Aquatic & Shoreline Terrestrial Plant Composition with Floristic Quality Index of Powers Creek, at Loyola University Retreat and Ecology Campus, McHenry County, IL 2016

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Mentor: Father Stephen Mitten, S.J.

Institute of Environmental Sustainability
Loyola University Chicago
Summer 2016

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Abstract

Aquatic plant species and shoreline terrestrial plant species along the spring-fed Powers Creek at Loyola University Retreat and Ecology Campus (LUREC) were collected, identified, and analyzed to determine plant diversity using a percent coverage method. The purpose of this project was to conduct a baseline assessment of the plant species that inhabited the portion of Powers Creek that runs along the border of the LUREC property. Floristic quality index (nonnative and native) using coefficient of conservatism values was calculated for each site. A total of twenty five different plant species, including nineteen different families, were identified at ten sites along Powers Creek (Appendix A). Fifteen of the twenty five plant species (60%) were native to Illinois. The average total vegetation cover of the creek was 88.6%. The average FQI of all the sites was 13.639, and the average native FQI was 7.61. This research is a companion study to the research on aquatic insect community structure and the accompanying physiochemical parameters of Powers Creek and contributes to the continuing biodiversity assessment of the entire property and is used to monitor ecosystem progression and change.

Introduction

Boone-Dutch Creek Watershed Plan- McHenry County

LUREC is located at 2710 S. Country Club Rd, Bull Valley, McHenry County, IL, and encompasses 98 acres (9.7 hectares) total. The property is located in Section 13, Township 44, North, Range 7, and East of the Third Meridian. LUREC, at its southeastern tip, is situated next to the Parker Fen, an Illinois Nature Preserve (Perez and Mitten, 2012). Past biodiversity assessments of the property can be found at Olmedo, G. and S. Mitten 2015; C. Pacholski, et al. 2014; Perez, E and S. Mitten 2012.

Boone-Dutch Creek Watershed is located in McHenry County, IL. A watershed is the land area from which rainwater and snowmelt drains into a body of water such as a stream or lake. Watershed boundaries are defined by nature and are largely determined by the surrounding topography. Within the watershed are substantial areas where invasive brush species have overtaken former "natural" areas. The brush species – primarily non-native bush honeysuckle, buckthorn, and autumn olive, along with aggressive trees such as box elder and Siberian elm – tend to create dense understory canopies within woodlands. They create stress for native oaks and hickories and greatly reduce the potential for native tree reproduction, thereby impacting the long-term health and viability of native woodlands. These same species can overtake grasslands, old pastures, remnant prairies, and wetland edges. Their aggressive growth behavior creates nearly impenetrable thickets and produces a very dense shade cover that, over time, virtually eliminates herbaceous ground cover. (Boone-Dutch Creek Watershed-based Plan, 2016). The issues of invasive plant species, such as honeysuckle and buckthorn, is also prevalent on the LUREC campus and along Powers Creek. Invasive species increase erosion along the creek and therefore reduce the floristic quality index and overall health of ecosystems. Restoration efforts on the LUREC campus have targeted these invasive species and work to remove them. However, there have been no significant restoration efforts along Powers Creek, which then promotes the overgrowth of invasive species and promotes further erosion. Because of the location of Powers Creek, it has been observed and further hypothesized that the aquatic and shoreline plants of the creek have been previously affected and degraded by various invasive species.

This research provides a baseline evaluation of the plant community with an assessment of the floristic quality index of Powers Creek since it has never been extensively studied before. A companion study of the aquatic insect community and the accompanying physiochemical parameters of Powers Creek can be found at Becker and Lucansky, 2017. Thus the aquatic insects, the accompanying plant community and the water and soil quality were investigated.

Coefficient of Conservatism

The c-value stands for the coefficient of conservatism. The c-value is an ordinal weighting factor of the degree of conservatism (or fidelity) displayed by that species in relation to all other species of the region. Plants with a c-value of zero are plants with a wide range of ecological tolerances and are often opportunistic invaders of natural areas. C-values of one or two are widespread taxa that are not typical of (or only marginally typical of) a particular community.

Plants with a c-value range of three to five are plants with an intermediate range of ecological tolerances that typify a stable phase of some native community, but persists under some disturbance. A higher c-value range of six to eight are plants with a narrow range of ecological tolerances that typify a stable or near "climax" community. The highest c-value range of nine to ten are plants with a narrow range of ecological tolerances that exhibit relatively high degrees of fidelity to a narrow range of habitat requirements. (Andreas *et al*., 2004).

