FLORISTIC INVENTORY AND FLORISTIC QUALITY ASSESSMENT OF THE LSL TRACT, STRAITS OF MACKINAC,

EMMET COUNTY, MICHIGAN

EEB 556 Field Botany of Northern Michigan

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ABSTRACT

The 55 ha Emmet County LSL tract was obtained in 1990 by Emmet County as an addition to their adjacent Cecil Bay Park. The perimeter of the preserve consists of disturbed roadside and a two-track clearing to the north and a power line in the southwest corner. Though the LSL tract is surrounded by paved road and residential properties, the central core of the site remains fairly untouched. The majority of the site consists of a *Thuja* forest (37 ha) that surrounds relict beach pools and their surrounding marshes (12 ha). Our objective was to conduct a botanical inventory and floristic quality assessment (FQA) of the LSL Tract to establish a baseline of botanical knowledge that may inform future management of the site. We surveyed the property on four separate occasions in June and July of 2013. We collected every new species we encountered within focal habitats. The inventory consisted of 199 species, 165 of which (83%) were native. Coefficients of conservatism and wetness were calculated for every species identified. The entire tract had an FQA of 66.6, the roadsides 24.0, the power line 14.9, the two-track 34.7, the *Thuja* forest 37.6, and the beach pool marshes 44.1. The majority of the native plants with high conservation value were located in the beach pool marshes. However, two federally threatened, Great Lakes endemic species (Iris lacustris and Solidago houghtonii)

were found in the two-track clearing at the northern end of the property. Some invasive species found in the site that may be able to colonize inner parts of the preserve if trails are established. Of these, *Cirsium palustre* (swamp thistle) and *Fallopia japonica* (Japanese knotweed) need to be carefully monitored. Here, we provide suggestions for the protection of the valuable native flora of the LSL Tract, a property that is a noteworthy representation of a Straits of Mackinac native forest and wetland complex.

INTRODUCTION

In recent years biological science has been shifting its focus away from taxonomy towards ecosystem function. With less scientific emphasis on taxonomic knowledge and community composition, it is becoming increasingly difficult to assess which natural areas are of conservation value (Bortolus 2008). Dating back to the 1700s, taxonomists have evaluated the importance of ecosystems by conducting biodiversity inventories of noteworthy locations. Floristic inventories would identify vascular plants within small parcels of land or entire regions (Funk 2006). These floristic inventories list each species of plant found in the area and allow qualitative comparison of natural areas across regions and through time (Palmer et al. 1995). Inventories were commonplace through the mid-1900s but have been dwindling in the literature in recent decades. As habitat fragmentation and climate change alter habitats, species composition and abundance also changes. Over long periods of time, floristic inventories provide a benchmark for studying succession at a particular location in addition to providing information regarding conservation of an area (Bortolus 2008).

Correct identification of organisms is necessary to study ecological interactions and are critical for effective conservation (Bortolus 2008). Botanical inventories describe the identity

and abundance of resident species and this information can be very important for management. Of special concern to land managers are rare species and exotic invasive species that can degrade native habitats. If land owners hope to restore a location to a particular point in its natural history, floristic inventories can be valuable in determining what species should be the focus of management either as targets of restoration or in the case of exotics, targets for removal (Bortolus 2008). Additionally, having an accurate understanding of the taxonomy of native species, can help managers monitor their lands for the introduction of exotic species not previously known from the site (Bortolus 2008).

METHODS

I. Regional overview and site description

Our floristic inventory was conducted at the Emmet County "LSL Tract." Located along the Straits of Mackinac, the LSL Tract lies on a peninsula east of Wilderness State Park. The LSL Tract (ca. 55 ha) was obtained by Emmet County in 1990 as an addition to the adjacent Emmet County Cecil Bay Park. The parcel lies on a small peninsula extending into Lake Michigan between Cecil Bay to the west and Trails End Bay to the east, on the west side of the Straits of Mackinac. The tract's triangular perimeter is defined by Straits View Drive to the east, north, and west and by Wilderness Park Drive to the south (Figure 1). The east, west and north sides of the property lie mostly within a few hundred meters of the Lake Michigan shoreline. There are numerous private parcels and houses located between the LSL tract and the Straits. The LSL Tract contains disturbed areas (including roadside shoulders, a powerline, and a small two-track pull off area), as well as *Thuja*-dominated forests. The interior of the tract consists of marshes surrounding former beach pools (Figure 1).

II. Disturbed Habitats

Disturbed habitats are characterized by human disruption of the environment, (specifically vehicle traffic, road and powerline). Some of these disruptions that can influence plant communities include soil compaction, soil perturbation, vegetation removal, and related hydrological changes. The LSL Tract has three disturbed habitats: the roadside, two-track clearing, and the powerline.

Roadside. The roadside area (Figure 1, Figure 2) is consists of the outer perimeter of the tract along Straits View Drive and Wilderness Drive. The road shoulder and vegetated verge is about 5 m wide. The roadside is characterized by dry, gravelly soil. In some areas, there are ditches with standing water.

Powerline. The southwest corner of the LSL Tract is crossed by a powerline (Figure 1, Figure 3) which runs through the forest and creates an open area of approximately 0.4 ha. A wetland depression that contains *Typha* is located at the west end of the powerline. This area was cut through the *Thuja* forest and has created a high light environment that is regularly disturbed in order to maintain access to the electrical lines.

Two-track clearing. At the northern extent of the LSL Tract along Straits View Drive, there is a small, cleared area (ca. 0.05 ha) used by vehicles that we refer to as the two-track area (Figure 1, Figure 4). This open area is characterized by disturbance related to vehicle compaction (Figure 1). Based on the proximity of this pull off to one of the main hunting trails, we speculate that this area is an access point for hunters. As a result of vehicle traffic, the soil is compacted and retains water, creating a habitat that mimics the calcareous Great Lakes shoreline habitats found throughout the Straits region.

III. Habitats with minimal disturbance

Thuja forest. This habitat in northern Michigan is dominated by Thuja occidentalis.

Thuja forests are cool, moist, nutrient-rich, and have calcareous mineral soils (Schwintzer 1981).

These habitats are characterized by seasonal fluctuations in water level. Although mixed conifer swamps were once among the most common of Michigan's forests, almost 75% of these forests have become hardwood swamps or been lost due to land conversion in northern lower Michigan alone (Albert et al. 2008).

At the LSL Tract, a *Thuja-Abies* forest (ca. 37 ha) surrounds the wetlands and is the largest part of the tract, but relatively uniform in terms of habitat diversity and floristic composition. *Thuja* forests are characterized by shaded, sparsely vegetated understories (Figure 5). These forests have numerous canopy gaps due to abundant tree fall due to shallow soils (Figure 6). Areas of this forest located in the interior of the tract are quite wet and likely vary in their wetness based on yearly hydrological fluctuations. The species we observed in this habitat were consistent with Schwintzer's (1981) classification of conifer wetlands in northern Michigan (i.e. *Thuja* occidentalis, *Abies balsamea*, *Maianthemum canadense*, and *Chaemaedaphne calyculata*). Some parts of the forest are crossed by trails that seem to be access routes to the interior wetlands of the LSL Tract.

Beach pool marshes. The center of the LSL tract opens into an expanse of several shallow ponds and surrounding marshes (Figure 1, Figure 7). We interpreted these wetlands to represent barrier-protected, ridge and swale complexes using a hydrogeomorphic Great Lakes wetland classification (Albert et al. 2005). These areas are characterized by a series of beach ridges separating narrow swales from the Great Lakes, indirect seepage through barrier features

and prime hydrological influences from surrounding uplands. These swales, or beach pool marshes, are formed in response to fluctuations in lake level (Albert et al. 2005). There is some evidence of hunting activity along these wetlands as we found old and relatively recent remains of hunting blinds.

IV. Floristic inventory: Field sampling and conservation indices

Floristic surveys of the LSL Tract were conducted by a team of 7 (5 students and 2 instructors) from the University of Michigan Biological Station (UMBS) Field Botany of Northern Michigan class on June 27, July 1, July 4, and July 29, 2013. Specimens were collected by groups sampling across all habitats at the sampling sites (roadside, wetland, powerline, and forest). At UMBS, specimens were identified using the *Field Manual of Michigan Flora* (Voss and Reznicek 2011), *Michigan Flora Online* (Reznicek et al. 2011), the *Manual of the Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason and Cronquist 1991), and voucher specimens from the UMBS herbarium. Plant identifications were verified by course instructors C. E. Hellquist and J. E. Dorey. Voucher specimens were retained for eventual curation in the UMBS herbarium.

Once our inventory was finalized, we were able to evaluate the diversity of vascular plants at the LSL Tract using Floristic Quality Assessment (FQA) methods (Herman et al. 2001). Coefficients of conservatism and coefficients of wetness were recorded for each species (Herman et al. 2001). The FQA used in this study was modified by the Michigan Department of Natural Resources (DNR) from previous versions for use specifically in Michigan (Herman et al. 2001). Using our species inventory and the indices described below, we were able to evaluate the quality of the plant communities within the LSL Tract. We were also able to compare the LSL Tract to other natural areas in northern lower Michigan.

