Robin Creek Biodiversity Assessment

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Figure 1: *Robin Creek watershed at site M2.5*

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Introduction

The Robin Creek Watershed in Davenport, Iowa plays a significant role in the communal and ecological structures around it and can be considered in two parts, the stream and the riparian forest. Researchers agree that the health of riparian forests positively correlates to the health of the stream, with riparian zones acting as a sort of sponge for their corresponding streams. This is due to beneficial influences that forests have on the ecosystem as a whole, including flood control, filtering of pollutants, collection and deposition of nutrients such as Nitrogen and Phosphorus, increased pest resistance, wildlife habitats, healthier soils for agriculture, mitigation of erosion, and provision of naturalized areas (Burton 2007, Lind 2019, Diaz 2007). The importance of these green spaces in urban areas is not something to be overlooked, as they can contribute to overall improved mental and physical health of citizens. It is natural for cities to want to continue to develop and grow into more urbanized spaces, but studies show urbanization and development are some of the main drivers of ecosystem homogenization, more specifically land use changes and human disturbances (Brice 2017). Ecosystem health and human wellbeing make this a key issue in urban watersheds.

Due to the importance of these watersheds, it is crucial to understand their resilience to various disturbances present in our riverside urbanizing community. One way to measure this is by calculating functional diversity, or the measurement of biodiversity that focuses on the roles certain organisms play within the ecosystem (Cadotte 2011 & Schmera 2016). As an illustration, unrelated to our research, goldenrod and clover plants grow in the Quad Cities area, and both are mesophytic, meaning they are adapted to temperate climates that are neither wet nor dry. If the clover plant were to disappear, that niche/function would still be represented in the ecosystem since the goldenrod would keep performing that role for the temperate environment. Assessing functional diversity allows us to assess ecosystem functional resilience in terms of traits like nutrient uptake, drought tolerance, or ability to withstand water logging. Although functional diversity and species diversity are both used as ways to understand the ecosystem's health, researching them individually allows us to gain a better understanding of species specific roles for ecosystem resilience. It has even been shown that functional diversity and species richness were tied very closely as well, and that they would both increase with proper restoration, reaching the desired amount of maximized functional diversity when there is average species diversity (Paillex et al. 2013 & Liebergesell et al. 2016).

In Davenport, ecosystems are now facing disturbances that may impact these key ecosystems. As many as 90% of North American floodplains are considered ecologically dysfunctional following human development (Gonzales 2016). Urbanization almost always comes with increased impervious surface cover, which not only makes flooding events more severe, but harms ecosystem health, biodiversity, and leads to increased water pollution. What this means for local ecosystems is that the infiltration rate of water in the soil drops significantly, leading to pollutants and literal trash on these surfaces being deposited in local streams from overland runoff, rather than being absorbed by the soil to support local plant life and contribute to groundwater resources (Schuster 2005). Additionally, we see increased disruption to these ecosystems in the forms of diseases and pests, such as Emerald Ash Borer and Dutch Elm Disease. Both of these have been known to wipe out a majority of Ash and American Elm in ecosystems, leading to a decrease in species diversity and significantly altering the structure of our riparian zones. As urban riparian communities are assessed, the threat of climate change should also be taken into consideration. In the Quad Cities, we have already seen impacts of a changing climate, with longer periods of drought interrupted by heavier bouts of rain. This may have a profound impact on watershed ecosystems and is one of the reasons we decided to choose Wetness Index and Drought Tolerance as two of our functional diversity measurements. We also chose to look at Nutrient Uptake Strategies because these rain events can lead to more nutrient runoff which will ultimately drain into the Mighty Mississippi. Understanding different Nutrient Uptake Strategies allow us to better understand how these nutrients are being consumed, possibly gaining insight into the efficiency of nutrient uptake.

Since the riparian zones in the Upper Mississippi area have undergone significant morphological changes in the past few decades (Guyon 2018), current research is needed to assess the health of the forests in the Robin Creek Watershed using functional diversity methods in order to provide the best management techniques for the ecosystem. Using this framework, the following research aims to create a holistic understanding of the watersheds of Robin Creek to inform proper management and resilience in the future. Creating urban spaces that are healthy and functioning properly creates happy communities and encourages positive relationships between humans and the environment.

Results

Within the Robin Creek watershed, four separate sites were assessed to look at the health and resilience of the riparian forests (Figure 1). The sites were identified as M1 (most downstream), M2, M2.5, and M3 (Figure 2). At each site, point-quarter intercept, line-point intercept, and visual land cover estimate methods were used to identify mature and sapling tree species densities and land cover. For point-quarter intercept we established two 50 m transects with 18 total points parallel to the right and left banks of the stream. For line-point intercept, we ran three 25 m transects (at 5, 15, and 25m) perpendicular to the 50 m transect from point-quarter and assessed the vegetation at every half-meter. Our sample sizes varied dramatically, as the site M2 was cut short on one bank of the stream due to Marquette Street. In order to determine the role that species have on the ecosystem the abundance, importance value, and species diversity were calculated. To determine the ecosystem’s resilience to various environmental changes the functional diversity of drought and wetness tolerance, as well as nutrient uptake strategies was measured. The line point intercept and land use data highlight the direct relationship that the land has with the riparian forests.

