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Introduction

Purpose

The purpose of this study is to survey the effect of proximity to water on woody plant communities in Bull Creek District Park in Austin, Texas.

Hypothesis

The closer a woody plant community is to water, the higher the woody plant species richness will be. Soil moisture content is higher near the water, so it is easier for woody plants species to survive there.

Site Description

Location

Bull Creek is in northwest Austin, Texas. The park is adjacent to Highway 360 and is about 5 kilometers from the intersection of Highway 360 and Route 183. Bull Creek Park is to the west of the intersection.

Size and Shape

There are two major sections of the park: Bull Creek District Park and Bull Creek Greenbelt Upper. Both sections are included to better investigate the physical variable (proximity to water). The rough shape of the park is an irregular rectangle, and the greenbelt is a curved trapezoid. The approximate size of the park is 81.7 hectares.

Topography

The maximum elevation is 262 meters, and the minimum is 152 meters. The topographic relief is 110 meters. The area is surrounded by hills on which people live.

Geology

Fluviatile terrace deposits composed of gravel, sand, silt, and clay line the creek. This formed in the Pleistocene Period, during the Quaternary Period. The dominating underlying geologic formation is Upper Glen Rose. The rock type of the Upper Glen Rose is limestone, dolomite, and marl, with alternating hard and soft beds forming stairstep topography. Upper Glen Rose, which formed in the lower Cretaceous period, is usually fine to medium grained, and gray to tan. Parts of the creekbed are exposed, making the limestone of the Upper Glen Rose visible.

Areal Extent and General Type of Vegetation

Approximately 10% of the park is grassy, while the other 90% is woodland. Three examples of plant species typically found in the area are Ashe Juniper, Plateau Live Oak, and Japanese Privet.

Availability of Water

Bull Creek runs through the park. The creek bed is not completely flat, so there are very small waterfalls in various locations. The creek has relatively low flow, and an estimated range of depth of 5 cm to 1 m. A large part of the creek bed is exposed, indicating the drought that Austin has been experiencing over the past few years. There are cement structures on the side of the creek that are most likely for flood control since Austin often has flash floods.

Proximity to Urban or Industrial Areas

Highway 360 cuts through Bull Creek Park and Greenbelt. The center of the park is approximately 10.7 kilometers from the center of Austin. The park is surrounded by suburban neighborhoods.

History

The years of acquisition of Bull Creek are 1971-1987. In the district park area, there are benches and bridges for recreational use. There are also cement structures possibly for flood control or erosion prevention. There is an area where the city parks and recreation department is trying to restore the natural forest that used to surround the creek that has been ruined by human presence.

Research Plan

Design of Study

Woody plant samples will be collected on nine 50m transect lines that will be placed varying distances from Bull Creek. All of the transect lines will be placed as parallel to the creek as possible. 3 transect lines will be placed about one meter from the water, 3 transect lines will be placed 60 meters from the water, and 3 transect lines will be placed 150 meters from the water. The purpose of this specific placement of the transect lines to study the effect of proximity to water on woody plant communities. Samples will be collected one time each on 9 different transect lines. Approximately 0.12% of the total study area will be sampled during the study.

Background Information

In Franklin, North Carolina, Frank P. Day and Carl D. Monk conducted a study on vegetation patterns on a Southern Appalachian watershed. Vegetation on a hardwood forest watershed was sampled; and density, basal area, and aboveground biomass were estimated. Elevation, aspect, slope angle, distance from stream channel, and distance from water divide were used to analyze the site. Oaks were found to be the dominating type of vegetation, but it was also discovered that considerable change had occurred in the vegetation composition since the appearance of chestnut blight, a tree disease. Distance from the stream produces a soil moisture gradient, which was also found to be one of the most important factors in determining species distribution. This

helped the development of the hypothesis that the closer a woody plant community is to water, the higher the woody plant species richness will be (Day and Monk, 1974.).

In a study conducted at Saint Mary's University in Canada, Wolf and Lundholm investigated the effects of plant species and water availability in green roof microcosms. They studied and compared various plant species from the succulent, herbaceous dicots, grass, and woody creeping shrub groups after different watering treatments. The watering treatments varied in frequency, with the plants being watered for one test every 4 days, the second every 11 days, and the third every 24 days, each over a period of 2 months. They found that out of all the plant groups, only succulents survived the dry watering treatment (every 24 days). This study relates to the hypothesis by showing how plants species may be affected by periods of drought, such as the recent one in Austin. (Wolf and Lundholm, 2008.)

In Northeast Colorado, Dodd, Lauenroth, and Welker studied water resource use by herbaceous and woody plants. They monitored water status in the soil, took samples of plant tissue during growing season, and applied plant removal treatments. Upon removal of certain grasses and shrubs, the water storage in the top 60 cm of the soil increased. Grasses generally use the upper soil levels, while trees exclusively use groundwater. This study contributed to the hypothesis in regards to plant diversity in varying water sources. Because trees require more groundwater, and there is likely more groundwater near the creek, there will be more trees, and more diverse trees by the creek. (Dodd, Lauenroth, and Welker, 1998.)

Materials

- 50m transect tape/line
- Scissors
- Notebooks
- *Native and Naturalized Woody Plants of Austin and the Hill Country* by Brother Daniel Lynch (plant identification guide)
- Pen

- Clipboard
- Ziploc baggy to store samples

Procedure

1. Place the 50 meter transect line as straight as possible with as much overhang as possible.
2. Record all species overhanging the transect with the common name, intercept range (where the tree starts to hang over the transect and when it stops) and length (where the tree stops overhanging minus where it starts) to the nearest decimeter, and the interval in which the species is found (intervals of the transect are every 5 meters, record which interval(s) the tree overhangs).
3. Collect a representative leaf sample from every unique species encountered. Press and tape it to the sample pages. Record leaf type and arrangement, description of the bark, description of the fruit/flower, whether it is a tree, shrub, or vine on each sample page.
4. Other than the transect data, make a checklist of other plants (woody or non-woody) that can be identified
5. Calculate the relative density (Total number of individuals of a species divided by the total number of individuals of all species, multiplied by 100), the relative dominance (Total intercept length of the species divided by the total intercept length of all species, multiplied by 100), relative frequency (Total number of intervals of that species divided by the total number of intervals of all species, multiplied by 100), and the importance value (Relative density plus relative dominance plus relative frequency)

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Aerial Map, provided in class.

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Texas Geology Web Map <http://txpub.usgs.gov/DSS/texasgeology/>

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Conclusion

Results

The data collected does not support the hypothesis. There were a total of 27 species of woody plants found on the 9 transects. The most common species found were Ashe Juniper, Cedar Elm, Plateau Live Oak, Yaupon, and Lindheimer Silktassel.

As displayed in Figure 1, there is no clear pattern between the relative frequencies from close, medium, and far for each of the top 5 species. The only trend visible is that Ashe Juniper was the most frequently found species.

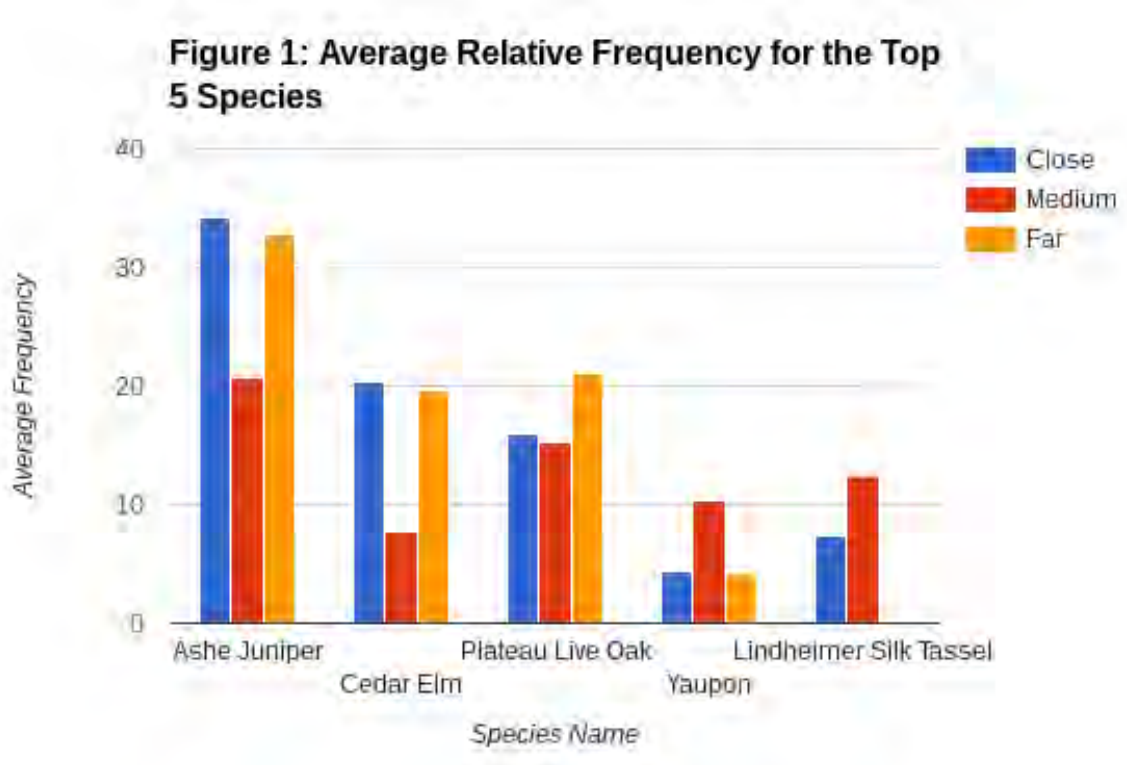

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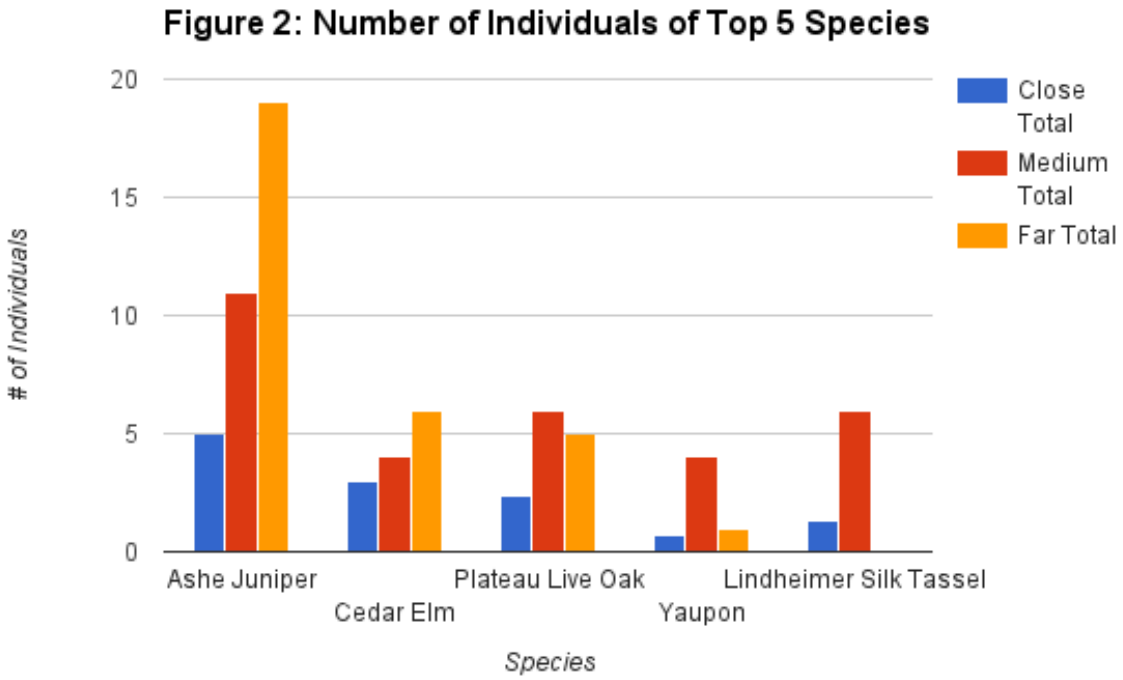
Figure 2 shows number of individuals of each of the top 5 species at the varying distances from the water. Again, there is no distinct visible pattern between the varying distances, and Ashe Juniper is clearly the most frequently found. ANOVA was performed on each of the top 3 frequent species: Ashe Juniper, Cedar Elm, and Plateau Live Oak. The P-value for Ashe Juniper was 0.428. The P-value for Cedar Elm was 0.373. The P-value for Plateau Live Oak was 0.903. None of those P-values indicated significance. Thus, the differences between the close, medium, and far transects for each of the top 3 species are all insignificant.



As seen in Figure 3, an apparent pattern in the number of species at each distance from the water was that the medium distance had the highest number of species, and the far distance transect had the least number of species. The average number of species at the close distance was

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9. The average number of species found at the medium distance was 10. The average number of species at the far distance was 6.67. ANOVA was performed on this data. The P-value was 0.534, showing that the seen difference in the graph is not significant.

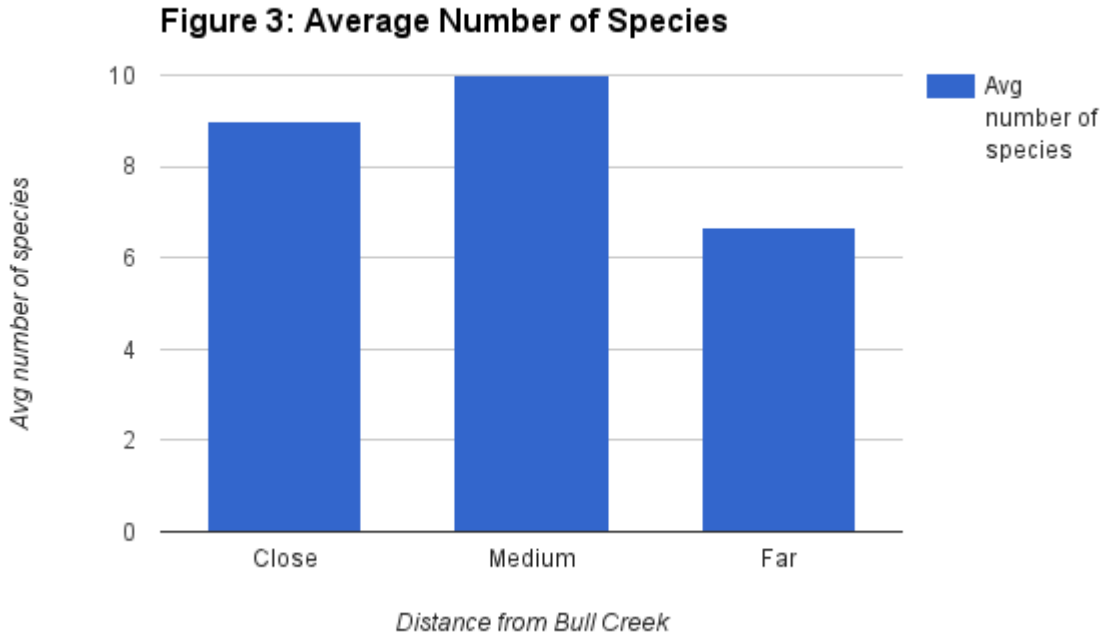

Figure 4 shows the graph of the species importance of the top 5 most prominent species. Ashe Juniper had the highest species importance in general. Otherwise, there is no clear trend in the data.

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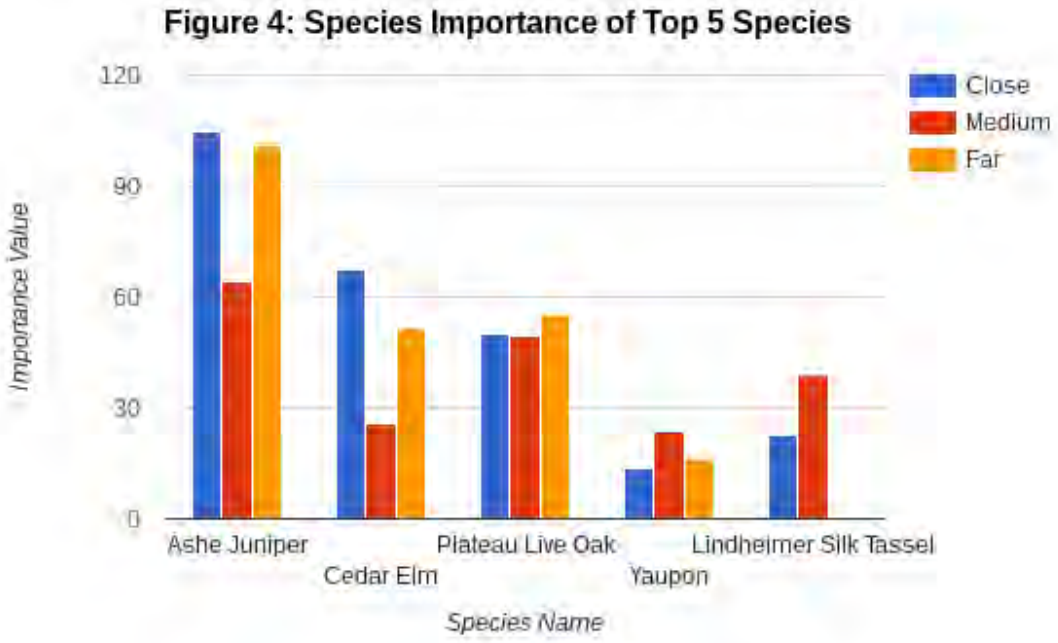

Discussion

_____For this investigation, data was collected with a 50 meter transect a total of nine times. The data was insignificant mostly because the sample size was very small- not the entire park was surveyed. Some issues that were presented were that the distance from water was not measured each time. Ideally, the distance from water should have had a significant difference, and be consistent throughout each transect. The results do not support the hypothesis. The negative results do not support the hypothesis, but are still important because they suggest that there may be another variable present. Another possible variable is proximity to urban areas. There may also be error in the conducting of the study.

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One study that took place in the Tarim River in Western China, conducted by Chen, Zhang, and Zilliacus, looked at groundwater (wells) in relation to plant diversity. As the distance between the well and the area studied increased, the plant diversity decreased (Chen et al 2006). This matches the results from the study, however the data taken at Bull Creek was not considered significant.

Another study, conducted by Fuhlendorf, Smeins, and Grant on the Edwards Plateau of Texas, which is where Bull Creek is located, explored the fire-sensitive ecological threshold of Ashe Juniper. Without fire, Ashe Juniper increases and herbaceous biomass decreases at an exponential rate (Fuhlendorf et al. 1999). Thus, Ashe Juniper being the most frequently found woody plant on the transects may be due to the fact that Austin has not experienced any fires or wildfires in a while.

The other most plausible explanations for the results is error in conducting the study, and the fact that only a small portion of the park was surveyed. It is understood that the data has not "proven" anything.

The study could be more valid if conducted another time by using more transects at properly measured distances from the creek. Surveying more of the park would provide more accurate and indicative results. Future students could measure soil moisture content, which might affect woody plant diversity at Bull Creek and could potentially add insight into this study.

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Maddie Drga
Andie Denson

Introduction

Purpose

The purpose of this study is to determine the effects of distance from water on the populations of woody plants. This study will specifically analyze how distance from water affects the diversity of the plant population in Gus Fruh Park, a section of the Barton Creek Greenbelt located in Austin, Texas.

Hypothesis

This study's claim is that there will be greater diversity of woody plants in an area that is not subjected to regular flooding, that is closer to a water source and that is farther away from an urban center. Studies show that soil is higher in nutrients in areas closer to water and that riparian ecosystems have a greater diversity of woody plant life than wetland or dry ecosystems. Studies also show that proximity to urban centers may affect plant diversity and that regular flooding can have negative effects on plant diversity.

Site Description

Location

Gus Fruh Park is located in southeast Austin, approximately 6.72 kilometers southwest of the Texas Capitol. The park's main entrance is adjacent to the intersection at Highway 360 and Mopac. The park is located approximately 15.77 kilometers southwest of the Liberal Arts and Science Academy.

Size and Shape

The park is shaped roughly like a jagged semi circle with the middle cut out, with protrusions to the north, northwest, northeast, and west. The park has an area of roughly 1,339,200 square meters which is equivalent to approximately 133.92 hectares.

Topography

The park is somewhat hilly, sloping down towards the creek bed on both sides. The slope of the sides is mostly gradual, sometimes almost flat. However, in some areas, such as on the eastern side of Barton Creek, there are sometimes sudden changes in elevation. The elevation decreases and gradually slopes down closer to the creek, but dramatically increases on the opposite side of the creek. The maximum elevation is about 210 meters, and the minimum elevation is about 150 meters, giving a relief of 60 meters.

Geology

Gus Fruh Park contains mainly shale, limestone, and clay, deposited almost entirely during the Cretaceous period. The Georgetown, Edwards Limestone, and Del Rio Clay formations are the most prominent in the park. The Edwards Limestone formation is the most visible of these formations, primarily due to the Balcones Fault running through the park. This fault exposes quite a bit of older rock to erosion. Barton Creek, which runs continuously through the park, has grown in width over time due to erosion from heavy rains in the area. The creek also deposits

alluvium (sand and pebbles) along and to the sides of the creekbed. These heavy rains also flood the creek, causing further erosion, deposition, and habitat destruction.

Areal Extent and General Type of Vegetation

The park contains vegetation like Texas colubrina, Ashe juniper trees, and Eve's necklace. The park has roughly 99% woodland, with the remaining 1% consisting of eroded rocky areas and uprooted vegetation due to flooding around the creek bed.

Availability of Water

Barton Creek runs through the entirety of Gus Fruh Park, and continues through the Barton Creek Greenbelt. However, the creek only runs through a somewhat small portion of the park. This means that only a relatively minimal portion of the park is at risk of flooding. Even so, there is evidence of severe flood damage from previous heavy rains up to almost 10 meters away from the creekbed in some cases. As heavy rain runs off from the sloping sides of the creekbed, the creek has widened its banks over time due to erosion. This high runoff potential also means, though, that pollution from the various residential and commercial areas is more likely to end up flowing through the park and into Barton Creek.