As part of our FQA, we assigned coefficients of conservatism (CC) to each species as defined by the Michigan DNR. These CC values are on a scale of 1 to 10 and measure the ability of a plant species to exist in human altered landscapes. Values closest to zero are given to species that can thrive in nearly any environment, including human altered areas. These species are often of low priority for conservation (Herman et al. 2001). Values closest to ten are assigned to species that can only thrive in areas that have not been disturbed by humans for an extensive period of time, and are sometimes only found in patches of land that have been untouched since pre-colonization times (Herman et al. 2001). Plant species that are not native to Michigan are assigned an asterisk (*) instead of a CC value. The presence of an exotic species lowers the average CC by contributing to the total species, but not to the sum of the coefficients of conservatism (Herman et al. 2001).

By averaging coefficients, a numerical representation of the floristic diversity of the area is obtained. To transform the CC into a value that can be compared among sites of various sizes, the average CC is multiplied by the square root of the number of species in the area (Herman et al. 2001). This value is known as the floristic quality index (FQI). FQI values can be used to compare the plant diversity, community composition, and conservation quality between sites.

We also calculated the wetness index for the LSL Tract (Herman et al. 2001).

Coefficients of wetness (CW) evaluate vascular plant diversity associated with aquatic and wetland environments as opposed to well-drained, upland environments. CW are assigned to all plants known from Michigan (native and non-native) on a scale of -5 to 5 (Table 1; Herman et al. 2001). Species associated with aquatic environments are given a coefficient of wetness less than zero. The wetness index is calculated by averaging the CW that is assigned to a species. A

wetness index of less than zero indicates that species within the plot are predominantly associated with wetlands (Herman et al. 2001).

RESULTS

The flora of the LSL Tract consisted of 199 species representing 61 families (Table 2; Appendix). Of these species, 165 were native to Michigan and 34 were non-native. The LSL Tract has an abundance of notable native species (*Appendix*) including two federally threatened Great Lakes endemic species (*Iris lacustris* and *Solidago houghtonii*). We define "notable" as those species with a coefficient of conservatism (CC) of 8 or greater (see methods for explanation). We found thirteen species with a CC of 10, five with a CC of 9, and seventeen species with a CC of 8 (Table 4). Four out of five habitats had at least four species of conservation value with the majority of species of conservation significance found in the beach pool marshes.

There were 34 introduced species collected the LSL Tract that were categorized based on their degree of invasiveness (Table 5; Table 6; *Appendix*). The *Thuja* forest had one invasive species. The two-track along Straits View Drive had two invasive species and four exotic species; the powerline had nine invasive species (including *Fallopia japonica*) and five exotics; and the roadside had five invasives (including *Cirsium palustre*) and seven exotics.

The species richness in each habitat ranged from 47 (Beach Pool Marshes) to 68 (Two-track; Table 2). The mean CC for each species collected was 5.2. The overall FQI value was 66.9 (Figure 8; Table 2). The mean CW was -1.6 for all native species and decreased to -0.8

when exotic species were included in the analysis. The flora was characterized by species with strong affinities for wetland habitats (Figure 9).

Roadside. We collected 66 species from the roadside (44 native). The roadside had a FQI of 27, a mean CC of 4.1 and a mean CW of -0.4 (Figure 8). The 22 non-native species lowered the FQI to 24.0. The mean CC and CW were lowered to 3.0 and 0.4, respectively. The roadside was colonized by graminoids such as *Dactylis glomerata*, *Juncus balticus*, *Phalaris arundinacea*, and *Schizachyrium scoparium*. *Toxicodendron rydbergii* also was abundant along the roadside. The invasive knapweed species *Centaurea stoebe* was abundant on dry road shoulders while *Cirsium palustre* was present in scattered wet ditches. This area also contained large stands of the Federally Endangered Species, *Iris lacustris* (Dwarf Lake Iris). On the northwest portion of Straits View Drive, contiguous to nearly contiguous patches of *Iris lacustris* extended approximately 460 m along the road.

Powerline. Forty-nine species were collected from the powerline site (32 native and 17 exotic). The mean CC for the native species was lowest (3.3) for all habitats (Table 2). The powerline was characterized by graminoid species such as *Elymus canadensis*, *Elymus repens* and *Phleum pratense*. *Toxicodendron rydbergii* is also extremely abundant in the powerline. *Monarda fistulosa* is also interspersed throughout this area and the noxious invader *Fallopia japonica* is located in the centeral area of the powerline.

Two-track. We collected 68 species from the two-track site (51 native and 17 exotic). The mean CC, FQI (Figure 8) and mean CW for the native species was 5.6, 40.0, and -0.5, respectively. With non-natives included, the indices changed to an FQI of 34.7, a mean CC of 4.2, and a mean CW of 0.0. The two-track has a unique assemblage of calciphile species typically associated with damp, shoreline habitats and wetlands, such as *Parnassia glauca* and

Triantha glutinosa. Importantly, two federally threatened species (*Iris lacustris* and *Solidago houghtonii*) were also present at the two-track.

Thuja forest. Fifty three species were collected from the forest site. The FQI was 38.0, the mean CC was 5.3, and the mean CW was -0.4 for the native species. Adding the non-native species changed these values to 37.6 and 5.2, respectively. The CW value did not change. This forest is dominated by Thuja occidentalis and Abies balsamea. The understory largely consisted of herbs including Maianthemum canadense and Aralia nudicaulis. Wet microhabitats within the Thuja forest contained Carex trisperma, Lycopodium clavatum, Gaultheria hispidula, and Coptis trifolia.

Beach pool marshes. The interior part of the LSL Tract consists of an extensive marsh (ca. 11.5 ha) dominated by *Cladium mariscoides* and *Carex lasiocarpa*. Surrounding the herbaceous marsh was a fringing community of shrubs including *Myrica gale*, *Chaemaedaphne calyculata*, and *Alnus incana* that formed a boundary between the *Thuja* forest and the open marsh. All 47 species that were collected in this habitat were native. These marshes surround four large, shallow, marl-bottom ponds (ca. 3.1 ha) located in the interior of the LSL Tract. Aquatic vegetation in the ponds was sparse and consisted of *Nuphar variegata*, *Utricularia gibba*, *Utricularia vulgaris* and macroalgae (*Chara* sp.). The beach pool marshes FQI, mean CC, and CW were the highest of all the LSL Tract habitats (Table 2).

DISCUSSION

Floristic overview. The LSL Tract had a floristic quality index of 66.6. This value indicates that the site is of high conservation importance (DNR 2001). A site of comparable

conservation value is Grass Bay Preserve (Figure 10). In 2005, the UMBS Field Botany class found an FQI of 72.7 at Grass Bay (Table 3). The LSL Tract has great potential for conservation and educational use. With increased development pressure in the Straits region, the protection of the LSL Tract is a notable contribution to the region's conservation legacy.

The habitat richest in species of high conservation value was the beach pool marshes (Table 2). The beach pool marshes habitat had a higher FQI than some entire sites from past UMBS Field Botany projects (Table 3). The high FQI and lack of exotic species in the interior marshes and beach pools attests to the relatively unimpacted condition of the LSL Tract wetlands. Conversely, the highest amount of invasive and exotic species (14 out of 34) was found at the power line (Table 5). The road also contributed a high number of exotic species to the LSL Tract flora.

Although we located 199 species, our flora is not complete. Ideally, a tract of this size would be sampled more thoroughly throughout the summer in addition to the spring and fall. We estimate there are likely 25-50 additional species to be identified from throughout the site. We expect that with further sampling of all areas within the LSL Tract additional species will be found that will slightly adjust or conservation index values. It is likely that we sampled non-native, invasive species within the LSL Tract more efficiently due to many factors including the difference in accessibility of each area and the ease of identifying well known invasives. For example, we were better able to access the Power-line, Roadside, and Two-track areas, which have a higher proportion of non-native species than the *Thuja* forest which was more difficult to survey efficiently.

The LSL Tract provides an area of high interest for floristic analysis due to the wide range of landscape and hydrologic conditions present within the site that include aquatic ponds to

moderately drained and slightly acidic upland terrain. Because the tract is surrounded by roads, regular disturbance along the edges of the tract allow for the growth of disturbed-ground specie, many of which are exotic. Additionally, being surrounded by roads may contribute to microhabitat differences caused by increased wind speed, decreased humidity, and increased salinity (Chen et al. 1999). Both regular disturbance and microclimate effects allow the growth of many generalist species, which contrasts highly to the disturbance intolerant species found within the interior of the tract. However, a high ratio of edge length to forest area often decreases vascular plant diversity within the central, less-disturbed area, because the movement of plant species into the area via animal and wind dispersion is restricted (Matlack 1994). Studies of the edge effect on plant diversity have shown that the land-use types of areas adjacent to forests determine the wildly variable effect on vascular plant diversity (Ma et al. 2013).

The LSL Tract is also an area of interest due to the relatively undisturbed nature of the interior of the tract. The only evidence of human activity in the interior of the tract were some primitive trails that led to the interior wetlands. Along the edge of the marshes we found a variety of dilapidated hunting blinds and a rusted car in the *Thuja* forest to the south. Because of the lack of disturbance to the innermost region of the plot, many species that are sensitive to ecosystem alterations are able to thrive.