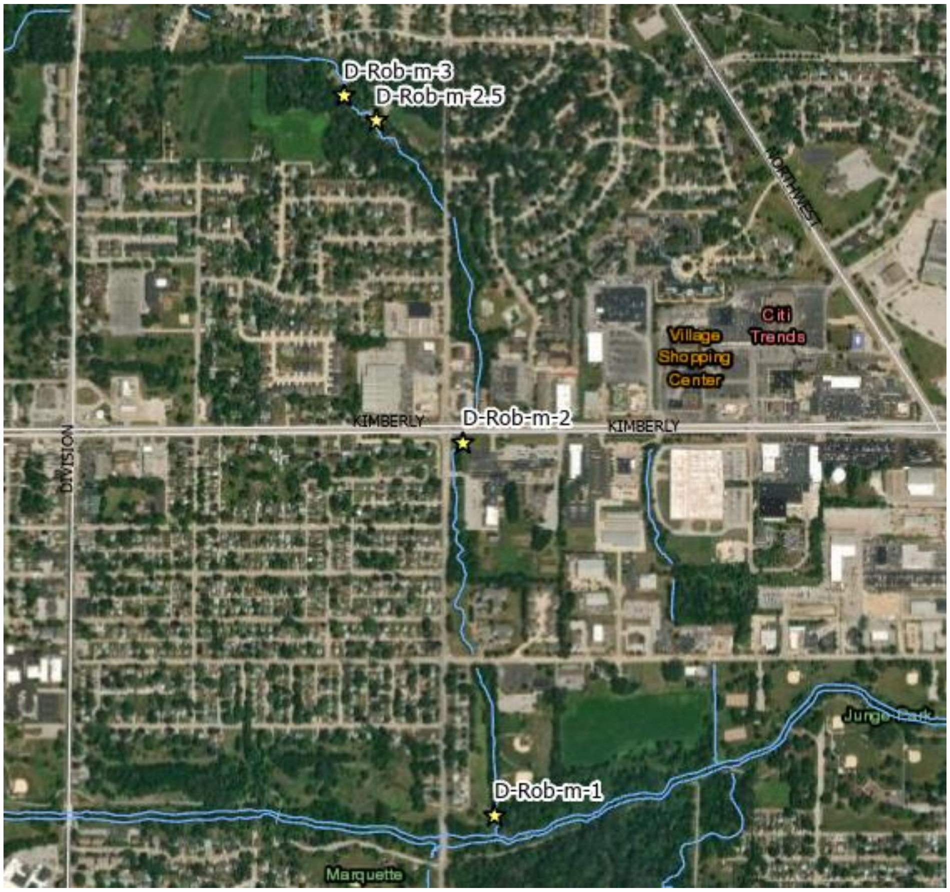

Figure 2: *GIS map of the four sites indicated by stars that were assessed in the Robin Creek Watershed*

Abundance and Species Diversity:

Abundance:

We performed a comparative analysis of the abundance of each tree species and their relative importance value at each site. Included are graphs of the top five most abundant species (Figs. 5-10) with the five species with the highest importance values in the appendix. In most cases, abundance and importance value are correlated, with very minute differences in every site except M2, where abundance and importance value are identical for both mature trees and saplings. We had significant difficulty in distinguishing red and white mulberry in the field, so these two species abundances should be interpreted with caution. It is likely the case that White Mulberries were frequently misidentified as Red (Dr. Jason Koontz personal communication) Looking through the data, Black Walnut, Green Ash, and Red/White Mulberry come up most often in terms of being in the top five for both abundance and importance value, with Red/White Mulberry being the most abundant. One potential threat to riparian forest integrity is that many

Green Ash trees will likely not last due to the Emerald Ash Borer. Additionally, it is likely that trees such as the Red Stemmed Dogwoods, American Plums, Crabapples, and Chinese Elms were once planted as ornamentals for aesthetic purposes and have escaped and integrated into the ecosystem, influencing it as an original non-native species and now abundant species. While looking at the sites, it is apparent that there is species level diversity; however, many of the species were found repeatedly at the same site alluding to a high species redundancy. This can be seen in many different sites since a lot of them had the same species present. Many sites were dominated by a few species. This can be seen in the abundance graphs as the first three species tend to have a significantly higher abundance compared to the next two species, which occur at M2.5 saplings and M3 matures where the first most abundant towered over the others (Figures 3-10).

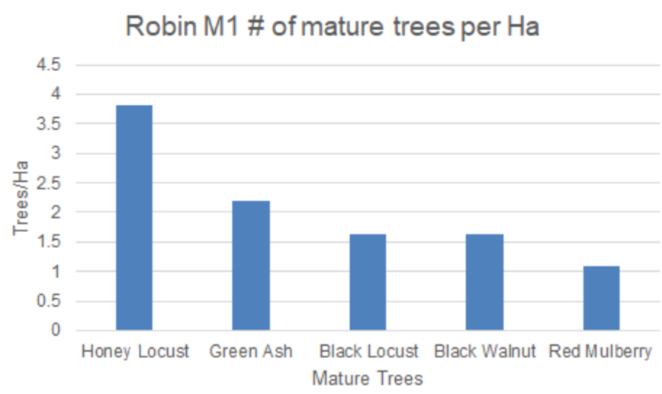

Figure 3: *Abundance (trees/Ha) of the five most abundant mature tree species at site M1. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

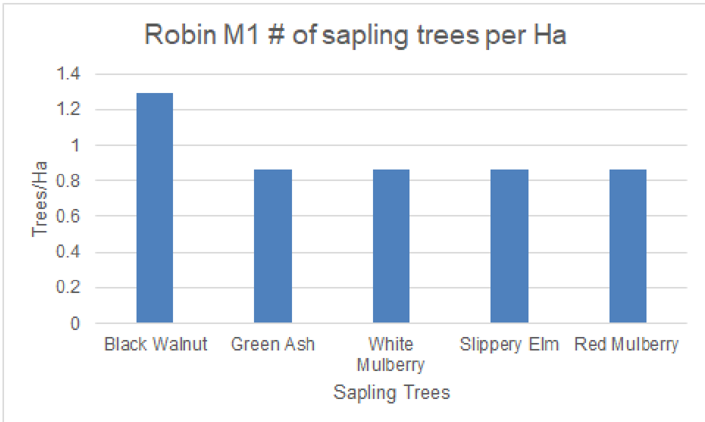

Figure 4: *Abundance (trees/Ha) of the five most abundant sapling tree species at site M1. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