Proximity to Urban or Industrial Areas

The park is surrounded by both residential and commercial areas, as well as highways. The park is bordered by Loop 360 to the southwest, Mopac Expressway to the northwest, and by residential areas on its entire east side. Shopping malls and workplaces also encompass the park to the south, southwest, and north. The Brodie Oaks Shopping Center is directly adjacent to the park on its southwest side, and a commercial workplace is directly adjacent to the park on its west side. Barton Creek Square Mall is 1.66 km northeast of the entrance to the park.

History

The springs in the Barton Springs Greenbelt get their name from William Barton, who built a house nearby in 1837. The park and springs were doing fine until the growing rise of development in the city. This development lead to the ordinances of 1980, 1986, and 1992. The Save Our Springs Citizens Initiative of 1992 severely limited construction in the watershed, limited exemptions, and attempted to reduce pollution and risks for accidental contamination.

Research Plan

Design of Study
Two adjacent transect lines, six total, each line being 50 meters long, will be placed at equal elevations. This setup will be duplicated in three sections, one set along the creek bank, and two more parallel to the first set, but progressively 30-40 meters away. Data will be collected once along each transect. The transects will cover approximately 0.45% of the park. This method of data collection allows plants in different areas to be cataloged and mapped out to produce a larger picture of the diversity of Gus Fruh Park.

Background Information
In a study conducted by Christer Nilsson and Magnus Svedmark that analyzed data from previous studies, it was found that riparian zones (transition zones between wet and dry areas near a riverbank) are more diverse in plant life than extremely wet or dry zones. This study also found that this increased diversity was a result of the transport of organic and inorganic material that was influencing the plant life along riverbanks. This supports the study's claim that plant life population and diversity will increase in moderately wet areas but will decrease in very wet or dry areas (Nilsson and Svedmark 2002).

In this study conducted in west Georgia in the United States by Michele Burton, Lisa Samuelson, and Shufen Pan, it was found that in riparian forests near urban areas, diversity decreased closer to the urban center. Conducted by cataloging plants along transects at different distances from urban and riparian areas, this study also found that invasive plant populations increased towards the urban center. This supports the study's hypothesis that plant diversity will be greater closer to water, and presents a reason why plant diversity in Gus Fruh Park may decrease farther away from the riverbank (Burton *et al* 2005).

In this study conducted in Jau National Park in Brazil by Leandro Valle Ferreira and Thomas J. Stohlgren, it was found that areas subjected to heavy flooding will have significantly lower species diversity than areas out of the flood zone. Conducted by cataloging and measuring plants along transects in regularly flooded and irregularly flooded areas, this study also found that areas with moderate water levels had much greater species diversity than areas with little to no water. This supports the study's claim that plant diversity decreases in regularly flooded areas (Ferreira and Stohlgren 1999).

Materials
The materials used for collecting data are a field guide, a transect tape, the project packet and notebook, and scissors. The field guide contains a dichotomous key, a list of types of woody plants, and a picture and word glossary.

Procedures
All data will be recorded in a data table, with multiple rows and columns. These columns will be for species name, intercept range, intercept length, intervals, and comments. All plants that overhang the transect line will be given an identifying letter or species name if applicable. The intercept range represents what part of the transect the plant overhangs, and the intercept length

shows how much of the transect line the plant overhangs. The transect line is also marked out in 5 meter intervals, and the interval column in the data table shows at what interval or intervals the plant overhangs. The comments column is where any comments about the bark, leaf type, leaf arrangement, and flowers/fruits are to be recorded. Each species encountered requires a representative leaf sample to be taken for further identification (in the case of poison ivy and fleshy cacti, pictures will be taken). These samples will then be placed in the project notebook for identification and cataloging. On the species pages, all field data, the plant's common and Latin names, whether the plant is a vine, tree or shrub, and any other identifying information will be included. When all plants on a transect have been recorded, the plant populations will be analyzed. Each type of plant will be given a relative density (which shows how many plants of a certain species there are as compared to the total number of plants), relative dominance (which shows how much of the transect line a certain species takes up), relative frequency, and importance value.

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Planet Earth: Period 2-6
23 September, 2016

Introduction and Research Assignment

Introduction

Purpose

Aquatic Macroinvertebrates are the focus of this study, which will be conducted in Gus Fruh Park in Austin, Texas. The experimental question that will be addressed by the study is how the width of the creek affects the population of macroinvertebrates found in the water.

Hypothesis

If the creek is wider, then there will be a greater abundance of aquatic macroinvertebrates. This is because where the creek is wider the water tends to not flow as quickly (the water has room to spread out more and is not rushed), allowing for aquatic macroinvertebrates to have a more stable habitat.

Site Description

Location

Gus Fruh Park is in South/Central Austin, Texas. The park is adjacent to the intersection of highways Mopac and 360. Gus Fruh Park is roughly 6.5 kilometers southwest of the capitol building, and 3.9 kilometers southwest of the Colorado River.

Size and Shape

The general shape of Gus Fruh Park is a right trapezoid with a rectangle in the center of the top side (along Mopac), and the area of the park is roughly 150 Hectares.

Topography

The maximum elevation of the park is 210.37 m, and the minimum elevation is 149.39 m. The difference (relief) is 3.98 m. The park elevation is really varied, but it slopes downward towards the creek.

Geology

Some underlying geological formations under Barton Creek include alluvium (sand, gravel, silt, and clay that is a tan to a slight gray color) and the tributary terrace deposits (same rock types as above), both of which were from the Quaternary geologic time period. Around the creek, there is a little bit of the Georgetown Formation (composed of limestone and marly limestone, gray to tan-colored, hard to soft, and bedded to nodular; this also has many mollusk fossils), which is from the Cretaceous period. Primarily the creek sits on the Edwards Formation (composed of limestone and dolomite, light gray to tan colored, hard to soft, thin to thick bedded, fine to medium grained, also is made up of fossils), which is also from the Cretaceous time period. The

creek also flows across the Mount Bonnell Fault. There are different rock sizes on the bottom of the creek, and clay on the creek beds. Limestone cliffs also compose the park. There is a variation of rock sizes on the terrestrial parts of the park, and there are many larger sized rocks along the trails.

Areal Extent and General Type of Vegetation

There are numerous terrestrial trees around the creek and throughout the park, and there is also an abundance of poison ivy along the trails. Along the creek bed (and especially the right-hand side of the creek), there is abundant vegetation. Some examples of vegetation in the park includes ragweed *Ambrosia*, sycamore *Platanus occidentalis*(farthest right), pecan trees *Carya illinoinensis*, inland sea oats *Chasmanthium latifolium*(farthest left), Eve's necklace *Sophora affinis*(second from right), maidenbush *Leptopus*(second from left), and creek plum *Prunus rivularis*. Over the creek itself there is minimal tree cover, but there is lots of greenery otherwise. The water of the creek is green, and many leaves are in the water and bottom of the creek. There is approximately 95% vegetation (primarily woodland) throughout the park.



Availability of Water

Of course, the transects that will be taken are all in the water itself. In Gus Fruh, there is a lot of water. Along Barton Creek, there are lower trees, which shows evidence of flooding. Currently, there is also a lower water level than usual, which can be perceived by the creek bank exposed (about ⅔ meters of exposure). The water was flowing rapidly along shallow and narrow parts of the river, and was slower when it reached wider parts.

Proximity to Urban or Industrial Areas

There are two highways, which for the most part border Gus Fruh (360 and Mopac), and is bordered by several neighborhoods (directly adjacent to both). Also, while in the park airplane activity is audible. The area is becoming increasingly settled with neighborhoods and then more roads are being formed.

History

Of course, there are many trails throughout the park for human (and pet) usage, and fences have also been built around the trails at parts and at the entrances to the park, etc. There is lots of human use of the park throughout the year. The park was created in 1980, and expanded in both 1986 and 1992 (Crosby 1).

Research Plan

Design of Study

Overall, there will be three evenly spaced 1 m^2 transects along a line (transect line) across the width of the creek (determined by the boundaries of the creek banks) at the chosen location. The picture below depicts where the data will be taken. Each day of data collection will be taken at a different group, which are clearly labeled in red on the map. There will be 2 of these transect lines for each time data is collected, and each transect line will be at a different part of the creek to ensure varied and representable data (actual transect line positions to be determined). This method and placement of the data collection will help with answering the question in the Purpose because taking many samples from different transect lines (thus different widths of the creek) will yield interesting and varied data to draw a conclusion. Of course, there are many major factors within this variable that will impact the data, such as vegetation, speed of the water, temperature of the water, depth of the water, etc. We will end up studying 18 m^2, which is equivalent to roughly 0.0012% of the Gus Fruh park, and roughly 0.021% of the creek area in the park.



Background Information

According to a study done in Portugal, many different factors cause a variety in aquatic macroinvertebrate taxa, and one of the major factors being the width of the river in which the data is collected. In the study, data was collected in different areas for different reasons, one of which was the width of the river. Collecting data in this way resulted in a variety of taxa of aquatic macroinvertebrates collected in the streams of Portugal (A.S. Graca 2004). The fact that this study found that the aquatic macroinvertebrates were affected by the width of the river means that it is more likely that the current study's results will be similar. In theory the results that will be collected will correlate with this study, pushing the hypothesis towards the width of the creek will change the abundance of the invertebrates and what invertebrates are found. More

specifically, the wider the creek is, the more likely it is that a more abundant population of aquatic invertebrates will be present.

A study in northern Israel looked at how velocity and the depth of the river affected the aquatic macroinvertebrates found. They used colonization cages and ended up collecting 35 taxa of invertebrates. The results were that there were some areas where most of the macroinvertebrates could be found all together, but both depth and the velocity of the river affected exactly where certain macroinvertebrates could survive. Though directly this study is not about the velocity or depth of the river, the width of the river affects both the velocity and depth of the river (Degani 1993). Therefore if the velocity and the depth of the river affect the biodiversity of macroinvertebrates then most likely the width of the river is a cause for the change in what macroinvertebrates are found. The slower velocity and the smaller depth indicates that the river where the data was collected was wider, and therefore the hypothesis would reflect the idea that the wider the river the more macroinvertebrates that are likely to be found.

A study done in Oregon, U.S. looked at how the latitude of the river affects the macroinvertebrates that are found. They looked at what invertebrates were found in the river based on latitude and found that based on latitude there was different environments and therefore different macroinvertebrates were found. The actual results of the study do not affect the hypothesis but the general idea does. The idea is that in different environments, different organisms will be found (O'Rear 2007). This leads to the hypothesis that the width of the river creates different environments, so therefore should affect the types of aquatic macroinvertebrates that are found in the different widths of the creek. From previous research done, it is known that

the slower the river is (typically when the creek is wider), more macroinvertebrates are found (Degani 1993).

Materials

The following materials will be necessary for collecting the necessary data for the study being conducted (Lynch):

- Aquatic D-Ring net
- Metal tray for sifting through items/organisms found in the net
- Kill jars/vials
- Thermometer
- Tennis ball and string for speed
- Ph paper
- Tape measure
- Meter box
- Dissecting scope
- Camera

Procedure

The following is the instructions in order to complete the study:

1. Choose a location on the river in Gus Fruh Park to conduct the study which will yield useful data.
2. Use transect tape to make a line across the river, on which to collect data.

3. Along the imaginary line created in the previous step, measure out where the three different 1 m^2 transect areas will be taken so that they are evenly spaced along the transect line.
4. Place the 1 m^2 box on the first location determined in the previous step.
5. Within this box, use the Aquatic D-ring net to gather invertebrates by sweeping it through the water at all levels of the water in a continuous movement of the arm.
6. Take the net out of the water (facing up so that none of the materials collected/specimens fall out) and place the contents on the metal tray.
7. Sift through the contents of the net to find any present aquatic macroinvertebrates.
8. When a specimen is found, photograph it.
9. When ready, place specimens in killing jar for preservation or a vial.
10. Repeat directions 3-9 2 more times per transect line.
11. On return to school, identify the collected specimens under the dissecting microscope.
12. Take from killing jars the necessary specimens for the final product, and put them in vials.

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Andie Denson

Maddie Drga

Crosby Planet Earth 1/5

Written Conclusion

Results

The results of the study show that plant diversity and abundance are overall greater at medium distances from water. Although some plants, like Ashe Juniper (*Juniperus ashei*), were only present at distances farther away from water, the opposite was also true. There was a large presence of ragweed, for example, at the transects closest to water only. Cedar Elm was present in at least one transect at each study area. Despite the presence or lack of presence of certain plants at certain study sites, the graphs clearly indicate a higher average diversity at medium distances from water than at the closest or farthest distances. The abundance between the farthest and medium distance from the water was similar with the farthest having the highest abundance, but because of the low diversity in that transect the middle transect has the best results. The nearest transects and the farthest transects had a lower average diversity of 7 shown in fig. 2. The middle transect had a higher average diversity of 8.5. The sum of the intercept lengths were also lower in the nearest and farthest transects, shown in fig. 4. This shows that transects 3 and 4, the medium length transects, had the most diversity and overhang. Some of the plants with significant means that were found were: Ashe Juniper (*Juniperus ashei*) with a P-value of 0.0313, Texas Oak (*Quercus buckleyi*) with a P-value of 0.0134, and Yaupon (*Ilex vomitoria*) with a P-value of 0.0099. All of these values were found using an ANOVA test with the average values of the abundance of these plants in each area. These trees thrive in areas with dry soil, and are not present in transects 1 and 2, nearest to the water. This is the reason why they have such a

significant value. Between a medium distance and a far distance however, by using a t-test it was found that Ashe Juniper (*Juniperus ashei*) did not have a significant P-value, .0886. Texas Oak (*Quercus buckleyi*) does not have a significant value between the nearest and farthest transects because in all of those transects there were none found making the P-value undefined. The abundance of Texas Oak can be found in fig. 5. Yaupon (*Ilex vomitoria*) was only significant between the medium and far distances from the water a P-value of .0377. With the other relations, close and medium or close and far, Yaupon was not significant. In the close and medium relationship there was no variance between the data collected and so the P-value was undefined. Between close and far there was only the difference of one specimen making the P-value .4226. Cedar Elm was close to significant with a P-value of 0.1259. The number of Cedar Oaks present in the transects exponentially declined as the transects got further from the water. This exponential curve can be seen in fig. 6.

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Fig. 1: Average Abundance at Different Distances from Water