Native species of conservation significance by habitat. There were many native species on conservation importance found at the LSL Tract. By far the habitat richest in natives on high conservation value was the beach pool marshes. Two federally threatened, Great Lakes endemic species were found in more disturbed areas however. *Iris lacustris* (Dwarf lake iris) was found along the road near *Thuja* and *Solidago houghtonii* (Houghton's goldenrod) was found in the two-track along Straits View Drive.

Roadside. Four species of conservation importance were found along the roadside (Table 4). *Iris lacustris* was found primarily along the western extent of Straits View Drive. This species if unique to the Great Lakes region. *Iris lacustris* was discovered on Mackinac Island in 1810 by Thomas Nuttall (Voss 1963). *Iris lacustris* is also Michigan's state wildflower (Reznicek et al. 2011). Beyond Michigan *I. lacustris* is only found on the Door Peninsula of Wisconsin and in Ontario on Manitoulin Island and the Bruce Peninsula. *Iris lacustris* tends is found on moist sands and in limestone crevices, as well as along the edges of conifer forests that dominate the northern shores of Lakes Michigan and Huron. *Iris lacustris* is typically found on cobble beaches associated with modern or former shorelines of Lakes Michigan and Huron (DNR 2013; Reznicek et al. 2011).

Dwarf Lake Iris is threatened under Michigan and federal law and is vulnerable to human disturbances such as development and recreation along shorelines (DNR 2013) although it can be found in powerlines, shoulders of roads, and along two tracks (Hellquist, pers. obs.). At the LSL Tract, *I. lacustris* was found along the edges of the cleared two track area and in extensive mats within 5 m or less of the asphalt edge of Straits View Drive. Patches were also found in the *Thuja* forest just north of Wilderness Park Drive. Some disturbance probably simulates the disturbances associated with fluctuating water levels and ice push associated with its Great Lakes habitats.

Two-track. We found a surprising amount of diversity within the two-track pulloff along the northern portion of Straits View Drive. Eight species have coefficients of conservatism of 8 or higher (Table 4) and two of these are federally threatened. The two-track was the only location for the Great Lakes endemic species, Houghton's goldenrod (*Solidago houghtonii*). This species is closely linked with the early scientific history of the region, named for Douglas

Houghton, Michigan's first state geologist who collected it during his first survey of the state (Voss 1963). *Solidago houghtonii* is threatened under both Michigan and federal law (Reznicek et al. 2011) and occurs almost solely in Michigan along the northern shores of Lake Michigan and Lake Huron. The range of *S. houghtonii* extends east to the Bruce Peninsula in Ontario (Voss 1963). Most populations in northern Michigan occur in the vicinity of the Straits of Mackinac. *Solidago houghtonii* can usually be found on moist interdunal flats or occasionally on low dunes and beaches or nearby fens in addition to alvars on Drummond Island. Increased human activity in shoreline habitats is a primary threat to *Solidago houghtonii*. The fluctuating water levels of the Great Lakes play an important role in maintaining Houghton's goldenrod populations. High water levels submerge the goldenrod, but some plants survive and when the water recedes seedlings can establish on the moist sand (Reznicek et al. 2011).

Other notable calcareous shoreline species at the two-track include *Triantha glutinosa*, *Lobelia kalmii*, and *Hypericum kalmianum*. *Triantha* is common on wet and calcium-rich shores around northern Lake Michigan and Lake Huron or on the shores of peatlands. It can also be found in rock crevices in rock crevices along Lake Superior. *Lobelia kalmii* is a caliciphile that occurs along sandy, marly shores and in marshes, fens, and swamps (Reznicek et al. 2011). Additionally, a healthy population of *Iris lacustris* was also found in the two-track area near *Thuja*.

Thuja forest. There are eight species of high conservation value in the *Thuja* forest (Table 4). In small pockets and hollows at the base of Thuja trunks and roots *Carex disperma* was often found. This sedge is native to the United States and Canada as well as parts of Greenland and France and is found in cedar swamps like we found it often in *Sphagnum*.

Petasites frigidus was found throughout the *Thuja* forest and is a relatively common species

occurring in many parts of northern Michigan and the Upper Peninsula. *Petasites frigidus* is found in the northern United States and California as well as all of Canada (Gleason and Cronquist 1991). It can generally be found in moist coniferous forests and swamps (Gleason and Cronquist 1991). *Petasites frigidus* tends to grow best along trails and after clearing takes place (Reznicek et al. 2011). Shaded patches of *Iris lacustris* just north of Wilderness Park Drive were found in this habitat as well.

A likely change to the LSL Tract is loss of ash trees that can be found at the edges of the *Thuja* forest that border the open marsh area. These ash trees are likely to be killed by the northward expansion of the Emerald Ash Borer. The Emerald Ash Borer (*Agrilus planipennis* Fairmaire, EAB) is an invasive insect that was brought to the United States in the early 1990's from northern Asia and was first discovered in Detroit, MI (Flower et al. 2013). This insect burrows into the trunk of all species of Ash (*Fraxinus* spp.) and causes damage that eventually culminates in its death (Flower et al 2013). This species has caused the devastation of all five species of Ash found in Michigan. With the encroachment of this species, it is inevitable that *Fraxinus* populations in Northern Michigan will soon decline rapidly. As these trees die off due to the effects of *A. planipennis*, canopy cover along the edges of the marsh where it is most common will open up and allow for the growth of other woody marsh species such as *Alnus incana*. The emerald ash borer will thus act as an ecological disturbance that will initiate new community composition in areas where ash trees are currently located.

Beach pool marshes. These aquatic ponds and wetlands contained 17 native species with high conservation value, the greatest in any habitat (Table 4). *Cladium mariscoides* and *Carex lasiocarpa* were the dominant sedges in the marshes. These species occur in bogs and marshes and are minerotrophic. The rhizomes of both species are vital components in the

formation of floating mats in fens. *Carex buxbaumii* was also abundant in the marshes. This species tends to form large stands along shores and in meadows, marshes and fens (Reznicek et al. 2011). *Eriophorum angustifolium* was found in isolated patches of the marsh. It is a northern species found in bogs, fens and conifer swamps especially in slight disturbances such as trails and ditches. We also made a collection of *Calamagrostis stricta* in the marsh. This species occurs in fens, low dunes and swales and rocky, calcareous shores of the Great Lakes, occasionally in drier sites (Reznicek et al. 2011). Lastly, *Sarracenia purpurea* (pitcher plant), is an insectivorous species that characteristic of *Sphagnum* bogs and tamarack swamps. *Sarracenia purpurea* can thrive across the pH gradient and in the full range of light conditions (Reznicek et al. 2011).

The open marsh was bordered by a shrub community that separated the marsh from the *Thuja* forest. Characteristic species of this community included *Andromeda glaugophylla*, *Chamaedaphne calyculata, Hypericum kalmianum*, and *Myrica gale. Andromeda* also occurs in bogs, but especially fens on the floating mats in the northeastern US and Canada. It can be found occasionally in other wet places such as interdunal hollows (Reznicek et al. 2011). *Hypericum kalmianum* is primarily found in the Great Lakes region and is often found in moist, calcareous interdunal hollows and fens (Reznicek et al. 2011).

Powerline. The powerline consisted of human-modified disturbed habitat that typically does not have a wide variety of species of high conservation value. Of the species documented from the powerline, we only found a single, population of *Mitella nuda* that met our criteria for conservation significance. This population appeared to be a relict population left behind following the clearing of the *Thuja* forest to create the powerline.

Species of conservation significance that may be found in future surveys of the LSL

Tract. Unfortunately, due to limited time and the season we were unable to catalogue the entire LSL Tract. We believe there are some plants of conservational importance that are likely to occur that we may not have found. Two likely, though rare, orchids are *Calypso bulbosa* and *Cypripedium arietinum*. Calypso occurs in mixed moist coniferous forests and on old beach ridges of the Great Lakes. Calypso is mostly present in the northern and western United States and most of Canada (Gleason et al. 1991). In Michigan, calypso is restricted to the northern Lower Peninsula and scattered sites in the Upper Peninsula (Reznicek et al. 2011). Calypso is found in the straits of Mackinac in Wilderness State Park, though it is quite rare, and very inconspicuous when not in flower (Hellquist, pers. obs.). *Calypso bulbosa* is threatened in Michigan, Vermont, and Wisconsin and endangered in New York and New Hampshire (USDA 2005).

Cypripedium arietinum (Ram's Head Lady-Slipper), thrives on low dunes and in partial shade in conifer forests along the northern shores of Lakes Michigan, Huron and Superior. It can also occur inland under jack pines, in thin soil over rock and in conifer swamps (Reznicek et al. 2011). Ram's Head Lady Slipper is found in the Great Lakes region, in the northeastern United States and parts of Canada (Gleason and Cronquist 1991). Cypripedium arietinum is frequently found on old beach ridges and dunes of Wilderness State Park and is likely found somewhere in the Thuja forest of the LSL Tract.