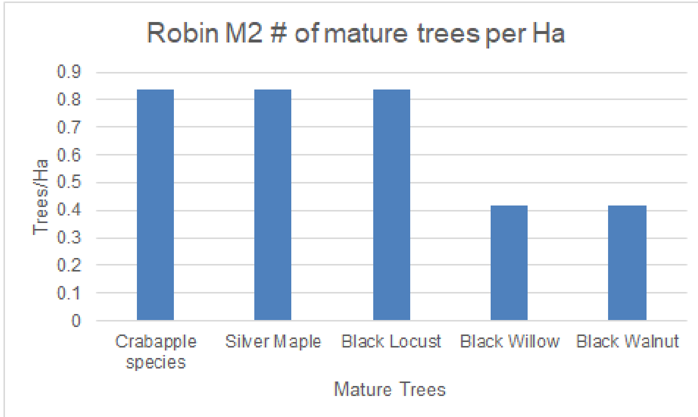

Figure 5: *Abundance (trees/Ha) of the five most abundant mature tree species at site M2. Abundance represents total abundance based on nine points assessed on each bank.*

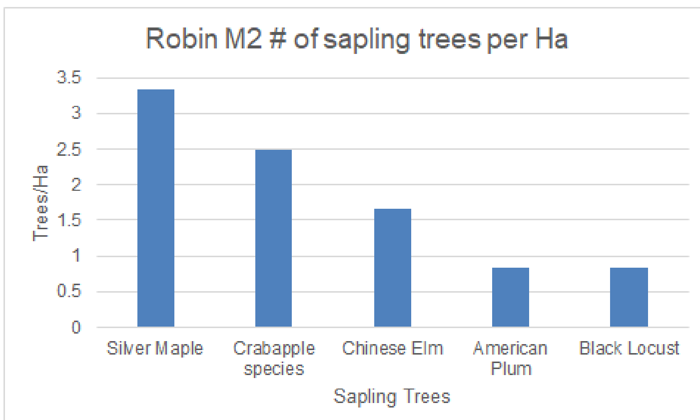

Figure 6: *Abundance (trees/Ha) of the five most abundant sapling tree species at site M2. Abundance represents total abundance based on nine points assessed on each bank.*

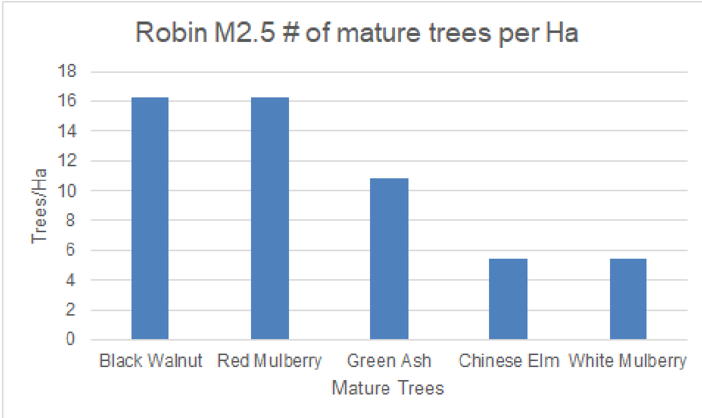

Figure 7: *Abundance (trees/Ha) of the five most abundant mature tree species at site M2.5. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

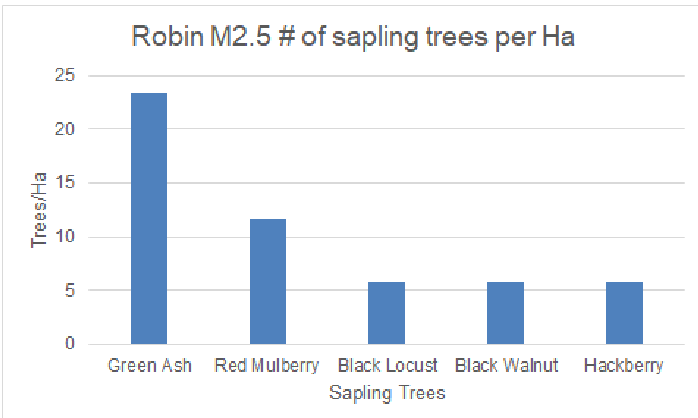

Figure 8: *Abundance (trees/Ha) of the five most abundant sapling tree species at site M2.5. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

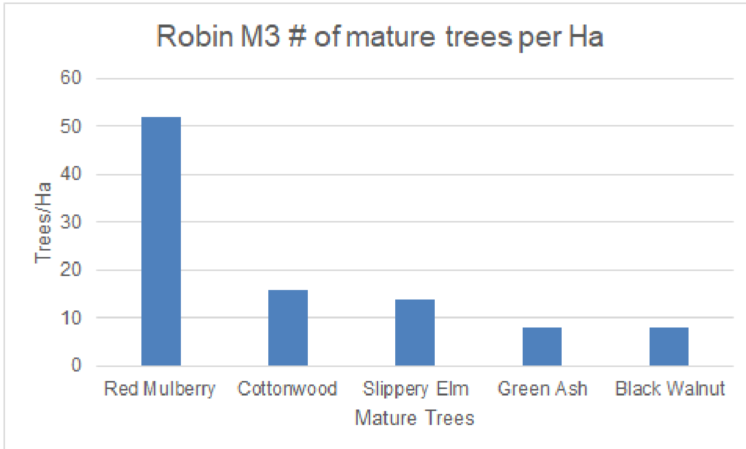

Figure 9: *Abundance (trees/Ha) of the five most abundant mature tree species at site M3. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

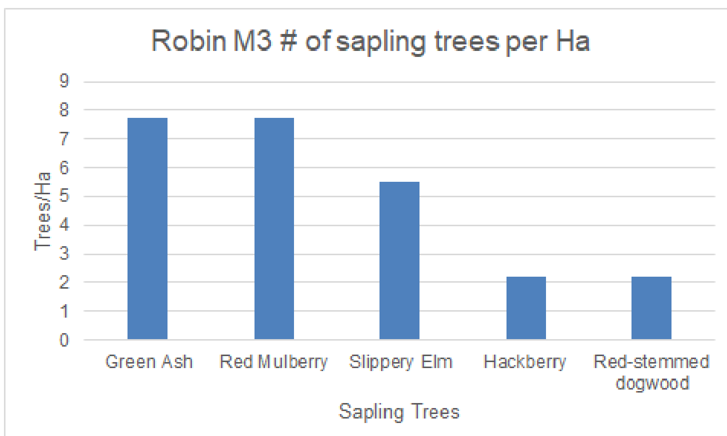

Figure 10: *Abundance (trees/Ha) of the five most abundant sapling tree species at site M3. Abundance represents total abundance based on nine points assessed on each bank. White Mulberries may have been misidentified as Red.*