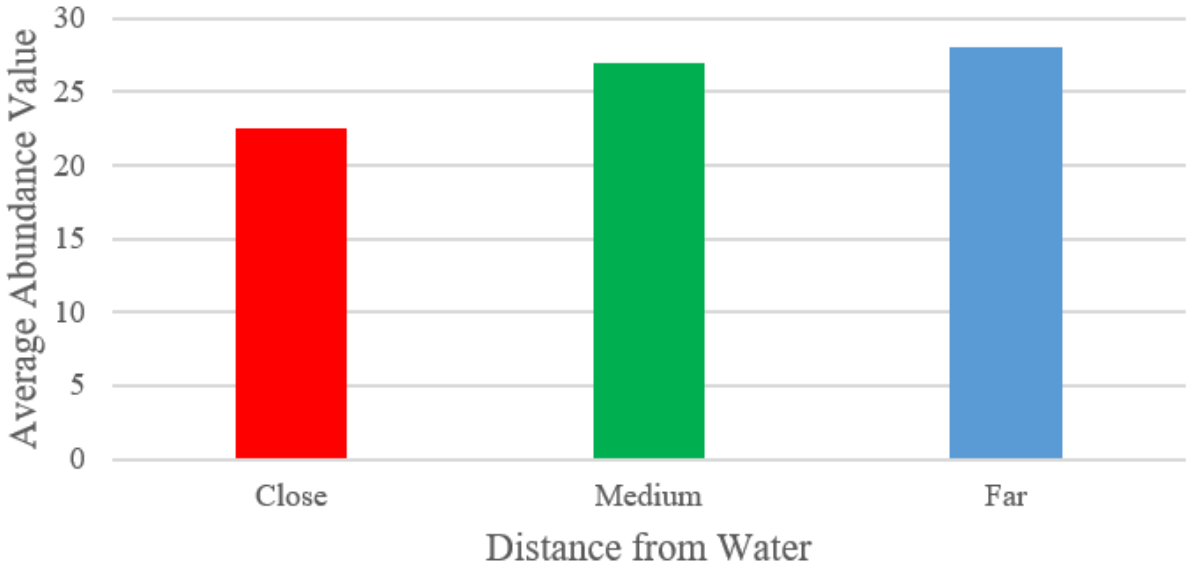


Fig. 2: Average Diversity at Different Distances from Water

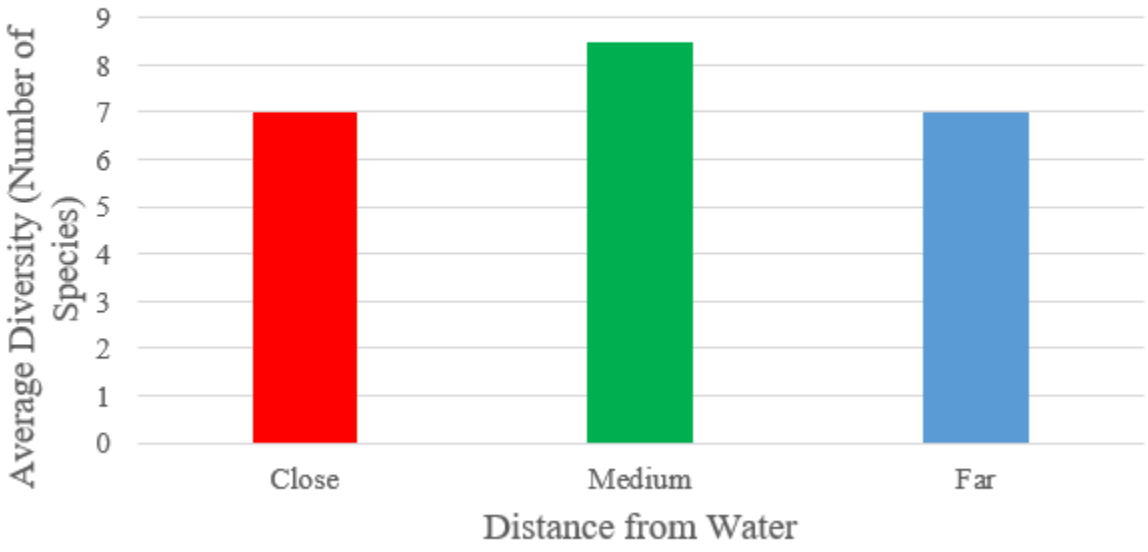


Fig. 3: Number of Ashe Junipers at Different Distances from Water

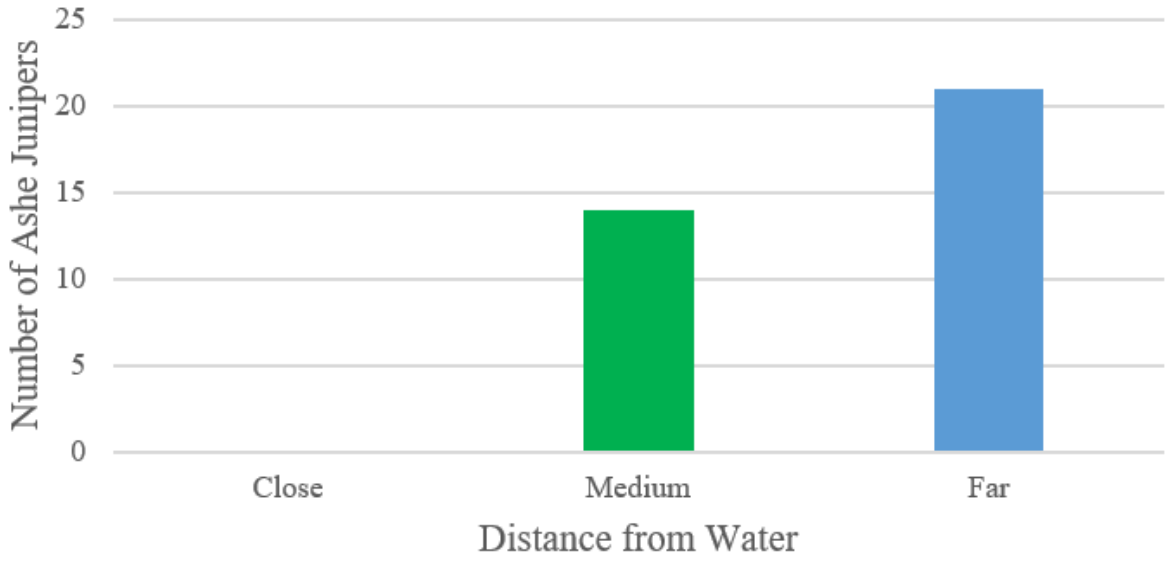


Fig. 4: Average Sum of Intercepts at Different Distances from Water

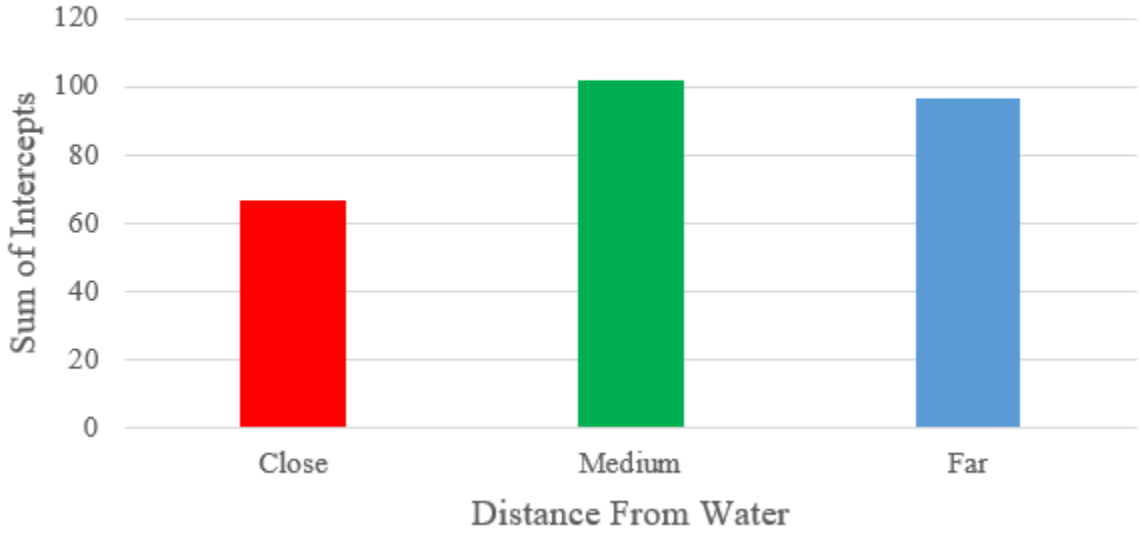


Fig. 5: Number of Texas Oaks at Different Distances from Water

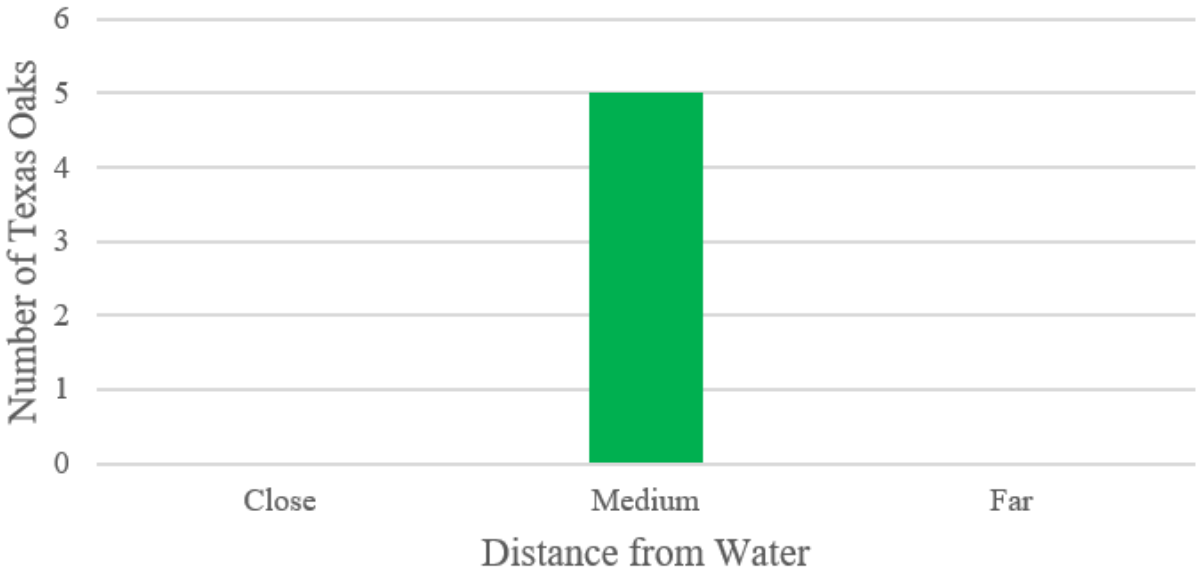
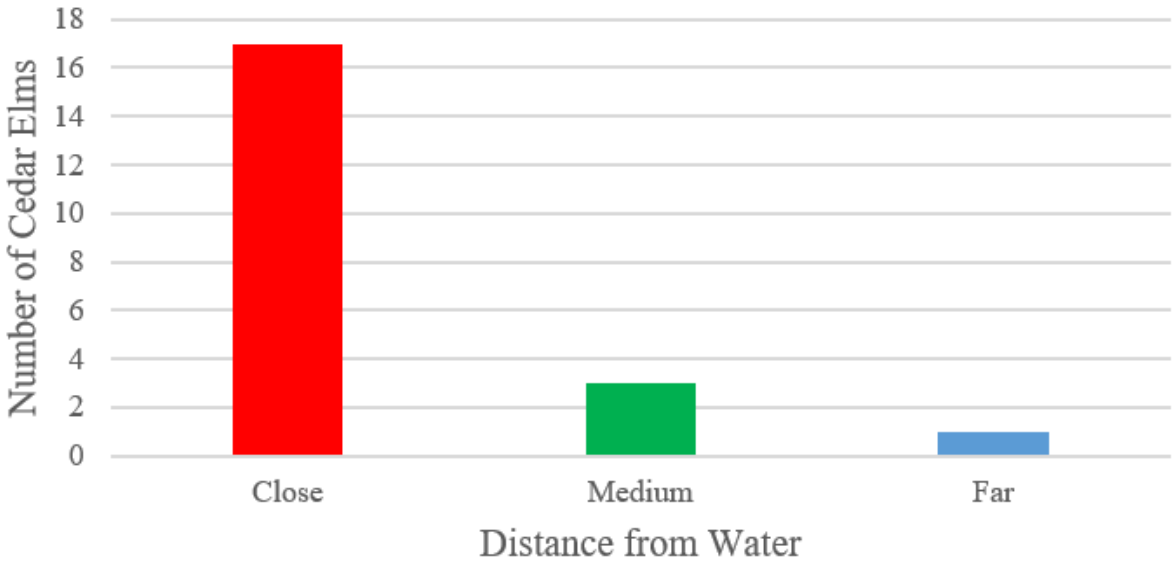


Fig. 6: Number of Cedar Elms at Different Distances from Water



Discussion

These results were consistent with the study's hypothesis that plant diversity would be increased closer to water. As mentioned above, the most plant diversity was present at the middle transect set. This is most likely because of two causes. Firstly, the high likelihood of flooding along the creek bank most likely affected both plant diversity and abundance. Second, the effects of urbanization and the usage of the park also could have had an impact on plant diversity and abundance farther away from water. Taking these different factors into account, this study's results are consistent with the researcher's hypothesis that plant diversity will be increased in an area close to water, but not subjected to regular flooding events or the effects of urbanization.

Flood damage was most likely the factor that had the most impact upon the results of this study. On the initial site visit and on subsequent data collection, the researchers noticed flood damage up to 15 meters away from the banks of the creek. Although slight elevation changes had an impact on the actual flood damage seen, there was still evidence of regular flooding.

Other studies have shown the impact of flooding on plant diversity and abundance. One meta-analysis, compiled by TT Kozlowski in 1997 from multiple studies and experiments, found that flooding can lead to damage in plants such as less complex root structures and increases in plant mortality and decreases plant diversity (Kozlowski 1997). This is present in the data found where Ragweed and Cedar Elm were the dominant species close to the water and there were almost no other plants, probably because they couldn't survive the effects from the floods that occur. The article also talks about how salt can affect water. This does not apply to the transects because there was no salt present in the river.

Another probable cause of this study's results is the urbanization of the area surrounding Gus Fruh Park. Multiple office complexes, a highway, and other commercial structures around

the Barton Creek Greenbelt are the closest urban areas that could have affected plant population and diversity. A study conducted by researchers in Arizona in 2009, it was found that "species richness at the plot scale was higher for desert as opposed to urban sites" (JS Walker *et al*, 2009). By comparing species along 60 meter transect crosscutting the entire Phoenix, Arizona metropolitan area and a portion of the surrounding Sonoran Desert, the researchers established that species diversity increased closer to the desert area, but overall plant spread and coverage was greater around the urban area. This study correlates with the results of the study at Gus Fruh well.

The results of this study at Gus Fruh Park may have been influenced by errors made on the part of the researchers. Both researchers particularly had difficulty finding adequate trail systems and transect locations at the precise distances described in the Introduction and Research Plan. As such, there was some variation between the distance of transects both between distances from water and between individual transects along the same level. This could have affected the data gathered. Another possible error made by the researchers was the possibility of missing some of the plants on the transects. This could mean either missing a plant or failing to recognize a new species. Both of these scenarios could have influenced the results of the study in at least some way. The study could have also been modified by covering more area of the park and the transect lengths could have been extended to gather a more complete data set.

Future researchers, when coming to Gus Fruh, could expand the data collection area and time. Collecting data over a period of 6 weeks is not enough time for species to adapt to new changes, but expanding the data area and collection time could collect a more representative sample of data and provide more conclusive results. New collections and experiments could

provide conclusive evidence that plant diversity is greatest in areas close to water, but not subjected to regular flooding and not close to urban areas.

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Ms. Crosby

PlEarth: Period 2-6

9 December 2016

Biodiversity Project Conclusion

Results

There are many important findings from this biodiversity research project and the subsequent data collected. For example, the order Hemiptera (namely water striders) was the most collected order or organisms (there were 51 collected hemiptera organisms out of a total of 92 organisms, which is something quite notable), and some of the other orders which were largely collected include the orders Ephemeroptera and Odonata.

Furthermore, the most number of organisms (on average) that were collected at each transect were at the first plot of the transect. (Each transect line across a section of the creek served to measure the width of the creek at that area, and three plots were taken at an approximate proportional three different spots along the transect, the first being at the 0 meters, which is the beginning mark of the transect). For example, for the second wide transect had 20 organisms collected at the first plot, and 9 for the third.

As far as speed of the creek at the transects is concerned, the mean speed of the wide transects is 37.84 seconds/meter, and the mean speed of the narrow transects is 6.85 s/m. The correlation between the speeds of the wide and narrow transects is insignificant ($p=0.4$). There is also not a significant enough p-value between the number of organisms per plot (approximately 0.65) that the correlation of that between the narrow and wide transects is not significant.

On a more general scale when comparing wide versus narrow transects, overall there was a greater average number of organisms for the wide transects (31.5 organisms) compared to the average organisms found in narrow transects (average of 16 organisms), and this had an insignificant p-value (0.44). Also, the average depth of the wide transects (with a significant p-value of 0.04!) was almost double the depth of the narrow transects, as seen in Figure 4, and wider transects were slower moving than the narrow ones. The wider transects were approximately 31 seconds per meter slower than that of the narrow transects.

Another important piece of information gathered is that there was a greater amount of orders in the wider transects (more diversity), in which there was an average of 5.5 orders for the wide transects, and 4 in the narrow. Also, the wide transects had an average of 14.5 morphospecies, and the narrow ones had an average of 11.5 morphospecies (more morphospecies diversity in the wider transects) ($p=0.61$ between the averages of the morphospecies of the wide versus narrow transects, which is insignificant).

Finally, there were more organisms in the second location that data was collected (location 2) than the first location (location 1), as seen in Figure 10 (this will be further explained in the section below). Specifically, the mean number of organisms of the second location is 33.5, whereas the mean number of organisms in location 1 is 14 ($p=0.29$)

Discussion

The data does not significantly support the hypothesis, however it does lean towards supporting the hypothesis. Things that impacted the data were that the wider transect had a significantly larger volume than the narrower transects (figure 4), but it is the opposite of what

would be expected. Theoretically the narrower and wider transect should have the same volume, meaning the narrower transect should be deeper to account for not being as wide, and the wider river should be shallower, so there is a balance. Not only this but speed influenced the data because two of the four transects had a speed of 0. However the speed of the narrower transect on average was faster than that of the wider transect, which is to be expected (figure 5).

At the second location there were more organisms on average (figure 9). This is most likely because of the still water and greater amount of overhang. The overhang provides food, indirectly, and shade/protection from solar radiation (Platts, 1983). The still water affects the data because the low in the second location is close to the wide value of the first location. In general the data points to the wide transects having more organisms but there is still a chance that it is all coincidental and not actually significant.

The different plots of the transects have different numbers of organisms. On average the plot closest to the shore had the most organisms. The shore was also the most shallow, and had more vegetation than other areas. Vegetation allows organisms to be protected from predators, have easier access to food supplies, have higher growth rates, lower mortality, and higher fecundity. This has been found in a study conducted in Virginia by Lawrence P. Rozas, and William E. Odum on how SAV or Submerged aquatic vegetation affects organisms. They compared how well mummichogs (*Fundulus heteroclitus*), banded killifish (*Fundulus diaphanus*), and bluespotted sunfish (*Enneacanthus gloriosus*) did in both areas with and without SAV. Though the test was done on fish, it would most likely be the same with aquatic macroinvertebrates. The invertebrates still deal with predation, need food, and use plants for protection (Rozus, 1988).

As many variables that were controlled and accounted for there were still lots of flaws with the experiments. There was not much data that was collected, meaning any error made had a much larger impact on the data. The disturbance in the water caused by collecting data would have caused organisms to avoid that area. While taking data there were dogs and people in the water, not directly next to the transect but close enough to possibly affect data collection. During data collection, both bugspray and sunscreen were used, and the smell of the chemicals could possibly have kept away aquatic organisms. It took a little while to figure out exactly how to take the data correctly, but once it was figured out it went smoother. Another thing affecting data collection was the lack of ability to find and collect all organisms from the plots. Even though the search was thorough there was no way to find all the organisms with the limited supplies.

Not only that but the actual procedure was flawed. It was not noticed until after the data was collected, and being analyzed. The problem with the plots was that the depths were drastically different, meaning each plot had a rather different volume. Some had a depth of less than a foot, while others a meter or more deep. The volume difference would skew the data, but it is impossible to say for sure in what way. One way that would theoretically work would be using a plastic box with one open side and a lid that can be taken off and put back on. To use it, the collector would but the lid on the bottom of the river, marking where, and leave it to settle for a while. Later they would take the top half and put it down into the water on to the lid securing it, therefore trapping organisms in that immediate area in the box. It would be necessary to have multiple boxes, of different widths and depths to keep the volume the same. The deeper the plot, the narrower and deeper the box would need to be, while the opposite is true for the shallower areas. The organisms would then be able to be taken in the box to be looked at under a

microscope. This allows for a more precise data collection, as the boxes could be taken back to the lab and more of the organisms in that plot-box would be found. More plots would need to be taken in order to have more accurate data. The more plots taken in an transect, the better the average and accuracy the tests will be. More transects would need to be tested and compared, as to account for the different variables that are not controllable.

Other issues were that location was not controlled, and different parts of the river have drastically different environments. In the first location the transepts were overall longer than that of the second location. It was more open, and there was less overhang. Also, the first location had moving water, with a speed measurable, while in location two the water was not moving at a speed that was measurable with the available tools. The first location had many small rocks along the bottom, with big clumps of vegetation in areas, mainly along the shoreline. While the second location mainly had larger rocks, with huge ones every once and awhile, with little vegetation besides dead tree limbs or trunks in the creek. The data was collected at different times, when it was different temperatures. Another variable that was not controlled or couldn't be controlled is the collectors of data. The collectors of data changed each transect, and the speed in which data was collected also speed up as time went along. It is not known exactly how this would affect the data.

For future tests it is important to take a lot more data, because it would balance out and make it more obvious if the width actually affects organisms or if it is due to other factors. It would also help to rule out different factors by testing the effects of depth, speed, vegetation, time of day, temperature outside, overhang and other environmental factors. Each variable is important and could have a huge impact. The width of the river would affect the different

variables but by knowing how much the different variables affect organisms it is easier to compare. It would be rather important to standardize the amount of time and smaller variables as to make the data more accurate. As talked about above, an idea as how to standardize more variables and make it more accurate is using a plastic box with different sizes.

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Introduction

Purpose

This study is being conducted in order to determine how the distance from a body of water, specifically Barton Creek located in Gus Fruh Park in Austin, Texas, affects the biodiversity of woody plants in that area.

Hypothesis

The greatest species richness of woody plant species will be at a medium distance from a body of water (in this case 100 m away from the creek). This is due to how a greater water level in a body of water causes an increased species richness in the organisms surrounding the source of water, however an abundance of water also means that there will be a greater amount of invasive species nearby a water source, which results in a lower richness. At a medium distance from a body of water, plants will be close enough to the source to get an abundance of nutrients, but also far enough away from the water source to not be overwhelmed by invasive species.

Site Description

Location

Gus Fruh is located in South-Central Austin, TX in the Barton Creek Greenbelt. The center of the park is 2.0 km SW from the center of Barton Creek Mall. The NW side of Gus Fruh is bordered by the Texas State Highway Loop 360 and MoPac Expressway intersection.

Size and Shape

Gus Fruh Park is composed of two quadrilaterals, which have four sides, but each side may not be equal to one another, and they have rounded edges. This park has an area of 115.2 hectares.

Topography

At the Loop 360 entrance of the park, the land was flat, but as the distance from the entrance increased, the land became more hilly. Often the land would be flat at one moment and hilly the next. The river bed is a flat area with slight elevation changes because of the rocks that cover it. The land on the banks of the creek was at a

higher elevation than the creek itself. The area on the banks of the creek is steep and hilly with dense vegetation. The maximum elevation above sea level is 210.3 m and the minimum elevation above sea level is 149.4 m.

Geology

The study area lies above the Edwards formation which is composed of limestone and dolomite. The majority of the geologic features in the park are made of limestone and were deposited during the Cretaceous period when there was an ocean over Texas. The limestone and dolomite of the Edwards formation are porous and permeable, allowing water to drain to the aquifer below. In addition, this bedrock also contains nodular chert and fossil rudist. Along the creek, there are tributary deposits, composed of gravel, sand, silt, and clay, and formed in the Pleistocene (making it younger than the Edwards Formation). However, the most recent geologic formation is Alluvium, which is composed of sand, silt, clay and gravel. Another interesting geologic feature of this park is the abundance of fossils due to the ocean covering Texas in the past. In this park, *Exogyra* and *Archimedes* can be found. There are high terrace deposits which formed in the early Pleistocene and are composed of gravel, sand, silt, and clay. Another formation is the Del Rio Formation which is composed of clay, pyrite, gypsum, and calcareous rocks. This formation was formed in the Lower Cretaceous, explaining why so many specimens of Exogyra were found in the park.The park contains some of the Georgetown Formation which contains limestone and marly limestone as well as many fossil mollusks and was also formed during the Lower Cretaceous. Another geologic feature is the Mount Bonnell Fault. Mount Bonnell exposed the Edwards Formation and the Edwards Formation went through extensive erosion, which resulted in porous limestone, and eventually the Edward's Aquifer was formed as a result.

Areal Extent and General Type of Vegetation

Gus Fruh Park is highly vegetated, with a high level of biodiversity. The common species in this park are the American Beautyberry (French Mulberry), Yaupon, Poison Ivy, and Red Oak. There is not very much grass at all, only about 5% of the park was comprised of it. However, the majority of the park was woodland, with woody plants, including both trees and shrubs, making up around 95% of the vegetation.

Availability of Water

The most prominent body of water in Gus Fruh is Barton Creek, which is in the Edwards Recharge Zone. On September 25th, 2016, the flow was fairly low to nonexistent, with the water standing still in a majority of areas, but slightly flowing

where there was a large concentration of rocks. The depth was also pretty low, with a few deep pockets measuring around 40 cm, but the majority of the creek measured from 10-20 cm. There was a large amount of debris on the shoreline including dead limbs, fallen trees, etc., which suggests a past flood. In addition there was also trees in the middle of the creek, showing that the creek may have been located in a different area in the past, or that the water levels were so low at one point that plant growth occurred. There was also evidence of water levels decreasing due to the dark ring surrounding the shoreline that indicated the past water level.

Proximity to Urban or Industrial Areas

The center of Gus Fruh Park is 1.98 KM SW from the center of the Barton Creek Mall and is bordered by the MoPac Expressway and State of Texas Highway Loop 360 intersection. On either side of Loop 360, there is portion of Gus Fruh, making it the intersection that divides Gus Fruh. In addition, the main entrance to NE side of Gus Fruh Park is located in the Barton Hills neighborhood, making the entrance of the NE side of Gus Fruh Park adjacent to the neighborhood.

History

Gus Fruh was acquired as a parkland in 1980, 1986 and 1992. It was named after Doctor Edward Gus Fruh, who was a professor at the University of Texas at Austin. The larger Barton Creek Greenbelt that Gus Fruh is a part of was named after William Barton, who settled the area in 1837. Before the land was settled by William Barton, it was home to three Spanish missions from 1730-1731.

Research Plan

Design of Study

In order to determine the relationship between proximity to Barton Creek and plant species richness, data will be collected on transects that are placed varying distances from Barton Creek, which is the main water source at Gus Fruh. The set transects are below, with exact locations mapped out. Each group member has 3 transects that are 50 meters long, resulting in a total of 9 transects (for all 3 group members) and every group members' transect will be set at different places along the creek in order to see if species richness changes are the same along the entire creek. Data will be collected at each transect once. The transects will measure 1 meter from the creek, 100 meters from the creek, and 200 meters from the creek for each group member, with each group member's distances from transects being the same to eliminate any slight variables. The percentage of the study area that will be sampled during the study is 0.78%. By placing the transects at various distances from the creek, a correlation between proximity to the creek and species richness will be more prominent because the variation in distances will make it clear.



Above are all transects that will be studied (the actual transects are in pink, each placed along the section of the creek close to a neighborhood with the same distances between the three transects in each.

Background Information

In a study conducted by Y-N Chen and other researchers along the Tarim River in Western China, researchers examined the relationship between plants' species diversity and ground-water level by analysing data from 40 monitoring wells

and 18 vegetation survey plots from 2000-2002. The water level was fairly low in the in the lower reaches of the Tarim River, and displayed clear gradient in water level from upper to lower reaches. The low groundwater levels was one of the major attributes to low plant species diversity; plant species became less diverse and the structure of plant communities became simpler. The diversity of plant species decreased moving from the upper to lower reaches of the Tarim, directly corresponding to ground-water level. Therefore, a conclusion was drawn that the lower the water level the lower the diversity in plant species. This study can help in determining the hypothesis by showing that plant biodiversity is affected by water level in a creek, with less species diversity with a lower water level, and therefore lower biodiversity the farther the transects are taken from the creek. If the same trend is followed in Gus Fruh Park, there will be a greater species diversity with a greater water level(Chen et al., 2006).

In a study conducted by Guadalupe Williams-Linera and Francisco Lorea in ten tropical dry forests in Veracruz, Mexico, researchers looked at the effect of 10 environmental factors on plants. They conducted this study by choosing transects that differed in elevation along with 9 other environmental factors and they went through and documented all the different types of plant species that they found at each transect. The researchers found that the main variables that affected the amount of species in an area are cattle, trails, elevation, water proximity, slope, aspect, and altitude. It was found that proximity to water mattered for seedlings, but the adult plants did not require it. The closer the seedling was to water, the species diversity would increase. They also found that human disturbance had a big effect on the species diversity, and proximity to cattle and trails lowered how complex the plants are, while proximity to water increased the complexity of plants. This study helps to form a hypothesis about how water proximity affects plant species in Central Texas because Mexico has a similar climate to Texas, so the main factors that affect their plant species are going to be similar to the main variables that affect plant species in Central Texas. This also means that the part of their study that used water proximity as a variable will be similar to data collected to measure plant biodiversity due to water proximity in Central Texas. If the same trend is followed, there will be a greater species diversity for seedlings closer to water (Williams-Linera & Lorea, 2009).

