

**Floristic Inventory and Quality Assessment of
Bessey Creek Nature Preserve, Cheboygan County, Michigan, 2011**

EEB 556 Field Botany of Northern Michigan

Jenna Dorey, Nicholas Van Dyke, Megan Vogt

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Abstract

Wetlands are habitats that provide critical ecosystem services. As transitional habitats between terrestrial and aquatic environments, wetlands contain plant communities that are typically species rich. One way to measure the composition of plant communities is to inventory the species and conduct a Floristic Quality Assessment (FQA) of the species. Created by Michigan's Department of Natural Resources (MDNR), the FQA is a tool to evaluate areas that may be of floristic importance and calculate the diversity and species richness of a site. We conducted an FQA of the Bessey Creek Nature Preserve in Cheboygan County, MI, which is owned by the Little Traverse Conservancy (Harbor Springs, MI). The site is located at the mouth of Bessey Creek where it enters Douglas Lake. The preserve contains several plant communities located throughout four habitat zones: the roadside, the swamp, the littoral marsh, and the aquatic shoreline. Our sampling identified a total of one hundred sixteen species in fifty-four families, with a mean coefficient of conservatism of 4.44 for only native species, and 3.62 including introduced species. The preserve has wetlands index of -2.52, signifying that the preserve contains mostly facultative wetland species. Twenty species are considered exotic and are not native to the area. Based on the MDNR's FQA equations, we calculated the Floristic Quality Index (FQI) of Bessey Creek to be 41.87 when considering only native species and 37.83 when including introduced species. Bessey Creek has a lower FQI than other preserves, ranking

below Orchis Fen Preserve (FQI: 49.60) and Kalman Preserve (FQI: 61.70). However, Bessey Creek's FQI value is above the current threshold of 35 determined by the MDNR, and is thus considered floristically important to the state of Michigan.

Introduction

In an era of significant environmental changes and habitat destruction, there is an increased need for floristic data in order to understand, preserve, and manage biodiversity (Palmer *et al.* 1995). At the core of floristic data is accurate taxonomy (Bortolus 2008). This is essential to prevent errors in the ecological research and the associated experimental manipulation or environmental management that stems from floristic data (Bortolus 2008). Taxonomically accurate floristic data has great importance to academic research and has a wide range of practical uses, such as in regional biological inventories, impact assessments, testing ecological models, and evaluating ecological management and restoration plans (Palmer *et al.* 1995). Beyond research and experimentation, floristic data is increasingly employed by civic and private organizations, including engineers, city planners, landscape architects, lawyers, and environmental consultants (Palmer *et al.* 1995).

Michigan's environment has been dramatically altered by human settlement (Albert *et al.* 2008). From widespread logging and deforestation in the 1800s to the continued growth of urban, residential, and industrial centers that characterize the present day, diverse forces continue to modify the state's natural forests, grasslands, and wetlands (Albert *et al.* 2008). To better understand nature preserves and to determine how best to manage sites in an era of significant environmental pressures, Michigan's Department of Natural Resources created the Floristic Quality Assessment (FQA) (Herman *et al.* 2001). The FQA is a tool that aids in determining an

area's floristic importance, diversity, and species richness (Herman *et al.* 2001). The FQA includes equations that utilize a site's floristic inventory data to calculate a Floristic Quality Index (FQI) (Herman *et al.* 2001). FQIs indicate whether or not an area is floristically important, which has practical implications in the state's continued management of nature preserves (Herman *et al.* 2001). Performing FQAs for nature preserves throughout the state contributes to forming a complete picture of Michigan's biodiversity and goals for management into the future.

Bessey Creek Nature Preserve has been managed by the Little Traverse Conservancy since 1988, and no FQA has been performed at this site. In 1911, Dr. Frank C. Gates conducted a floristic inventory of Cheboygan County that focused on the areas surrounding Douglas Lake (Gates 1912). Though Bessey Creek was included in his sampling, his inventory did not focus explicitly on the preserve (Gates 1912). A survey of aquatic vascular flora of Douglas Lake conducted by Haynes and Hellquist also included Bessey Creek as a sampling site (Haynes and Hellquist 1978). Bessey Creek has been included in past floristic inventories, but we were not able to find research with Bessey Creek as the primary focus of an FQA.

The Bessey Creek Preserve's location on Douglas Lake makes it an important site for floristic analysis. Floristic inventory and quality data may be used to better understand how to manage and maintain this site while faced with surrounding human-induced disturbances, recreational uses, and developments. Understanding the species composition and richness of the preserve not only contributes to the larger picture of Northern Michigan biodiversity, but also serves as an educational opportunity and resource. For practical management purposes, a thorough inventory of the site's flora is also a key tool for maintaining the area in a way that supports environmental integrity, as potential harmful or invasive species may be identified and accordingly monitored.

Our work at Bessey Creek was intended to create a thorough floristic inventory of vascular species diversity within the preserve. We used this data to conduct an FQA to determine the floristic quality index of the site. We were also able to calculate the overall wetland status of the preserve. Together, these indices form a picture of the overall floristic importance of the Bessey Creek Nature Preserve.

Methods

Site Description

The Little Traverse Conservancy is a land trust organization dedicated to protecting the natural diversity of Northern Michigan (LTC 2011). Since 1972, it has grown to manage more than 164 nature preserves, some of which have been the subject of floristic sampling (LTC 2011). Bessey Creek Nature Preserve is a Little Traverse Conservancy property located in Munro Township in Cheboygan County, MI, on 0.20 hectares of land with GPS coordinates of 45.60153938 N, -84.71579875 (Little Traverse Conservancy 2011). The site includes 91 meters of frontage along Douglas Lake's Marl Bay (Little Traverse Conservancy 2011). The area of Bessey Creek we sampled begins on the south side of Silver Strand Road and includes the 91 meters of property bordering Douglas Lake at the mouth of Bessey Creek. This site is composed of four distinct habitats, each of which supports a unique flora. The roadside is a narrow strip of dry, disturbed ground that separates the road from the swamp zone. The swamp comprises the majority of this preserve area and is a forested wetland with microhabitats varying in degree of saturation. Between the edge of the swamp and Douglas Lake is the littoral marsh, which includes shoreline and shallow-water habitats. The aquatic community is found in the open water of Douglas Lake and within Bessey Creek.

Floristic Inventory

In order to complete a thorough sampling of the Bessey Creek site, we canvassed the area on June 30, July 18, and August 15, 2011. We collected specimens in all four habitats which were stored in a vasculum and transported back to the University of Michigan Biological Station (UMBS) for identification. In order to identify unknown plants, we utilized Gleason and Cronquist's *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (1991), the three-part *Michigan Flora* series (Voss 1972, 1985, 1996), and Michigan Flora Online (Reznicek *et al.* 2011). Plant identities were cross-referenced with information from Michigan Flora Online (Reznicek *et al.* 2011), as well as checked against the voucher specimens stored in the UMBS herbarium. Final plant identifications were annotated by our course instructors E. Hellquist and E. Haber to ensure accuracy before being stored for pressing. These voucher specimens were pressed and labeled for future mounting and inclusion into the UMBS teaching and research herbaria.