Species diversity:

Species diversity tells us the richness and evenness of the ecosystem and is often used as a starting point to understanding the overall health of the environment. In order to assess the species diversity in the Robin Creek Watersheds, we used proportional abundance data that was collected from our point-quarter data and performed Shannon's diversity index to determine species richness and evenness at each site. To categorize species diversity, Shannon's Diversity provides a number that tells us how diverse the ecosystem is. These values are unit and scaleless lead to confusion about what constitutes high or low values. In order to solve this problem we calculated the exponent of the index, also known as Euler's number, to the power of Shannon's diversity index (e^H). This equation offers a better solution to understanding the data by telling us the equivalent number of equally abundant species there are in the ecosystem. This means that based on our Shannon's index, the value of e^H shows us how many equally abundant species there must be in a population to reach that same Shannon's Index. For example, in M1 the Shannon's Index for mature trees is 2.078 and when raised to the e power it equals 7.99, meaning that it would take 7.99 (basically 8) equally abundant species in an ecosystem to reach a Shannon's index of 2.078. So it is easier to understand that seven species is a significant amount of species diversity compared to knowing that a value of 2.078 is correlated to high species diversity.

According to Table 1, the overall species diversity found at each site never exceeded a 2.0 value so it could be argued that it has a low species diversity. Yet, when we apply the e^H equation, we see that there are differences between the four sites. As shown in the example above, M1 has an e^H value of 7.99, meaning it would take roughly 8 different, equitably abundant species to reach Shannon's diversity index. M2 had similar results in that it would take 7.54 relatively abundant species which is a lot compared to sites M2.5 and M3 which had 5.82 and 4.91 respectively. This means that M1 and M2 had higher species diversity than sites M2.5 and M3. Although none of them are a monoculture, they are also not exhibiting high species diversity compared to other urban ecosystems, for example Burton's study of urban riparian zones in Georgia (Burton, 2005). This means that either species richness, or species evenness must be lower than the other or a combination of both to make the Shannon's index lower than what we would like to see.

From Table 1, we can also see a high species evenness for mature trees at the 4 sites. Since the evenness is on a scale from 0 to 1, the fact that all 4 sites' evenness are closer to 1 means that the sites are almost entirely even in their distribution of mature trees. Since our sites have relatively even species distributions we can therefore conclude that we have a low species richness, which is why our species diversity values are on the lower side. These two findings suggest that the riparian forests in the Robin Creek Watershed do not have many different species in the area, but the ones that are there are relatively evenly distributed. Which leads to the urbanized riparian forests in Davenport expressing a low diversity ecosystem of only 4-7 species which can result in lower ecosystem functioning and resilience.

Site	M1	M2	M2.5	M3
Shannon's Diversity (H)	2.078	2.020	1.761	1.592
Shannon's Diversity: Equitability (E)	0.902	0.971	0.905	0.724
Exponent of Index (e^H)	7.99	7.54	5.82	4.91

Table 1: *Shannon's Diversity calculations for mature trees at the four sites in the Robin Creek Watershed.*

Similar results were found with the saplings trees at the four sites as expressed in Table 2. The species diversity was highest at M2.5 with an H value of 2.269 and an e^H value of 9.67, which highlights the idea that it would take roughly 10 species to meet this diversity index. Site M1 was also higher in species diversity compared to the other two sites and had an e^H value of 9.31 compared to M2 and M3's 5.12 and 6.27 respectively. Yet, in terms of species evenness, all four E values are higher than 0.8, meaning that they are more even in terms of distribution and no dominating species is present. Since our species diversity was low and our species evenness is significantly higher, we can therefore conclude that the sites have a low richness and high evenness in terms of sapling tree diversity. It must be noted that the species diversity for the sapling trees was higher for three out of the four sites (M1, M2.5, and M3) compared to the species diversity for the mature trees. Since the evenness values are too similar for both the mature and sapling trees, we can conclude that the richness of the sapling trees is higher than that of the mature trees.

Site	M1	M2	M2.5	M3
Shannon's Diversity (H)	2.231	1.633	2.269	1.835
Shannon's Diversity: Equitability (E)	0.969	0.911	0.885	0.882
Exponent of Index (e^H)	9.31	5.12	9.67	6.27

Table 2: *Shannon's Diversity calculator for sapling trees at the four sites in the Robin Creek Watershed.*

The potential misidentification of White Mulberries as Red would not change these numbers significantly. Richness and Shannons diversity would be slightly lower in each case.

Functional Diversity

Another assessment we used to assess functional diversity was the Rao Index. A Rao index measures the likelihood of two species, chosen at random, to be functionally similar, with low values indicating similarity and high values indicating high diversity (Rao 1982). It is based on the relative basal area of the trees instead of the abundance of different species like Shannon's Index. Looking at the Rao indices for both mature and sapling trees, there are profound differences. While high values on the Rao indices do not measure the fitness of the site to respond to disturbances like wetness or drought, they do indicate the diversity of the between species' response to them. Diversity among species response to environmental changes can impact overall resilience and functioning capabilities. Having a higher value here suggests a greater difference in the index calculated between species. Mature trees typically had low values for wetness index, drought tolerance, and nutrient uptake strategy, meaning that there is little diversity between species for these specific traits. Nutrient Uptake Indices also differ at sites M1 and M2 having significantly higher values than M2.5 and M3. Wetness Indices are similar to the mature trees; however, drought tolerance is much higher for all sites except M3. In the case of functional diversity, our potential misidentification of some White Mulberries as Red would have no impact at all on drought tolerance or nutrient uptake as the two species are identical with respect to these traits. The two species differ very slightly on wetness index, but the difference is so small that it could not impact the overall trends observed here (Dr. Kevin Geedey personal communication).