In a series of studies around the world in areas with an abundance of invasive species conducted by Montserrat Vila and other researchers, researchers looked at the effect of invasive species on the species richness of plants. The researchers created transects in known invasion areas and collected samples. After analyzing the samples, the researchers found that invasive species decrease the species richness of plants. The researchers also found invasive species thrive close to water

due to the abundance of resources. It can be concluded that invasive species nearby water will decrease the species richness of native plant species. Therefore in Gus Fruh Park, it is likely that there will be a greater number of invasive species in close proximity to water, resulting in a decreased species richness (Vila et al., 2011).

Materials

The materials that will be used in gathering data are:

- 50m Transect Tape (1)
- Native and Naturalized Woody Plants of Austin and the Hill Country Field Guide
- Gus Fruh Trail Map
- Gus Fruh Aerial Photo
- Gus Fruh Topographic Map (1)
- Pencil (1)
  Scissor (1)
- Plastic bags (to transport samples)

Procedure

For Data Collection:

Along each of the transects:

1. Stretch 50m transect tape.
2. Move along the transect and collect any woody plants samples using scissors that are along that transect, even if it is the same species as another sample that has previously been collected.
3. Record the species name (if known), if not label the plant sample with a letter and correspond any repeating samples of that species to that letter; the intercept range (the distance along the transect at which the species overhang starts and ends) and length in meters (the difference between the starting and ending point of the overhang); the 5m interval at which the sample was collected and any additional information such as type of plant it came from (tree, vine, shrub) the type of bark etc. Organize all this data into a table.
4. Observe leaf type, leaf arrangement, description of bark and description of the fruit and/or flower for each plant on the corresponding page for each sample in the project notebook
5. If possible, identify the species and glue to the back of notebook, if not carefully place the unidentified species into a plastic bag.

For Data Analysis:

1. Identify plants samples to species using the field guide
2. Once all plant samples are identified, begin the data analysis for each of the samples which includes:
    a. Recording species name
    b. Recording the number of the species found along that transect
    c. Relative density of the species= (total # individuals of species/total # individuals of all species)x100
    d. Intercept lengths (explained in field procedure)
    e. Sum of intercepts for a species
    f. Relative dominance of the species= (total intercept length of that species/total intercept length of all species)x100
    g. Relative frequency of the species= (total # of intervals of that species/total # of intervals of all species)x100
    h. Importance Value= (relative density+relative dominance+relative frequency)

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Gus Fruh Park Trail Map

Gus Fruh Park Topographic Map

Gus Fruh Park Aerial Photo

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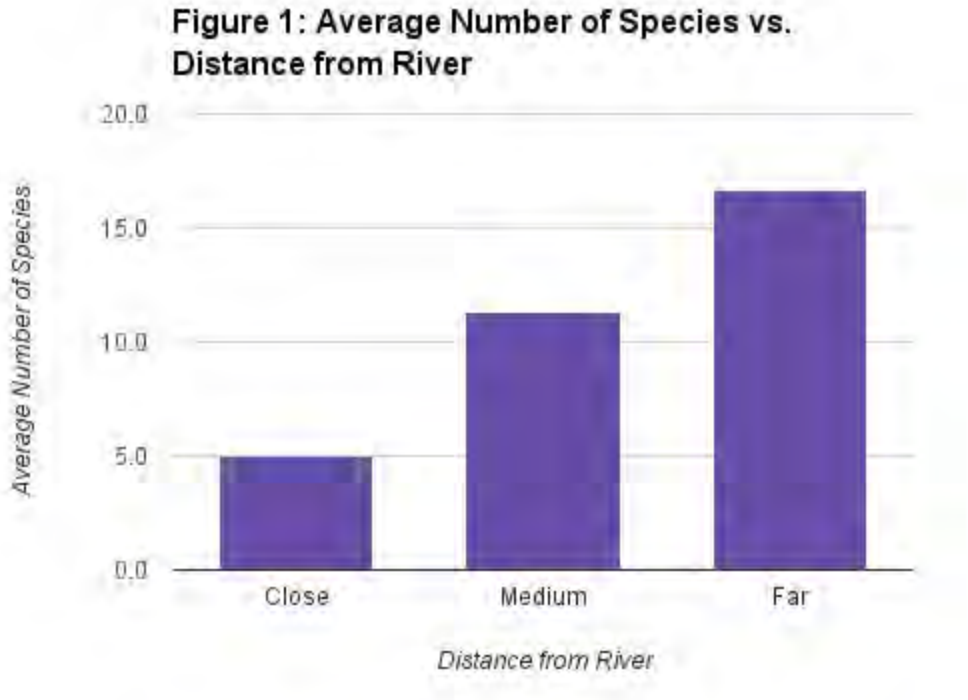
Period: 2/6

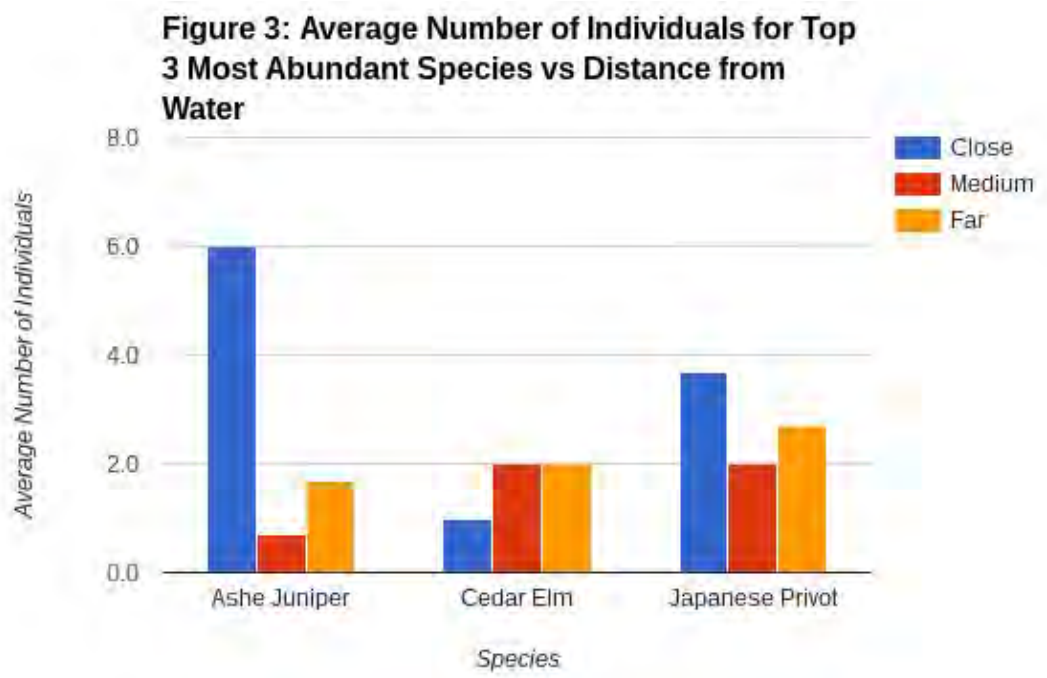
Conclusion

Results

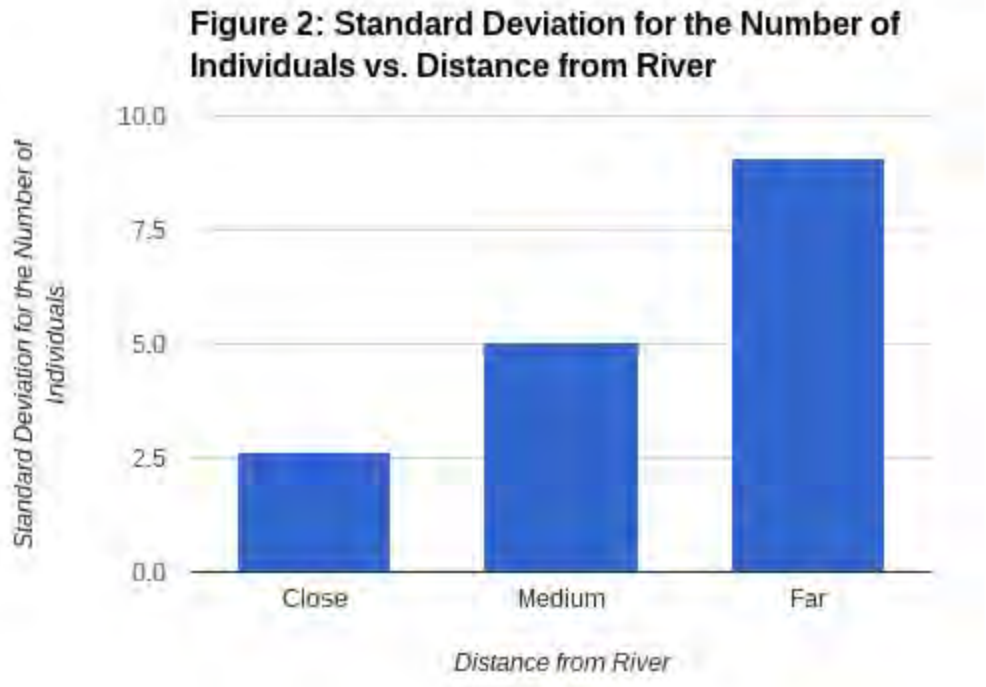
The average number of species in the close transect was 5 species, 11.3 species in the medium transect, and 16.7 species in the large transect. As seen in Figure 1: the number of species increases as the distance to water also increases. There was a near-significantly (P Value= 0.05) greater number of species in the far transect from water than the medium and close transects. According to T-Tests, the difference between the means of the close and medium was significant (P Value= 0.01) while the differences between close and far; and medium and far were not significant (P Value=0.10 and 0.56).



The average number of species for each transect were 16 for close, 20.67 for medium and 29.67 for far. As the distance from the river increased, so did the average number of plant species. The abundance of plants was not significantly different for each proximity to water (P=0.30). Ashe Juniper was most abundant at the close transect, with an average of 6 plants. Cedar Elm was equally abundant at the medium and far transects with an average of 2 plants. Japanese Privet was most abundant at the closest transect with an average of 3.7 plants. Each plant species does tend to be more abundant in one transect compared to another. However, there is no correlation between distance from the river and abundance of individual plant species, as evidenced by Figure 3.

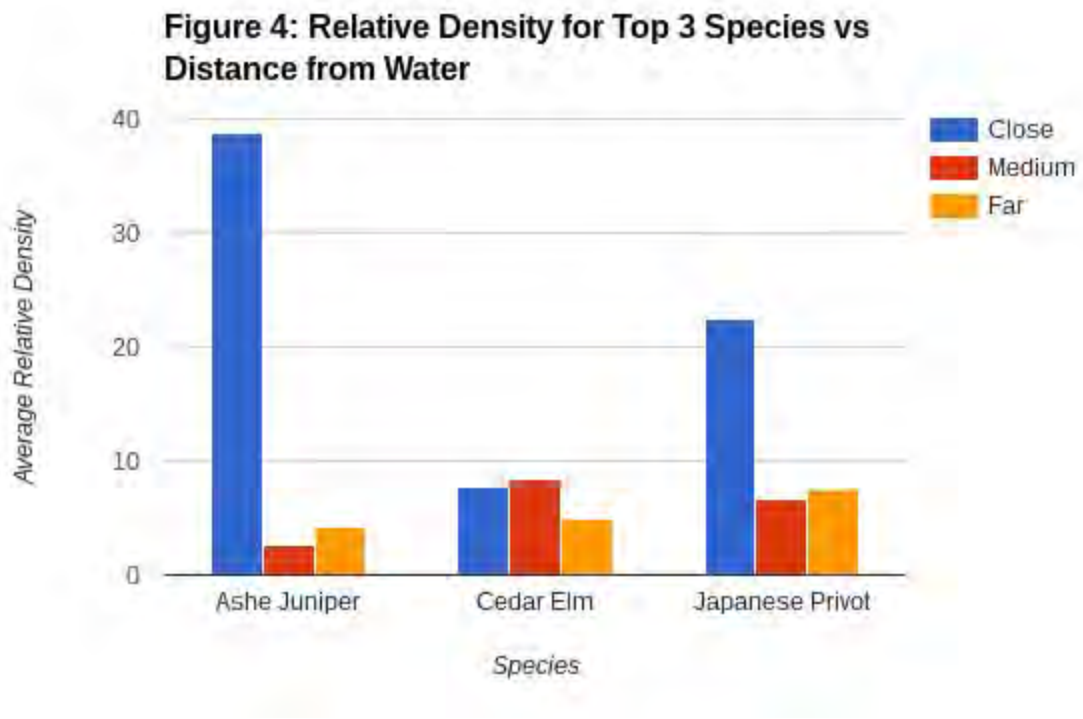


Standard deviation describes the variance in data. For the number of individuals, the standard deviation increases as the distance from the river also increases. There is a standard deviation of 2.7 in close, 5.0 in medium and 9.1 in far. The standard deviation is the lowest in the close and highest in the far. This means that the data has more variance as the distance from the river increases.



Relative density is closely associated with abundance or the number of individuals. It says how many individuals were found in an area, expressed in a

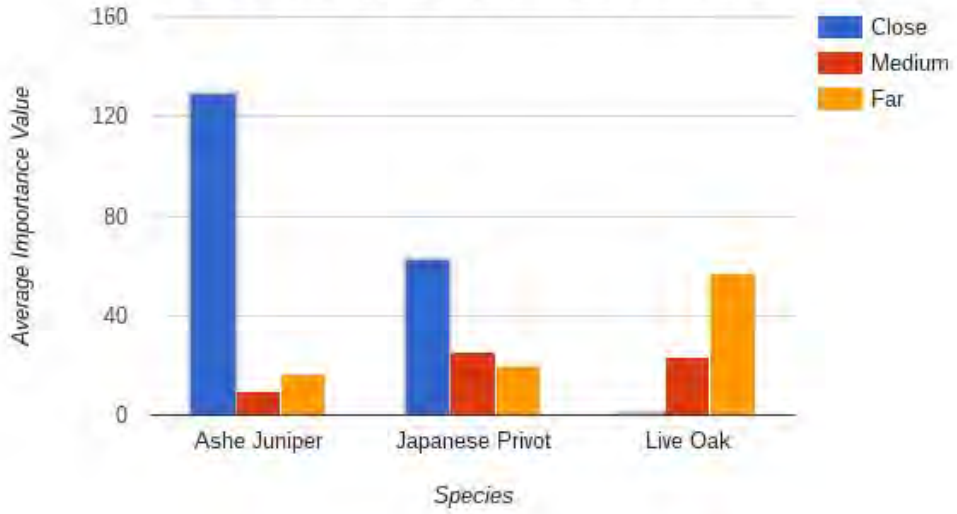
percentage. For relative density, the top three most abundant species were used in figure 4. The most abundant species were used because relative density and abundance are closely related. As seen in Figure 4, the relative density for specific species fluctuates but each species has a higher relative density in a specific distance. Ashe Juniper has the highest average relative density compared to other species in the close transect with 38.7%. According to the ANOVA Test for Ashe Juniper, The relative density for Ashe Juniper was not significantly different for different proximities of water (P=0.27). The second most abundant species was Japanese Privet. Japanese Privet has a higher relative density in the close transect compared to the medium and far transects. However according to the ANOVA Test, the relative density for Japanese Privet is not significantly different for different proximities to water (P=0.13). Also seen in Figure 4 is the relative density for Cedar Elm. Cedar Elm tends to be toward the smaller end of the range for relative density, yet it is still one of the top 3 most abundant species. Cedar Elm's relative density is lower in the far transect than in the close and medium transect. Since Cedar Elm was toward the smaller end of the relative density spectrum compared to Ashe Juniper and Japanese Privet, an ANOVA test was not completed. The trend from this data tends to be that different species have the highest average relative density for each transect.



The importance value is the measure of how influential a species is in a community. It is the sum of the relative density value, relative dominance value, and relative frequency value. For figure five, the species were chosen because between all of the data, those species have the highest average importance values. There is no correlation within each of the three species based on where the transect was located and the average importance value, but in each of the species there was one transect where their average importance value was higher than in the other transects, but not statistically significant, as proven by the ANOVA tests. As seen in figure five, Ashe

Juniper had an importance value of 129.4 in the close transect, 9.8 in the medium and 16.3 in the far. Ashe Juniper had about a difference of about 100 between the importance value for the close transect and the importance values in the medium and far transects. According to the ANOVA tests, the importance value for Ashe Juniper is not significantly different for different proximities to water (P=0.21). Also seen in figure 5, Japanese Privet has an importance value of 62.3 in the close, 25.3 in the medium and 19.9 in the far. Japanese Privet had a higher importance value in the close transect compared to the medium and far transects. According to the ANOVA test, the importance value for Japanese Privet is not significantly different for different proximities to water (P=0.17). The importance value for Live Oak is 0 in the close transect, 23.6 in the medium and 57.1 in the far. Live Oak has a higher importance value in the far transect compared to the close and medium transect. However, an ANOVA test was not done for Live Oak because it is not a significant species in the rest of our areas of study (diversity, relative density and abundance).

Figure 5: Average Importance Values of Top 3 Most Important Species vs Distance from Water



Discussion

The results regarding to the diversity of woody plants suggests that as the distance from water increases, the plant species diversity also increases. In Gus Fruh Park, the land toward the water tends to be rocky and riddled with broken branches, making it hard for woody plants to make efficient use of the land. The area is also more prone to flooding. The land also has many non-woody plants such as weeds and shrubs. While the land farther away has more space and better quality soil. A study done in Maine, USA by Bruce Milne and Richard Forman in 1986 found that species diversity decreased significantly the further from the mainland and the closer to water. The method used to conduct this study was creating transects close to the mainland, in the middle, and close to the peninsula and collecting plant samples along 100m transects to count how many different species were found along each transect. This study's results aligned with the results from the study conducted in Gus Fruh, which

found that the average number of species increased the further away from a body of water that they were (Milne & Forman, 1986).

In the study conducted at Gus Fruh, woody plant species were more abundant at the far transect. This is likely due to the condition of the land. The land farther away from the from the water has more space for bigger trees to grow and and better soil conditions. The land farther away from the water is also closer to the limestone found in Gus Fruh. A study relating the abundance of plant species was conducted in Danish Streams by Tenna Riis, Kaj Sand-Jensen and Søren E. Larsen in 2001. This study used 40000 quadras (rectangle shaped areas) to collect plant samples and test the effect of various factors relating to water on plant species. There were a total of 208 sites and 87 species over these sites. There were a greater number of plant individuals submerged in the water than the number of individuals on land near the water. The researchers suggest that plant species are more abundant in the water rather than on land. They also suggest that species abundance increases as proximity to the water increases (Riis et.al, 2001). This is evidence contrary to the group's data. The researcher's data was different from the data collected at Gus Fruh because the study was conducted in a larger area than the group's study, as well as at more sites. Also the researchers' study included terrestrial and amphibious taxa. While the group's study only included woody plants.

The data collected at Gus Fruh does not support the initial hypothesis that there would be a greater number of species at the medium transect. Even though the results say there is a greater number of species at the far transect, most scholarly sources say that there is a greater number of species at the close transect. The results of the scholarly sources are more reliable because they cover a greater area.

The abundance of Ashe Juniper, Japanese Privet and Cedar Elm suggests that there is no correlation between Individual species and proximity to water. Although each species is more abundant in one transect compared to the other. For some species, there is a greater difference between abundance for each transect. While other species tend to have a smaller difference. This is due to how each plant species has its own requirements for its environment and some species adapt to the environment better. For example, Japanese Privet was more abundant closer to the water due its effective use of water. However, Japanese Privet still had a greater abundance in the other two transects compared to Ashe Juniper. So as an invasive species, Japanese Privet adapted better to the environment. The abundance of species is similar to relative density and for this reason, the results can be interpreted similarly. The reasoning for the top three most abundant species is also explained below in the relative density paragraph.

Both Ashe Juniper and Japanese Privet have a higher relative density in close proximity to water than other distance from water. Since Japanese Privet is an invasive species, it thrives in areas with greater resources (such as water). As a result, there is a greater number of Japanese Privet individuals. Ashe Juniper however should not have had a high relative density in close proximity to water since Ashe Juniper is generally more abundant near limestone hills. In Gus Fruh, the limestone hills are located closer

to the far transect rather than close transect. However Ashe Juniper is a part of the Cedar family and this family is characterized by pollen-like leaves, resulting in effective reproduction. The pollen spreads easily. So the wind could have blown the pollen from the Ashe Juniper into closer proximity of water. This is likely since the Ashe Junipers seen in the close transect tended to be seedlings. However Cedar Elm has a higher relative density in the medium transect because Cedar Elm is common in wooded areas. The medium transects tended to be more wooded than the farther away transects. The relative density of other species in the medium transect was also lower than that of Cedar Elm. This would have allowed Cedar Elm to do better in the medium transect.

The standard deviation for the abundance of species increases as the distance from the river increases. The data is more consistent in the close transect rather than the far transect. This means the far transect is not as precise as the first two transects. The data in the far transect could have been influenced by another factor such as the abundance of paths and a greater distance away from human activities such as swimming and walking dogs. So in the far transect, both the distance from water and the proximity to urban areas (pathways and human activities) could have influenced the data. For all three transects, they could have also been affected by the elevation on the specific side of the river.

The importance values showed no correlation between the species, except for that for each species there was one transect that had a clearly higher importance value than the other transects. In Figure Five, it's shown that Ashe Juniper is the most important species in the closest transect, which is unusual because Ashe Juniper is generally more abundant further away from water and on limestone hills. This occurrence is likely an error where the group may have mixed up samples from different transects. Also seen in figure five, Japanese Privet is the most important in the transect that is in between the other transects, which is significant because it is an invasive species and this shows that it is taking over the area around that transect, increasing the influence of this species. There was an increase in the amount of Live Oak along the farthest transect, which made it the most important species in the far transect. This is because Live Oaks (and other evergreen trees) tend to grow better when they have more space and higher quality. In addition, Live Oak is drought-tolerant making the occurrence farther away from the water reasonable and it is less dense further away from the water. In addition, Live Oak tends to take up more space, resulting in a greater influence of this species.