Coefficients of Conservatism

In our floristic inventory, each native species was assigned a coefficient of conservatism (CC) according to the values listed on Michigan Flora Online (Reznicek *et al.* 2011). The range of coefficients span from 0 - 10, and represent the approximate probability of encountering a plant in an unaltered environment that would resemble natural conditions before European settlement (Herman *et al.* 2001). Plants with a coefficient of 0 have a wide ecological amplitude and may be found almost anywhere and are not limited to remnant unaltered environments, whereas plants with a coefficient of 10 are restricted to high quality areas that maintain unaltered

habitat integrity (Herman *et al.* 2001). Exotic species, those which are considered introduced to Michigan, do not have a coefficient of conservatism and are instead indicated by an “E.”

The Floristic Quality Index (FQI) is calculated by multiplying the mean C of the area by the square root of the species richness in the area: $FQI = \bar{C} * \sqrt{S}$

As the mean C is just the sum of all coefficients of conservatism of the site divided by the number of species of the site, the FQI can be rewritten: $FQI = Cn * \sqrt{S}$

Coefficients of Wetness

Each species in the inventory was assigned a coefficient of wetness (CW) according to the values determined by Michigan Flora Online (Reznicek *et al.* 2011). The values range from –5 (most wet) to 5 (most dry) and are derived by Michigan Flora from the National Wetland Indicator Categories (Herman *et al.* 2001; Table 1). The CW indicates the probability of a species occurring in wetland conditions (Herman *et al.* 2001). A value of 5 indicates an estimated <1% probability of a species occurring in a wetland, and a value of -5 indicates an estimated >99% likelihood of a species occurring in a wetland (Herman *et al.* 2001). These values were averaged and the mean was regarded as the site’s wetness index, which describes the wetland category of the entire preserve (Herman *et al.* 2001; Figure 1).

Results

The species richness, mean coefficient of conservatism, floristic quality index and wetness index was calculated for the entire preserve, but also for each of the four distinct habitats found within the preserve. All values were calculated twice: once taking only native species into account and once taking both native and introduced species into consideration.

Entire Preserve

In total, we collected and identified 212 specimens representing 116 species of vascular plants from the roadside, swamp, littoral marsh, and aquatic habitats within the site. Of the 116 species found in the preserve, 96 are native. The native species composed 82.8% of all measured species, and the introduced species composed 17.2%. The mean C of the preserve was 4.44 for native species and 3.62 including non-natives. The FQI of natives species found was 41.87 and 37.83 when introduced species were included. The wetness index of native species was -3.44 and -2.52 for all species (Tables 2 & 3).

Of all the species collected, grasses (*Poaceae*) and sedges (*Cyperaceae*) may be under-represented within our results, as we were not able to fully identify some specimens. Due to the long blooming season of vascular plants and our senester time constraints, we were unable to compile a complete list of flora that may be found within the preserve.

Seperate Habitats

Of all of the habitats measured, the swamp had the highest species richness, containing over 56% of the species identified. The littoral marsh had the second highest species richness, containing 25% of the species identified. The roadside and aquatic portions were the least species rich, with the roadside containing 14% of the species identified, and the aquatic portion containing 11% (Table 3). The aquatic portion had the greatest proportion of native species, containing no introduced species (0%). The roadside had the highest proportion of introduced species: 56% of species found in the roadside are introduced (Tables 2 & 3).

The mean C was highest for the aquatic portion, followed by the littoral marsh, the swamp, then the roadside. The very low mean C of the roadside is due to its low number of

native species and high number of introduced species. This was the case for calculations using only native species, and calculations using both native and introduced species (Tables 2 & 3).

For both calculations using only native species and those using all species, the FQI was highest for the swamp. This was a result of the high species richness of the swamp. The littoral marsh had the second highest FQI, followed by the aquatic zone. The roadside had the lowest FQI (Tables 2 & 3, Figure 2).

The mean wetness indices classified the aquatic zone as obligate wetland, as all of the species found there were completely aquatic. The littoral marsh and swamp wetland indices classified them as facultative wetlands, as the majority of species found in these habitats prefer wetland-like habitats, but are capable of growing in drier conditions. The roadside was classified as facultative, as most of the species found there are very tolerant of both wetland and dry conditions (Tables 2 & 3, Figure 1).

Bessey Creek compared to Other Preserves

When compared to the FQIs of other preserves in the northern Michigan area, Bessey Creek is near the bottom range of the quality index (Figure 3). The Offield Family Nature Preserve Bog has a FQI of 31.81 ranking below Bessey Creek (DeGabriele et al. 2009). With a FQI of 40.72, the Fisher Family Nature Preserve expresses roughly the same degree of floristic quality as Bessey Creek (Doucet-Bëer *et al.* 2007). The Orchis Fen Preserve, Kalman Preserve, and Grass Bay all outrank Bessey Creek on the FQI scale, with indices of 49.60, 61.70, and 72.70 respectively (Falk *et al.* 2008, Baskerville *et al.* 2006, Awood *et al.* 2005) Though Bessey Creek may have a lower FQI than neighboring preserves, it is important to take Bessey Creek's small size, only 0.5 acres, into account. All other preserves studied were much larger (Table 4).

Larger preserves offer a broader range of habitat types and are typically more species rich (MacArthur and Wilson 1967), so the high FQIs of the previous studies are not surprising. For its small size, Bessey Creek has an incredibly high FQI value and is very species rich. Herman *et al.* (2001) consider any area with a FQI above 35 to possess enough native species richness to be floristically important to the state.

Discussion

Bessey Creek is located in a glaciolacustrine plain that was formed during the Greatlakean glacial advances at least 13,000 years ago (Schaetzl and Barnes 2009; Evenson *et al.* 1975). A glaciolacustrine plain usually has a mix of sand, gravel and silt that make up the parent layer below the soil horizon (Schaetzl and Barnes 2009). But since that glacial retreat, Bessey Creek Preserve has spent some time under water. The shores of Douglas Lake were higher immediately after the glaciers melted, and the water levels would have completely submerged Bessey Creek (Schaetzl and Barnes 2009). During this time, layers of rich organic material, that were carried from Bessey Lake or percolated out of Douglas lake, were deposited in the area. This very rich buildup of nutrients likely only occurred along parts of the northern and western shores of present-day Douglas Lake. The rest of Douglas Lake is made up of coarser parent material that was deposited by an outwash plain (Schaetzl and Barnes 2009). These processes of the distant past still influence the unique species makeup of Bessey Creek today.

Bessey Creek has a notably high floristic quality index of 37.83. This value indicates that the preserve is of conservational importance, and the native diversity should be protected. The small size of Bessey Creek further stresses the importance of its preservation, as our study was able to identify 116 distinct species in the 0.20 hectare plot. There is especially a large diversity

of sedges (Cyperaceae) present in the littoral marsh and swamp, many with high individual conservation values. The site is also important for conservation as an area relatively unique to Douglas Lake, as it is the single major inlet of water from Lancaster Lake (Haynes and Hellquist 1978). The geologic history of the site is also slightly different from other areas of Douglas Lake, which supports a unique flora. Literature archived at the University of Michigan Biological Station provides interesting insights into the changing flora composition over the past century. A closer look at the current makeup and community status of species in the preserve also indicates potential for future change. There are several ecological disturbances, such as the Emerald ash borer and a handful of invasive species that may impact Bessey Creek in the future. Overall, the diverse flora and unique history of Bessey Creek Preserve make it a worthwhile place to direct conservation effort.