Rao Index for binary traits for mature trees	Robin M1	Robin M2	Robin M2.5	Robin M3
Wetness Index	0.116089	0.147609	0.116743	0.175948
Drought Tolerance	0.124176	0.048669	0.113026	0.166469
Nutrient Uptake Strategy	0.2478	0.3112	0.445	0.2134

Table 3: *Table of Functional Diversity Indices for mature trees at each site*

Rao Index for binary traits in sapling trees	Robin M1	Robin M2	Robin M2.5	Robin M3
Wetness Index	0.189359	0.22253	0.08739	0.144901
Drought Tolerance	0.650232	1.059684	0.988264	0.389508
Nutrient Uptake Strategy	0.5668	0.4926	0.1504	0

Table 4: *Table of Functional Diversity Indices for saplings at each site*

Land Use

In order to best grasp the data collected, it is important to understand how much data was collected. During our collection we noticed the width of the riparian forests varied dramatically within the watershed (Fig. 2) and we often ran into roads, dog parks, parking lots, and baseball fields. To account for this, land cover and land use data were collected. It was observed that M3 had the highest percentage of natural land cover, with 95.32% of it being natural forest. To contrast that, M2 only had 1.67% natural forest cover with 58.67% being impervious road. Also notable is M2.5, with 73.33% of it being unmoved grass and M1 with 50% of it being unmowed grass. Evidently, there is diversity in land cover between the sites and none of our sites were one hundred percent naturally forested areas. The point-quarter calculations take this into account and this is why we see low tree densities at some sites as the method corrects overall densities for quarters in which no trees were observed (appendix). We also collected data on ground cover using the line-point intercept method. We found an abundance of grasses with leaf litter as the main ground cover (Table 5). It is important to understand that the canopy percentages can go above 100% due to the ability for there to be more than one of the ground cover categories at a single site. For example, there can be three different strata of grasses found at a single point of the line-intercept and will be categorized as grass three different times. Additionally, the bare soil cover varies greatly among the sites, but are significant because they inform us about possible erosion rates that the stream may encounter. The highest bare soil percentage was 22.66% at M3, followed by 16% in M2.5, 1.33% at M2, and 0% at M1.

Site	Forb	Grass	Moss	Wood	Herb	Litter	Road	Shrub	Sapling	Bare Soil
M1	85.34	308.66	3.32	0	394	82.66	0	22	0	0
M2	40.66	107.33	0	0	0	1	32.33*	0	0	1.33
M2.5	114.67	97.33	0	17.33	0	96	0	0	0	16
M3	100.67	67.33	0	12.67	0	135.33	0	6.67	2	22.66**

Table 5: *Percentage of different ground cover based on random selection every 0.5 m (Line-point intercept). *Road is Marquette Street. ** Bike trail and associated cleared area.*

Discussion

In terms of abundance, we observed that White/Red Mulberry, Green Ash, and Black Walnut were our most abundant species, respectively. In M3 specifically, White/red mulberry dominated the site, while in M2.5, we saw that green ash saplings were the dominant species present. This is cause for concern from a management perspective due to the invasive Emerald

Ash Borer that continues to wipe out ash species in states like Iowa and Illinois (Illinois Department of Agriculture). If we are seeing a domination of green ash saplings at a site, this means that we may not see them there as mature trees due to the emerald ash borer and this could cause a significant restructuring of the ecosystem. However, even though we see some domination of specific tree species we also see that species richness is higher in saplings than it is in mature trees at three out of the four sites. Based on this we predict that we will see slightly more tree species but similar evenness which ultimately means higher species diversity at these sites in the future. This suggests that the riparian zones will have a more diversified response to disturbances over time. In terms of land use, we noticed that site M3 was the most heavily forested area out of our four sites but also had the highest exposed bare soil meaning that it is the most vulnerable to erosion. This might be due to the dense overhead canopy of the forest reducing the amount of light that underlying vegetation is exposed to, meaning they do not grow as dense as they would if they had access to light. Yet, M3 is also the site of off-road biking so excess bare soil might be caused by increased foot and bike traffic and preventative measures to ensure that erosion does not increase should be taken into consideration. It is clear that the operators of the bike trail have taken care in the placement of the trail to minimize erosion, however, there may be a few trail segments that need monitoring.

Mature Trees	M1	M2	M2.5	M3
Wetness Index	Low	Low	Low	Low
Drought Tolerance	Low	Low	Low	Low
Nutrient Uptake Strategy	Low	Low	High	Low

Table 6: *Table of Rao functional diversity indices for mature trees in terms of "high" (>.4) or "low" (<.4)*

Saplings	M1	M2	M2.5	M3
Wetness Index	Low	Low	Low	Low
Drought Tolerance	High	High	High	Low
Nutrient Uptake Strategy	High	High	Low	Low (0)

Table 7: *Table of Rao functional diversity indices for saplings in terms of "high" (>.4) or "low" (<.4)*

The Rao indices tell us that the younger sapling trees that are growing in M1 and M2 will be more diverse in terms of drought tolerance and more diverse nutrient uptake strategies than what we are currently seeing in mature trees. The wetness indices in mature trees are currently almost identical, but the sapling indices suggest that these numbers could change in all sites in the future. The M2.5 and M3 sapling values for each index are likely to fall as these trees grow to maturity because of the high presence of Green Ash in each of these sites. In M1 and M2 the indices could increase as their saplings grow to maturity. However, these trees have a high likelihood of dying and will likely not contribute to the future values for nutrient uptake, wetness index, or drought tolerance. The differences that we are seeing at each sampling site for nutrient uptake strategy in saplings can be explained by species abundance patterns. For example, the value of 0.0 in M3 is because every species has the same nutrient uptake strategy, and therefore there is no diversity. An interesting finding in Robin M1 is that only the Black Walnut has a different nutrient uptake strategy than the rest of the species, but the Black Walnut is also the most abundant and most important in the site. This would confirm the importance value of this species because M1 has the highest nutrient uptake strategy value of .5668 despite only having one difference in the actual strategy. M2 also had a higher nutrient uptake value and can be attributed to the fact that the species in this site could have as many as four different uptake strategies, suggesting a high diversity in this index. In M2.5 while it did have more types of uptake strategies, the Green Ash is significantly more abundant than every other species in this site and this is why the uptake value would be so low still. The overwhelming amount of Green Ash in this site could suggest an inflation in the diversity values we are seeing. This is because these trees often do not make it to maturity due to the Emerald Ash Borer disease.