Some of the mistakes made during the study may include misreading the transect tape, getting the transect tape tangled, or an inaccurate placement of the transect, which would all result in data that was for the most part completely insignificant. While collecting data, the group tended to place leaves in one Ziploc bag, leaving the chance for the leaves from different transect to mix up. This could have caused issues with the abundance/species diversity of species in the wrong area. For example, Ashe Juniper found closer to the water rather than further away. One mistake of the inaccurate placement of the transect tape was measuring the distance from the

river to one spot and then proceeding to shift the transect tape over more to reach the required “30m of overhang”. This resulted in the distance from the water being a little off.

This study was conducted on the side of the river that was steeper and had greater changes in elevation. The transects tended to be on steep edges making it difficult to place the transect tape straight and to collect data. The danger of these steep edges resulted in the group hurrying through data collection (due to safety issues). On the other side of the river there is a flatter area with no geologic features that could cause isolation. This means that if the study was conducted on the other side of the river, there is a higher chance of the data being significant. Additionally, the study should consist of more transects because more transects would make it more likely that the data would be significant. In addition, the close transect should be placed at least 5m away from the water since 1m away from the water was over the rocks. The rocky area consisted of far less species and rocky soil, if any at all. The study should also be conducted in farther down the river so elevation doesn’t affect the data.

A possible future study to further develop the study could be done on the abundance of species along different parts of the river to see if water quality or depth has an influence. Another possible future study is a study on species diversity on different sides of the river to see if the proximity to urban areas or to the water is causing the variance in the data.

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Nadia Freeman
Sergio Flores

Introduction

Purpose:
The purpose of this study is to determine whether elevation will have an effect on the variation of woody plant species in Gus Fruh Park in Austin, Texas.

Hypothesis:
Woody plants species richness will be highest at levels of moderate elevation, because such areas are habitable by species that thrive at high and low elevations.

Site Description:
Location:
Gus Fruh is 6.5 km SW from the state capitol as the crow flies. It is adjacent to the intersection of S. Mopac Expressway and Loop 360, in the Southwestern quadrant of Austin.
Size And Shape:
Gus Fruh is shaped like a triangle, with jagged chunks missing in the South, North East, and North corners. The edges of the park are irregular all the way around. Gus Fruh is 127.62 hectares.
Topography:
The minimum elevation in Gus Fruh is 152.4 meters, and the maximum elevation is 210.3 meters. The relief of the park is 57.9 meters. The general topography of the park is hilly, since the entire park slopes towards the creek. The largest change in elevation is at the Seismic Wall, where there is a cliff overhang.
Geology:
Gus Fruh is diverse in its geology. Surrounding Barton Creek, the rock is alluvium (sand, silt, clay, gravel, deposited during the Quaternary period). In the bend of the creek, the rock is the Tributary Terrace Deposit (gravel, sand, silt and clay, deposited during the Quaternary period). Surrounding the alluvium and the tributary and trace deposit is edwards formation (limestone, dolomite and fossil rudist, deposited during the Cretaceous period). The majority of the Park is the Edwards Formation; exposed along the fault line that cuts through Gus Fruh and creates the recharge zone. Lining the Edwards Formation, extending in all directions is the Georgetown Formation (limestone with abundant fossil mollusks, deposited during the Cretaceous period). Past the Georgetown formation (especially in the East and South side of the park) is an expanse of Del Rio Formation (pyritic, gypsiferous, and calcareous clay, deposited during the Cretaceous period). Surrounding the Del Rio Formation is the Buda Formation (dense, hard limestone with abundant fossil mollusks, deposited during the Cretaceous period), separating the Del Rio Formation from the High Terrace Deposits (gravel, sand, silt and clay, deposited during the Quaternary period), which are scattered on the most southern/eastern edges of the park's limits.
Areal Extent and General Type of Vegetation:

Gus Fruh is 95% woodland, and 5% exposed creekbed. One type of plant that is found in Gus Fruh is the sycamore tree. Another type of plant that is found in Gus Fruh is the Ashe juniper tree. A third plant found at Gus Fruh is the brown spined prickly pear.

Availability of Water: Barton Creek runs through the entirety of Gus Fruh, with a small width (3 meters approx.) in the East and West portions of the park, increasing in width (12 meters approx.) along the Seismic wall. Small streams run downhill all throughout the park, feeding into the creek.

Proximity to Urban or Industrial Areas:

Goose Fruh is surrounded by urban areas, with South Lamar being parallel to the park in the East. It is also right next to the Barton Creek Mall/shopping centers. The South side of the park is bordered by apartment complexes and strip malls. Loop 360 cuts through the Southwestern corner of the park.

History:

Gus Fruh is part of the Barton Creek Greenbelt, which was named after William Barton, who built a house on the creek's banks in 1837. Before that, in the 17th and 18th centuries, the creek was also believed to have hosted Comanche and Tonkawa camps. As the city of Austin, Texas grew in size and complexity, the land currently known as the Barton Creek Greenbelt (including our site of study; Gus Fruh Park) was increasingly threatened by developers. In order to protect the land and the wildlife residing in the area, the Trust For Public Land bought substantial portions of the Greenbelt, including Gus Fruh in 1980, 1986, and 1992.

Research Plan

Design of Study:

The study will be conducted with 6 transects, each at 50 meters in length. 2 transects will be placed at an elevation of 160 meters, the next 2 will be placed at an elevation of 180 meters, and the final 2 will be placed at an elevation of 200 meters. Data will be collected throughout a period of 3 weekends, with 2 transect data sets being collected per weekend, one per group member. All 6 transects cover ~0.47% of the park.

By placing the transects at 3 different elevations, will help answer the purpose since the group will be able to compare species richness at three different elevations to see which has the highest, if any. See project notebooks for exact transect placement locations.

Background Information:

A study conducted in Kenya used regression analysis to observe the changes in woody plant species diversity and population density along three transects placed at different altitudes (600 m, 700 m, 800 m). Each transect ran along an altitudinal gradient of 100 meters. Among the three transects and the forty-three woody plant species, species diversity was richest along the

transects placed below 700 meters (Kuburu, 2008). This study supports the hypothesis that woody plant species richness will be greatest at medium elevations, because the transect that had the most woody plant species richness was the transect in the middle of the elevations they studied. This study agrees with the hypothesis proposed by Freeman and Flores: that woody plant species richness is greatest at mid-range elevations.

Another study, conducted in Eastern Mexico used a similar process of analysis to observe changes in the diversity/richness of woody plant species along eight transects between a steep elevation gradient (700-3500 meters). The findings of this study suggest that woody plant species diversity/richness was not affected by changes in elevation (Guevara, 2016). This study contradicts the hypothesis proposed by Freeman and Flores, which proposed that woody plant species richness would be greatest at mid-range elevations.

A third study, conducted in Korean temperate forests also used similar processes of analysis to observe changes in plant species richness as elevation changed. The data from this study also indicated that there is no observable relationship between elevation and woody plant species diversity. In addition, the scientists responsible for this study found reason to believe that elevational effects on woody plant species may differ based on the individual species being observed (Lee, 2016). This study contradicts the hypothesis proposed by Freeman and Flores: that woody plant species richness is greatest at mid-range elevations.

Materials:

- Transect tape
- Field Guide (Lynch, Brother Daniel. Native and Naturalized Woody Plants of Austin and the Hill Country. Austin, Texas: St. Edward's University, 1981.)
- Project Packet
- Scissors

Procedure:

1. Lay out the 50 meter transect tape as straight as possible along the designated line of data collection
2. For all woody plant specimens that hang over the transect tape, record their common name, the intercept length and range (to the nearest decimeter)
3. Collect a representative leaf sample from each species encountered on the transect line. Save the sample in notebook, on unlabeled pages. Proper leaf sample required to have many leaves so that arrangement can be seen. While in the field, record leaf type and leaf arrangement , a description of the bark, and a description of the fruit and/or flower for each plant on the same sample page. Also record what the type of the woody plant was (Shrub, tree, vine).
4. Analyze data gathered with the following methods: Relative density, a measure of how many members of a specific species there are in a transect. Relative density is calculated by dividing the total number of individuals of a certain species, divided by the total number of individuals of all species, and multiplying the quotient by 100. Relative

dominance, a measure of the size that a certain species takes up in the transect. Relative dominance is calculated by dividing the total intercept length of a certain species by the total intercept length of all species, and multiplying the quotient by 100. Relative frequency, a measure of how common a species is in a transect. Relative frequency is calculated by dividing the total number of intervals of a certain species by the total number of intervals of all species, and multiplying by 100. Finally, importance value, calculated by adding up relative density, relative dominance, and relative frequency. Importance value gives an overall estimate of the total influence/importance of a certain plant species on a community.

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Conclusion

The study conducted in Gus Fruh Park by Sergio Flores Osorio and Nadia Yamini Freeman explores the effects of elevation on the biodiversity of woody plant species. The number of species peaked at total of 15 species at medium elevation (transects 2,4) as the researchers hypothesized. Interestingly, as seen in Figure 5, the abundance of Ashe Juniper increased with elevation, as the total abundance of all other species decreased with elevation. In contrast, as seen in Figure 2, the abundance of Cedar Elm decreased with elevation, as the total abundance of all other species decreased. As seen in Figure 4, Prickly Pear Cacti were only observed at medium elevation, however the p-value of Prickly Pear cacti abundance was 0.46. After the data collection the results of this study appear to be statistically insignificant. The data on number of species at each elevation range were analyzed and a p-value of 0.17 was determined. Though the data is considered statistically insignificant, is is significant to discussion and interpretation.

The highest value of number of species at medium elevation appears to support the researcher's hypothesis, and the insignificant p-value determined through analysis of diversity of species raises the questions; what caused the trend observed, and why is the data insignificant? The researchers in charge of this study concluded that the small sample sizes may have limited the results of the study and not been comprehensive enough to precipitate significant data. If the study were to be modified, a larger sample size/more samples may be beneficial.

Research related to Flores and Freeman’s study appears to support the hypothesis that woody plant species richness is highest at medium elevations. A study conducted in Vietnam measured the diversity of species along a mountain range using field transects placed along single elevation gradients. Researchers found that at elevations greater than 300 meters, (mid

elevation) the richness of woody plant species peaked (McCain, Grytnes 2010). This evidence was supported by 80% of studies regarding the researcher's hypothesis, and is in line with Flores and Freeman's hypothesis that woody plant species richness is highest at medium elevations.

A study conducted in the Himalayas in six 50x20 meter plots at 15 100 meter elevation bands between 100 and 1,500 meters above sea level shows found that the highest species richness for woody plants occurred near 600 meters, or approximately the halfway point. (Bhattarai, K. R. and Vetaas, 2003) This study supports Flores and Freeman's original hypothesis that woody plant species richness is highest at medium elevations.

The researchers of this study would recommend additional studies be conducted in Gus Fruh Park re: species diversity at different elevations (of greater quantity and specificity), abundance of dominant species in the area, and the dominant species effect on the abundance of other species in the area. These studies would elaborate on the data that Flores and Freeman collected and create a more comprehensive picture concerning the hypothesis.

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Alec Bennett
Andy Mueller
Paul Sherrill

Introduction

Purpose:
The purpose of this project is to determine the effects of the distance away from an open body of water on the species richness of woody plants at Bull Creek District Park, in Austin, TX.

Hypothesis:
There will be more species richness of woody plants farther away from an open water source than species richness of woody plants closer to an open water source, because plants closer to water need to be adapted to wetter environments, while plants in areas with no near open water sources do not need such adaptations allowing for more species, increasing the species richness.

Site Description of Bull Creek District Park:

Location

Bull Creek District Park is in Northwest Austin, Travis County, Texas in the United States of America. It is located at the intersection of Highway 360 and Spicewood Springs Rd. It is about 1.29 km North of Ranch to Market Road 2222. The park runs along Highway 360 for 17.71 km until it reaches Lakemoore Dr., crossing under Highway 360 twice.

Size and Shape

The area of the park is about 250.67 hectares. The park is also in the shape of a rough rectangle, connected by a curve to a smaller square.

Topography

The highest elevation in the park is 277.063 meters, and the lowest is 157.13 meters. The terrain is very rocky and hilly, and descends from the top of a hill down to a creek bed (highest to lowest elevation). The hill is in the South West corner of the park. There is also a berm that runs along the Eastern edge of the park.

Geology

The park is composed of Glen Rose Formation, Walnut Formation, Edwards Formation, Lower Colorado River Terrace Deposits, Upper Colorado River Terrace Deposits and Alluvium. The Glen Rose Formation includes limestone, dolomite and marl, gray to tan, alternating hard and soft beds forming stairstep topography, thick to thin bedded, it is fine to medium grained and is from the lower cretaceous period. The Walnut Formation includes limestone, marl, and marly

limestone, which ranges from gray to tan, soft to hard, thick to thin bedded, massive to nodular, fine to medium grained and is from the Lower Cretaceous period. The Edwards Formation includes limestone and dolomite, and ranges from light gray to tan, hard to soft, thin to thick bedded, and fine to medium grained. Fossil rudist and nodular chert are common, and there is a solution collapse zone near the middle. It is from the Lower Cretaceous Period. The Lower Colorado River Terrace Deposits include sand, silt, clay and gravel, which are yellow to orange-brown. It is from the Pleistocene period. The Upper Colorado River Terrace includes gravel, sand, silt, and clay, which are orange-brown, and it is from the Pleistocene period. It is found in trace amounts on the southern edge of the park. The Alluvium includes sand, silt, clay and gravel, is yellow to orange-brown, and is from the Quaternary period. The Lower Colorado Deposits and the Alluvium are found in and around the creek bed, while the other formations can be found in the wooded areas.

Area Extent and General Type of Vegetation

The area includes plants such as poison ivy, various grasses, oak, cedar, pecan, mesquite, and flowers. It's about 5% grassland, and 90% woodland with about 5% bare ground with no vegetation. The creek bed itself takes up about 15% of this woodland/grassland.

Availability of Water

The area has a creek known as Bull Creek. The creek ranged from 0.02 to 3 meters deep at different places in the creek bed at the time of the initial site visit. There is some evidence of flooding with trash and debris in the grass and rocks, ranging from about 5 cm-1 m.

Proximity to Urban or Industrial Areas

The park is boxed in by Highway 360 and Spicewood Springs Rd. to the North and West, both major roads with heavy traffic running directly adjacent to the edge of the park. The park is also overlapping Marquis at Treetops, a large urban neighborhood, at the Eastern corner.

History

A family of Anglo settlers called the Preeces bought the Bull Creek land and a good portion of the surrounding fields back in 1838 for agricultural purposes. Will Preece, the father of the family, was said to have killed a Comanche bull on the property, which later became the park's namesake. Throughout the 19th Century, they housed Confederate soldiers within the parkland, until the end of the Civil War. Dick Preece, Will's son, then took ownership of the property, and ran the land until he died only a few years later. In 1846, Mormon settlers colonized what is now known as Travis County, and the Preece's land became theirs. As the city progressed, the various Indian trails surrounding the park became Spicewood Springs and Highway 360, and the land officially became a park in 1971. It grew through donations until 1987, when it became the park it is today (Zelade, 2016).

Research Plan

Design of Study

The method and placement of data collection will lead to an answer to the question stated in the Purpose by examining and differentiating the relative amount of diverse species of plants both close to water (within 25 meters of an open water source), and far away from water (at a distance of 150-200 meters away from an open water source). Five transects will be placed along borders/strips of land near the creek bed itself, while four others will be placed deeper within the wooded areas of the park, as the creek bed is surrounded by a large wooded area. Nine transects of 50 meters each will be used in designated distances from water (the four transects within 25 meters of the creek bed and the four on either side of the creek bed, all 150-200 meters away from water) in an attempt to gather the most accurate and precise representation of the park and it's relation to the study purposes. Data will be taken three times each visit to the park, with three transects being recorded each visit to the park. Data will be taken from each transect only once.

Background Information

In Western China, a study was conducted where multiple study sites researched the biodiversity of plants based on their distance from ground water. The study was conducted over the course of two years, and focused on the lower levels of the Tarim River. The scientists conducting the study discovered that plant diversity was directly related to their level according to the ground water, through 9 water wells over 50 testing sites across the river. They conducted surveys within the wells, and concluded that as the plants got closer to the water, the biodiversity began to thin, from a range of 0.53-1.93 to 0.35-0.82 moving from upper to lower portions of the surrounding land. Other results affirmed that the flowing water put stress on many plant species ecosystems, and only plants suited for such a wet environment survived. This means that as plants get closer to open water, they become less diverse, supporting the hypothesis (Chen, 1996).

In Cedar Creek (Minnesota), a study was conducted that tested the effects of the characteristics of an ecosystem affected plant diversity in 1996. This studied 168 plots of plants randomly chosen from 18 plant species. The scientists concluded that diversity-dependent ecosystem feedbacks and interspecific complementarity accumulate over time as their main result, through intensive experiments on the species in their respective crop fields. Other findings concluded that if an ecosystem is fed by a specific body of water, all with a consistent water source, the diversity will be specific to that water source. They measured this by using transects along man made water sources throughout testing fields. The study shows that diversity is affected by the source of water feeding the area, as the study showed that plants are fed by a consistent body of water will have diversity to specific to that water source. This supports the hypothesis because it says that an open water source does have an affect on diversity, meaning that their should be a difference in species richness between the plants near and the plants further away from the water (i.e they will not have the same species richness)(Tilman, 2016).

In areas of central and southern Missouri, multiple studies were conducted that studied native plants that live in dry areas. The study showed that the foundation plants of a landscape are native wildflowers, shrubs, and grasses. These are important because they attract birds, and pollinators, such as butterflies and bees. Not only do these native plants attract wildlife, but they also act to maintain it. Plants such as these can be found only at a longer distance from open water sources, and differ from those that are found near creek beds. They came to this conclusion by studying multiple nature reserves in their state. This is because plants away from open sources need fewer adaptations to thrive. This supports the hypothesis because it shows that there is vast plant biodiversity far away from open water bodies (Sternberg, 2016).

Materials

- 50m transect tape
- Knife or scissors to take plant samples
- Native & Naturalized Woody Plants of Austin & the Hill Country book
- Topographic, Trail and Aerial maps.
- Permission slips from the City of Austin and Balcones Canyonland preserve permission form
- Journal for notes and samples

Procedure

1. Walk along transects and collect samples of each new plant species encountered along with recording every plant that was found, where it was found, and a written description of each plant.
2. Record the data collected
3. Identify the plants using a Dichotomous Key
4. Calculate and record the Relative Density to find the percentage of the total number of plants found each species of plant is; calculate and record the relative dominance to find what percentage of the total intercept length each species is taking up; calculate and record the relative frequency to find the commonness and distribution of each species; and calculate and record the importance value to get an overall estimate of the influence or importance of each species.

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Planet Earth Biodiversity Project

Conclusion

From the data gathered from the studies conducted at Bull Creek, it was determined that one factor that affects species richness of woody plants is proximity to water. By taking eight 50 meter transects of data, four within 50 meters of the creek bed and four 150 meters-200 meters away from the creek bed, the experiment attempted to determine whether proximity to water played a factor in the species richness of woody plants. The hypothesis was proposed that as the distance from water increased, the richness of local woody plant species would increase due to the more welcoming and less specified environment. However, the studies actually directly contradicted the previous guess, and the average number of plant species far from water was roughly 2.75 less than creekside areas. This is most likely the case because running water makes it more difficult to sustain plant life, and only more specific plants suited for that particular environment could thrive in such a wet and kinetic area.

Results:

Figure one of the data collected at Bull Creek District Park in Austin, Texas, United States of America, in the fall of 2016 shows a trend of that woody plants are found to be in more abundance near an open source of freshwater, Bull Creek. This was determined by observing that on average, more woody plants were found along the 50m transects of data that were taken within 50m of an open source of fresh water than the average amount of woody plants found on 50m transects of data at a distance between 150m and 200m away from the creek. In addition, a trend can be seen in that certain plants such as Ash Juniper, Lindheimer Silk-tassel, and Possumhaw being more abundant nearer water as the transects of data within 50m of water had more of these plants than the transects of data at a distance between 150m and 200m. However, after running a T-Test on the data shown by figure one, the data that shows this trend is was found to be insignificant.

Figure two of the same data shows a trend that woody plants are found to have more species richness near an open source of freshwater. This was determined by observing that on average, 8.50 species of woody plants were found along the 50m transects of data that were taken within 50m of an open source of fresh water which was greater than the average of 5.75 species of woody plants found on 50m transects of data at a distance between 150m and 200m away from the creek. After running a T-Test on the data shown by figure two, the data that shows this trend is was found to be significant.

Figure three of the same data shows fails to show a trend in the difference in relative density between woody plants near freshwater and away from fresh water. The data shows that some plants such as Ash Juniper and Texas Ash have a higher average relative density on transects further from the water while other plants such as Possumhaw having a higher relative density nearer to the water (can be seen in figure 3 bar graph). This data shows no correlation between a the relative density of a woody plant and its proximity to water. After running a T-Test on the data shown by figure one, the data was found to be insignificant.

Figure four of the same data shows the importance value of the top four most recorded species observed at Bull Creek District Park. The data shows that Ash Juniper was the most important species (importance determined by adding a species relative density, relative dominance and relative frequency) with it having an importance value of 116.29, which was 38.8 percent of the total Importance value for all plants. Lindheimer Silk-tassel was the second most important with an importance value of 65.65 (21.9 percent of the total importance value), followed by Texas Ash and Possumhaw. The data can be seen represented in the pie chart of figure 5.

Figure five of the same data shows fails to show a trend in the difference in relative frequency between woody plants near freshwater and away from fresh water. The data shows that some plants such as Ash Juniper and Possumhaw have a higher average relative frequency on transects nearer the water while other plants such as Possumhaw having a higher relative frequency further from the water (can be seen in figure 5 bar graph). This data shows no correlation between a the relative frequency of a woody plant and its proximity to water. After running a T-Test on the data shown by figure one, the data was found to be insignificant.