Invasive and exotic species. Invasive species are those that establish in a new area and persist, causing negative ecological changes in the new range (Mack et al. 1999). Invasive species have the potential to drastically alter the community structure, physical features, nutrient cycling, and plant productivity of an ecosystem (Mack et al. 1999). Introduced species

abundance is correlated with road density (Zedler and Kercher 2004). While 34 introduced species were identified during our reconnaissance of the LSL Tract, only a few species have the potential to thrive as invasives in the interior marshes and *Thuja* habitats. In the *Thuja* forest and the marshes, soil wetness and shade act as ecological filters which prevent certain exotic plant species from establishing (Myers and Harms 2011). Problem species that could penetrate the interior of the tract include *Cirsium palustre* and *Fallopia japonica*.

Cirsium palustre (Marsh Thistle) is native to the moist meadows, forest edges, pastures, and riversides of western Europe (Ramula 2008). First found in Michigan's Lower Peninsula in 1959, Marsh Thistle continues to move southward (Reznicek et al. 2011). This invasive thistle is pollinated by insects and spreads primarily via wind dispersal but also through water runoff, animals, and logging equipment (van Leeuwen 1981; van Leeuwen 1987; Gucker 2009).

Cirsium palustre is a strong competitor and establishes colonies quickly in moist, alkaline habitats such as cedar-dominated swamps (Tohver 1998). Cirsium palustre is able to colonize and persist in an area due to a long life cycle, ability to reproduce at multiple ages, persistent seed bank formation, wind dispersal of seeds, and the emergence and juvenile survival underneath old rosettes (Falinska 1997; van Leeuwen 1983).

Marsh Thistle was found on the eastern extent of Straits View Drive at the LSL Tract. It was found in wet ditch in relatively close proximity to the interior wetlands. If trails are made into the interior of the LSL Tract, marsh thistle is likely to colonize wet trailside, as is often observed in northern Michigan. Control methods for *Cirsium palustre* include hand-pulling or digging of rosettes prior to flowering as well as mowing colonies multiple times during the growing season for three to four years (Cao et al. 2013). Mechanical removal must be closely monitored and consistent over long periods of time, as aggressive regrowth after mowing and

enhancement of *C. palustre* seed banks can occur (Cao et al. 2013). The preferred chemical treatment for *C. palustre* is foliar spraying with clopyralid and/or glyphosate (Cao et al. 2013). Every effort should be made to keep this species out of the interior marshes of the LSL Tract.

Fallopia japonica (Japanese knotweed) was introduced from Asia to North America in the nineteenth century as an ornamental (Reznicek et al. 2011). Japanese knotweed is an aggressive invader, reproducing vegetatively via rhizomes and re-sprouting from root and stem fragments (Weston et al. 2005). Establishment of Japanese knotweed colonies occurs when rhizome-contaminated topsoil is moved during building development (Beerling 1991). Fallopia japonica thrives in wet, disturbed, and open places like roadsides and riparian corridors (Weston et al. 2005). Fallopia japonica was found in the powerline of the LSL Tract. Fallopia japonica thrives in a variety of light conditions. This species has the potential to spread from the powerline to the interior Thuja forest if disturbances are created. Disturbances where fill is a component (e.g. trails and parking lots) are particularly likely to be colonized by Fallopia (NRCS 2007). Fallopia would likely colonize along parking lots and trails. Mechanical control methods include repeated hand-pulling, cutting and mowing (Baker 1988; Delbart et al. 2012). Herbicide spraying and stem injection are also possible means of control (Delbart et al. 2012).

While *Lonicera morrowii* (Morrow Honeysuckle) was not found at the LSL Tract, this species is an aggressive invasive shrub present in Emmet County (Reznicek et al. 2011). This honeysuckle could colonize along the edge of parking areas if soils are moist, but well-drained. *Lonicera morrowii* was introduced from Japan to the United States in 1875 for horticultural purposes (Love et al. 2009) and has since spread throughout the United States and Canada. One of the most invasive introduced bush honeysuckles, *L. morrowii* often hybridizes with *L. tatarica* to form dense thickets of *L. x bella* in introduced ranges (Whitehead and Bowers 2012;

Reznicek et al. 2011). Morrow honeysuckle produces an abundance of fruit that is primarily dispersed by birds and potentially dispersed by white-tailed deer (Whitehead and Bowers 2012). This shrub most commonly colonizes disturbed sites including roadsides, railroads, thickets, banks, shores, borders of woods, and forest interiors and (Love et al. 2009; Voss 1996). Repeated fire applications, foliar spraying with glyphosate, and mechanical pulling from soft soils can be used to remove invasive honeysuckle (Schulz et al. 2008). Another effective control method is cutting stems to ground level and painting stumps with concentrated glyphosate (Schulz et al. 2008).

Management considerations. In many areas, Michigan's plant communities are very different today compared to their composition prior to European settlement in the 18th century (Albert et al. 2008). However, the LSL Tract is an exception to that pattern. The vegetation of LSL Tract in the 1800s was a mixed conifer swamp dominated by *Thuja occidentalis* with *Abies balsamea*, *Larix laricina*, *Pinus strobus*, and *Betula papyrifera* secondary components of the forest community (Albert et al. 1995). Today, the LSL Tract is still dominated by that community.

Much of the surrounding forest of Cecil Bay and vicinity was logged for *Pinus strobus* (white pine) in the early 1800s (Planisek 2013). By the late 1800s, many less valuable trees including *Larix*, *Picea*, *Populus*, *Thuja*, and *Tsuga* were being removed for lumber (Planisek 2013). The sudden removal of the area's vast forest initiated rapid succession in the region as former forest became open expanses of clear cut forests covered by snags and slash. Further development continued to remove tree biomass, but since the establishment of Wilderness State Park in 1928, much of the forest cover in the park's 43 km² has been preserved. Because of the

undeveloped nature of the LSL Tract, this site is likely very similar to how the region was during European colonization (Albert et al. 2008).

Ecologist Jared Diamond has stated that the "...goal [of restoration ecology] is not itself a self-evident mandate. It is a choice based on values, and it is only one of many possible choices" (Diamond 1987). Like all conservation areas, management and restoration goals for the Emmet County LSL tract will be value-based and management could proceed in a variety of directions based on the priorities of Emmet County and its citizens.

The Two-track, *Thuja* forest, and beach pool marshes habitats had the highest coefficients of conservation (Figure 8). Management could focus on preserving the high fidelity of natural plant communities found in these habitats. Management efforts could also target habitats where the most invasive species were documented. The power line and the roadside had the lowest coefficients of conservation (Table 2) and also had the highest number of invasive species (Table 2). If a trail system is extended into the LSL Tract, invasive species, especially *Cirsium palustre* are likely to follow the trails into the interior of the tract. Once established, their wind-dispersed fruit will facilitate colonization of the marsh.

As an isolated parcel of habitat that is relatively well-buffered from extensive human activity, the LSL Tract has great botanical and conservation value. Management of this site should be given careful consideration to preserve this value and protect the site from negative alteration. It is our understanding the county may be considering establishing formal trails, parking areas ,and wetland viewing sites. Although trails, roads, and parking access are an important way to allow public access to a site and promote environmental awareness, as mentioned above, these human conveniences will provide opportunities for invasive species colonization (Campbell and Gibson 2001, Tyser and Worley 2003, Christen and Matlack 2006,

Mortensen et al. 2009). The occurrence of exotic plant species along trails is readily apparent at the Emmet County Headlands Wood trail system. Trails through the Headlands are fringed by non-native *Myosotis sylvatica*, *Berberis thunbergii*, exotic *Lonicera* sp., and *Lactuca muralis*. These species colonized along the trails and are now becoming prominent components of the forest understory beyond the trails as well.

Due to the nature of exponential growth, the invasion of non-native species is recognized only after it has entered an explosive reproductive phase (Asher and Spurrier 1998). Eradication no longer becomes an option and it is enormously expensive to control the increase of the invader (Huenneke 1996). Fortunately, as shown in a study by Kupfer et al. (1997), these types of species are generally dispersal limited. Due to this general characteristic, careful efforts to control the spread of non-natives can be effective. Currently, no invasive species are observable in the beach pool marshes and yet several were collected from the outer disturbed areas, some were collected only dozens of meters from the interior wetlands on the north east side of the tract. Fortunately, the relative soil wetness and shade from the *Thuja* forest serve as a barrier to many invasive species and these conditions have not allowed exotics to spread to the interior of the tract.

The establishment of paths would alter the soil moisture (and increase compaction), and potentially allow a corridor for invasives to penetrate further into the tract. Trails create disturbance and often bring in fill that can contain seed contaminants or facilitate invasive species establishment. Openings along trails are frequently places where *Cirsium palustre* can be found in northern Michigan. In addition, any fill brought in that is contaminated with *Fallopia japonica* could facilitate its further establishment along parking areas or open trailsides. As such, the development and placement of trails to allow access into the interior portions of the

tract should be carefully considered. Attempts should be made to locate these paths away from already established non-native species and regularly monitor the flora along these paths.

Consideration needs to be given to protect the native, threatened species located within the tract. The abundance of *Iris lacustris* along the western portion of the roadside is a notable floristic element of this site. Likewise, the other threatened native species, *Solidago houghtonii*, should be protected. It is located in a more precarious location that clearly receives vehicle activity. *Solidago houghtonii* is currently located in a section (the two-track clearing) that is accessible to vehicle traffic and as such is highly vulnerable. Efforts should be made to make this area inaccessible to vehicles, perhaps with the establishment of a barrier at the two-track entrance.