Floristic Quality Index

The Floristic Quality Index (FQI) is a variation diversity indices in ecology. The FQI is designed to reduce subjectivity and create an objective standard of quality. The principal concept underlying the FQI is that the quality of

$$FQInative = (\sum(CCi)/\sqrt{NativeSpecies})$$

$$FQI2 = (\sum(COVERit*CCi)/100) * 10$$

$$FQI3 = (\sum(COVERit*CCi)/\sum(TOTAL\ COVERt)) *10$$

FQI2 when total vegetation cover is ≤100%
FQI3 when total vegetation cover is > 100%

CCi: coefficient of conservatism
NativeSpecies: total number of native species
COVER: Percent cover of given species (i) at a given time (t)

Fig. 1.0 *(U.S. Geological Survey, 2011. FS11-3044)* a natural community can be evaluated by examining the degree of ecological conservatism (c-value) or fidelity of plant species in that community. (Andreas *et al*., 2004). It is a "weighting average" technique. There are three equations used to calculate the FQI *(U.S. Geological Survey, 2011. FS11-3044).* The equations are based on percent cover of vegetation and number of native species. FQI scores are scaled from 0 to 100. Generally, FQI values of 1-19 indicate low vegetative quality; 20-35 indicate high vegetative quality and above 35 indicates "Natural Area" quality. Wetlands with a FQI of 20 or greater are considered high quality aquatic resources (*US Fish and Wildlife Service, 2016*). The native Floristic Quality Index reflects these values on native plant species only. If there are more native plant species with high c-values (a value range from 7-10), the native FQI will be higher, representing a "natural area." It is hypothesized that the sample locations along Powers Creek will have "medium-low" FQIs due to the existing invasive species and erosion of the location.

Diversity Indices

The Shannon Index and Inverse Simpson Index are diversity indices that were also used to determine diversity of the creek as well (*Fig 3.2*). Diversity indices are statistics used to summarize the diversity of a population in which each member belongs to a unique group. For example, in ecology the groups are typically species. In ecology, species richness refers to number of species and species evenness refers to homogeneity of the species. That is, the more equal the proportions for each of the groups, the more homogeneous, or even, they are. Different fields of application may use different terminology for these concepts. The Shannon equilibrium index, which normalizes the Shannon diversity index, has a value between 0 and 1 where lower values indicate more diversity while higher values indicate less diversity. Specifically, an index value of 1 means that all groups have the same frequency. The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled. On the other hand, the Simpson index is a dominance index because it gives more weight to common or dominant species. In this case of the Simpson Index, a few rare species with only a few representatives will not affect the diversity. *(Shannon Diversity Index. National Institute of Standards and Technology. Statistical Engineering Division Dataplot. 1 p.*).

Methods:

General Sampling:

Ten sampling sites along the creek of the LUREC property line were selected. Site one was as close to the main water source of the creek that was accessible and still in the LUREC campus property boundary. The rest of the nine points were measured from this starting point 76.2m (250 ft.) apart (*Fig. 1.1 and 1.12*). Measuring distance was completed by hand with a 150ft tape measure by walking along the edge of the creek. Each of the ten sites were then flagged for the placement of the quadrat and each location's geographic coordinates were recorded with a Garmin GPS device. With this type of site selection technique, the sites are representative of the dynamic habitats that can be found along this creek. Two separate rounds of samples were collected over 7 weeks through June and July of 2016. Field collection took place in the morning between 9am-12pm. Lab analysis for plant specimen identification and pressing for preservation took place in the afternoon 1pm-5pm.

Fig. 1.1 Distance of Powers Creek as it borders LUREC property

Fig 1.12 Yellow stars represent ten sampling locations

Protocol:

At each of the ten sites along Powers Creek, a 1m by 1m quadrat was laid down to measure percent coverage of vegetation. Plant data was collected in the mornings from 9:00am-12:00pm. Each of the sites were previously flagged to predetermine where the quadrat was to be placed on the ground (*Appendix B and C*). The quadrat was placed with the creek in the center. If the creek had a width that was further than one meter, then the quadrat was placed with the bank of the creek (on the side of LUREC's property) in the center. This was to ensure aquatic-emerging and bordering terrestrial vegetation was accounted for at each location. Once the quadrat was placed down, the weather, air temperature, comments, and picture of the area were taken and recorded. Then the average height of vegetation within the quadrat was measured using a meter stick. A picture was also taken of the site with the meter stick standing up in the quadrat for future reference to identify individual species height (*Appendix B*). Total vegetation percent coverage and no-cover percentage were determined next. To determine percent coverage of total vegetation, two smaller square quadrants that represented twenty five percent and one percent of the initial quadrat were utilized to visually determine cover. Vegetation included living plants and leaf litter. No-cover included areas with no vegetation, bare soil, fallen trees/branches/logs, and water. Once total percent cover and no-cover percentage were recorded, percent cover of each plant species in the quadrat was determined. Plant species were recorded as either on the bank of the creek, emerging from the water, or floating on the water. A picture was taken of each plant species for further assistance with identification. The percent cover of each species was determined using the same method as the total vegetation percent cover used before. Each picture was labeled with the species name (if known) and percent cover. If a plant species was unknown, a picture and a specimen of the plant was taken back to the lab in the afternoon for analysis and identification. At each site, a specimen from each plant species was also taken and put into a zip block bag to save for pressing and preservation. The pressed plants were later put into a data collection booklet. All of the pictures were put into a document labeled with the site and species identification. All data was recorded in handwritten tables and later entered into an excel file for analysis using R and Rstudio programs. ArcGIS was also incorporated to create a visual of plant diversity along the creek *(Fig. 4.1 and 4.2)*. Two weeks later, each site was surveyed again. Newly sprouting plant species or flowering species in the quadrat locations were collected for preservation and recorded for additional species richness data. Average height was also visually measured again with a meter stick to determine average plant growth from the first round of data collection to the second. The Floristic Quality Index (FQI) was calculated for each site and then for the creek as a whole using the equations listed in Figure 1.0. These values were used to determine the overall health and native plant production of the locations. The equations are based on percent cover of vegetation and number of native plant species. FQI scores are scaled from 0 to 100. Generally, FQI values of 1-19 indicate low vegetative quality; 20-35 indicate high vegetative quality and above 35 indicates "Natural Area" quality. Wetlands with a FQI of 20 or greater are considered high quality aquatic resources *(US Fish and Wildlife Service, 2016).*

Results:

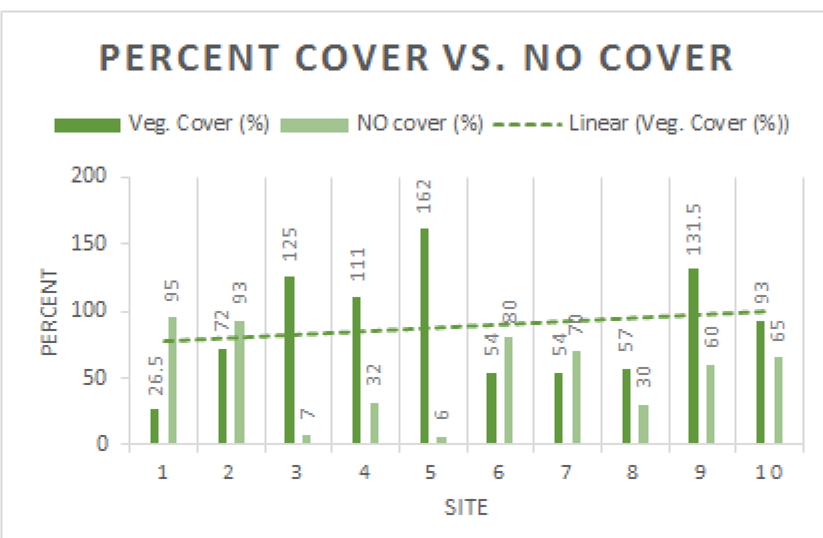


Fig. 2.1. Total vegetation cover, total no vegetation cover percentage of each site in a histogram with a gradual linear increase of percent cover from site 1 to site 10: ***Average total cover of all the sites= 88.6%, average no cover of all the sites=53.8%.***

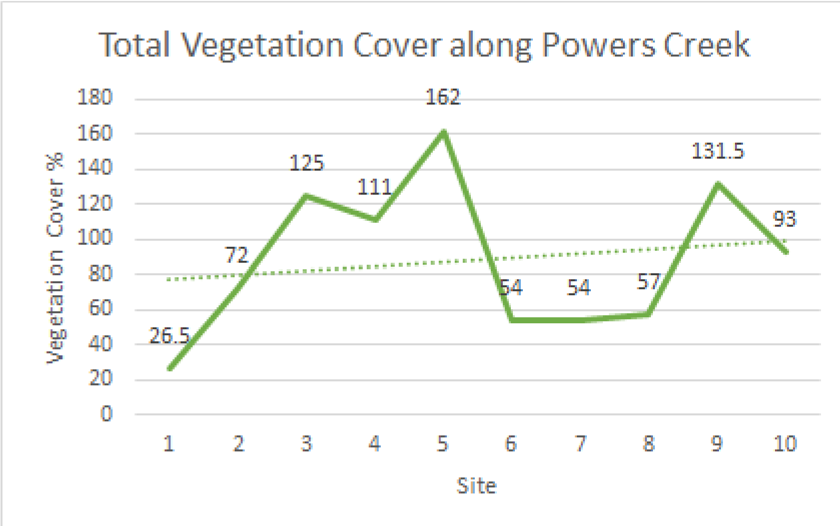


Fig. 2.2 Total vegetation cover throughout the creek. There was a peak in vegetation cover at site 3, 5, and 9. Site 5 had the greatest percent cover of vegetation at 162%. Total percent cover for each site is labeled above each collection point. The increasing linear line represents average vegetation cover from site 1 to site 10.