Discussion:

Of the eight transects analyzed for the final data, the four species that were most abundant were the Ash Juniper, Lindheimer Silk-tassel, Possumhaw, and Texas Ash. Out of these top 4 plants, 3 were denser in areas further from a water source than those within 100 feet. From this data, it can be concluded that proximity to water is directly related to species richness of woody plants, because water provides an open resource for plants that allows for more species to thrive. As conducted in a 2001 experiment by the Journal of Vegetation Science, it was concluded that “Many studies have found relationships between changes in species richness and a gradient of nutrient availability”(Grime 1973). This means that, like the Bull Creek experiment also showed, that as proximity to water grows nearer, such does the species richness.

Another study conducted in Mexico held results that “Show that the effects of [water availability] are dependent on the vegetation type and that these are not strongly related to the species richness, and diversity in a microscale”(Aguirre-Gutiérrez 2014). This study also shows that though water availability does have a direct effect on plant life diversity, it varies depending on the specific species of the plant. This is evident in the data collected at Bull Creek, which showe ¾ of the most popular plants were more common in further forest areas, while the Texas Ash was quite more abundant in areas within 100 feet of an open water source. This means that, although there are some exceptions, availability of water positively correlates to species richness in woody plants.

The results seemed to suggest that our hypothesis was incorrect. Our collected data showed a significant relationship between a higher species richness near water than the species richness away from water. In all, the total further from water was significantly greater than the total nearer to water, which means that the results suggested our hypothesis was incorrect. That still contributes to the original purpose, as the objective to determine the correlation, nor prove its positivity.

The group conducting the experiment didn't find many problems with what they were trying to study, although there were some foreign species that were unidentifiable according the the Texas Dichotomous Key. This made species density slightly more difficult as it was harder to label foreign species, although it didn't matter much when it came to conclusions. If redone, however, the study could be modified by taking more data, because only 8 transects studies in random spots throughout the whole park did not provide an accurate enough scope for the area. Because some species only appeared in one or two transects, that may mean that other more remote areas in the park may hold small niches of plant species that appear nowhere else in the park. This would drastically change the data, even if the study only added a handful more transects.

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James Palmer
Bryce Yeazell

Introduction and Research Plan

Purpose

The goal is to study the density and diversity of woody plants, in Bull Creek Canyon in Austin, Texas, in relation to proximity of urban areas to their location.

Hypothesis

Woody plant species richness will increase as the distance to industrialized areas increases because humans remove some woody plants and there are lower nutrient levels closer to urban areas.

Site Description

Location

Bull Creek Canyon is a park found in Austin, Texas. It is in Northwest Austin. A major intersection that is 3.5 miles east of the center of Bull Creek Canyon Preserve is the intersection of Loop 360 and Research Boulevard (183). One major intersection on the western border, in the northern part of the park, of Bull Creek Canyon is the intersection of Spicewood Springs and Loop 360.

Size and Shape

Bull Creek Canyon resembles two rectangles at the southwest and northern areas, the northern rectangle being significantly larger than the southern one. These two rectangles are connected by a thin strip of land, following the path of the creek. Bull creek is approximately 214.6 hectares.

Topography

Bull Creek Canyon's highest point is 286.6 meters above sea level and its lowest point is 152.6 meters above sea level, so there is a 134 meter change in elevation throughout the park. The highest points in the Canyon are the peaks of hills, and the lowest point of the canyon is where the creek is flowing. There are several hills around the canyon varying from about 90 meters to 125 meters tall.

Geology

The five types of bedrock in Bull Creek Canyon Preserve are Glen Rose Formation, Walnut Formation, Edwards Formation, Lower Colorado River Terrace Deposits, and Alluvium. Glen Rose Formation is a shallow marine to shoreline bedrock mostly composed of limestone and a bit of chalk from the Lower Cretaceous Period. Walnut formation is comprised of limestone with clay seams and is from the Lower Cretaceous Period. Edwards Formation is comprised of

different types of limestone from the Lower Cretaceous Period. Lower Colorado River Terrace Deposit is comprised of silt, sand, gravel, and clay, and is from the Pleistocene Period. Alluvium is comprised of silt, sand, clay, and gravel, and this formation was formed recently. There were fossilized Gryphaea, a fossilized Turritella and various other fossilized pieces in Bull Creek Canyon Preserve.

Areal Extent and Types of Vegetation

Four common species of plants found throughout Bull Creek Canyon are Plateau Live Oak, Ashe Juniper, French Mulberry , and Lindheimer Silktassel. Approximately 3% of the park is grasslands and 97% of the park is woodlands.

Availability of Water

Bull Creek Canyon has Bull Creek running from the Northwest corner of the park to the Southeast corner of the park. Bull Creek has a slow flow of water in it. It has water depths ranging from 0 meters to 2.5 meters that are largely based on the amount of rainfall in recent times. Bull Creek has massive floods at time, and this is evident based on the amount of brush washed into high branches of trees near the bank.

Proximity to Urban or Industrial Areas

Bull Creek has a large range of distances from urban areas, spanning from directly below a developed bridge to distances of approximately one kilometer from neighborhoods in the center of the park. Bull Creek is bordered by Jester, on the southwestern side; Great Hills, on the northwestern side; and Northwest Hills, on the eastern side.

History

Throughout the 1990's, Bull Creek Canyon Preserve was bought by the city of Austin, and turned into a park. Bull Creek Canyon Preserve used to be a dog park, but was changed due to the large amounts of harmful bacteria present in the water due to the presence of dogs. Bull Creek has also always been a popular swimming spot due to the shallow flat bottom of the creek. Near the more urbanized areas and on roads there have been flood resistant designs as these areas are prone to flooding.

Research Plan

Design of Study

The group will visit six 50 meter long transects, throughout Bull Creek Canyon Preserve, to record data, and each transect will be visited once. Each transect will be covered by more than thirty meters of woody plant overhang. The transects are each placed at different distances from industrialized areas. The two highly industrialized transects are under the points where 360

crosses over Bull Creek. These points lie in the central southern part of the park, and the transects will be running parallel to the creek on the bank. The second set of transects are under the moderately industrialized category, and are 50 to 100 meters from roads and neighborhoods. Both of these transects are relatively near roads that are low traffic. The first transect of the category is in the far south-west corner of Bull Creek Canyon Park, just east of the creek itself, pointing north-east to south-west. The second transect lies in the east section of the park, in between low traffic roads and developing residential areas pointing north-west to southeast. The two final transects are in the north east section of the park, pointing North South, lying fairly close to each other and a distance between 500 meters and a kilometer from industrial areas. These two transects are in the center of Forest Ridge, a section of Bull Creek Canyon preserve inaccessible in the winter. The group will study 0.28% of the actual area of the park in their study. The group has the transects placed at different distances from industrialized areas throughout Bull Creek Canyon Preserve in order to see how distance from industrialized areas affects the species richness of woody plants.

Background Information

The study conducted by Michael L. McKinney about how urban development affects the richness of different species was conducted in Knoxville Tennessee. The method for this study was to measure the biodiversity by counting number of species in heavily urbanized areas and compare that data to biodiversity counts in rural areas. The study concluded that species diversity is decreased in central urban areas, but in areas with suburban levels of industrialization biodiversity is increased. Although there are a higher amount of plant species in urbanized areas, a large percentage is non-native or invasive species. This article helps predict that in Bull Creek Canyon Park there will be less rich transects in more industrial areas (McKinney, 2008).

In Milwaukee, a research group surveyed 316 plots of land in a suburban area to determine their woody plant populations. The group studied the lots for tree density, and species of woody plants in them. They concluded that the structure of this area made it appear to be savannah like, and was dominated by Elms, Ash, and Maple. The urban area was different from a savannah due to the diversity of species and the productivity of vegetation. The lacking amount of plants in the urban area can lead to the belief that woody plant species are less productive and therefore less prevalent in suburban areas. Based on this research, the further an ecosystem is from a suburban area should lead it to having a greater species richness of woody plants (Dorney, 1984).

In West Georgia, a group surveyed the abundance of riparian forests and the diversity of woody plants in those forests. The group mapped the riparian forests, and found a lower density of them near urban areas. The lacking amount of forests near urban areas in Georgia can lead to the belief that woody plants are less common near urban areas. Based on the research, in Bull Creek

Canyon Preserve, a transect being farther from urban areas should lead it to have greater species richness of woody plants (Burton, 2005).

Materials

50 meter transect
A pair of scissors/knife
Native and Naturalized Woody Plants of Austin and the Hill Country by Daniel Lynch

Procedures

For the groups' data collection procedure, the research group will lay six fifty meter transects at different distances from urban areas and infrastructure throughout Bull Creek Canyon Preserve. At each transect, the group collects leaf samples, using scissors or a knife, from each species of woody plant; marks the number of each species there are; marks the number of 5 meter intervals each plant hangs over; and marks the number of meters that each plant overhangs. The group will place each sample they collect into their notebook to press the leaves while they dry. If the group finds poison ivy and cacti, the group will take pictures of the samples to identify them by. For the groups' analysis procedure, the group will identify each species of woody plant using *Native and Naturalized Woody Plants of Austin and the Hill Country* by Daniel Lynch. The group will determine the relative density, relative dominance, relative frequency, and importance value of the woody plants along each transect. To calculate relative density of each species, the group will divide the total number of individuals of a species along a transect by the total number of woody plant individuals along the transect. To calculate relative frequency, the group will put the number of 5 meter intervals one species covers of the transect over the number of total 5 meter intervals on the transect covered by woody plant species. To calculate relative dominance, the group will divide the total distance covered by a species of woody plant by the total distance of the transect covered by woody plant species. To calculate importance value, the group will add the relative density, the relative frequency, and relative dominance for a species. The group will record the number of woody plant species found along each transect, and the number of meters that the woody plants each hang over the transect in order to see which distance from urban areas best allows woody plant growth.

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Topographic Map of Bull Creek Canyon

Trail Map of Bull Creek Canyon

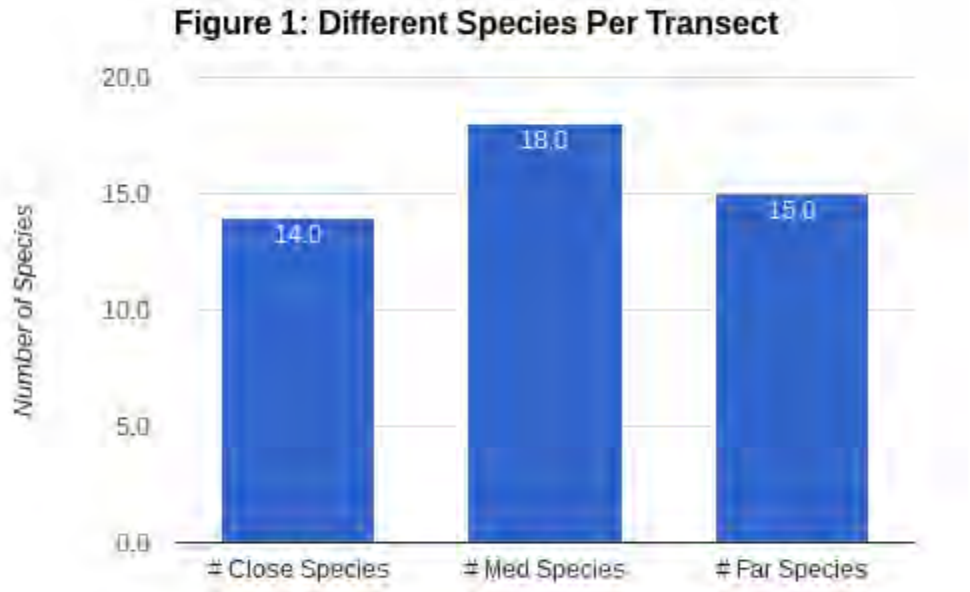
Effects of Urbanization on Species Richness of Woody Plants

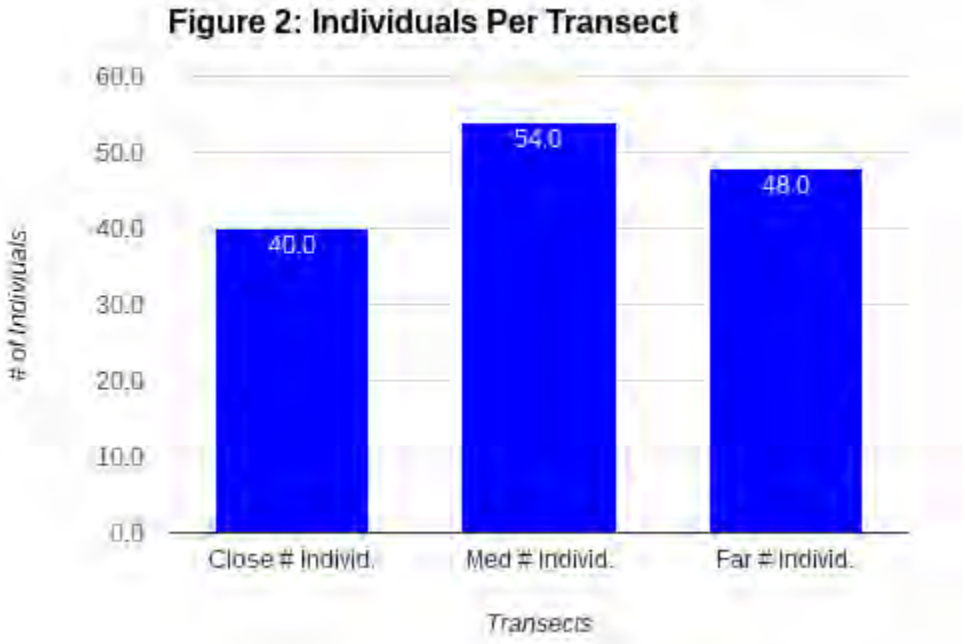
James Palmer and Bryce Yeazell

Results:

The research group found, in Bull Creek Canyon, in Austin, Texas, that the species richness of areas that were 50 to 100 meters from roads had a significantly greater species richness than areas that were directly beneath highways to within 25 meters of roads. The group took two 50 meter long transects in each area to collect the species and number of woody plants that hung over the transect. The areas that transects were taken in were within 25 meters of roads, from 50 to 100 meters from roads, and from 400 to 600 meters. Using the data collected on along the four transects, t-tests were executed, and two were found to produce significant results. These p-values were from two t-tests that compared the number of occurrences of woody plants and the number of species of woody plants between the close and medium distance transect from roads. The group was able to find that there was a 97% chance that the difference in number of species in each area was significant, and that there was a 96% chance that the difference in density of woody plants in each region was significant.

The species richness along transects medium distances from roads was generally greater than the species richness along transects far distances from roads, as seen in figure 1 and figure 2, but the T-Tests showed no significant difference between these groups.





The research group found that the most dominant species, in Bull Creek Canyon, in Austin, Texas are Ashe Juniper, Cedar Elm, Plateau Live Oak, and Texas Ash, as seen in figure 3. These 3 species combined make up approximately half of the species in Bull Creek Canyon Preserve based on the data taken by the group.

Figure 3: Total Occurences

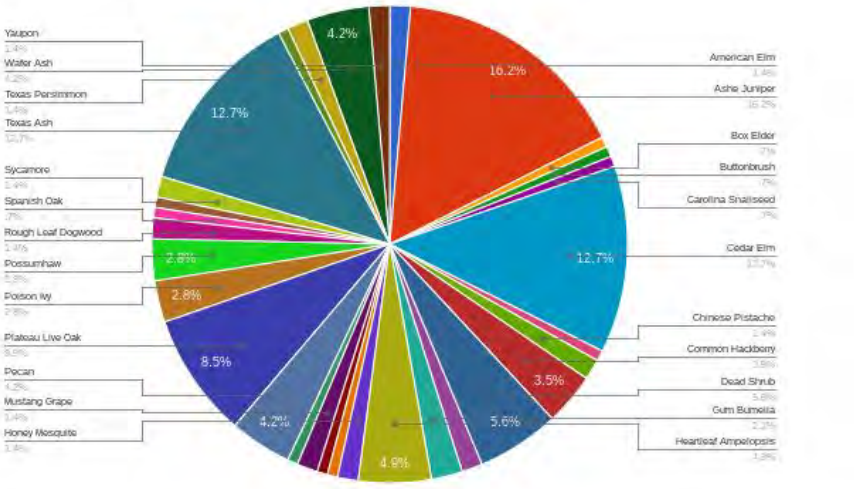


Figure 4, Figure 5, and Figure 6 all show how the dominance of each of the four most dominant species along the transects were affected by their distance from roads. Ashe Juniper were most dominant along transects at medium distances from roads, and were least dominant along transects short distances from roads. Cedar Elm were most dominant along transects at far distances from roads, and were least dominant along transects short distances from roads. Plateau Live Oak were most dominant along transects at moderate distances from roads, and were least dominant along transects far distances from roads. Texas Ash were very dominant along transects at close distances to roads, and weren't present along transects at further distances from roads.

Figure 4: Relative Dominance

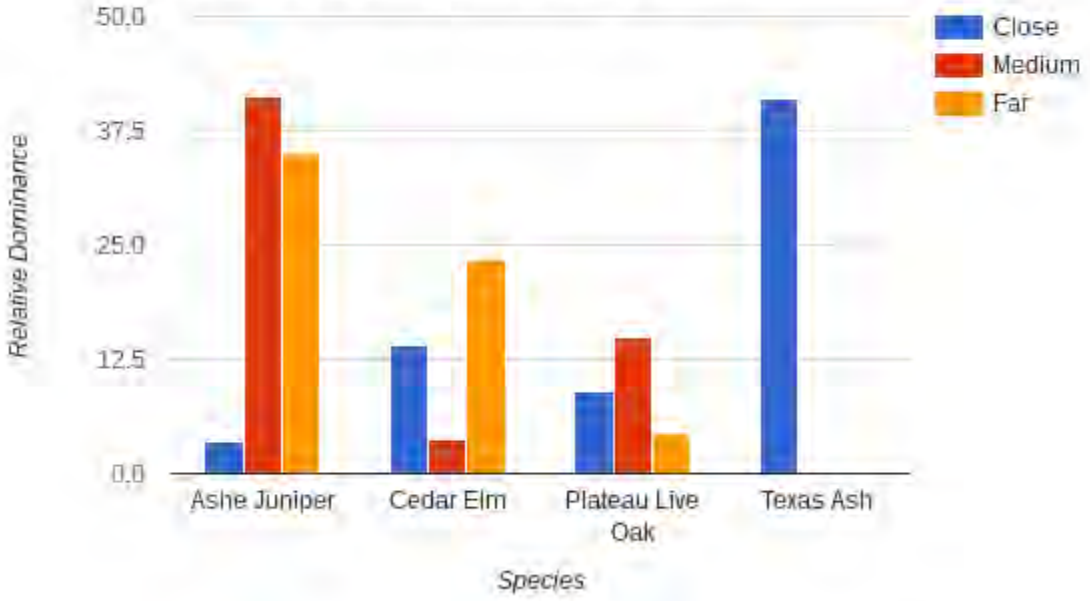
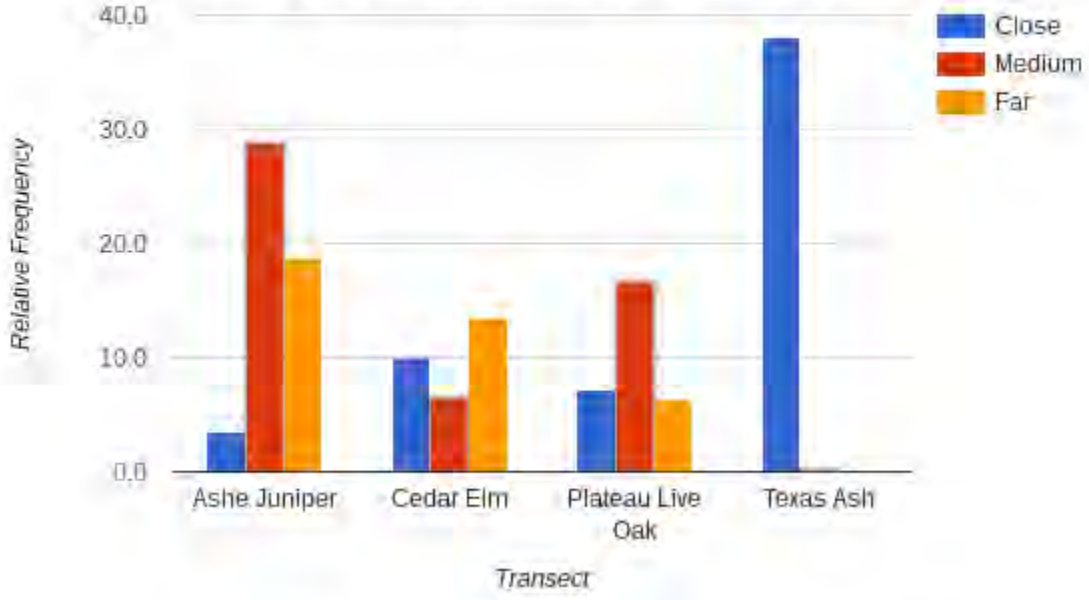
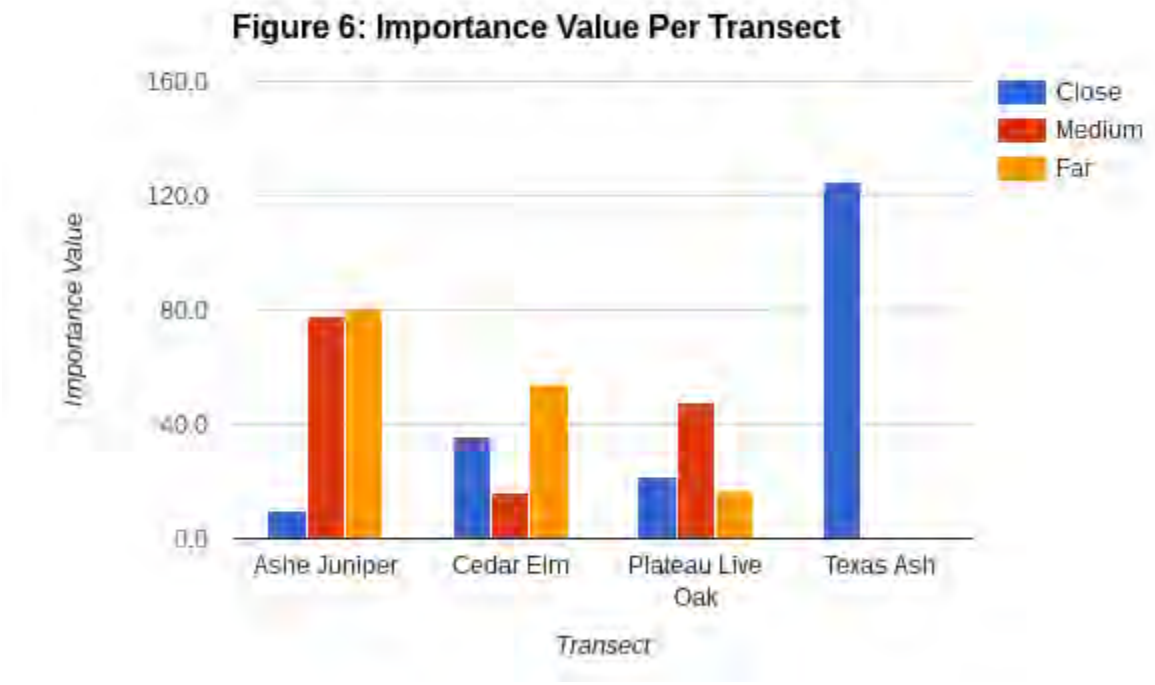


Figure 5: Relative Frequency Per Transect





Interpretation:

The species richness of woody plants, in Bull Creek Canyon Preserve, is greater in the range of 50 to 100 meters from roads than in the ranges within 25 meters of roads and 400 to 600 meters from roads. Figure 1 and Figure 2 both show that there are on average a greater abundance and diversity of woody plants at moderate distances from road than in areas close to and far from roads. The group's t-tests show that this difference, in species richness, is significant between the transects taken at close distances to roads and the transects taken at moderate distances from roads.