Of the species with the 5 highest conservation values, 4 of them belong to the Cyperaceae family (Rezincek *et al.* 2011). *Carex lasiocarpa*, *Dulichium arundinaceum*, *Carex rostrata* and *Cladium mariscoides* all have conservation coefficients of 8 or greater, and were found growing along the littoral marsh of Bessey Creek. Because all of these species have highly restricted littoral marsh habitats, they will be the first to disappear, should the Bessey Creek littoral marsh lose too much natural integrity. *Carex lasiocarpa* ranges in habitat from sandy or marly shores to marshes, swales, riverbanks and sphagnum bogs (Voss 1972). *Dulichium arundinaceum* can be found in marshes, hollows, ponds, swales, ditches, bogs, river margins, and tamarack swamps, but not in more than 30-60 cm of water (Voss 1972). *Carex rostrata* is limited to wet places, like stream margins, lake shores, riverbanks, swamps, marshes, ponds, ditches and bogs (Voss 1972). *Cladium mariscoides* is restricted to shallow water of sandy, boggy and marshy shorelines, sphagnum bogs, as well as ponds and interdunal swales (Voss 1972). The only non-Cyperaceae

species at Bessey Creek with a conservation coefficient higher than 8 is *Myriophyllum sibiricum*. This valuable aquatic can be found in calcareous or marly rivers, lakes and ponds at depths of up to 5.5 m (Voss 1984).

Changes in Bessey Creek Vegetation

It is difficult to know what the community composition was like at Bessey Creek before the intense logging and fires happened on Douglas Lake a century ago. However, we can make some inferences regarding changes in the flora from the work of Frank Gates, who surveyed the flora of Douglas Lake in 1911 and gave broad descriptions of common plant associations (Table 5). Because of his efforts, a fairly good picture of Bessey Creek can be pieced together. Many of the aquatic species present at Bessey Creek today were present in the creek in 1911. The composition of hydrophytes seems to have changed drastically, as *Schoenoplectus tabernaemontani* was noted as dominant at the creek mouth, with *Schoenoplectus pungens* present to a lesser extent. The 2011 survey of the site did not find either of these species, and instead noted the creek mouth to be dominated by *Schoenoplectus acutus* with occasional *Scirpus cyperinus*. *Sagittaria latifolia* still remains prominent along the littoral marsh of Bessey Creek. It is very interesting that *Typha latifolia* was noted as rare at the site in 1911, as it is now relatively common along the edge of the littoral marsh.

Unfortunately, Gates (1912) did not describe the canopy cover of Bessey Creek during his survey in 1911, and there very well may not have been any at the time since the area had just been heavily logged. Both cedar bogs and marshy thickets were described as common along the north and west shores of Douglas Lake, so if there was any canopy cover it may have included *Acer rubrum*, *Fraxinus nigra*, *Ilex verticillata*, and *Thuja occidentalis*. However, this is just

speculation. One important note by Gates (1912) is that all species of *Ulmus americana* along Douglas Lake were just saplings at the time of the survey, meaning that the solitary individual in Bessey Creek Preserve may be quite old. Its age implies that this individual survived the Dutch Elm disease that spread throughout the northeastern United States between 1920 and 1970 (Kashian and Witter 2011). It has been suggested that this individual be evaluated for potential resistance to the disease, though it may just be that it has not yet grown large enough to contract the fungal disease.

Frank Gates continued to botanize Northern Michigan at least into the late 1920's, keeping detailed records of his collections (Table 5). One annotation of particular interest describes a patch of *Phalaris arundinacea* growing infrequently amongst the *Calamagrostis canadensis* near the mouth of Bessey Creek (Gates 1924). It was the only site on Douglas Lake mentioned to have *P. arundinacea* present at any frequency. *Phalaris arundinacea* is now abundant throughout the preserve, especially in wet areas, and its growth should continue to be monitored.

Threat of the Emerald Ash Borer

The Emerald ash borer was first introduced to the Metro-Detroit area of southwest Michigan in 2002. Since then, it has infected over 50 million Ash trees, with mortality rates in the overstory reaching 100% in some places. Unlike the unlucky old growth Ash trees, many seedlings are surviving the onslaught. In 2007 and 2009, Kashian and Witter (2011) conducted studies in varying landscapes of Southern Michigan that lost a large proportion of Ash trees to the Emerald ash borer to test the potential for regeneration by Ash seedlings. Unfortunately, the death of older ash trees has depleted the seed bank, so new seedlings are no longer sprouting

(Kashain and Witter 2011). Regeneration depends upon the existing seedlings, thus have thus far avoided infection by the Emerald ash borer. Long term survival of these seedlings depends upon competition with other shrub and tree species. The number of Ash seedlings in the preserve was not noted, but the relative dominance of larger tree species was calculated. The genus *Acer* was overwhelmingly dominant at 72.2% coverage, while *Fraxinus nigra* was overshadowed at 14.9% coverage (see Batzer *et al.* 2011 Field Botany study). If this cover of Ash trees is lost to the Ash Borer, Ash seedlings will have a difficult time reclaiming the coverage that they once had in Bessey Creek. Kashian and Witter (2001) show that the remaining ash seedlings are declining due to competitive exclusion by other shade-tolerant species. These findings suggest that the canopy cover that may be opened up by the Ash borer will be replaced with *Acer rubrum*, a highly competitive, shade-tolerant species that already displays overwhelming dominance at the site (Abrams 1998). Should the Ash borer open up canopy cover, it will be very important to monitor the area for colonization by invasive species in the understory.

Exotic Species at Bessey Creek

Even though about 6% of earth's land surface is wetlands, 24% of the world's most notorious invasives are wetland species (Healy and Zedler 2004). Of the wetland invaders, many have the tendency to form habitat altering monotypes, often due to leaf litter production. The consequences of these invasions include declining species biodiversity, modification of nutrient cycling processes as well as altered food and resource availability (Healy and Zedler 2004). Wetlands are landscape sinks that accumulate nutrients and organic material due to a constant influx of water, facilitating the growth of invaders, who typically thrive in nutrient-rich environments (Healy and Zedler 2004). Disturbance from constantly changing water levels also

creates light gaps in the canopy, providing opportunities for the germination of fast-growing invasive seedlings (Healy and Zedler 2004). Because wetlands are generally susceptible to invasive species, it is important to begin management and removal of the invasives located at Bessey Creek Preserve while they are still few and not yet well established. Of the invasives noted to be growing in Bessey Creek, *Aegopodium podagraria*, *Lythrum salicaria*, *Phalaris arundinacea*, and *Celastrus orbiculatus* are mostly likely to spread, displace native wetland species, and change the community composition of the littoral marsh and swamp understory.