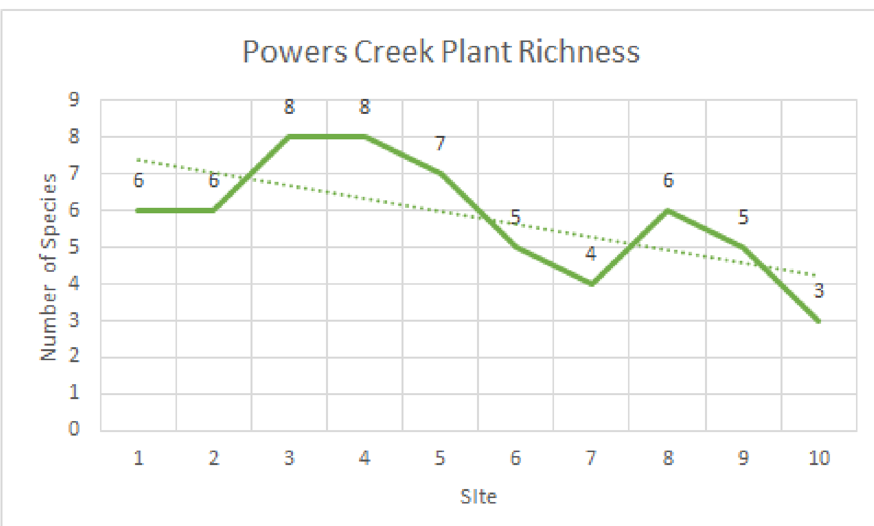


Fig. 2.3 Powers Creek had a total plant richness of ***twenty five*** *species. There is a linear decrease of plant richness from site 1 to site 10. Plant richness represented the number of different species at that location. There was a peak of plant richness at sites 3 and 4. Site 10 had the lowest plant richness with a total of three different species.Total number of different species of each site is labeled above each data point.*

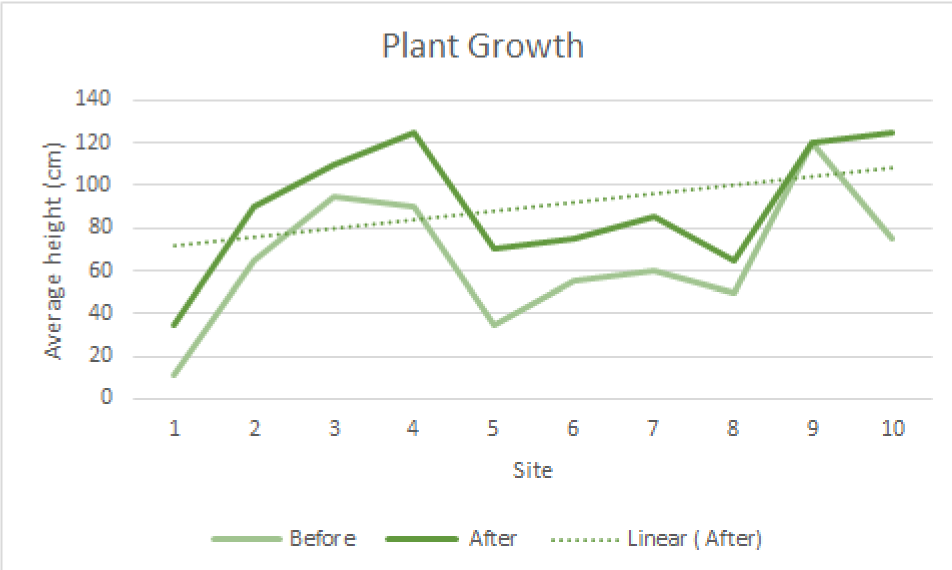
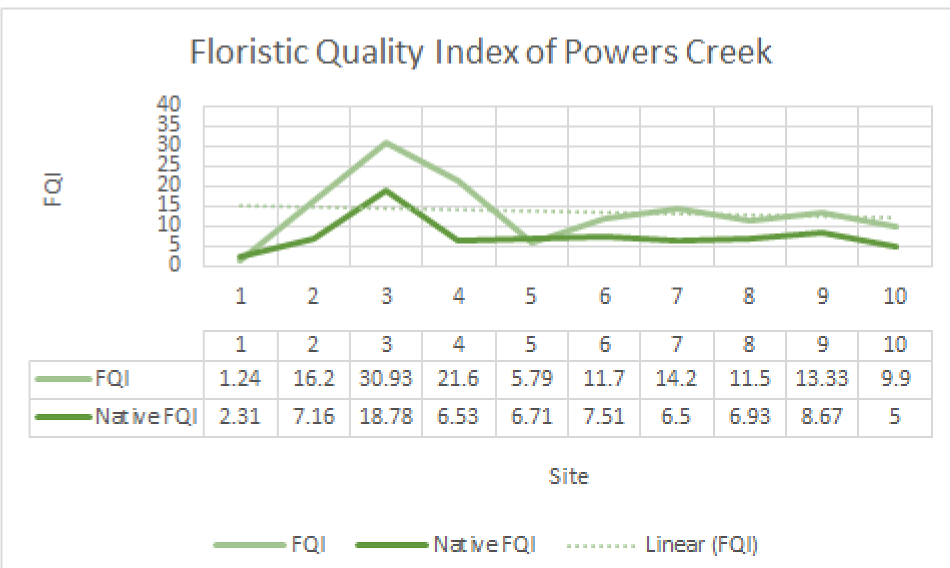