The data supports the group's hypothesis because the one significant difference is that the species richness is greater in areas at moderate distances from roads than in areas close to roads. Their data shows a general trend that the species richness is greater at moderate distances from roads than at far distances from roads, but based on the t-tests, this change is insignificant so, it could have been caused by an experimental error. The group's hypothesis aligns with their results because the only significant difference in their data was that there was a greater species richness of woody plants at moderate distances than at close distances from roads, which supports their hypothesis. Although the data supporting the group's hypothesis is possible, it is more likely that areas that are moderate distances from urbanization promote the greatest species richness of areas tested, and the areas at close distances to urbanization have the least species richness.

In an article by David Buckley, he studied the effects of skid trails, temporary roads loggers use, on species richness in the area surrounding these rural roads. His article showed that skid trails, a medium level of development, contributed to an increase of species richness, introducing 13% of new species in that area (Buckley). This article supports the results found in

the bull creek study, reinforcing the idea that medium levels of development increase species richness.

A study conducted by Nogués-Bravo, found that at various elevations, species richness was more affected by distance from urbanization than by changes in elevation. The results showed that there was an increase in different species in partially-urbanized areas (Nogués-Bravo), as there was more resources available, without limiting the available resources native species relied upon. These two articles show that minor levels of urbanization can contribute to an increase of species richness in the surrounding areas.

A possible error that could have occurred during this study is the transects that were used to measure overhang in different locations were not fully representative of the area as a whole. Each location of the transects had various levels of overhang which could not possibly be shown in the 50m transects used. Another possible error could have been the misidentification of recorded species. This would have resulted in an inaccurate representation of the species richness in each transect. A third error that could have occurred during this experiment is that the group didn't collect all of their transects on the same day. This would allow for different weather events to change the landscape, which would result in changed species richness of woody plants in different areas.

In the future, in order to gain a more detailed and better supported view of the effects of urbanization on species richness, there should be studies conducted in other parks and areas to confirm that the relationship shown through the results of this article is not confined to this one park. Further testing would result in a larger data pool to draw better conclusions about the significance of urbanization on species richness of woody plants.

Works Cited:

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George Borowski
Jacob Watson
Zach Walgren

Introduction

Purpose:
The purpose of the Biodiversity Project is to study the population and level of diversity in woody plants at Gus Fruh Park, in Austin, TX and how these variables are affected by distance from the area's main water source, Barton Creek.

Hypothesis:
As distance from Barton Creek increases, the level of species diversity will decrease along with population in woody plants, because an environment is more survivable for plants when there is more water directly available, as shown by several studies.

Site Description

Location

Gus Fruh Trail is located in western Austin, Texas. It is situated within the Barton Creek Greenbelt, the area surrounding Barton Creek, a tributary of the Colorado River. As for notable landmarks, the park is intercepted by the South Capital of Texas Highway (Highway 360), and the official entrance is approximately 1.2km from *Toys 'R' Us* as the crow flies.

Size and Shape

The park is shaped like an ellipse south of 360 and shaped like a rectangle on the north side of 360. The park spans over roughly 204.5 hectares.

Topography

According to a topographic map of the area, the maximum elevation is 213.4m above sea level, and the minimum elevation is 149.4m. In general the park has a moderately steep incline going away from Barton Creek, but some areas are more flat in character.

Geology

Gus Fruh Trail is on top of several geologic formations. According to a geologic map of the Austin area published by the University of Texas at Austin, the Barton Creek riverbed is recently deposited Alluvium and is composed of silt, sand, clay and gravel. Areas around the bends are Tributary terrace deposits, composed of similar materials, but have been deposited somewhat less recently, in the Pleistocene epoch of the Quaternary period. The dry land itself is largely from the Edwards Formation, which is composed of porous limestone and dolomite, formed in the Lower Cretaceous period. Another rock formation present in the park is the Georgetown Formation, composed of limestone and marly limestone, with abundant fossils present, formed after the Edwards Formation, but still within the Lower Cretaceous period. Around the bend of

Barton Creek is the Del Rio Formation, which is composed of clay, and was formed in the Lower Cretaceous period, after the Georgetown Formation. (Garner et al.)

Areal Extent and General Type of Vegetation

The park is 85% woods and 15% river and rocky river bed. The woodland and river beds have Ashe juniper growing in them, which are dispersed throughout the entire park. Poison Ivy was also very abundant around the park but only in the woodlands not used recreationally, where there is not as much human interaction. Bald Cypress was very common on the sides of the creek, near water sources.

Availability of Water

There is the large Barton Creek that runs through the park with some channels shooting off that fill during flooding. It is currently very full due to large amounts of summer rainfall which is unusual for this area of Texas. At some parts of the park the creek is very wide at roughly 100m while other areas it was closer to 45m. There was some evidence of flooding on the canyon walls beside the stream and from the debris surrounding the stream. The watermark on the canyon wall was higher than the stream at the time and there were various branches, pieces of litter, and rocks displaced a sizable distance from the stream. There was even a place where a bridge used to be but flooding destroyed it.

Proximity to Urban or Industrial Areas

Gus Fruh has the major Highway 360 crossing over it. There are many entrances along the park at different urban areas, including a business complex off of 360 adjacent to east side of the park and an entrance at a neighborhood adjacent to the east side of the park. The park is often used for recreational purposes (e.g. swimming, running, biking). It is also 1.38km from the Barton Creek Mall, one of the Austin Area's largest indoor shopping areas, and 0.6 km from Mopac a major highway.

History

Gus Fruh Trail was initially acquired in 1980, and was expanded in 1986 and 1992. The park is considered a part of the greater Barton Creek Greenbelt, a heavily forested and vegetated area that surrounds Barton Creek. Although it is nearby to several developed areas, the land claimed by Gus Fruh Trail has been undeveloped until it was made a park in 1980, and trails were drawn out to aid hikers. (Sharp)

Research Plan

Design of Study

Each of the processes described in the Procedures section will help describe the diversity in species of woody plants based on distance from water at Gus Fruh Trail by taking into account several population-related factors. There will be 3 transects along which data is collected which

will all be placed parallel to the southern bend of Barton Creek to the east of Highway 360, the first transect will be placed so that the center is 10m away from the creek. The second will be placed 40m away, and the third will be placed 70m away. One transect will create a sampling area that is 50m long, and approximately 20m wide, so therefore the area each transect covers will be approximately 1000m^2. Since there are 3 transects, the total is 3000m^2, or 0.3 hectares. Since the total study area is around 204.5 hectares, 0.15% of the total study area will be sampled during the study.

Background Information

A study conducted in Switzerland was observing the conditions of trees in relationship to their distance from a water source. They had three areas where they collected data from, a wet area, semi-dry, and very dry area. They then measured multiple variables on the same species of tree, such as the morphology, radial growth, wood anatomy, and leaf area. The data showed that both species thrived in the wet area and managed in the semi dry area. This data suggests that water and plant growth have a close correlation, so at Gus Fruh it can be expected that the distance from water will affect the growth of woody plants (Sass-Klaassen et al. 2006).

"Bayesian inference of tree water relations using a Soil-Tree Atmosphere Continuum model" is a scientific study monitoring the root-soil water interactions of mature white fir conducted by J. Rings, T. Kamaia, M. Kandelous, P. Hartsough, J. Simunek, J. A. Vrugt, and J.W. Hopmans. The goal was to identify the physical processes and hydrological properties that control spatial and temporal changes in the water flow of the soil-tree atmosphere. They discovered that there are very particular parameters that are optimal for the white fir to grow and perform its necessary functions. Using this information we can assume that some plants will be optimized to grow near water and others will need to gather less water and grow farther from the river bank (J. Rings et al. 2013).

A study was monitoring the relationships between tree water status and the amount of vegetative growth. The scientists took one year old peach trees and put them in different areas in California, after their preliminary growth the scientists transplanted the trees to a commercial orchard. Then the tree's water status were varied by using canopies to cover the trees on certain days and then measuring the vegetative growth and leaf gas exchanges. It was found that the trees that had about 60% of their canopy shaded had the most significant growth because they could get the necessary sunlight yet they didn't transpire that much water through their leaves and with that excess of water in their system the trees thrived. This is another study that shows that water and plant growth have a correlation so the hypothesis should have some validity to it (Solari et al. 2006).

Materials

- Transect Tape
- Notebook

- Pencil
- Clippers
- Maps
- Stake flag markers

Procedure

At differing distances [actual distances to be determined] from Barton Creek, 3 transect lines will be placed using 50m long transect tape, being sure that at least 30m of the tape is overlapped by vegetation. At each transect line, every woody plant that overlaps the transect line will be recorded, associated with one or more of 10 5m intervals along the line, along with the distance that the plant overhangs the transect line, the intercept, to the nearest decimeter. A description of the plant's physical characteristics will be included. After recording, a sample of the plant will be taken, so that the plant can be identified in the lab, if the plant can't be identified in the field. A sample will not be taken of poison ivy or fleshy cactus. After identifying the plants and gathering data, several analyses will be performed. The Relative Density of each species, the Relative Dominance of each species, the Relative Frequency of each species, and the Importance Value of each species will be calculated.

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Biodiversity Project Conclusion

George B., Jacob W., Zach W.

Results

After gathering data from the three transects, near, middle, and far from Barton Creek, at each site of study at Gus Fruh park (on the Barton Creek Greenbelt), it was found that near the water there was more biodiversity and as you got further there was less diversity but there were more specialized plants.

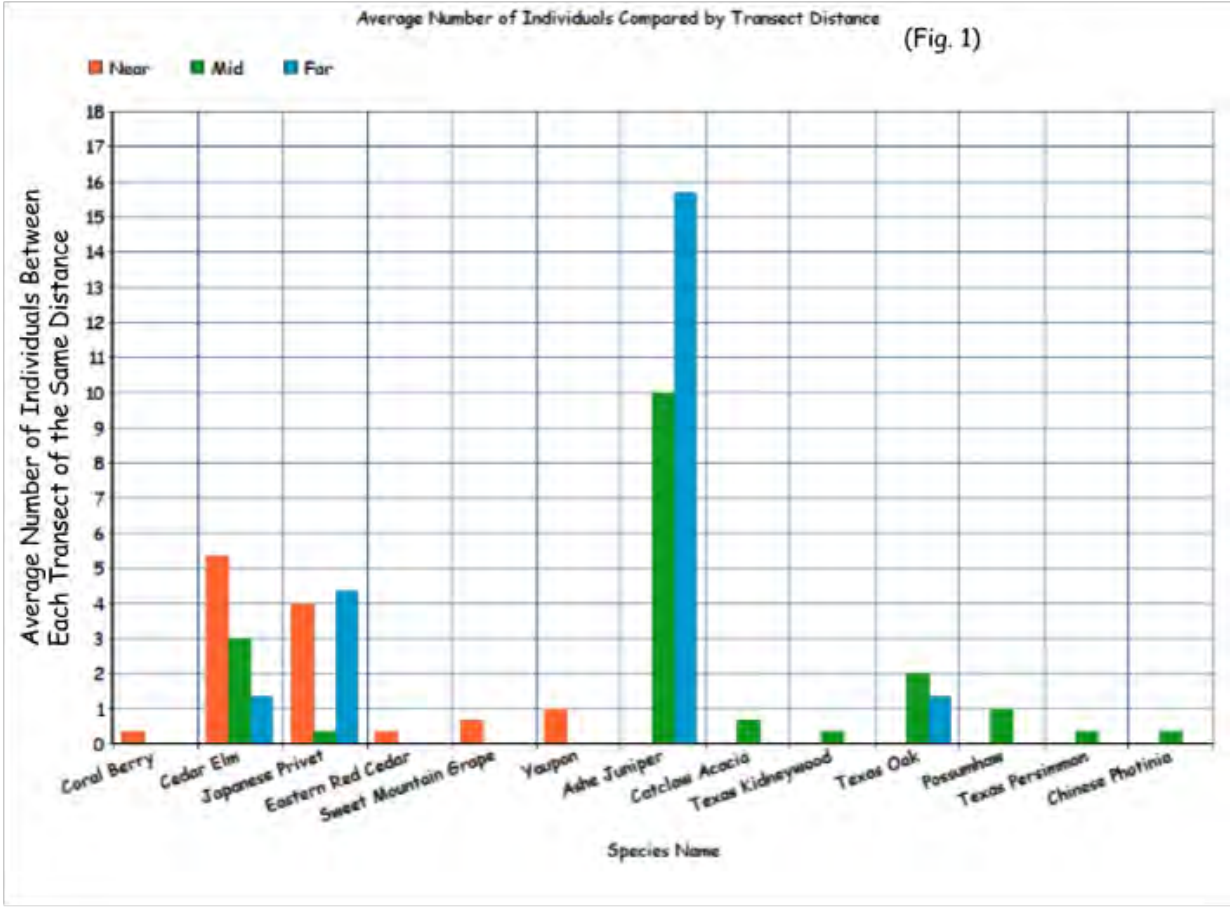
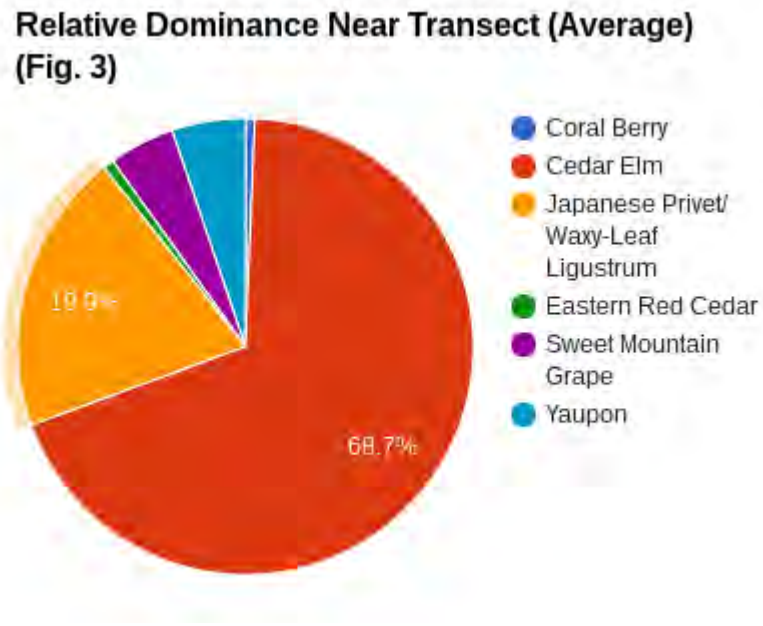


Fig. 1 shows the total number of average individuals found at each transect by species. However, there were some instances within certain species that followed the hypothesis that the population of woody plant species would be greater closer to a water source, such as cedar elm, while others followed the opposite trend, in the case of ashe juniper; a more drought resistant hardwood, whose population was increased as the distance from water increased. Some did not follow any trend: Japanese privet had a high population at the nearest and

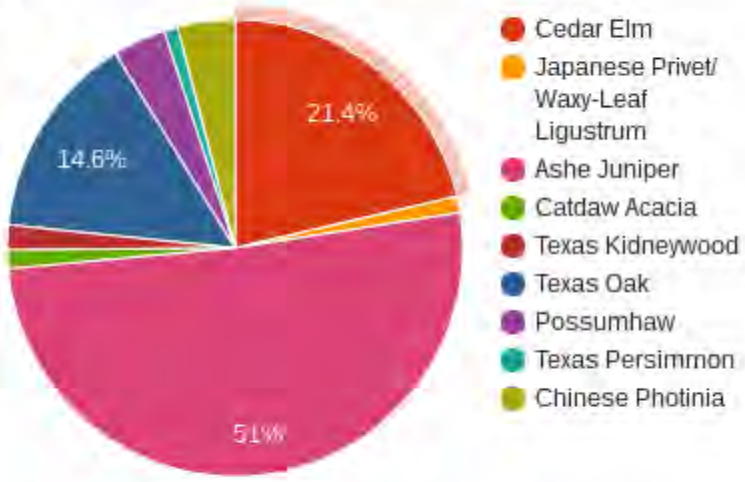
furthest transects but had a very low population at the middle transects. There is a significant difference between the amount of Ashe Juniper and the amount of Japanese privet (p-value of 0.038) though, which could show that while privet is spread fairly evenly across all transects, it may not be a good thing to base our conclusion off of due to its number being significantly lower than other species.

It can be noted in Fig. 1 that the level of diversity in species decreases significantly in the furthest transects, which had only 4 different species present, compared to the closest and middle transects having 6 and 9 different species respectively.

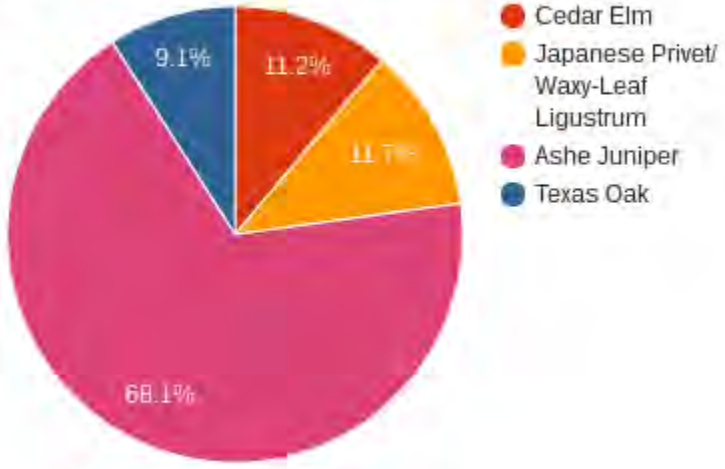
In an ANOVA test and subsequent T-test between the ashe juniper population, it was seen to have significant difference between the near and mid transect (P=0.003) and then the near and far transect (P=0.0006). The difference of the population between the mid and far transect did not have a significant difference however (P=0.069).



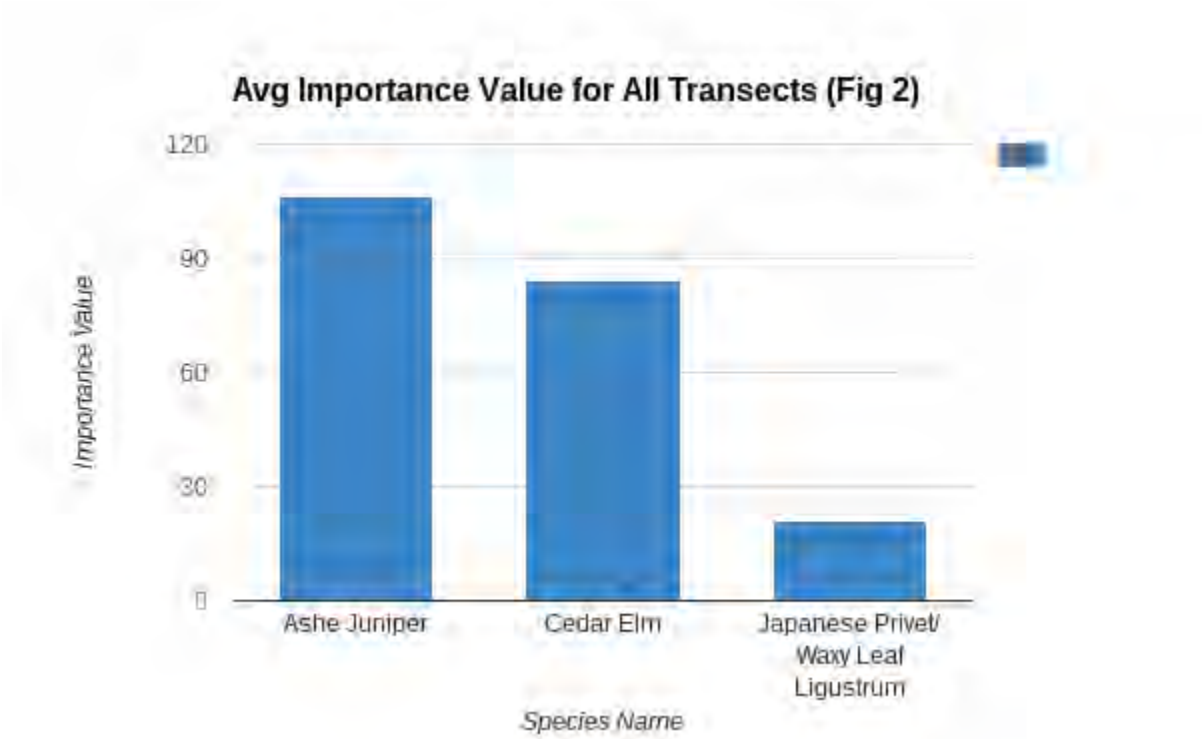
Relative Dominance Mid Transect (Average) (Fig. 4)



Relative Dominance Far Transect (Average) (Fig. 5)



For the closest transects, cedar elm showed the highest percentage for Relative Dominance at 68.7% of the transect (Fig. 3), meaning its biomass covers the largest area of the transect. In the middle and far transects, ashe juniper overtakes cedar elm, occupying 51% and 68.1% of the transects, respectively.