As a whole, this site has been well protected from human disturbance. The county or volunteer groups may want to consider removing the decaying remnants of the stranded vehicle and hunting blinds. The chairs, carpet and other blind construction debris could be removed by county personnel or volunteer groups with relative ease and minimal disturbance to the habitats. It is likely the car would require disassembly and removal by hand.

In conclusion, the LSL tract is a site of significant conservation importance. The presence of such a diverse ecosystem coupled with an abundance of rare plant species and species of high conservation value makes this tract a noteworthy northern Michigan conservation area. The lack of human disturbance to the area has allowed the persistence of a relatively undisturbed collection of plant communities that is similar to what was found in the Straits region before human settlement. Along with Wilderness State Park and Cecil Bay Park, the LSL Tract is an important area of conserved habitat on the west side of the Straits of Mackinac. The

LSL tract is a valuable conservation area for the residents of Emmet County and members of the public who travel to the region to appreciate its natural history and other attractions.

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FIGURES



Figure 1. LSL Tract (Emmet County) showing habitats designated for this study and local Roads. Aerial photo: Google Maps, accessed August 2013.



Figure 2. Roadside habitat showing the shoulder and verge along Straits View Drive. LSL Tract is located on the right side of the photograph.



Figure 3. Powerline habitat looking west LSL Tract, Emmet County, MI.



Figure 4. Two-track clearing along Straits View Drive, LSL Tract, Emmet County, MI. Soil compaction from vehicles is visible in the center of the photo.



Figure 5. *Thuja* forest habitat looking south towards the beach pool marshes. LSL Tract, Emmet County, MI.



Figure 6. Characteristic treefall and tip up mound, *Thuja* habitat, LSL Tract, Emmet County, MI.



Figure 7. Marsh habitat associated with beach pools in the interior of the LSL Tract, Emmet County, MI.

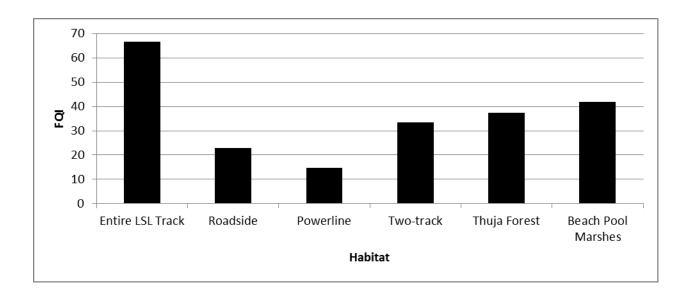


Figure 8: Floristic quality index (FQI) for native species in the entire LSL tract and its five constituent habitat types.

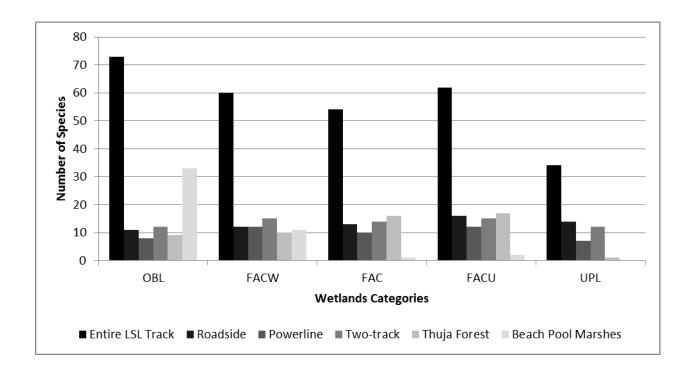


Figure 9: Number of species in each wetland category arranged across LSL Tract habitats.

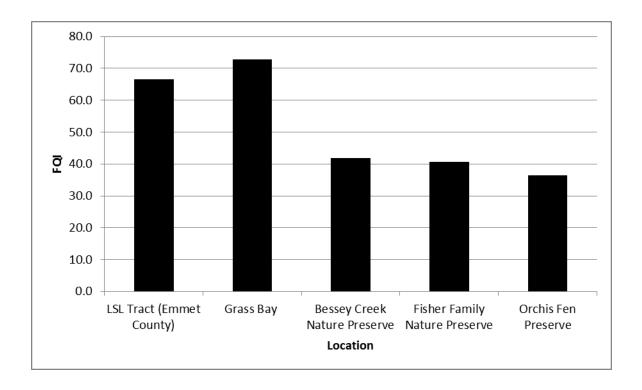


Figure 10. FQI comparison of the LSL tracts to other preserves sampled by previous UMBS Field Botany classes in Emmet and Cheboygan County, MI. See also Table 3.

TABLES

Table 1. Definitions wetland categories of coefficients of wetness (Herman et al. 2001).

Wetland Category	Symbol	W	Definition
Upland	UPL	5	Occurs almost never in wetlands under natural conditions (estimated < 1% probability).
Facultative Upland	FACU	3	Occasionally occurs in wetlands, but usually occur in nonwetlands (estimated 1% - 33% probability).
Facultative	FAC	0	Equally likely to occur in wetlands or non-wetlands (estimated 34% - 66% probability).
Facultative	FACW	2	Usually occurs in wetlands, but occasionally found in nonwetlands
Wetland	FACW	-3	(estimated 67% - 99% probability). Occurs almost always in wetlands under natural conditions
Obligate Wetland	OBL	-5	(estimated > 99% probability).

Table 2. Species richness (n), mean coefficient of conservation (CC), and mean coefficient of wetness (CW) of all native species for all 5 habitat types and for the entire LSL Tract.

All Species Native Species

	THE SPECIES					Tituti (o o pecies			
Habitat	n	Mean CC	Wetness Index	FQI	n	Mean CC	Wetness Index	FQI	
Entire LSL Tract	199	4.7	-0.8	66.6	165	5.2	-1.6	66.9	
Roadside	66	3.0	0.4	24.0	44	4.1	-0.4	27.1	
Powerline	49	2.1	-0.1	14.9	32	3.3	-1.5	18.4	
Two-track	68	4.2	0.0	34.7	51	5.6	-0.5	40.0	
Thuja Forest	53	5.2	-0.4	37.6	52	5.3	-0.4	38.0	
Beach Pool									
Marshes	47	6.4	-4.1	44.1	47	6.4	-4.1	44.1	

Table 3. Comparison of size and FQI of Cheboygan and Emmet County sites surveyed by UMBS Field Botany of Northern Michigan classes.

Preserve	Area (ha)	FQI
LSL Tract (Emmet County)	55.4	66.6
Grass Bay (Cheboygan County)	303.5	72.7
Bessey Creek Nature Preserve (Cheboygan)	0.2	41.9
Fisher Family Nature Preserve (Emmet County)	16.6	40.7
Orchis Fen Preserve (Emmet County)	14.2	36.5

Table 4. Species of high conservation value found in the habitats of the LSL Tract, Emmet Co., MI. CC = Coefficients of Conservation (see text).

	Species	Family	CC
A. Roadside	Veronica beccabunga	Plantaginaceae	10
	Iris lacustris Iridaceae		9
	Castilleja coccinea	Orobanchanceae	8
	Coreopsis lanceolata	Asteraceae	8
B. Two-track	Hypericum kalmianum	Clusiaceae	10
	Lobelia kalmii	Campanulaceae	10
	Solidago houghtonii	Solidago houghtonii Asteraceae	
	Triantha glutinosa Melanthiaceae		10
	Iris lacustris Iridaceae		9
	Arctostaphylos uva-ursi Ericaceae		8
	Carex garberi	Cyperacaeae	8
	Pyrola asarifolia	Ericaceae	8
C. Thuja Forest	Carex disperma	Cyperaceae	10
-	Petasites frigidus	Asteraceae	10
	Carex capillaris	Cyperaceae	9
	Carex trisperma	Cyperaceae	9
	Geocaulon lividum	Santalaceae	9
	Iris lacustris	Iridaceae	9
	Mitella nuda	Saxifragaceae	8
	Pyrola chlorantha	Ericaceae	8
D. Beach Pool Marshes	Andromeda glaucophylla	Ericaceae	10
	Calamagrostis stricta	Poaceae	10
	Carex buxbaumii Cyperaceae		10
	Cladium mariscoides	Cyperaceae	10
	Eriophorum angustifolium	Cyperaceae	10
	Sarracenia purpurea	Sarraceniaceae	10
	Salix candida	Salicaceae	9
	Carex lasiocarpa	Cyperaceae	8
	Chamaedaphne caylculata	Ericaceae	8
	Dasiphora fruticosa	Rosaceae	8
	Dulichium arundinaceum	Cyperaceae	8
	Menyanthes trifoliata	Menyanthaceae	8
	Rhamnus alnifolia	Rhamnaceae	8
	Rhododendron	Ericaceae	8
	groenlandicum		
	Utricularia gibba	Lentibulariaceae	8
	Utricularia vulgaris	Lentibulariaceae	8
	Vaccinium macrocarpon	Ericaceae	8

Table 5. Degree of invasiveness rankings for exotic plants based on information gathered by the US Forest Service for the eastern region (http://www.fs.fed.us/r9/wildlife/range/weed/Sec3B.htm). Accessed August 13 2013.