Aegopodium podagraria, or Goutweed, makes a nice variegated ground cover for gardens, but if neglected it will spread vigorously from rhizomes into areas with moist soils (Garske and Schimpf 2005). Seedlings need areas of open light to germinate, but the plants can easily spread from rhizomes in shaded areas (Garske and Schimpf 2005). Because it is shade tolerant, it is able to invade forests with dense canopy cover (Garske and Schimpf 2005). In June, 2011, the Ethnobotany class from the University of Michigan Biological Station noted several large, dense populations of *A. podagraria* growing in the understory of Colonial Point, one of the oldest hardwood forests remaining in this part of the state (J. Dorey, personal observation). It was almost certainly introduced by dumping of yard waste, as a seedling would not have germinated in such a low light environment. Introduction into Bessey Creek also occurred via a human vector, as *A. podagraria* was noted growing near the border of the property on the east side of Bessey Creek among piles of yard waste. Manual removal of the population in Bessey Creek is possible while the population is small, but all of the rhizomes must be removed from the soil and dried or placed into a bag before disposal, to prevent re-sprouting from the rhizomes. Another option suggested by the National Park Service is to cover the patches with opaque, black

plastic in early spring before the leaves have fully expanded, which will prevent the plant from photosynthesizing and building up carbohydrate reserves (Garske and Schimpf 2005).

Lythrum salicaria, more commonly called Purple Loosestrife, is just beginning to form a stand on the east side of Bessey Creek, on the shore of Douglas Lake. The stand consists of a single clump, measuring about 0.5 to 1.0 meters across. Although the stand is small now, *L. salicaria* can spread vegetatively from rhizomes at a rate of 30 cm per year (Swearingen 2005). Even more disconcerting is the high number of seeds that the plant can produce. Because *L. salicaria* has an extended growing season (June- September) and is pollinated by many species of insect, who are attracted to the purple petals, one plant can release up to 2-3 million seeds per year (Swearingen 2005). *Lythrum salicaria* is a notorious invader of both natural and disturbed wetlands, often displacing native grasses, sedges and herbaceous wildflowers of littoral marshes (Blossey *et al.* 2001). Bessey Creek has large sedge diversity, many of which have high conservation value and provide habitat for waterfowl. If Purple Loosestrife is allowed to spread through the littoral marsh, these native sedges will likely be extirpated from Bessey Creek. Biocontrol has become the most popular option for removal of Purple Loosestrife, but it is still in experimental stages (Swearingen 2005). Because the population in Bessey Creek is still relatively small, manual removal of the plants should result in sufficient mortality and prevent the plant from spreading.

Celastrus orbiculatus, also known as Oriental Bittersweet, is a woody perennial that is adept at climbing over existing vegetation and smothering it to death (Swearingen 2006). The native *Celastrus scandens* is often mistaken for this invasive, as they look very similar without closer attention to morphologic details (Leicht-Young *et al.* 2008). Oriental Bittersweet is most commonly found growing in open, disturbed areas, but because it is shade tolerant, it has also

been noted to invade forested areas (Swearingen 2006). The fruit of *C. orbiculatus* is attractive to many bird species, including blue jays, European starlings and mockingbirds, who help the plant disperse in wide ranges (Swearingen 2006). The individuals in Bessey Creek were found growing on the east side of the creek along the property boundary, and could very likely have been dropped by birds. *C. orbiculatus* is also a popular decorative garden plant, so dumping of yard waste can not be ruled out as a potential mean of introduction. Even if the plant is clipped, it will sprout again from its roots. Therefore, care should be afforded during manual removal of small infestations to pull up all parts of the plant (Swearingen 2006). For larger infestations, the plant can be clipped close to the ground, followed by a small application of herbicide to the exposed tissue to keep the roots from re-sprouting (Swearingen 2006).

Phalaris arundinacea, or Canary Reed Grass, is a long lived perennial that has become one of the most abundant species in wetlands across the state (S. Lishawa, personal communication). Like most grasses, it spreads vegetatively from rhizomes, forming dense monotypic stands, but it can also re-sprout from culms (Kercher *et. al* 2006). *Phalaris arundinacea* is able to facilitate its own growth by sprouting early in the spring, then reflexing back to the ground, thereby shading out its competitors. It then enjoys a long growing season, with green photosynthetic parts of the plant often remaining present until October (Healy and Zedler 2010). *Phalaris arundinacea* is already well established in the littoral marsh of Bessey Creek. Burning, mowing and herbicides have all been found to be ineffective forms of management control (Healy and Zedler 2010). Removing large amounts of sod to flood out the grass has proven to be effective in previous studies, but this may not be applicable to Bessey Creek, since *P. arundinacea* is growing among native hydrophytes (Healy and Zedler 2010).

Other exotic species present at Bessey Creek, but of less immediate concern, include *Cirsium arvense* (Canada thistle), *Myosotis scorpioides* (Forget-me-not), and *Lonicera morrowii* (Morrow's honeysuckle). *Cirsium arvense* is an upland species (Thunhorst and Swearingen 2005), and not likely to spread far into the preserve. There are currently only one or two individuals present at Bessey Creek along the roadside, and periodic clipping at the bottom of the stem should deplete the starch reserves in the roots and easily remove those individuals (Thunhorst and Swearingen 2005). However, there is a larger population of *C. arvense* directly across the road, so the site should be carefully monitored for new sprouts. *Myosotis scorpioides* is a European species that escaped from gardens not long after the European colonialists arrived in North America (Wells et. al 1999). This species is considered to be naturalized regionally, but it does have the ability to form dense thickets along littoral marshes and crowd out native plants, so it should be monitored for excessive growth (Wells et. al 1999). *Lonicera morrowii* is one of the exotic bush honeysuckles most likely to invade wetlands, but even then it will not be very resilient in shaded canopies (Williams 2005). Only one individual was noted as growing in the middle of the swamp in a drier, raised area. *Lonicera morrowii* does have the ability to deplete soil moisture and may release toxins into the soil to harm competitors, but like *C. arvense*, periodic clipping throughout the growing season should be sufficient for removal (Williams 2005).

We estimate that our floristic inventory located >90% of the species at Bessey Creek. Poaceae, Cyperaceae, *Salix*, and spring ephemerals may be under-represented. Nevertheless, we believe that for this site our understanding of the flora is more complete across the 4 habitats than in the past. In addition, the floristic quality assessment has brought to light several exotic species and successional concerns. Our inventory of the 2011 flora increased the ability to

predict future successional changes for Bessey Creek Preserve. Despite the small size of the Bessey Creek Nature Preserve, its wetland habitats are floristically rich and illustrate that even small preserves can conserve valuable habitat with a diverse flora.

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Floristic Inventory for Bessey Creek Nature Preserve, Cheboygan County, Michigan, 2011

Species in our inventory are grouped according to division, class, and family. Common names are included for each species. The habitat is noted where each species was most prevalent in the preserve. The coefficient of conservatism (CC) indicates the approximate probability of encountering a plant in an unaltered environment that would resemble pre-settlement conditions, where a value of 0 indicates a wide ecological amplitude and a value of 10 indicates a narrow growth range (Herman *et al.* 2001). Exotic species, those that are considered to be non-native to Michigan, do not have a coefficient of conservatism and are denoted by an “E.” The coefficient of wetness (CW) indicates the probability of a species occurring in a wetland, with -5 indicating that a species almost always occurs in a wetland and 5 indicating that a species almost never occurs in a wetland (Herman *et al.* 2001).