Fig.2.4 Change in height/average plant growth at each site over a two week period with increasing linear line. ***Ave. plant growth=25cm after 2 weeks.***



	1	2	3	4	5	6	7	8	9	10
FQI	1.24	16.2	30.93	21.6	5.79	11.7	14.2	11.5	13.33	9.9
Native FQI	2.31	7.16	18.78	6.53	6.71	7.51	6.5	6.93	8.67	5

Fig. 2.5 Total and native FQI for each site. Actual data is listed in the table directly below the graph. There is a slight linear decrease of FQI from site 1 to site 10. The ***average FQI of all the sites was 13.639****, and the* ***average native FQI was 7.61.****There was a peak in FQI and native FQI at site 3 with an FQI of 30.93 and a native FQI of 18.78.*

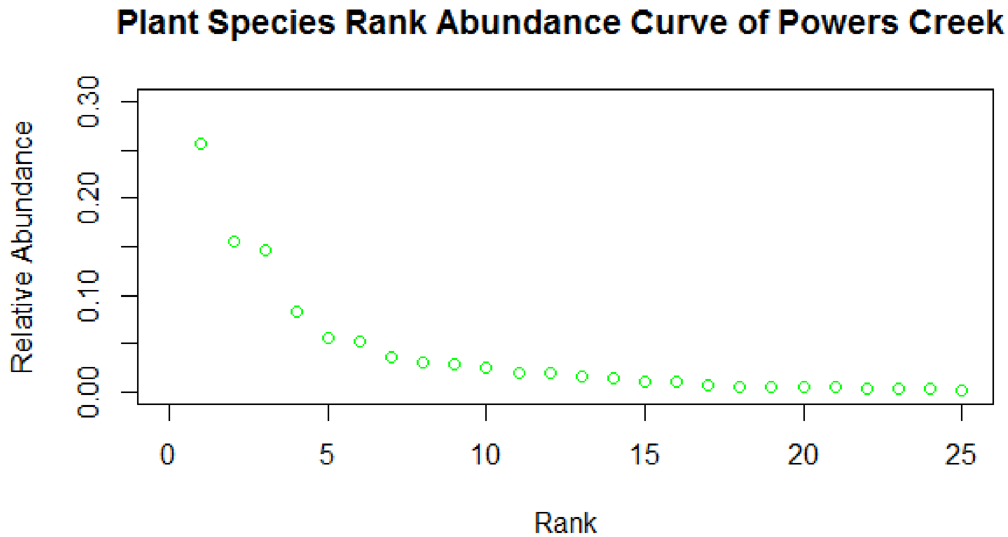
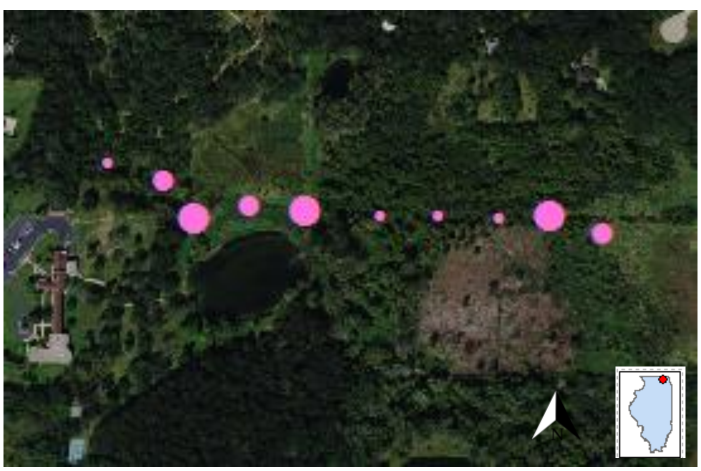