Functional diversity research is still a relatively new field and more research is needed to make meaningful connections between our findings and the findings of the scientific community. We were not able to find comparable studies with which to compare our own values; however, our values are still able to provide new insight on the value of functional diversity in a management context. While we do have some research done by Augustana College in the past, there has not been any done on functional diversity, and due to time constraints we were unable to compare the species data to ours.

One limitation that was faced in this study was that the length of Robin Creek is smaller compared to other watersheds in the Quad Cities area and it proved challenging to find appropriate sites to collect data. This is due to the fact that a lot of the land surrounding the watershed is private property and we were not able to gather the necessary permissions that granted us access to riparian areas. All of our selected sites represent the most heavily forested areas in the watershed, therefore, our assessment represents four “best-case scenario” sites along Robin Creek.

Our findings can be used to help implement best management practices in the watershed in order to increase ecosystem function and overall sustainability of the area. Managers could use this data to choose which areas need the most attention and what needs to be done in order to properly preserve the health of the ecosystem. The project can also be used as a starting point for observing the same Robin Creek sampling sites in the future, for example sites like M1 and M2.5 should be monitored in upcoming years to check for bore marks on Green Ash Trees. In response to climate change the species that are most important now may differ in the future. Many different pest or invasive species communities could shift their habitats and change the biodiversity in many of the sites. Also, changes in flood patterns in the Quad Cities could lead riparian zones to require much more flood tolerant species than when originally researched. Population increases in the area could cause more litter and pollution runoff to enter the ecosystem and cause a desire for more efficient nutrient uptake strategies. New projects could be created in each of the sites based on of our findings as well. For example, in the sites with Chinese Elm, these could be replaced with a native species. At M1 there was a significant clump of Japanese Knotweed which could be removed. At M2, next to Midcity Highschool, the riparian forest zone could be widened if the school district agrees. Widening the riparian zone at M2 could be an educational opportunity for the students as well. One site we were unable to access was along Marquette street just north of W 35th street. There is an extensive stretch of Robin Creek there where the property owner (an apartment or condominium complex) appears to mow right up to the stream bank. Would this owner be willing to manage the property differently? In the long run a more forested riparian buffer might save them money and time on mowing. The methods can also be used as a framework for future studies to assess functional and species diversity in similar small-scale watersheds. All of the field data collection techniques can be applied in almost any riparian zone.

In the appendix below is other data we collected for this study. Table 8 highlights the overall total densities of mature, sapling, and invasive species at each individual site. Tables 9-16 report the complete species list, abundance, and importance value for all mature trees and saplings encountered by point-quarter sampling. Lastly, figures 11-18 show the importance value graphs of the five more important mature and saplings trees (which based on abundance, frequency, and basal area) found at each site.

Appendix

	Site M1	Site M2	Site M2.5	Site M3
Total mature tree density (Trees/Ha)	13.67	4.61	60.87	105.46
Total sapling density (Trees/Ha)	7.31	9.99	78.88	29.83
Total invasive density (Shrub/Ha)	65.27**	2.28	385.52*	77.13***

Table 8: *Table of corrected total density (trees/Ha) of mature, sapling, and invasive species found at the four sites. * Mostly multiflora rose, which was dense in patches. **Mostly Honeysuckle. ***A mix of honeysuckle and multiflora rose.*

Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Gleditsia triacanthos	Honey-Locust	2.19	0.47
Fraxinus pennsylvanica	Green Ash	1.09	0.37
Robinia pseudoacacia	Black Locust	3.83	0.80
Juglans nigra	Black Walnut	1.64	0.31
Morus rubra	Red Mulberry	1.64	0.27
Ulmus parvifolia	Chinese Elm	1.09	0.25
Morus alba	White Mulberry	0.55	0.11
Ulmus pumila	Siberian Elm	0.55	0.17
Prunus serotina	Black Cherry	0.55	0.11
Salix nigra	Black Willow	0.55	0.14

Table 9: *Table of mature trees found at M1 with overall abundance and relative importance value on a 0-1 scale. White Mulberries may have been misidentified as Red.*

Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Prunus serotina	Black Cherry	0.86	0.25
Fraxinus pennsylvanica	Green Ash	0.86	0.45
Ulmus rubra	Slippery Elm	0.86	0.31
Cornus sericea	Red-stemmed dogwood	0.43	0.14
Robinia pseudoacacia	Black Locust	0.43	0.27
Gleditsia triacanthos	Honey-Locust	0.43	0.19
Juglans nigra	Black Walnut	1.29	0.50
Morus alba	White Mulberry	0.86	0.44
Morus rubra	Red Mulberry	0.86	0.31
Celtis occidentalis	Hackberry	0.43	0.14

Table 10: *Table of saplings found at M1 with overall abundance and relative importance value on a 0-1 scale White Mulberries may have been misidentified as Red.*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Salix nigra	Black Willow	.42	.24
Juglans nigra	Black Walnut	.42	.22
Ulmus pumila	Slippery Elm	.42	.21
Fraxinus pennsylvanica	Green Ash	.42	.21
Ulmus parvifolia	Chinese Elm	.42	.23
Malus spp.	Crabapple Species	.84	.96
Acer saccharinum	Silver Maple	.84	.55
Robina pseudoacacia	Black Locust	.84	.38

Table 11: *Table of mature trees found at M2 with overall abundance and relative importance value on a 0-1 scale*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Prunus americana	American Plum	.83	.091
Accer aaccharinum	Silver Maple	3.33	.284
Robina pseudoacacia	Black Locust	.83	.086
Ulmus parvifolia	Chinese Elm	1.67	.186
Acer saccharinum	Sugar Maple	.83	.103
Malus spp.	Crabapple Species	2.50	.251