PTERIDOPHYTA (Spore bearing)

EQUISETOPSIDA (Horsetails)

EQUISETACEAE

Equisetum arvense L. “Common Horsetail” – Swamp. CC: 0. CW: 0.
Equisetum fluviatile L. “Water Horsetail” – Swamp. CC: 7. CW: -5.

POLYPODIOPSIDA (Ferns)

ASPLENIACEAE

Athyrium filix-femina (L.) Roth “Lady Fern” – Swamp. CC: 4. CW: 0.

ONOCLEACEAE

Onoclea sensibilis L. “Sensitive Fern” – Swamp. CC: 2. CW: -3.

OSMUNDACEAE

Osmunda regalis L. “Royal Fern” – Littoral marsh. CC: 5. CW: -5.

THELYPTERIDACEAE

Thelypteris palustris Schott “Marsh Fern” – Roadside and swamp. CC: 2. CW: -4.

PINOPHYTA (Gymnosperms)**CUPRESSACEAE**

Thuja occidentalis L. “Cedar, White-cedar” – Swamp. CC: 4. CW: -3.

PINACEAE

Abies balsamea (L.) Mill. “Balsam Fir” – Swamp. CC: 3. CW: -3.

MAGNOLIOPHYTA (Angiosperms)**MAGNOLIPSIDA (Dicots)****ADOXACEAE**

Viburnum lentago L. “Nannyberry” – Swamp. CC: 4. CW: -1.

ANACARDIACEAE

Toxicodendron radicans (L.) Kuntze “Poison-ivy” – Swamp. CC: 2. CW: -1.

APIACEAE

Aegopodium podagraria L. “Goutweed” – Swamp. CC: E. CW: 0.

Daucus carota L. “Queen Anne’s Lace, Wild Carrot” – Roadside. CC: E. CW: 5.

Sium suave Walter “Water-parsnip” – Littoral marsh. CC: 5. CW: -5.

APOCYNACEAE

Apocynum cannabinum L. “Indian-hemp” – Roadside. CC: 3. CW: 0.

Asclepias incarnata L. “Swamp Milkweed” – Littoral marsh. CC: 6. CW: -5.

AQUIFOLIACEAE

Ilex verticillata (L.) A. Gray “Michigan Holly, Winterberry, Black-alder” – Swamp. CC: 5.
CW: -4.

ASTERACEAE

- Cichorium intybus* L. “Chicory, Blue-sailors” – Swamp. CC: E. CW: 5.
Cirsium arvense (L.) Scop. “Canada Thistle, Field Thistle” – Roadside. CC: E. CW: 3.
Hieracium aurantiacum L. “Orange Hawkweed, Devil’s Paintbrush” – Roadside. CC: E. CW: 5.
Leucanthemum vulgare Lam. “Ox-eye Daisy” – Roadside. CC: E. CW: 5.
Solidago canadensis L. “Canada Goldenrod” – Roadside. CC: 1. CW: 3.
Solidago rugosa Mill. “Rough-leaved Goldenrod” – Swamp. CC: 3. CW: -1.
Sonchus oleraceus L. “Common Sow-thistle” – Swamp. CC: E. CW: 3.
Symphytotrichum spp. – Roadside. Possibly 3 species still need identification at this site.
Symphytotrichum puniceum (L.) Á. Löve & D. Löve “Swamp Aster, Purple-stemmed Aster” –
 Roadside. CC: 5. CW: -5.
Taraxacum officinale F. H. Wigg. “Common Dandelion” – Roadside. CC: E. CW: 3.

BALSAMINACEAE

- Impatiens capensis* Meerb. “Spotted Touch-me-not, Jewelweed” – Swamp. CC: 2. CW: -3.

BETULACEAE

- Alnus incana* (L.) Moench “Speckled Alder” – Swamp. CC: 5. CW: -5.
Betula papyrifera Marshall “White Birch, Paper Birch” – Swamp. CC: 2. CW: 2.

BORAGINACEAE

- Myosotis scorpioides* L. “Forget-me-not” – Littoral marsh. CC: E. CW: -5.

CAMPANULACEAE

- Campanula aparinoides* Pursh “Marsh Bellflower” – Swamp. CC: 7. CW: -5.
Lobelia cardinalis L. “Red Lobelia, Cardinal-flower” – Swamp. CC: 7. CW: -5.

CAPRIFOLIACEAE

- Lonicera morrowii* A. Gray “Morrow Honeysuckle” – Swamp. CC: E. CW: 5.

CARYOPHYLLACEAE

- Cerastium fontanum* Baumg. “Mouse-ear Chickweed” – Swamp. CC: E. CW: 3.

CELASTRACEAE

Celastrus orbiculatus Thunb. “Oriental Bittersweet” – Swamp. CC: E. CW: 5.

CERATOPHYLLACEAE

Ceratophyllum demersum L. “Coontail” – Aquatic. CC: 1. CW: -5.

CLUSIACEAE

Triadenum fraseri (Spach) Gleason “Marsh St. John’s-wort” – Swamp. CC: 6. CW: -5.

CORNACEAE

Cornus amomum Mill. “Silky Dogwood, Pale Dogwood” – Swamp. CC: 2. CW: -4.

Cornus sericea L. “Red-osier Dogwood” – Swamp. CC: 2. CW: -3.

FABACEAE

Apios americana Medik. “Groundnut, Wild-bean, Indian-potato” – Swamp. CC: 3. CW: -3.

Lathyrus palustris L. “Marsh Pea” – Swamp. CC: 7. CW: -3.

LAMIACEAE

Lycopus uniflorus Michx. “Northern Bugle Weed” – Swamp. CC: 2. CW: -5.

Mentha canadensis L. “Wild Mint” – Swamp. CC: 3. CW: -3.

Prunella vulgaris L. “Self-heal, Heal-all” – Roadside. CC: 0. CW: 0.

Scutellaria galericulata L. “Marsh Skullcap” – Swamp. CC: 5. CW: -5.

LENTIBULARIACEAE

Utricularia vulgaris L. “Common Bladderwort” – Aquatic. CC: 6. CW: -5.

LYTHRACEAE

Lythrum salicaria L. “Purple Loosestrife” – Littoral marsh. CC: E. CW: -5.

MYRICACEAE

Myrica gale L. “Sweet Gale” – Swamp. CC: 6. CW: -5.

MYRSINACEAE

Lysimachia thyrsiflora L. “Tufted Loosestrife” – Swamp. CC: 6. CW: -5.
Trientalis borealis Raf. “Star-flower” – Swamp. CC: 5. CW: -1.

NYMPHAEACEAE

Nuphar variegata Durand “Yellow Pond-lily” – Aquatic. CC: 7. CW: -5.
Nymphaea odorata Aiton “Sweet-scented Waterlily” – Aquatic. CC: 6. CW: -5.

OLEACEAE

Fraxinus nigra Marshall “Black Ash” – Swamp. CC: 6. CW: -4.