Category of	
Invasiveness	Definition
	All non-native, highly invasive plants which invade natural
1	habitats and replace native species.
	Less invasive plants than those in Category 1. If these species
2	are significantly replacing native species, then they are doing so only in local areas.
	Restricted to disturbed ground, and are not especially invasive in undisturbed natural habitats. Most of these species are found
3	throughout much of our range.
	Non-native species that occur only locally in our region. They are not currently known to be especially invasive, but should be monitored in the future. Many of these plants are cultivated
4	species, which occasionally escape. Native to North America and have been reported as being invasive in our region, or parts thereof. Some of these plants are regionally exotic, having moved in from another part of North
5	America.
ND	No Data

Table 6. Invasive species found in the LSL Tract, Emmet Co., MI. Categories of invasiveness are defined in Table 5. Accessed August 13 2013. Available from http://www.fs.fed.us.proxy.lib.umich.edu/r9/wildlife/range/weed/Sec3B.htm.

		Species	Family	Category
		Epipactis	Orchidaceae	3
A. Thuja Forest	Invasive	helleborine		
		Hypericum	Hypericaceae	3
B. Two-track	Invasive	perforatum		
		Poa pratensis	Poaceae	2
		Hieracium	Asteraceae	ND
	Exotic	piloselloides		
		Medicago	Fabaceae	ND
		lupulina		
		Leucanthemum	Asteraceae	ND
		vulgare		
		Vicia villosa	Fabaceae	ND
C. Power line	Invasive	Fallopia japonica	Polygonaceae	1
		Cirsium arvense	Asteraceae	2
		Hypericum	Hypericaceae	3
		perforatum		
		Rumex acetosella	Polygonaceae	3
		Cerastium	Caryophyllaceae	3
		fontanum		
		Poa pratensis	Poaceae	2
		Rumex crispus	Polygonaceae	3
		Verbascum	Scrophulariaceae	3
		thapsus		
		Stachys palustris	Lamiaceae	ND
	Exotic	Elymus repens	Poaceae	ND
		Medicago	Fabaceae	ND
		lupulina		
		Leucanthemum	Asteraceae	ND
		vulgare	G 1 11	1170
		Silene pratensis	Caryophyllaceae	ND
	<u> </u>	Vicia villosa	Fabaceae	ND
D. Roadside	Invasive	Cirsium palustre	Asteraceae	2
		Centaurea stoebe	Asteraceae	1
		Poa pratensis	Poaceae	2
		Melilotus albus	Fabaceae	2
		Phalaris	Poaceae	5
		arundinaceae	A .	170
	Exotic	Hieracium	Asteraceae	ND

piloselloides		
Medicago lupulina	Fabaceae	
Leucanthemum vulgare	Asteraceae	ND
Trifolium arvense	Fabaceae	ND
Trifolium pratense	Fabaceae	ND
Tragopogon dubius	Asteraceae	ND
Equisetum arvense	Equisetaceae	ND

APPENDIX

Flora of the LSL Tract, Emmet County, Michigan, 2013

PTERIDOPHYTA (Spore bearing)

EQUISETOPSIDA (Horsetails)

EQUISETACEAE

Equisetum arvense L. "Common Horsetail" – Roadside, Two-track. CC: 0. CW: 0. Equisetum hyemale L. "Scouring Rush" – Two-track. CC: 2. CW: 0. Equisetum fluviatile L. "Water Horsetail" – Roadside. CC: 7. CW: -5. Equisetum variegatum Schleich. "Variegated Scouring Rush" – Roadside. CC: 6. CW: -3.

LYCOPODIOPSIDA (Club Mosses)

LYCOPODIACEAE

Lycopodium clavatum L. "Running Ground-Pine" – *Thuja* Forest. CC: 4. CW: 0. *Spinulum annotinum* (L.) A. Haines "Stiff Clubmoss" – *Thuja* Forest. CC: 5. CW: 0.

POLYPODIOPSIDA (Ferns)

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn "Bracken Fern" – Two-track, *Thuja* Forest, Roadside. CC: 0. CW: 3.

THELYPTERIDACEAE

Thelypteris palustris Schott "Marsh Fern" – Beach Pool Marshes. CC: 2. CW: -3.

ONOCLEACEAE

Onoclea sensibilis L. "Sensitive Fern" – Powerline and Thuja Forest. CC: 2. CW: -3.

OSMUNDACEAE

Osmunda regalis L. "Royal Fern" – Beach Pool Marshes. CC: 5. CW: -5.

PINOPHYTA (Gymnosperms)

CUPRESSACEAE

Juniperus communis L. "Common Juniper" – Two-track. CC: 4. CW: 3. *Thuja occidentalis* L. "White Cedar" – Two-track, *Thuja* Forest. CC: 4. CW: -3.

PINACEAE

Abies balsamea (L.) Mill. "Balsam Fir" – Thuja Forest. CC: 3. CW: 0.

Larix laricina (Du Roi) K. Coch "Tamarack" – Beach Pool Marshes. CC: 5. CW: -3.

Picea glauca (Moench) Voss "White Spruce" – Two-track. CC: 3. CW: 3.

Picea mariana (Mill.) Britton, Sterns & Poggenb. "Black Spruce" – Beach Pool Marshes. CC: 6. CW: -3.

Pinus strobus L. "White Pine" – Powerline, Thuja Forest. CC: 3. CW: 3.

MAGNOLIOPHYTA (Angiosperms)

LILIOPSIDA (Monocots)

CYPERACEAE

Carex aquatilis Wahlenb. "Sedge" – Beach Pool Marshes. CC: 7. CW: -5.

Carex buxbaumii Wahlenb. "Sedge" – Beach Pool Marshes. CC: 10. CW: -5.

Carex capillaris L. "Sedge" – Two-track, Thuja Forest. CC: 9. CW: -3.

Carex debilis Michx. "Forest Sedge" – Two-track, Thuja Forest. CC: 6. CW: -3.

Carex disperma Dewey "Sedge" – Thuja Forest. CC: 10. CW: -5.

Carex eburnea Boott "Sedge" – Two-track, Thuja Forest. CC: 7. CW: 3.

Carex flava L. "Sedge" – Two-track. CC: 4. CW: -5.

Carex garberi Fernald "Sedge" – Two-track, Powerline, Thuja Forest. CC: 8. CW: -3.

Carex intumescens Rudge "Sedge" – Two-track, Powerline, Thuja Forest. CC: 3. CW: -3.

Carex leptalea Wahlenb. "Sedge" – Thuja Forest. CC: 5. CW: -5.

Carex lasiocarpa "Sedge" – Ehrh. – Beach Pool Marshes. CC: 8. CW: -5.

Carex lupulina Willd. "Sedge" – Powerline and Thuja Forest. CC: 4. CW: -5.

Carex magellanica Lam. "Sedge" - Beach Pool Marshes. CC: 8. CW: -5.

Carex stipata Willd. "Sedge" – Powerline. CC: 1. CW: -5.

Carex stricta Lam. "Sedge" – Beach Pool Marshes. CC: 4. CW: -5.

Carex trisperma Dewey "Sedge" – Thuja Forest. CC: 9. CW: -5.

Carex viridula Michx. "Sedge" – Two-track. CC: 4. CW: -5.

Carex vulpinoidea Michx "Sedge" – Powerline. CC: 1. CW: -5.

Cladium mariscoides (Muhl.) and Torr. "Twig-Rush" – Beach Pool Marshes. CC: 10. CW: -5.

Dulichium arundinaceum (L.) Britton "Three-Way Sedge" – Beach Pool Marshes. CC: 8. CW: 5.

Eleocharis acicularis (L.) Roem. & Schult. "Spikerush" – Two-track. CC: 7. CW: -5.

Eleocharis elliptica Kunth "Golden-Seeded Spikerush" – Beach Pool Marshes. CC: 6. CW: -5.

Eriophorum angustifolium Honck. "Narrow-Leaved Cotton-Grass" – Beach Pool Marshes. CC:10. CW: -5.

Rhynchospora alba (L.) Vahl "Beak-Rush" – Beach Pool Marshes. CC: 6. CW: -5.

Schoenoplectus acutus (Bigelow) A. Love & D. Love "Hardstem Bulrush" – Beach Pool Marshes. CC: 5. CW: -5.

Scirpus atrovirens Willd. "Bulrush" – Roadside. CC: 3. CW: -5.

IRIDACEAE

Iris lacustris Nutt. "Dwarf Lake Iris" – Two-track, Roadside, *Thuja* Forest. CC: 9. CW: 0. *Iris versicolor* L. "Wild Blue Flag" – *Thuja* Forest, Roadside. CC: 5. CW: -5.

JUNCACEAE

Juncus balticus Willd. "Rush" – Two-track. CC: 4. CW: -5.

MELANTHIACEAE

Triantha glutinosa (Michx.) Baker "False Asphodel" – Two-track. CC: 10. CW: -5.

ORCHIDACEAE

Cypripedium parviflorum Salisb. "Yellow Lady-Slipper" – *Thuja* forest. CC: 5. CW: 0. *Epipactis helleborine* (L.) Crantz "Helleborine" – *Thuja* Forest, Two-track. CC: *. CW: 0.