Table 12: *Table of saplings found at M2 with overall abundance and relative importance value on a 0-1 scale*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Juglans nigra	Black Walnut	16.23	0.77
Ulmus parvifolia	Chinese Elm	5.41	0.26
Morus rubera	Red Mulberry	16.23	0.88
Morus alba	White Mulberry	5.41	0.27
Tilia americana	Basswood	2.71	0.15
Fraxinus pennsylvanica	Green Ash	10.82	0.47
Ulmus rubra	Slippery Elm	4.06	0.20

Table 13: *Table of mature trees found at M2.5 with overall abundance and relative importance value on a 0-1 scale*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Robinia pseudoacacia	Black Locust	5.843	0.16
Cornus drummondii	Roughleaf Dogwood	2.92	0.10
Acer negundo	Box Elder	2.92	0.11
Fraxinus pensylvanica	Green Ash	23.37	0.55
Juglans nigra	Black Walnut	5.84	0.21
Ulmus parvifolia	Chinese Elm	2.92	0.38
Celtis occidentalis	Hackberry	5.84	0.21
Morus rubera	Red Mulberry	11.69	0.58
Cornus florida	Flowering Dogwood	5.84	0.21
Ulmus rubra	Slippery Elm	2.92	0.15
Ulmus americana	American Elm	2.92	0.10
Prunus serotina	Black Cherry	2.92	0.11
Morus alba	White Mulberry	2.92	0.15

Table 14: *Table of sapling trees found at M2.5 with overall abundance and relative importance value on a scale of 0-1. White Mulberries may have been misidentified as Red.*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Morus rubera	Red Mulberry	51.74	1.27
Ulmus rubra	Slippery Elm	13.93	0.42
Fraxinus pennsylvanica	Green Ash	7.96	0.25
Acer negundo	Box Elder	1.990	0.09
Juglans nigra	Black Walnut	7.959	0.26
Populus deltoides	Cottonwood	15.92	0.53
Prunus serotina	Black Cherry	1.99	0.09
Carya spp.	Hickory species	1.99	0.05
Quercus rubra	Northern Red Oak	1.99	0.05

Table 15: *Table of mature trees found at M3 with overall abundance and relative importance value on a scale of 0-1. White Mulberries may have been misidentified as Red.*

Species Scientific Name	Common Name	Abundance (Trees/Ha)	Importance Value
Acer negundo	Box Elder	1.11	0.11
Celtis occidentalis	Hackberry	2.21	0.20
Fraxinus pennsylvanica	Green Ash	7.73	0.62
Morus rubera	Red Mulberry	7.73	1.01
Ulmus rubra	Slippery Elm	5.52	0.59
Cornus sericea	Red-stemmed dogwood	2.21	0.19
Acer rubrum	Red Maple	2.21	0.18
Populus deltoides	Cottonwood	1.11	0.10

Table 16: *Table of sapling trees found at M3 with overall abundance and relative importance value on a scale of 0-1. White Mulberries may have been misidentified as Red.*

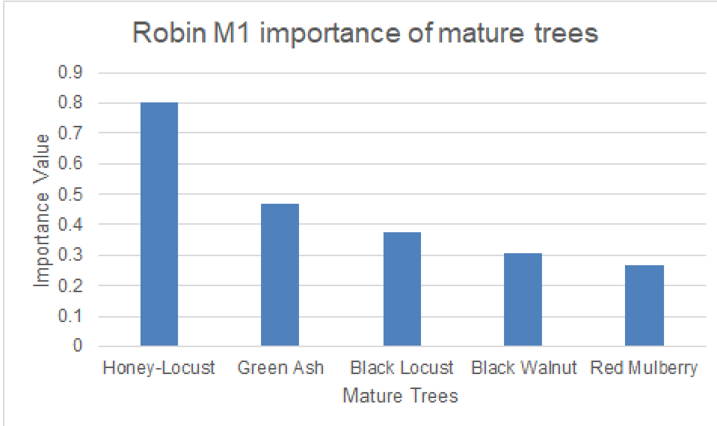

Figure 11: *Importance value of mature trees at M1 using proportional abundance values from point-quarter method . White Mulberries may have been misidentified as Red.*

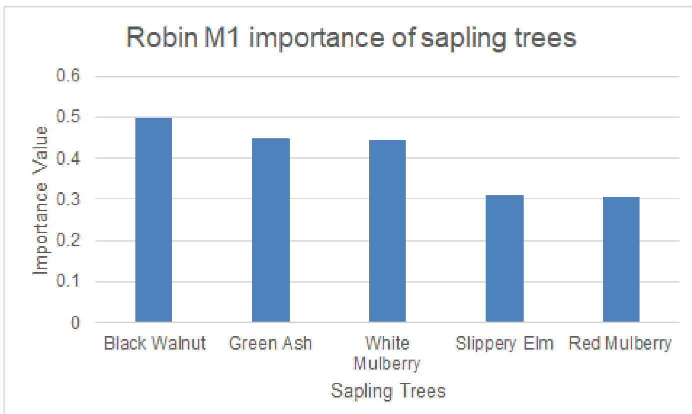

Figure 12: *Importance value of sapling trees at M1 using proportional abundance values from point-quarter method. White Mulberries may have been misidentified as Red.*

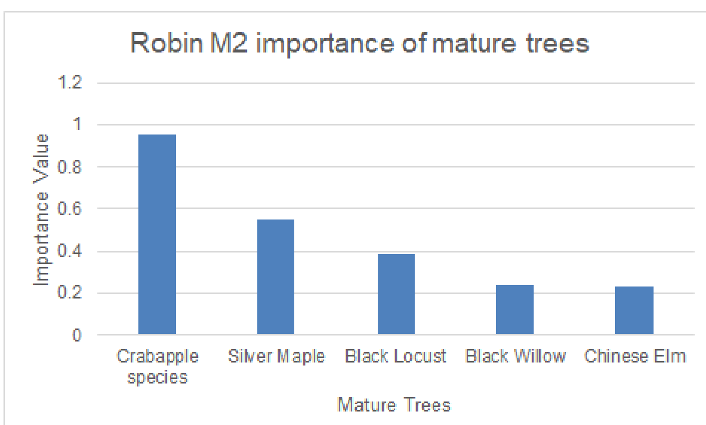

Figure 13: *Importance value of mature trees at M2 using proportional abundance values from point-quarter method.*

