthus minor L. [*RDR121*]

OXALIDACEAE
Oxalis montana Raf. [*RDR163*]
Oxalis stricta L.

PAPAVERACEAE
Dicentra cucullaria (L.) Bernh.

PHRYMACEAE
Erythranthe geyeri (Torr.) G.L. Nesom (=*Mimulus glabratus* (Bentham) Grant)
Mimulus ringens L.

PLANTAGINACEAE
Callitriche palustris L.
Chelone glabra L.
Gratiola neglecta Torr.*
Hippuris vulgaris L.
Plantago lanceolata L. [*RDR279*]
Plantago major L.
Plantago rugelii Decne.
Veronica beccabunga var. americana L. [*RDR263*]
Veronica officinalis L. [*RDR181*]
Veronica serpyllifolia L. [*RDR295*]
Veronica verna L.*

POACEAE
Agrostis gigantea Roth [*RDR129*]

Agrostis scabra Willd. [*RDR248]*
Avenella flexuosa (L.) Drejer
Brachyelytrum aristosum (Michx.) P. Beauv. ex Trel.
Bromus ciliatus L.
Bromus inermis Leyss.
Calamagrostis canadensis (Michx.) P. Beauv.
Cinna latifolia (Trevis. ex Goepp.) Griseb.
Dactylis glomerata L.
Danthonia compressa Austin [*RDR261*; *SF1932*]
Deschampsia cespitosa (L.) P. Beauv.*
Dichanthelium implicatum (Scribn.) Kerguelen [*RDR242*]
Elymus repens (L.) Gould
Elymus smithii (Rydb.) Gould
Festuca saximontana Rydb. [*RDR 185*]
Festuca trachyphylla (Hack.) Hack.*
Glyceria borealis (Nash) Batch.
Glyceria canadensis (Michx.) Trin. [*RDR142*]
Glyceria striata (Lam.) Hitchc.
Leersia oryzoides (L.) Sw. [*SF1934*]
Lolium arundinaceum (Schreb.) Darbysh.
Lolium perenne L.
Milium effusum L.
Muhlenbergia mexicana (L.) Trin.
Oryzopsis asperifolia Michx.*
Panicum capillare L. [RDR269]
Phalaris arundinacea L.
Poa alsodes A. Gray
Poa annua L.
Poa palustris L.
Poa pratensis L. [*RDR232*]
Schizachne purpurascens (Torr.) Swallen*
Setaria pumila (Poir.) Roem. & Schult.
Sphenopholis intermedia (Rydb.) Rydb. [*RDR249*]
Torreyochloa fernaldii (Hitchc.) Church [*RDR147*]

Polygalaceae
Polygala paucifolia Willd.*

Polygonaceae
Fallopia cilinodis (Michx.) Holub
Persicaria amphibia (L.) Delarbre
Persicaria hydropiper (L.) Delarbre
Persicaria lapathifolia (L.) Delarbre
Persicaria punctata (Elliott) Small
Polygonum douglasii Greene
Rumex acetosella L.
Rumex britannica L.
Rumex obtusifolius L.

Pontederiaceae
Heteranthera dubia (Jacq.) MacMill. [*RDR252*]

Potamogetonaceae
Potamogeton alpinus Balb.
Potamogeton amplifolius Tuck.
Potamogeton confervoides Rchb. [*RDR111*]
Potamogeton epihydrus Raf. [*RDR250*]

Potamogeton friesii Rupr.
Potamogeton natans L.
Potamogeton obtusifolius Mert. & W.D.J. Koch*
Potamogeton praelongus Wulfen*
Potamogeton pusillus L. [*RDR265*]
Potamogeton richardsonii (A. Benn.) Rydb. [*RDR305*]
Potamogeton robbinsii Oakes
Potamogeton zosteriformis Fernald [*RDR254*]
Stuckenia pectinata (L.) Börner

PRIMULACEAE (=MYRSINACEAE)
Lysimachia borealis (Raf.) U.Manns & Anderb. (=*Trientalis borealis* Raf.)
Lysimachia terrestris (L.) Britton, Sterns & Poggenb.
Lysimachia thyrsiflora L.