ONAGRACEAE

Ludwigia palustris (L.) “Water-purslane” – Aquatic and Littoral marsh (terrestrial form).
 CC: 4. CW: -5.

PLANTAGINACEAE

Chelone glabra L. “Turtlehead” – Swamp. CC: 7. CW: -5.
Plantago major L. “Common Plantain” – Roadside. CC: E. CW: -1.
Veronica officinalis L. “Common Speedwell” – Swamp, on hummock. CC: E. CW: 5.

POLYGONACEAE

Fallopia cilinodis (Michx.) Holub “Fringed False Buckwheat” – Swamp. CC: 3. CW: 5.
Persicaria amphibia (L.) A. Gray “Water Smartweed” –
 Swamp and Littoral marsh. CC: 6. CW: -5.
Persicaria hydropiperoides (Michx.) Small “Water-pepper, Mild Water-pepper” –
 Swamp. CC: 5. CW: -5.
Rumex crispus L. “Sour Dock, Curly Dock” – Roadside. CC: E. CW: -1.

RANUNCULACEAE

Ranunculus acris L. “Common Buttercup, Tall Buttercup” – Roadside. CC: 5. CW: 0.
Thalictrum dasycarpum Fisch. & Ave-Lall. “Purple Meadow-rue” –
 Littoral marsh. CC: 3. CW: -2.

ROSACEAE

Comarum palustre L. “Marsh Cinquefoil” – Swamp. CC: 7. CW: -5.
Potentilla anserina L. “Silverweed” – Swamp. CC: 5. CW: -4.
Rosa palustris Marshall “Swamp Rose” – Swamp. CC: 5. CW: -5.

RUBIACEAE

Galium brevipes Fernald & Wiegand “Short-stalked Bedstraw” – Swamp. CC: 6. CW: -5.
Galium triflorum Michx. “Fragrant Bedstraw” – Swamp. CC: 2. CW: 2.
Mitchella repens L. “Partridge-berry” – Swamp. CC: 5. CW: 2.

SALICACEAE

Populus balsamifera L. “Balsam Poplar” – Swamp. CC: 2. CW: -3.
Salix petiolaris Sm. – Littoral marsh. CC: 1. CW: -4.
Salix sp. – Littoral marsh and swamp. 2 to 3 species may remain unidentified in the preserve.

SAPINDACEAE

Acer rubrum L. “Red Maple” – Swamp. CC: 1. CW: 1.

Hybrids

Acer sp. (*Acer rubrum* x *Acer saccharinum*) “hybrid maple” – Swamp.

SOLANACEAE

Solanum dulcamara L. “Woody Nightshade, Bittersweet” – Roadside. CC: E. CW: 0.

ULMACEAE

Ulmus americana L. “White Elm, American Elm” – Swamp. CC: 1. CW: -2.

VITACEAE

Vitis riparia Michx. “River-bank Grape” – Swamp. CC: 3. CW: -2.

LILIOPSIDA (Monocots)**ACORACEAE**

Acorus calamus L. “Sweet Flag, Calamus” – Littoral marsh. CC: E. CW -5.

ALISMATACEAE

Sagittaria latifolia Willd. “Wapato, Duck-potato, Common Arrowhead” – Littoral marsh.
 CC: 4. CW: -2.

ARACEAE

Arisaema triphyllum (L.) Schott “Jack-in-the-pulpit, Indian-turnip” – Swamp. CC: 5. CW: -2.
Lemna trisulca L. “Star Duckweed” – Aquatic. CC: 6. CW: -5.

CONVALLARIACEAE

Maianthemum canadense Desf. “Canada Mayflower” – Swamp. CC: 4. CW: 0.
Streptopus lanceolatus (Aiton) Reveal “Rose Twisted-stalk” – Swamp. CC: 5. CW: 0.

CYPERACEAE

Carex aquatilis Wahlenb. “Sedge” – Swamp and littoral marsh. CC: 7. CW: -5.
Carex hystericina Willd. “Sedge” – Swamp and littoral marsh. CC: 2. CW: -5.
Carex intumescens Rudge “Sedge” – Swamp. CC: 3. CW: -4.
Carex lacustris (Willd). “Sedge” – Swamp and littoral marsh. CC: 6. CW: -5.
Carex lasiocarpa Ehrh. “Sedge” – Littoral marsh. CC: 8. CW: -5.
Carex lupulina Willd. “Sedge” – Swamp and littoral marsh. CC: 4. CW: -5.
Carex rostrata Stokes “Sedge” – Swamp and littoral marsh. CC: 10. CW: -5.
Carex sp. “Sedge” – There are likely 2-3 additional unidentified species of *Carex*.
Cladium mariscoides (Muhl.) Torr. “Twig-rush” – Littoral marsh. CC: 10. CW: -5.
Dulichium arundinaceum (L.) Britton “Three-way sedge” – Littoral marsh. CC: 8. CW: -5.
Eleocharis palustris (L.) Roem. & Schult. “Spike-rush” – Littoral marsh. CC: 5. CW: -5.
Schoenoplectus acutus (Bigelow) Á. Löve & D. Löve “Hardstem Bulrush” –
 Littoral marsh. CC: 5. CW: -5.
Scirpus cyperinus (L.) Kunth “Wool-grass” – Littoral marsh. CC: 5. CW: -5.

HALORAGACEAE

Myriophyllum sibiricum Komarov “Spiked Water-milfoil” – Aquatic. CC: 10. CW: -5.

HYDROCHARITACEAE

Elodea canadensis Michx. “Common Waterweed” – Aquatic. CC: 1. CW: -5.
Najas flexilis (Willd.) Rostk. “Slender Naiad” – Aquatic. CC: 5. CW: -5.

IRIDACEAE

Iris versicolor L. “Wild Blue-flag” – Swamp. CC: 5. CW: -5.

ORCHIDACEAE

Platanthera psycodes (L.) Lindl. “Purple Fringed Orchid” – Swamp. CC: 7. CW: -3.

POACEAE

- Calamagrostis canadensis* L. “Blue-joint” – Swamp. CC: 0. CW: -4.
Dactylis glomerata L. “Orchard Grass” – Roadside. CC: E. CW: 3.
Phalaris arundinacea L. “Reed Canary Grass” – Swamp and littoral marsh. CC: 0. CW: -4.
Phragmites australis Saltonst., P. M. Peterson & Soreng “Reed” – Littoral marsh. Native genotype. CC: 5. CW: -4.
Spartina pectinata Link “Cordgrass” – Swamp. CC: 5. CW: -4.

POTAMOGETONACEAE

- Potamogeton gramineus* – L. “Pondweed” – Aquatic. CC: 5. CW: -5.
Potamogeton natans L. “Pondweed” – Aquatic. CC: 5. CW: -5.
Potamogeton pusillus L. “Small Pondweed” – Aquatic. CC: 4. CW: -5.
Potamogeton zosteriformis Fernald “Flat-stemmed Pondweed” – Aquatic. CC: 5. CW: -5.
Stuckenia pectinata (L.) Börner “Sago Pondweed” – Aquatic. CC: 3. CW: -5.