Fig. 3.1 (above) Shannon Index: 2.455517, Inv. Simpson Index: 7.745815

Site	1	2	3	4	5	6	7	8	9	10
Shannon Index	1.570546	1.589201	1.405927	1.869009	1.104874	1.291707	1.104151	1.522697	0.582989	0.443757
Inverse Simpson Index	4.620934	4.438356	2.847444	5.907776	1.998812	2.821333	2.49325	3.886756	1.360337	1.273128

Fig 3.2 (above) Diversity Index calculations for the ten sites individually



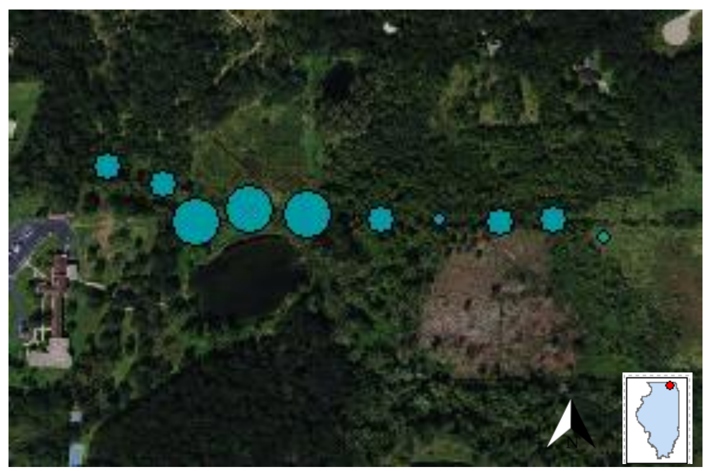


Figure 4.1 and 4.2 GIS maps of sample sites. Left: Illustrating total percent vegetation cover with larger symbols representing larger percent cover. Right: Illustrating total number of different species (richness) with larger symbols representing larger number of species present at the site.

A total of twenty five different plant species, including nineteen different families, were identified at ten sites along Powers Creek *(Appendix A)*. Fifteen of the twenty five plant species (60%) were native to Illinois. The average total vegetation cover of the creek was 88.6%. The average total percentage of no vegetation cover was 53.8% *(Fig. 2.1)*. No-cover included areas with no vegetation, bare soil, fallen trees/branches/logs, and water. There was a slight linear increase of vegetation cover from site one to site ten, upstream to downstream. *(Fig. 2.2)*. There was a peak in vegetation cover at site three and site five *(Fig. 2.2)*. Site three through five were located along the drainage ditch of Powers Creek on the side of the LUREC property border. Site five had the greatest percent cover of vegetation at 162%. Moreover, there was a linear decrease of plant richness from site one to site ten *(Fig. 2.3)*. Plant richness represented the number of different species at that location. There was a peak of plant richness at sites three and four where the drainage ditch was located. Site ten, which was located in the back of the fen, had the lowest plant richness with a total of three different species. Plant growth rate was also monitored after two weeks of visiting each site *(Fig. 2.4)*. The average plant growth at the sites was 25 cm. There was also a linear increase of height from site one to site ten. Site nine was the only site that did not experience plant growth/height difference in the two week span. Floristic Quality Index (FQI) and native Floristic Quality Index were calculated for each site *(Fig. 2.5).* Floristic Quality Index included all of the species recorded at each site, while native Floristic Quality Index was only calculated using the native plant species. There was a slight linear decrease of FQI from site one to site ten. The average FQI of all the sites was 13.639, and the average native FQI was 7.61. Both of these numbers indicate a "low" rank in floristic quality. There was a peak in FQI and native FQI at site three with an FQI of 30.93 and a native FQI of 18.78.These numbers indicated a "natural area." Diversity of plants along Powers Creek was also analyzed using rank abundance curves, Shannon indices, and Inverse Simpson indices. All ten sites had a similar richness and evenness of plants *(Fig. 3.1 and 3.2)*. Richness was determined by analyzing the x-axis distance, while evenness was determined by analyzing how flat the points on the curve were- the flatter the curve meant the more even the sample was. Evenness represented the abundance of each species. Powers Creek had a plant richness of twenty five. The abundance of each species was relatively even down the sites with the exception of three species that had higher relative abundances- Jewelweed, Reed Canary Grass, and Watercress. Jewelweed was found at every site, except site ten. Site ten was the host to the abundant Reed Canary Grass. The Shannon index was 2.455517, and the Inverse Simpson index was 7.745815 which indicate medium to high diversity.