POACEAE

Bromus ciliatus L. "Fringed Brome" – Roadside. CC: 6. CW: -3.

Calamagrostis canadensis (Michx.) P. Beauv. "Blue-Joint" – Two-track, Powerline, Beach Pool Marshes, Roadside. CC: 3. CW: -5.

Calamagrostis stricta (Timm) Koeler "Narrow-Leaved Reedgrass" – Roadside. CC: 10. CW: -3.

Dactylis glomerata L. "Orchard Grass" – Two-track and Roadside. CC: *. CW: 3.

Elymus canadensis L. "Canada Wild Rye" – Powerline. CC: 5. CW: 3.

Elymus repens (L.) Gould "Quackgrass" – Powerline. CC: *. CW: 3.

Glyceria striata (Lam.) Hitchc. "Fowl Manna Grass" - Powerline, Roadside. CC: 4. CW: -5.

Phalaris arundinacea L. "Reed Canary Grass" - Roadside. CC: 0. CW: -3.

Phleum pratense L. "Timothy Grass" – Powerline. CC: *. CW: 3.

Phragmites australis (ssp. *americanus*) Saltonst., P. M. Peterson and Soreng "Reed" – Beach Pool Marshes. CC: 5. CW: -3.

Poa pratensis L. "Kentucky Bluegrass" – Powerline, Roadside. CC: *. CW: 3.

Schizachyrium scoparium Michx. "Little Bluestem" - Roadside. CC: 5. CW: 3.

TYPHACEAE

Typha angustifolia L. "Narrow-Leaved Cattail" – Roadside. CC: *. CW: -5. *Typha latifolia* L. "Common Cattail" – Powerline, Roadside. CC: 1. CW: -5.

MAGNOLIOPSIDA (Dicots)

ANACARDIACEAE

Rhus typhina Desf. "Staghorn Sumac" – Roadside. CC: 2. CW: 3.

Toxicodendron rydbergii (Rydb.) Greene. "Poison Ivy" – Roadside, Powerline, *Thuja* Forest. CC: 3. CW: 0.

APIACEAE

Daucus carota L. "Common Queen-Anne's Lace" – Roadside. CC: *. CW: 5.

APOCYNACEAE

Apocynum androsaemifolium L. "Spreading Dogbane" – Powerline, Thuja Forest.

CC: 3. CW: 5.

Asclepias incarnata L. "Forest Milkweed" – *Thuja* Forest, Beach Pool Marshes.

CC: 6. CW: -5.

Asclepias syriaca L. "Common Milkweed" – Roadside. CC: 1. CW: 5.

AQUIFOLIACEAE

Ilex verticillata (L.) A. Gray. "Michigan Holly" – Beach Pool Marshes. CC: 5. CW: -3.

ARACEAE

Lemna minor L. "Common Duckweed" – Beach Pool Marshes. CC: -5. CW: 5.

ARALIACEAE

Aralia nudicaulis L. "Wild Sarsaparilla" – Two-track, Thuja Forest. CC: 5. CW: 3.

ASTERACEAE

Achillea millefolium L. "Yarrow" – Roadside. CC: 1. CW: 3.

Centaurea stoebe L. "Spotted-Knapweed" – Roadside, Powerline, Two-track. CC *. CW: 5.

Cichorium intybus L. "Chicory" - Roadside. CC: *. CW: 3.

Cirsium arvense (L.) Scop. "Canada Thistle" – Powerline. CC: *. CW: 3.

Cirsium palustre (L.) Scop. "Marsh Thistle" – Roadside. CC: *. CW: -3.

Coreopsis lanceolata L. "Sand Coreopsis" – Two-track. CC: 8. CW: 3.

Erigeron philadelphicus L. "Common Fleabane" – Roadside, Two-track. CC: 2. CW: 0.

Eupatorium perfoliatum L. "Boneset" – Roadside, Powerline, Two-track. CC: 4. CW: -3.

Eurybia macrophylla (L.) Cass. "Large-Leaved Aster" – Two-track. CC: 4. CW: 5.

Euthamia graminifolia (L.) Nutt. "Grass-Leaved Goldenrod" – Roadside. CC: 3. CW: 0.

Eutrochium maculatum (L.) E. E. Lamont "Joe-Pye-Weed" – Powerline. CC: 4. CW: -5.

Hieracium piloselloides Vill. "Yellow Hawkweed" – Two-track, Roadside. CC: *. CW: 5.

Lactuca canadensis L. "Wild Lettuce" – Roadside. CC: 2. CW: 3.

Leucanthemum vulgare Lam. "Ox-eye Daisy" - Two-track, Roadside, Powerline.

CC: *. CW: 5.

Packera paupercula Michx. "Northern Ragwort" - Two-track. CC: 3. CW: 0.

Petasites frigidus (Aiton) A. Gray "Sweet Coltsfoot" – Thuja Forest. CC: 10. CW: -3.

Rudbeckia hirta L. "Black-eyed Susan" – Two-track, Roadside, Powerline. CC: 1. CW: 3.

Solidago houghtonii Torr. & A. Gray "Houghton's Goldenrod" - Two-track. CC: 10. CW: -5.

Solidago ohioensis RIddell "Ohio Goldenrod" – Two-track. CC: 8. CW: -5.

Tragopogon dubius L. "Goat's Beard" – Roadside. CC: *. CW: 5.

BETULACEAE

Alnus incana (L.) Moench "Speckled Alder" – Two-track, Powerline, Beach Pool Marshes. CC: 5. CW: -3.

Betula papyrifera Marshall "Paper Birch" – Thuja Forest, Two-track. CC: 2. CW: 3.

CAMPANULACEAE

Campanula rotundifolia L. "Bluebell" – Roadside. CC: 6. CW: 3. Lobelia kalmii L. "Bog Lobelia" – Two-track. CC: 10. CW: -5.

CAPRIFOLIACEAE

Lonicera canadensis Marshall "Canadian Fly Honeysuckle" – *Thuja* Forest. CC: 5. CW: 3. Lonicera dioica L. "Red Honeysuckle" – Roadside, *Thuja* Forest. CC: 5. CW: 3. Lonicera hirsuta Eaton "Hairy Honeysuckle" – Roadside, *Thuja* Forest. CC: 6. CW: 0.

CELASTRACEAE

Celastrus scandens L. "American Bittersweet" – Thuja Forest. CC: 3. CW: 3.

CONVALLARIACEAE

Clintonia borealis (Aiton) Raf. "Bluebead-Lily" – Thuja Forest. CC: 5. CW: 0. Maianthemum canadense Desf. "Canada Mayflower" – Two-track, Thuja Forest. CC: 4. CW: 3.

Maianthemum stellatum (L.) Link "Starry False Solomon's-Seal" – Two-track, Roadside, *Thuja* Forest. CC: 5. CW: 0.

CORNACEAE

Cornus canadensis L. "Bunchberry" – Thuja Forest, Two-track, Roadside. CC: 6. CW: 0. Cornus rugosa Lam. "Round-Leaved Dogwood" – Two-track, Roadside, Powerline. CC: 6. CW: 5.

Cornus sericea L. "Red Osier Dogwood" - Two-track, Roadside, Powerline. CC: 2. CW: -3.

DIERVILLACEAE

Diervilla lonicera Mill. "Bush-Honeysuckle" – Thuja Forest, Two-track. CC: 4. CW: 5.

ELAEAGNACEAE

Shepherdia canadensis (L.) Nutt. "Soapberry" – Two-track, Roadside. CC: 7. CW: 5.

ERICACEAE

Andromeda glaucophylla Link "Bog-Rosemary" – Beach Pool Marshes. CC: 10. CW: -5.

Arctostaphylos uva-ursi (L.) Spreng. "Bearberry" – Two-track, Roadside. CC: 8. CW: 5.

Chamaedaphne caulata (L.) Moench "Leatherleaf" - Beach Pool Marshes. CC: 8. CW: -5.

Gaultheria procumbens L. "Wintergreen" – Thuja Forest. CC: 5. CW: 3.

Gaylussacia baccata (Wangenh.) K. Koch "Huckleberry" – *Thuja* Forest, Beach Pool Marshes. CC: 7. CW: 3.

Moneses uniflora (L.) A. Gray "One-Flowered Pyrola" – Thuja Forest. CC: 8. CW: 0.

Myrica gale L. "Sweet Gale" – Two-track, Beach Pool Marshes. CC: 6. CW: -5.

Pyrola asarifolia Michx. "Pink Pyrola" – Two-track. CC: 8. CW: -3.

Pyrola chlorantha Sw. "Shinleaf" – Thuja Forest. CC: 8. CW: 3.

Rhododendron groenlandicum (Oeder) Kron & Judd "Labrador-Tea" – Thuja Forest, Beach Pool Marshes. CC: 8. CW: -5.

Vaccinium macrocarpon Aiton "Large Cranberry" – Beach Pool Marshes. CC: 8. CW: -5. *Vaccinium myrtilloides* Michx. "Velvetleaf Blueberry" – *Thuja* Forest. CC: 4. CW: -3.

EUPHORBIACEAE

Euphorbia cyparissias L. "Cypress Spurge" – Powerline. CC: *. CW: 5.