Hybrids

- Potamogeton* sp. (*P. perfoliatus* x *P. richardsonii*?) – Aquatic.
Potamogeton sp. (*P. praelongus* x *P. richardsonii*?) – Aquatic.
Stuckenia sp. (*S. pectinata* x ?) – Aquatic.

TYPHACEAE

- Sparganium americanum* Nutt. “American Bur-reed” – Littoral marsh. CC: 6. CW: -5.
Typha latifolia L. “Broad-leaved Cattail” – Littoral marsh. CC: 1. CW: -5.

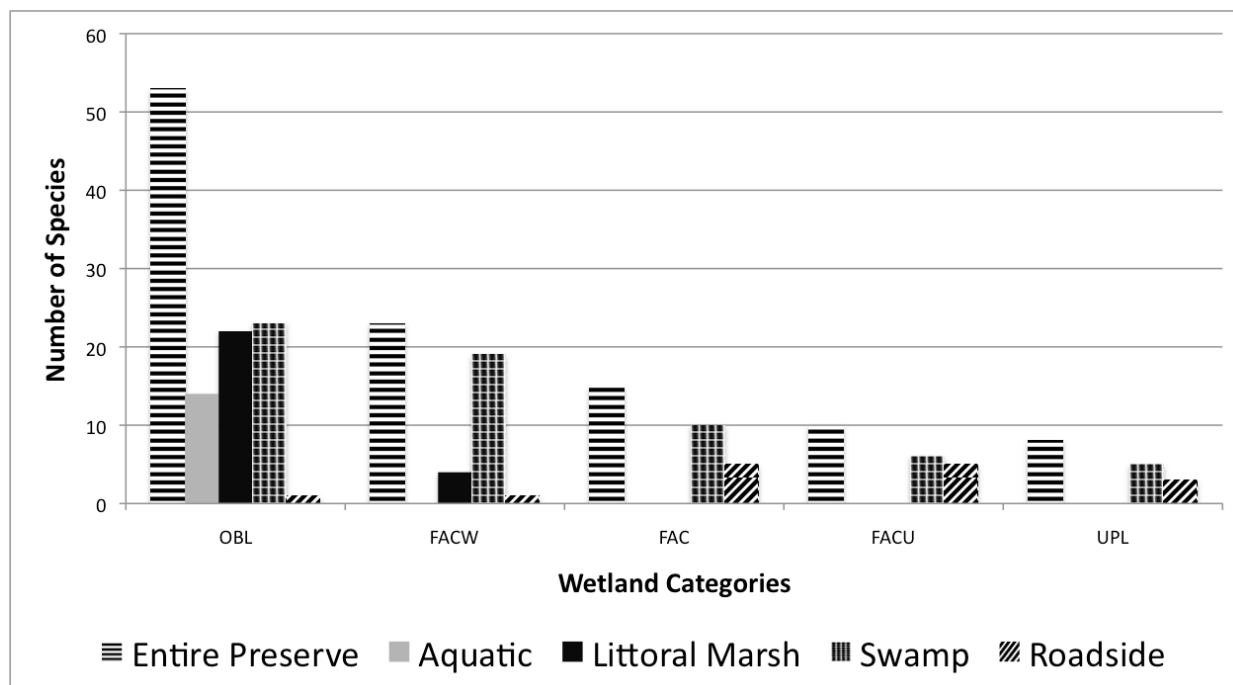


Figure 1: Distribution of species through the Bessey Creek Nature Preserve by wetland category.

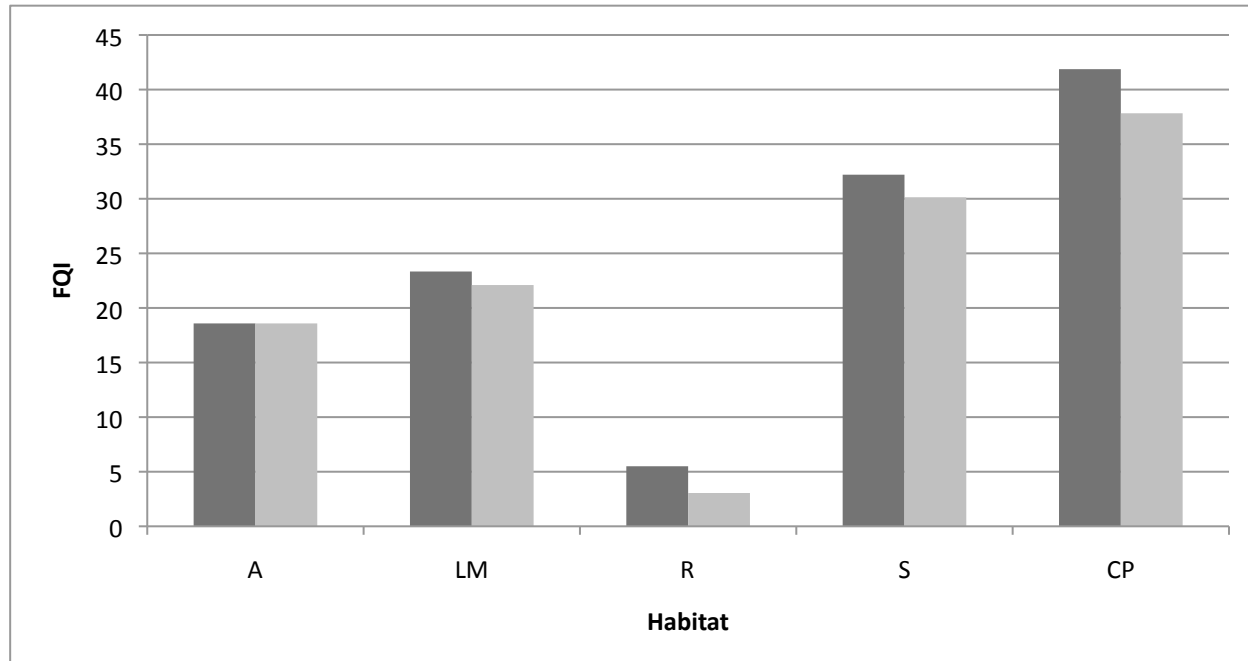


Figure 2: Floristic quality indices of both native species (right, light) and total species (left, dark) of the various habitats and the entire preserve. A: aquatic; LM: littoral marsh; R: roadside; S: swamp; CP: entire preserve