RANUNCULACEAE
Actaea pachypoda Elliott*
Actaea rubra (Aiton) Willd.*
Anemone canadensis L
Anemone quinquefolia L. [*RDR236*]
Aquilegia canadensis L.*
Caltha palustris L.
Clematis virginiana L.
Coptis trifolia (L.) Salisb. [*RDR161*]
Ranunculus abortivus L.
Ranunculus acris L.
Ranunculus hispidus Michx.
Ranunculus pensylvanicus L.f. [*RDR244*]
Ranunculus recurvatus Poir.
Thalictrum dasycarpum Fisch. & C.A.Mey. & Avé-Lall

RHAMNACEAE

Rhamnus alnifolia L'Her. [*RDR257*]

ROSACEAE
Agrimonia gryposepala Wallr.
Agrimonia striata Michx.*
Amelanchier arborea (F. Michx.) Fernald
Amelanchier bartramiana (Tausch) M. Roem.
Amelanchier laevis Wiegand*
Aronia prunifolia (Marshall) Rehder [*RDR195*]
Comarum palustre L.
Fragaria virginiana Mill.
Geum aleppicum Jacq.
Geum macrophyllum Willd.
Geum rivale L.*
Malus domestica (Suckow) Borkh. (=*Malus pumila* Mill.) [*RDR233*]
Potentilla argentea L.
Potentilla norvegica L.
Potentilla recta L.*
Potentilla simplex Michx. [*RDR258*]
Prunus pensylvanica L.*
Prunus serotina Ehrh. [*RDR193*]
Prunus virginiana L.
Rosa arkansana Porter
Rosa palustris Marshall

Rubus allegheniensis Porter
Rubus canadensis L. [*RDR180*]
Rubus strigosus Michx. [*RDR179*]
Rubus nutkanus Moc. ex. Ser. (=*Rubus parviflorus* Nutt.)*
Rubus pubescens Raf. [*RDR297*]
Rubus setosus Bigelow
Sibbaldiopsis tridentata (Aiton) Rydb.
Sorbus americana Marshall
Sorbus decora (Sarg.) C.K. Schneid.

RUBIACEAE
Galium asprellum Michx.
Galium tinctorium L.
Galium trifidum L. [*RDR231*]
Galium triflorum Michx.
Mitchella repens L.

SALICACEAE
Populus balsamifera L. [*RDR283*]
Populus grandidentata Michx.
Populus tremuloides Michx. [*RDR285*]
Salix bebbiana Sarg.
Salix discolor Muhl.
Salix humilis Marshall [*RDR286*]
Salix interior Rowlee (=*Salix exigua* Nutt.)
Salix lucida Muhl.
Salix pedicellaris Pursh
Salix petiolaris Sm.
Salix pyrifolia Andersson

SANTALACEAE
Arceuthobium pusillum Peck [*RDR148*]

SAPINDACEAE
Acer pensylvanicum L.
Acer platanoides L. [*RDR197*]
Acer rubrum L. [*RDR176*]
Acer saccharum Marshall [*RDR171*]
Acer spicatum Lam.*

SARRACENIACEAE
Sarracenia purpurea L.

SAXIFRAGACEAE
Chrysosplenium americanum Schwein. ex Hook. [*RDR143*]
Micranthes pensylvanica (L.) Haw.

SCHEUCHZERIACEAE
Scheuchzeria palustris L.

SCROPHULARIACEAE
Scrophularia lanceolata Pursh [*RDR303*]
Verbascum thapsus L. [*RDR287*]

TYPHACEAE
Sparganium americanum Nutt.
Sparganium eurycarpum Engelm.

Sparganium natans L.
Typha latifolia L.

URTICACEAE
Urtica gracilis Aiton (=*Urtica dioica* L.)

VERBENACEAE
Verbena hastata L.

VIBURNACEAE (=ADOXACEAE)
Sambucus canadensis L.
Sambucus racemosa L.
Viburnum cassinoides L. [*RDR302*]
Viburnum trilobum Marshall*

VIOLACEAE
Viola blanda Willd.
Viola cucullata Aiton
Viola lanceolata L. [*RDR136*]
Viola macloskeyi F.E. Lloyd*
Viola renifolia A. Gray*
Viola sororia Willd.

XYRIDACEAE
Xyris montana Ries