FABACEAE

Lathyrus palustris L. "Marsh Pea" – Roadside. CC: 7. CW: -3.

Lathyrus sylvestris L. "Perennial Pea" – Roadside. CC: *. CW: 5.

Medicago lupulina L. "Black Medick" – Two-track, Roadside, Powerline. CC: *. CW: 3.

Melilotus albus Medik. "White-Sweet Clover" – Roadside. CC: *. CW: 3.

Robinia hispida L. "Bristly Locust" – Roadside. CC: *. CW: 5.

Trifolium arvense L. "Rabbitfoot Clover" – Roadside. CC: *. CW: 5.

Trifolium pratense L. "Red Clover" – Roadside. CC: *. CW: 3.

Vicia villosa Roth "Hairy Vetch" – Two-track, Powerline. CC: *. CW: 5.

GENTIANACEAE

Halenia deflexa (Sm.) Griseb. "Spurred Gentian" – Roadside, Powerline. CC: 7. CW: 0.

HALORAGACEAE

Proserpinaca palustris L. "Mermaid-Weed" – Beach Pool Marshes. CC: 6. CW: -5.

HYPERICACEAE

Hypericum kalmianum L. "Kalm's St. John's Wort" – Two-track, Roadside. CC: 10. CW: -3. Hypericum perforatum L. "St. John's Wort" – Two-track, Powerline. CC: *. CW: 5. Triadenum fraseri (Spach) Gleason "Marsh St. John's-Wort" – Beach Pool Marshes. CC: 6. CW: 5.

LAMIACEAE

Clinopodium vulgare (L.) Fritsch "Wild-Basil" – Two-track, Roadside, Powerline. CC: 3. CW: 5.

Lycopus americanus Muhl. "Common Water Horehound" – Roadside. CC: 2. CW: -5.

Lycopus uniflorus Michx. "Northern Bugleweed" – Beach Pool Marshes. CC: 2. CW: -5.

Monarda fistulosa L. "Wild-Bergamot" – Powerline. CC: 2. CW: 3.

Prunella vulgaris L. "Self-Heal" – Two-track, Roadside. CC: 0. CW: 0.

Stachys palustris L. "Woundwort" – Powerline. CC: *. CW: -5.

LENTIBULARIACEAE

Utricularia gibba L. "Humped Bladderwort" – Beach Pool Marshes. CC: 8. CW: -5. *Utricularia vulgaris* L. "Common Bladderwort" – Beach Pool Marshes. CC: 6. CW: -5.

LINNAEACEAE

Linnaea borealis L. "Twinflower" – Two-track, Thuja Forest. CC: 6. CW: 0.

MENYANTHACEAE

Menyanthes trifoliata L. "Buckbean" – Thuja Forest, Beach Pool Marshes. CC: 8. CW: -5.

MYRICACEAE

Myrica gale L. "Sweet Gale" – Two-track, Beach Pool Marshes. CC: 6. CW: -5.

MYRSINACEAE

Lysimachia ciliata L. "Fringed Loosestrife" – Powerline. CC: 4. CW: -3.

Lysimachia terrestris (L.) Britton, Sterns & Poggenb. "Forest-Candles" – Beach Pool Marshes. CC: 6. CW: -5.

Lysimachia thyrsiflora L. "Tufted Loosestrife" – *Thuja* Forest. CC: 6. CW: -5. *Trientalis borealis* Raf. "Star-Flower" – Two-track, *Thuja* Forest. CC: 5. CW: 0.

NYMPHAEACEAE

Nuphar variegata Durand "Yellow Pond-Lily" – Beach Pool Marshes. CC: 7. CW: -5.

OLEACEAE

Fraxinus pennsylvanica Marshall "Green Ash" – Beach Pool Marshes, Powerline. CC: 2. CW: -3.

ONAGRACEAE

Oenothera biennis L. "Common Evening-Primrose" – Roadside. CC: 2. CW: 3.

OROBANCHACEAE

Castilleja coccinea (L.) Spreng. "Indian Paintbrush" – Roadside. CC: 8. CW: 0.

PARNASSIACEAE

Parnassia glauca Raf. "Grass-of-Parnassus" – Two-track. CC: 8. CW: -5.

PLANTAGINACEAE

Veronica beccabunga Raf. "Brooklime" – Roadside. CC: 10. CW: -5.

Veronica officinalis L. "Common Speedwell" – Two-track, Roadside. CC: *. CW: 3.

POLYGALACEAE

Polygala paucifolia Willd. "Fringed Polygala" – Two-track, Thuja Forest. CC: 7. CW: 3.

POLYGONACEAE

Fallopia japonica (Houtt.) Ronse Decr. "Japanese Knotweed" – Powerline. CC: *. CW: 3. Rumex acetosella L. "Red Sorrel" – Powerline. CC: *. CW: 3. Rumex crispus L. "Sour Dock" – Powerline. CC: *. CW: 0.

RANUNCULACEAE

Anemone canadensis L. "Canada Anemone" – Two-track, Powerline, Roadside.

CC: 4. CW: -3.

Aquilegia canadensis L. "Wild Columbine" – Two-track. CC: 5. CW: 3.

Clematis virginiana L. "Virgin's Bower" – Powerline. CC: 4. CW: 0.

Coptis trifolia "Goldthread" – Thuja Forest. CC: 5. CW: -3.

Ranunculus acris L. "Common Buttercup" – Roadside, Two-track, and Powerline.

CC: *. CW: 0.

Thalictrum dasycarpum Fisch. & Ave-Lall. "Purple Meadow-Rue" – Powerline and Roadside.

CC: 3. CW: -3.

RHAMNACEAE

Rhamnus alnifolia L'Her. "Alder-Leaved Buckthorn" – Beach Pool Marshes. CC: 8. CW: -5.

ROSACEAE

Aronia prunifolia (Marshall) Rehder "Chokeberry" – Two-track, Beach Pool Marshes.

CC: 5. CW: -3.

Comarum palustre L. "Marsh Cinquefoil" – Beach Pool Marshes. CC: 7. CW: -5.

Dasiphora fruticosa (L.) Rydb. "Shrubby Cinquefoil" – Two-track, Beach Pool Marshes. CC: 8. CW: -3.

Fragaria virginiana Mill. "Wild Strawberry" – Two-track, Powerline. CC: 2. CW: 3.

Geum aleppicum Jacq. "Yellow Avens" – Powerline. CC: 3. CW: 0.

Physocarpus opulifolius (L.) Maxim. "Ninebark" – Powerline, Roadside. CC: 4. CW: -3.

Prunus serotina Ehrh. "Wild Black Cherry" – Thuja Forest. CC: 2. CW: 3.

Prunus virginiana L. "Choke Cherry" – Roadside, Thuja Forest. CC: 2. CW: 3.

Rosa palustris Marshall "Forest Rose" – Roadside, Thuja Forest, Beach Pool Marshes.

CC: 5. CW: -5.

Rubus hispidus L. "Forest Dewberry" – Powerline. CC: 4. CW: -3.

Rubus pubescens Raf. "Dwarf Raspberry" – Two-track, Thuja Forest. CC: 4. CW: -3.

Rubus strigosus Michx. "Wild Red Raspberry" - Powerline. CC: 2. CW: 0.

Spiraea alba Du Roi "Meadowsweet" – Beach Pool Marshes. CC: 4. CW: -3.

RUBIACEAE

Galium triflorum Michx. "Fragrant Bedstraw" – Two-track. CC: 4. CW: 3.

SALICACEAE

Populus balsamifera L. "Balsam Poplar" – Two-track. CC: 2. CW: -3.

Populus tremuloides Michx. "Quaking Aspen" – Two-track, Powerline. CC: 1. CW: 0.

Salix candida Willd. "Sage Willow" – Beach Pool Marshes. CC: 9. CW: -5.

Salix bebbiana Sarg. "Beaked Willow" – Beach Pool Marshes. CC: 1. CW: -3.

Salix myricoides Muhl. "Blueleaf Willow" – Two-track. CC: 9. CW: -3.

SANTALACEAE

Arceuthobium pusillum C. H. Peck "Dwarf Mistletoe" – On Black Spruce at edge of Beach Pool Marshes. CC: 10. CW: 0.

Comandra umbellata (L.) Nutt. "Bastard Toadflax" - Two-track. CC: 5. CW: 3.

Geocaulon lividum (Richardson) Fernald "Geocaulon" - Thuja Forest. CC: 9. CW: 0.

SAPINDACEAE

Acer rubrum L. "Red Maple" – Thuja Forest. CC: 1. CW: 0.

SARRACENIACEAE

Sarracenia purpurea L. "Pitcher-Plant" – Beach Pool Marshes. CC: 10. CW: -5.

SAXIFRAGACEAE

Mitella nuda L. "Naked Miterwort" – Two-track, Thuja Forest, Powerline. CC: 8. CW: -3.

SCROPHULARIACEAE

Verbascum thapsus L. "Common Mullein" – Powerline. CC: *. CW: 5.

SOLANACEAE

Solanum dulcamara L. "European Bittersweet" – Powerline, Thuja Forest. CC: *. CW: 0.

VITACEAE

Vitis riparia Michx. "River-Bank Grape" – Powerline, Roadside. CC: 3. CW: 0.