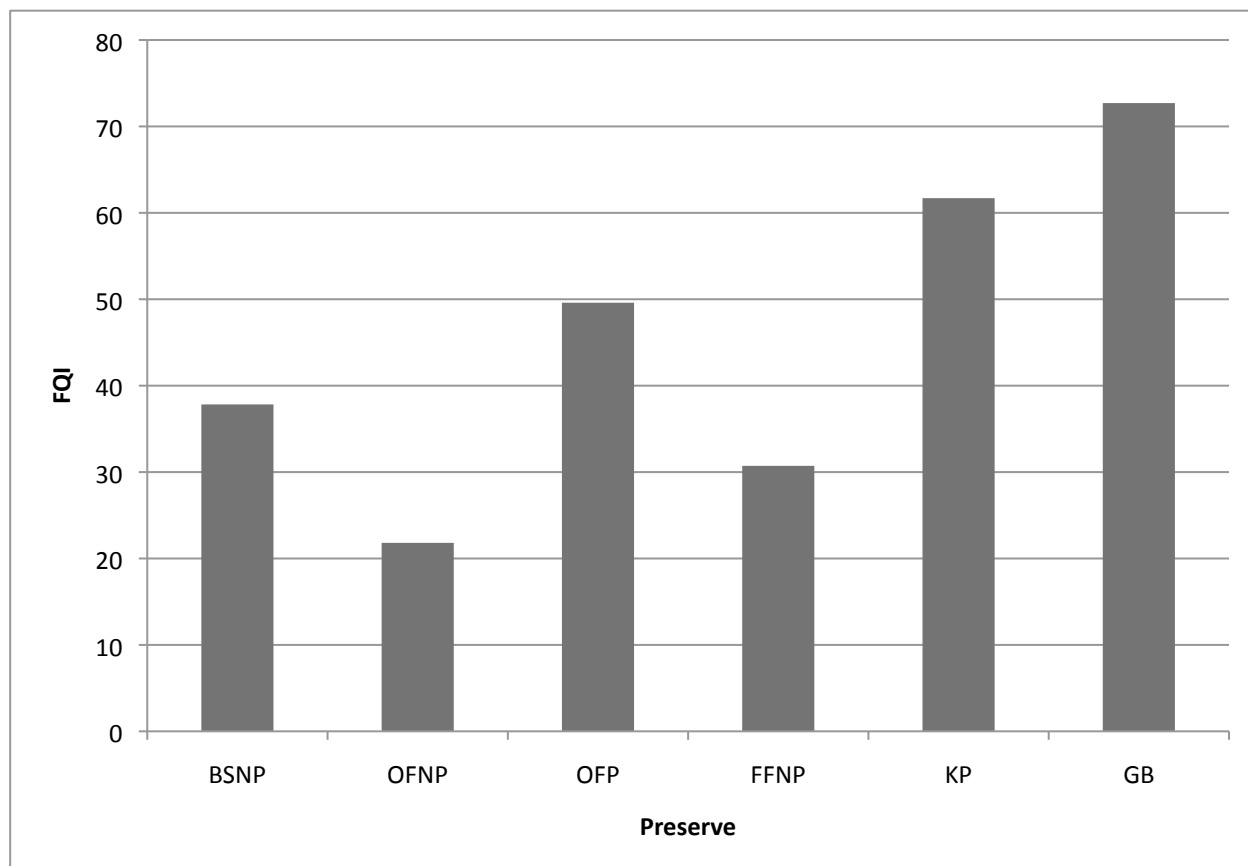


Figure 3: Comparison of the FQI value of Bessey Creek Nature Preserve (BSNP) to the FQI values of previous Field Botany FQAs around northern Michigan. OFNP: Offield Family Nature Preserve Bog; OFP: Orchis Fen Preserve; FFNP: Fisser Family Nature Preserve; KP: Kalman Preserve; GB: Grass Bay.

Table 1: Wetland category definitions and coefficients of wetness (W) from Herman *et al.* 2001

<i>Wetland Category</i>	<i>Symbol</i>	<i>W</i>	<i>Definition</i>
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 Wetland	FACW	-3	Usually occurs in wetlands, but occasionally found in nonwetlands (estimated 67% - 99% probability).
Obligate Wetland	OBL	-5	Occurs almost always in wetlands under natural conditions (estimated > 99% probability).

Table 2: Species richness (n), mean coefficient of conservatism (\bar{C}), floristic quality index (FQI) and mean wetness index (\bar{W}) for the native species identified in the Bessey Creek Nature Preserve. Values displayed for the entire preserve as well as for the four distinct habitats within the preserve.

<i>Habitat</i>	<i>n</i>	\bar{C}	<i>FQI</i>	\bar{W}
Entire Preserve	96	4.44	41.87	-3.44
Aquatic	16	5.15	18.58	-5.00
Littoral	26	4.58	23.34	-4.50
Roadside	7	2.75	5.50	0.50
Swamp	58	4.43	33.75	-2.71

Table 3: Species richness (n), mean coefficient of conservatism (\bar{C}), floristic quality index (FQI) and mean wetness index (\bar{W}) for all (both native and introduced) species identified in the Bessey Creek Nature Preserve. Values displayed for the entire preserve as well as for the four distinct habitats within the preserve.

<i>Habitat</i>	<i>n</i>	\bar{C}	<i>FQI</i>	\bar{W}
Entire Preserve	116	3.62	37.83	-2.52
Aquatic	16	5.15	18.58	-5.00
Littoral	29	4.10	22.10	-4.55
Roadside	16	0.85	3.05	1.46
Swamp	65	3.77	30.13	-2.11

Table 4: Various preserves studied by the UMBS Field Botany course and their areas. All preserves are in northern lower Michigan.

<i>Preserve</i>	<i>Area (hectares)</i>
Bessey Creek Nature Preserve	0.20
Offield Family Nature Preserve Bog	0.49
Orchis Fen Preserve	14.16
Fisher Family Nature Preserve	16.60
Kalman Preserve	28.73
Grass Bay	303.51

Table 5: Comparison of species present at Bessey Creek in 1911 to 2011, adapted from Gates (1912). Dominant indicates species most abundant in the site. Secondary indicates species present to a lesser extent. Relic indicates species that are thought to be decreasing in abundance. Invading indicates species that recently colonized the site. The far right column indicates whether the species was collected in the 2011 survey.

Present in 1911	1911 Community Status	Present in 2011
<i>Nymphaea odorata</i>	Relic	Yes
<i>Schoenoplectus pungens</i>	Invading, Relic (At different locations in the site)	No
<i>Sagittaria latifolia</i>	Dominant	Yes
<i>Sparganium simplex</i> (likely renamed <i>S. emersum</i> or <i>S. angustifolium</i>) (Gleason and Cronquist 1991)	Dominant	No
<i>Mentha canadensis</i>	Secondary (rare)	Yes
<i>Mimulus glabratus</i> var. <i>jamesii</i>	Secondary (rare)	No
<i>Eupatorium perfoliatum</i>	Invading	No
<i>Eupatorium purpureum</i>	Invading	No
<i>Lobelia cardinalis</i>	Invading	Yes
<i>Schoenoplectus tabernaemontani</i>	Dominant	No
<i>Myriophyllum spicatum</i> (Probably misidentified-likely <i>Myriophyllum sibiricum</i>)	Secondary	Yes (Likely <i>M. sibiricum</i>)
<i>Elodea canadensis</i>	Secondary	Yes
<i>Menyanthes trifoliata</i>	Dominant	No
<i>Eleocharis palustris</i>	Invading	Yes
<i>Carex lasiocarpa</i>	Invading	Yes
<i>Typha latifolia</i>	Invading (rare)	Yes
<i>Chamaedaphne calyculata</i>	Invading	No
<i>Iris versicolor</i>	Invading	Yes
<i>Decodon verticillatus</i>	Invading	No
<i>Asclepias incarnata</i>	Invading	Yes
<i>Salix lucida</i>	Invading	No
<i>Glyceria borealis</i>	Invading	No
<i>Nuphar variegata</i>	Secondary (rare)	Yes