Discussion and Conclusion:

Vegetation Cover

The total vegetation cover increased from site one to site ten, as the total plant richness decreased. The sites with greater cover may have blocked sunlight from reaching other sprouting plant species. The tall, abundant species out-competed other plant species for water, soil, and sunlight resources. The changing soil consistency at each site may also favor certain plant species more than others. Sites four and five were in a drainage ditch with low flowing water. Sites six through eight were located on the most eroded part of the creek. The steep soil was loose, so most of the vegetation cover came from nearby tree canopies. Site nine and ten were located in the back of the wetland with very wet soil. The vegetation cover and species richness does not fluctuate drastically because the creek runs a short distance around the property, so the water quality does not drastically fluctuate, and the restoration work on the campus monitors and controls the plants species as much as possible.

Floristic Quality Index

The FQI and native FQI for Powers Creek was ranked "low." This result proves the original hypothesis that stated a medium-low FQI rating for the creek to be true. Although fifteen out of the twenty five identified species were native (60%), most of the native species had low c-values. C-values (coefficient of conservatism values) were used to calculate FQIs. Low FQI means that the tolerance of that species in the habitat was low. Low native FQI indicates a lack of tolerant native species. As discussed in the Boone-Creek Watershed plan of McHenry county, IL, non-native species in the area include Honeysuckle and Buckthorn, which were found along Powers Creek. The invasive species out-compete native species for resources and decrease the quality of the vegetation and health of the waterway. Site three was the only site ranked as a "natural area"with the highest FQI and native FQI. This may be because the site had healthy water quality because it is located under the three trout ponds. There is also a lot of restoration work focused around that area, so there is an increase in richness and native plants with higher c-values from human alteration.

Diversity

The plant diversity of the creek was calculated to be "medium-low." Most of the species were redundant at every site which means the diversity was even. The richest sites were three through five. These sites were located closer to the spring. The sites with the lowest richness were six through ten. The sites with the lowest diversity were noted to have the greatest erosion. The steep loose soil made it difficult for seed germination and plant growth, especially for native species that are not suited for that soil type. The most abundant and rich sites were along the drainage ditch of the creek. The ditch provides many nutrients to the soil, and there was low canopy cover which provided more direct sunlight. The Shannon Index and Inverse Simpson Index of this research indicate medium-low diversity due to lack of species richness.

Plant Growth

Average plant growth in height at each site stayed constant with an average of 25 cm increase. Site nine had no plant growth, and this can be due to the large dead oak tree rising above the location. The tree may out-compete the surrounding plants for soil nutrients and sunlight. The consistent height increase is due to the normal seasonal weather conditions. The average temperature while sampling was in the eighties and it rained a minimum of once a week. While sampling at the end of summer, some of the plant species began to produce their late summer flowers, which helped with further identification of the specific species of vegetation.

Acknowledgements:
Special thanks are extended to Dr. Roberta Lammers-Campbell for her assistance in plant identification and various textual resources, and to Professor Michael Ribant for assistance using GIS software. Thanks to Erica Becker and Lian Lucansky for assistance with transect set up. In particular, thanks to the wonderful staff at LUREC. Financial support was provided as a biodiversity internship by the Institute of Environmental Sustainability, Loyola University Chicago.

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Appendix A

List of all species found surveying Powers Creek

*Native to Illinois

Common Name	*Scientific Name*	**Family**
Amur Honeysuckle	*Lonicera maackii*	**Caprifoliaceae-honeysuckle**
Bittersweet Nightshade	*Solanum dulcamara*	**Solanaceae-nightshade**
*Black Raspberry (Wild)	*Rubus occidentalis*	**Rosaceae-rose**
*Bog Clearweed	*Pilea fontana*	**Urticaceae-nettle**
*Common Arrowhead	*Sagittaria latifolia*	**Alismaceae (Alismataceae)-Water Plantain**
*Common Beggars Ticks	*Bidens frondosa*	**Asteraceae-aster**
Common Buckthorn	*Rhamnus cathartica*	**Rhamnaceae-Buckthorn**
*Common Fox Sedge	*Carex vulpinoidea*	**Cyperaceae-sedge**
Common Reed Grass	*Phragmites australis*	**Poacea-grass**
Field Sow Thistle	*Sonchus arvensis*	**Asteraceae-aster**
*Fowl Manna Grass	*Glyceria striata*	**Poaceae-grass**
Garlic Mustard	*Alliaria petiolata*	**Brassicaceae (Cruciferae)-mustard**
*Giant Ragweed	*Ambrosia trifida*	**Asteraceae-aster**
*Goldenrod (Canada)	*(Solidago canadensis) & n/a*	**Asteraceae-aster**
*Honewort	*Cryptotaenia canadensis*	**Apiaceae (Umbelliferae)-parsley**
*Jewelweed (Spotted Touch-me-not)	*Impatiens capensis*	**Balsaminaceae-Touch-me-not**
*Pilewort	*Erechtites hieracifolia*	**Asteraceae-aster**
*Purple Joe Pye Weed	*Eupatorium purpureum*	**Asteraceae-aster**
Reed Canary Grass	*Phalaris arundinocea*	**Poaceae-grass**
*Riverbank Grape (vine)	*Vitis riparia*	**Vitaceae-grape**
*Skunk Cabbage	*Symplocarpus foetidus*	**Araceae-arum**
Summer Moss	*Anoectangium aestivum*	**Bryaceae-moss**
Watercress	*Nasturtium officinale*	**Brassicaceae-mustard**