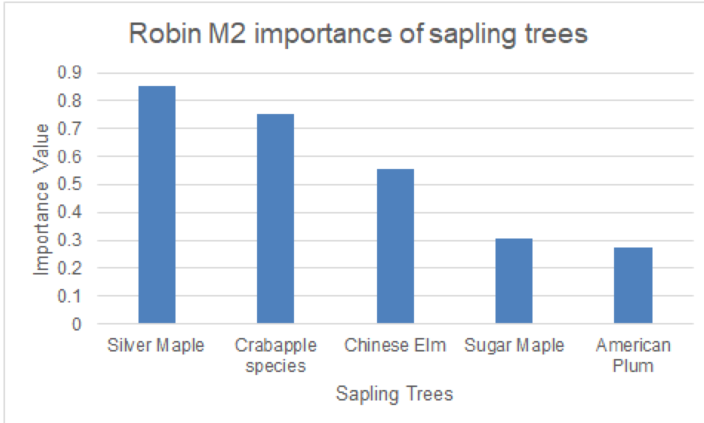

Figure 14: *Importance value of sapling trees at M2 using proportional abundance values from point-quarter method.*

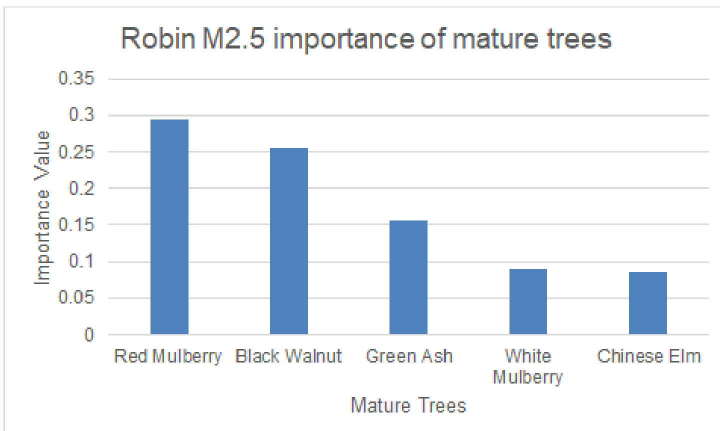

Figure 15: *Importance value of mature trees at M2.5 using proportional abundance values from point-quarter method. White Mulberries may have been misidentified as Red.*

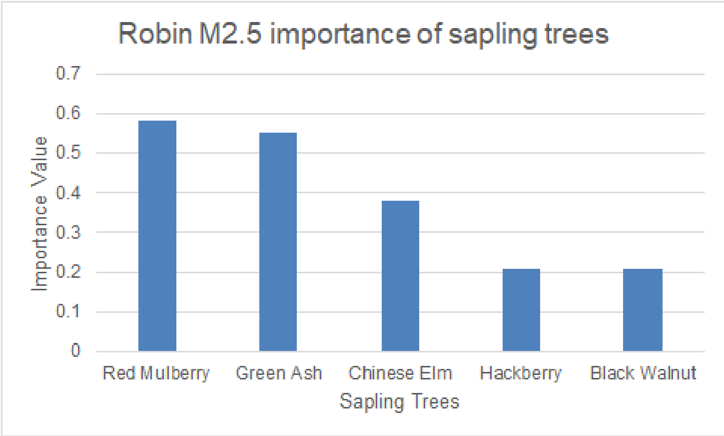

Figure 16: *Importance value of sapling trees at M2.5 using proportional abundance values from point-quarter method. White Mulberries may have been misidentified as Red.*

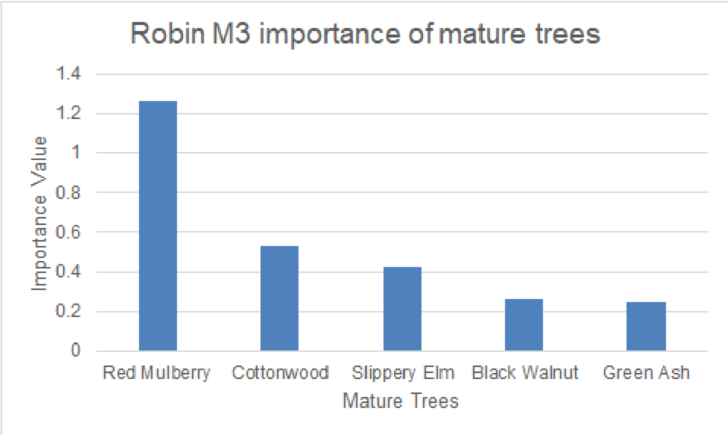

Figure 17: *Importance value of mature trees at M3 using proportional abundance values from point-quarter method. White Mulberries may have been misidentified as Red.*

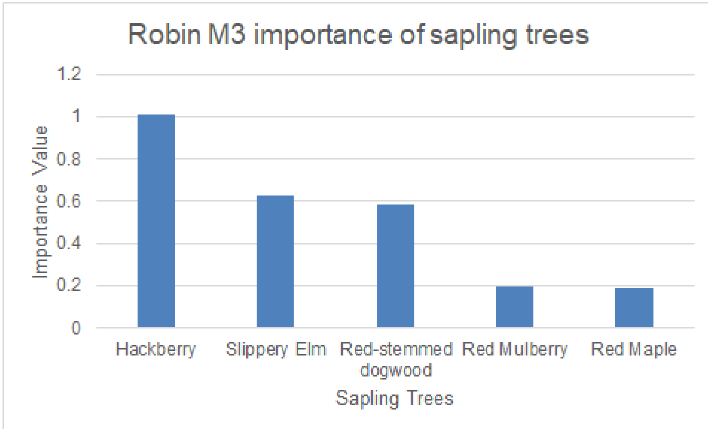

Figure 18: *Importance value of sapling trees at M3 using proportional abundance values from point-quarter method. White Mulberries may have been misidentified as Red.*

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