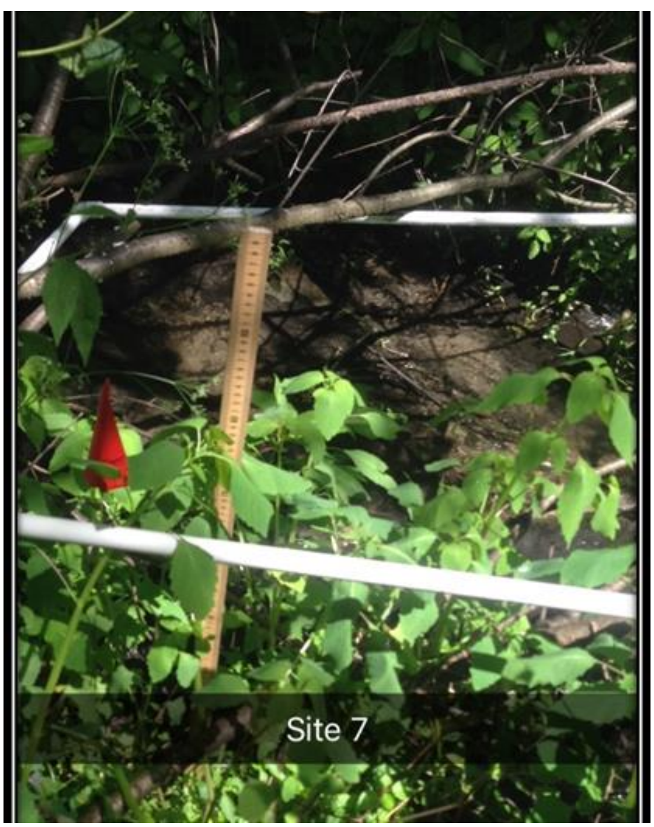
*Water Horehound (Common)	*Lycopus americanus*	**Lamiaceae (Labiatae)-mint**
Willow Sapling	*Salix nigra*	**Salicaceae-willow**

Appendix B

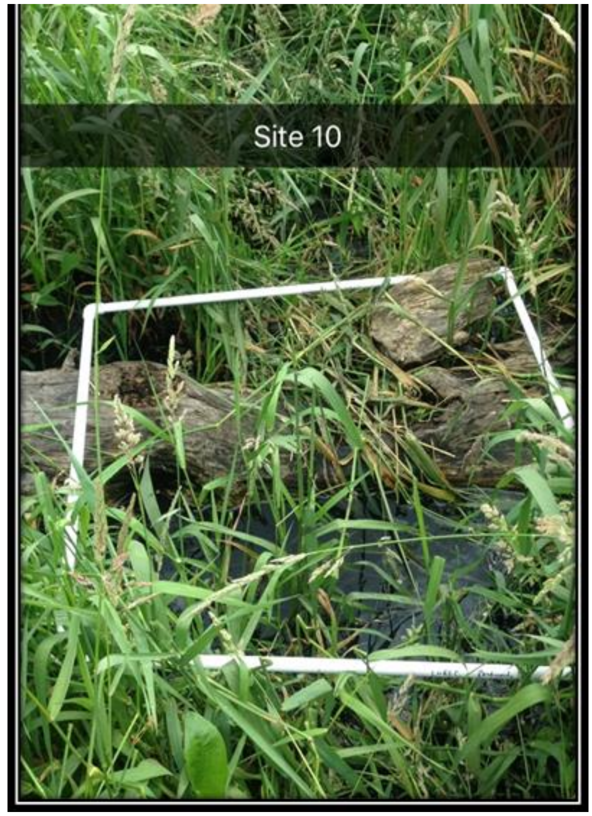
Photographs of each site


Site 5


Site 6


Site 7


Site 8



Appendix C: Geographic Locations of Sampled Sites

Site	Location
1	N 42.29010, W -88.36797
2	N 42.28991, W -88.36716
3	N 42.28948, W -88.36667
4	N 42.28964, W -88.36587
5	N 42.28958, W -88.36502
6	N 42.28956, W -88.36393
7	N 42.28956, W -88.36304
8	N 42.28955, W -88.36217
9	N 42.28957, W -88.36136
10	N 42.28938, W -88.36062