_____Looking at Figure 2 it can be seen that Ashe Juniper has the highest importance value from the study conducted with an average importance value of 106. Cedar elm is close behind with an average importance value of 84 and then Japanese Privet with an average importance value of 22. There is not that significant of a difference between the Importance Value of Ashe Juniper and the Value of Japanese Privet, but our other statistics show that there are other significant differences between these two species.

_____

Discussion

From the results found in the study, it can be inferred that due to the decrease in the population, dominance, and importance value of cedar elm in the transects further away from water, and the increase in the population, dominance, and importance value of ashe juniper in the transects further away from water, along with the decrease in species diversity in the transects furthest away from water, that areas close to water are able to support more species of woody plants.

The best explanation of the data comes from the fact that environments near to water tend to have soil that is more water-rich which makes for a

friendlier environment for woody plants to grow. "Soil properties influence growth considerably: for example...water content" (Larcher 16).

The plants with the highest importance value are shown in Figure 2. Each of these species represented a certain part of the results found. The ashe juniper population increased as the distance from water increased due to their ability to live with little water yet they needed space to grow which was not available at the water's edge. The cedar elm population decreased as the the distance from water increased.

Ashe juniper, whose population saw an increase in transects further away from water, is able to survive to a greater degree in dryer environments, so it would have little trouble growing away from water. Cedar elm on the other hand requires higher soil moisture, which caused it to have a greater presence in transects closer to water.

The lack of ashe juniper in the transects closest to water and the spike in ashe juniper population and dominance in the further transects may be explained by competition. Since cedar elm grows well close to water as the data shows, then its presence may have crowded out and out-competed the ashe juniper that would have grown closer to water. Since there was less cedar elm present in the further transects due to the dryer soil, ashe juniper was able to survive more easily. An academic text on the ecohydrology of systems in which water is present asserted that difference in soil moisture affects what kinds of species will grow (Rodriguez 4).

As with any study, there is some chance that the correlations found were not as a result of distance to water, but simply a result of chance. It is possible that ashe juniper seeds never landed near to the closer transects, and that the cedar elm just happened to grow closer to the creek. This is made more plausible by the pattern in the presence of Japanese privet, which had roughly equal populations in the closest and furthest transects, and experienced a major dip in presence in the middle transects. The pattern found with Japanese privet has no real explanation that can be found without extensive analysis, and contributes to the idea that the correlation with cedar elm and ashe juniper was simply a result of random distribution and chance.

Another possible source of error was the original locations of the transects being inaccessible in some cases. Sometimes there was an unprecedented change in elevation, or vegetation was too dense to run a 50-meter transect through. Having to adjust for obstacles such as these resulted in variance from the original planned locations of the transects, which may have resulted in skewed data.

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Henry Brodkin

Research and Site Description

Introduction

Purpose:

The purpose of this study is to study the correlation between the amount of woody plants and elevation in the eastern area of Gus Fruh.

Hypothesis:

There will likely be a denser population of woody plants in lower elevation because the proximity to the creek means smaller plants with shallow roots need to be closer to moist soil to survive in places with low rainfall. The creek flows at lower elevations throughout Gus Fruh.

Site Description:

Location:

Gus Fruh is located in southwest Austin, roughly 3 kilometers as the bird flies southwest of Zilker Metropolitan Park.

Size and Shape:

Gus Fruh is roughly 70 square kilometers, and is the shape of a misshapen star.

Topography:

Gus Fruh has many steep inclines and cliffs on either side of the creek bed. There are flat areas directly on either side of the creek bed, and the creek bed itself is mostly flat. The minimum elevation is 148 meters above sea level, and the maximum elevation is 212.2 meters above sea level.

Geology:

Commented [CC1]: Still missing Georgetown and Tributary terrace deposits and descriptions

Throughout Gus Fruh there are exposed limestone, from the Edwards Deposits (from the cretaceous era). Other exposed cliff faces and bedrock were also formed during the Cretaceous period. There are also smaller alluvium deposits, such as pebbles, all along the creek. The whole area is a valley like formation that the creek carved.

Areal Extent and General Type of Vegetation:

Gus Fruh is mostly dense woods (roughly 85-90%), with some grasslands (10-15%). There is a very high amount of woody plants, especially on the areas adjacent to the creek bed. Some examples of woody plants in Gus Fruh are oak trees, Ashe juniper, poison ivy, and box elder.

Availability of Water:

Barton Creek flows through the middle of the park. At the time of the site visit in mid-September 2016, the creek had a medium to low flow, at about 1.84 cubic meters per second (according to the austinparks.org at the time of the initial site visit in mid september). There is beaten down and washed out vegetation on either side of the creek that provides evidence of flooding.

Proximity to Urban Areas:

There are neighborhoods all around the eastern area of the park, and a large mall and shopping center to the west and north of the park. Major highways run to the west of Gus Fruh.

History:

The land in Gus Fruh probably was not used for anything previously due to the steep inclines and dense foresting. The terrain would be difficult to use for farming and

grazing due its relative difficulty to enter and exit. Gus Fruh was designated by the city in 1980, 1986, and 1992.

Research Plan:

Design of Study:

The study will utilize 50 meter transects, parallel to the creek at elevations of 150, 180 and 210 meters above sea level. 1 set of data will be collected from each transect line. These transects will show a large enough gradient of distances from the creek to show a noticeable correlation between elevation and amount of woody plants overhang (if there is one). The transects are located across the park due to there not being a range of elevations available in all areas, so roughly 75% of the park is being studied.

Commented [CC2]: % area studied refers to the actual area represented by your transects (assuming 10m width on either side of transect) as a percentage of the total area of the park. Should be much less than 75%. Let me know if you have questions about how to calculate it.

Background Information:

A study conducted in the Lower Rio Grande Valley in Texas tested how five significant shrub species reacted to major drought conditions by cultivating a group of each species. After a few months, four of each species were selected to be a control, and the remaining were subjected to conditions similar to that of a drought (adding increasing amounts of salt to dehydrate the plants). The results showed that some species did not have the capacity to survive in dehydrated soil (Adhikari). This supports the hypothesis because plants that cannot survive without moist soil will grow at lower elevations, closer to the creek, where the soil is moister.

Commented [CC3]: Include date: (Adhikari, 2014). Do this for all parenthetical citations

A study about the water use of different woody plants in central Texas tested how the depth of and moisture of soil affected the plants. The people that conducted the study chose three different areas of varying soil depths and moistures, and recorded how much water the plants used, as well as other indicators of the plant's healths. The study

concluded that plants in shallower and drier soils weren't as healthy as other plants in different conditions (Elkington 3). This supports the hypothesis because the soil at higher elevations are shallower and drier, which means there would be less woody plants in those areas.

Another study in Central Texas examined how plants perform in drought conditions in central Texas. They measured how many plants died off by walking transects during a large drought and wrote down how many living and dead plants there were of each species of plant. The study found out that certain plants died could not withstand the drought in dry soil (Twidwell). This data supports the hypothesis that there will likely be a denser population of woody plants at lower elevation in Gus Fruh because areas at higher elevations will likely be drier and have less moist soil, meaning fewer kinds of plants can survive there.

Materials

The two major materials required are the Woody Plant field guide, and a 50 meter Transect line.

Procedure

First, the location of the transect will be reached, and the 50 meter transect will be placed as straight as possible. The transect will then be walked, and the species of woody plants that overhang the transect line will be recorded. The common name, intercept range and length (the distance the woody plant overhangs the transect line to the nearest decimeter), and the interval the woody plant is found in (intervals include their endpoints.) Unknown species will be marked as Unknown X (x will be a letter that

Commented [CC4]: 5 m intervals

is demonstrative of how many unknown plants that have been identified previously i.e the 1st unknown plant is A, the 2nd is B, etc). Thirdly, a representative leaf will be collected. The leaf type and arrangement, as well as a description of the bark, and a description of the fruit or flower, will be recorded in the corresponding sample page in the back of the notebook. After the data is collected, Relative Density, Relative Dominance, Relative Frequency, and Importance Value will be calculated in the lab.

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http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1727&context=agronomyfacpub

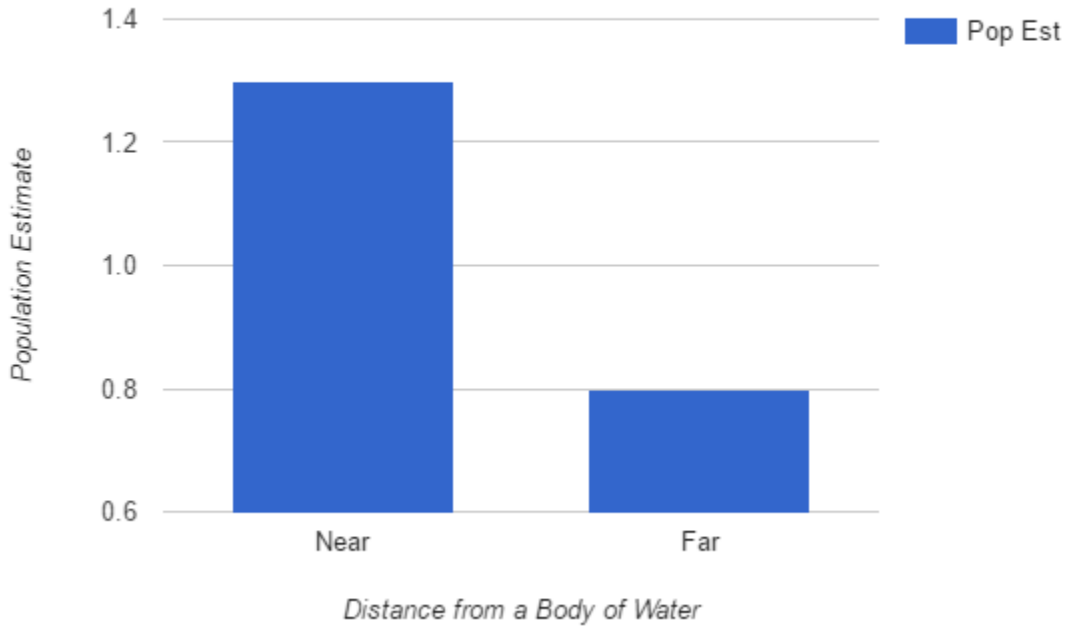
Griffin Davis
Planet Earth 3A - 7B
Crosby
6 December 2016

Conclusion

Results

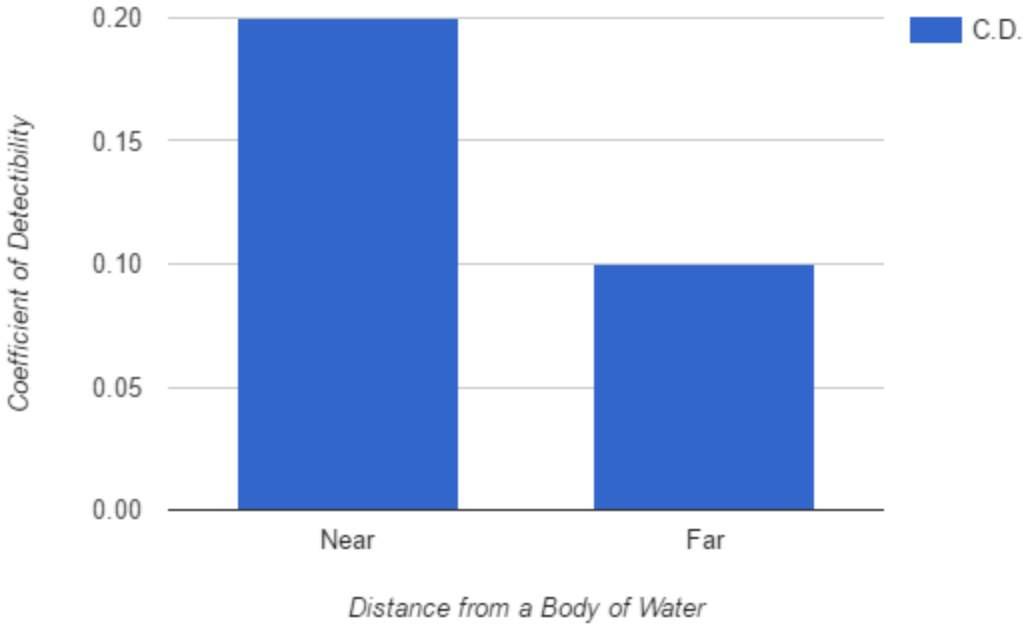
In a study of the effect of distance from a body of water on the population of Carolina Wren in the Gus Fruh Park, a trend of higher population estimates on a transect near a body of water as compared to a transect farther from a body of water was noticed (Figure 2). The average population estimate on the transect near a body of water was 1.3 Carolina Wren per Hectare, and the average population estimate on the transect farther from a body of water was 0.8 Carolina Wren per Hectare. In these average population estimates, the difference between each transect was nearing significant (P = 0.1).

Figure 2: Effect of Distance from a Body of Water on Population of Carolina Wren



An additional trend in the data collections was a similar average of coefficient of detectability. The average coefficient of detectability for the transect near a body of water was 0.2, and the average coefficient of detectability for the transect farther from a body of water was 0.1 (Figure 1). The difference between each of the data collections on each transect was not significant (P = 0.3).

Figure 1: Effect of Distance from a Body of Water on Coefficient of Detectability of Carolina Wren



Next, the data collected shows a lack of correlation between either temperature or human disturbances and a change in population estimate (Figure 3 and 4).

Figure 3: Effect of Human Disturbances on Population of Carolina Wren

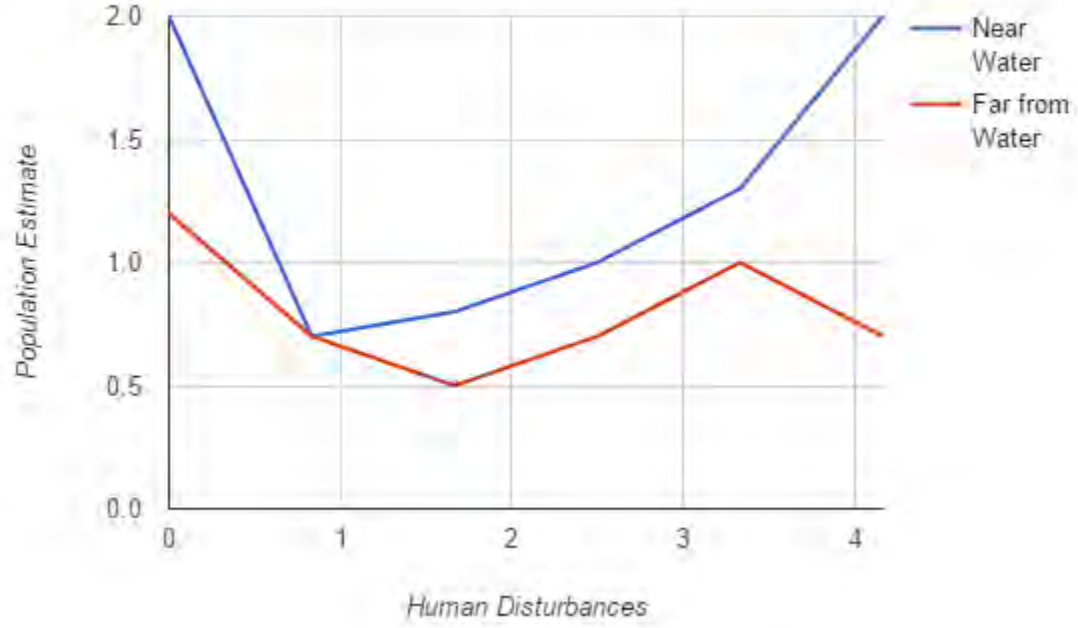
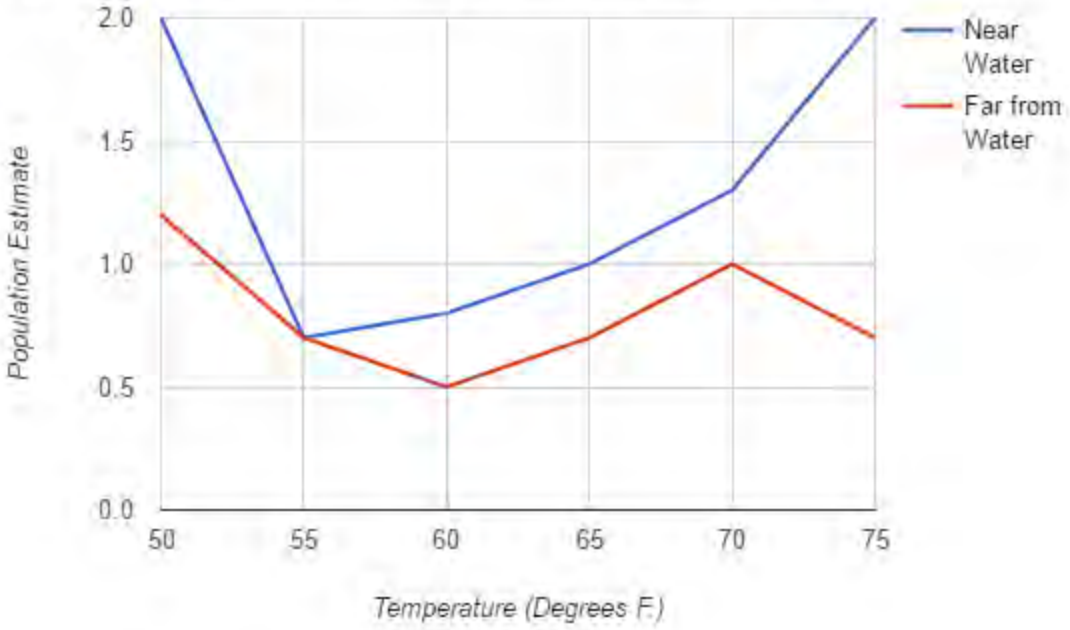


Figure 4: Effect of Temperature on Population of Caroline Wren



Discussion

The higher average population estimates of Carolina Wren near a body of water than farther from a body of water is likely due to the diet of the Carolina Wren. Carolina Wren are insectivores, this defines the diet of the Carolina Wren as consisting of insects (Haggerty, 1995). This was discovered in a study by Morten T. Haggerty. Morten T. Haggerty conducted this study on multiple characteristics of birds in North America. This study was run by collecting observational and quantitative data on the diet, nesting, appearance, and mating of multiple samples of a variety of bird species in North America including the Carolina Wren. The result of the study discovered a large amount of information about multiple bird species in North America, specifically the diet of the Carolina Wren. This study connects the Carolina Wren to its food source allowing for research on the location of this food source (Haggerty, 1995). A number of insects breed in large bodies of water, leading more Carolina Wren to live in close proximity to these areas.

Six percent of the diet of the Carolina Wren also comes from a small amount of vegetation (Jackson et. al., 2011). Some of this vegetation requires a close proximity to a body of water to survive. Allyson Jackson and colleagues discovered this along with other information about the diet of the Carolina Wren in a study. Allyson K. Jackson, David C. Evers, Matthew A. Etterson, Anne M. Condon, Sarah B. Folsom, Jennifer Detweiler, John Schmerfeld, and Daniel A. Cristol conducted this study on the effects of

mercury exposure on the reproductive success of Carolina Wren. This study was run by collecting quantitative data on the reproduction of Carolina Wren with mercury exposure versus a control group without mercury exposure. The results of the study also noted the diet of the Carolina Wren. This data connects the Carolina Wren to more of its food sources (Jackson et. al., 2011).

Other statistical analyses were done in order to rule out other factors in the data collection. The difference between the coefficient of detectability between the transects near a body of water and farther from a body of water is not significant, showing consistency in the detections of Carolina Wren between transects. Finally, the graphs showing no correlation between temperature and human disturbances and the effect of this factors on the average population estimates on both transects, show that these other variables did not have a major impact on the data collected. During this study, a low number of transects caused a sample size lower than desired. Increasing the number of transects for a future version of this study would be beneficial to the statistical analysis. A study on the insect populations near and farther from a body of water in Gus Fruh could provide a benefit to this study.

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Griffin Davis
Planet Earth: 3A - 7B
Crosby
13 September 2016

Introduction

Purpose

This research will study the effect of distance from a body of water on the abundance of Carolina Wren. This study will take place in Gus Fruh Park in Austin, Texas, United States of America.

Hypothesis

The expected result of this study is that the abundance of Carolina Wren will decrease with greater distance from a body of water. This result is expected because the food source of the Carolina Wren will be more prevalent near water.

Site Description

Location:

Gus Fruh Park is located in Southwest Austin, 3.2km Northeast of the intersection of Texas State Highway Loop 1 and Texas State Highway 290.

Size and Shape:

Gus Fruh Park has the approximate shape of a circle tangential to a rectangle along Barton Creek. This park has the approximate area of 112 hectares.

Topography:

The minimum elevation of the Gus Fruh Park is 155.48m and the maximum elevation is 198.12m. With these maximum and minimum elevation, the relief of the park can be calculated to be 140m. The terrain of this park can be described as rocky cliffs, overhangs, and it has the Barton Creek running through it.

Geology:

The geology of the Gus Fruh Park is made up of Gravel Deposits, Georgetown Formation, Fredericksburg Group, and Upper Glen Rose Limestone. The Gravel Deposits are composed of gravel exposed to the surface, and was created during the Quaternary Time Period. The Fredericksburg Formation is composed of Del Rio Clay, and was created during the Cretaceous Time Period. The Georgetown Formation is primarily composed of Edwards Limestone, and was created during the Cretaceous Time Period. The Upper Glen Rose Limestone is composed of limestone and dolomite, and was created during the Cretaceous Time Period. Additionally, this park is along the Balcones Fault, this will cause interesting geological formations including surface ruptures and fault scarps.

Areal Extent and General Type of Vegetation:
Woodland makes up 95% of the park, and grassland makes up the remaining 5%. Plants in the area include Ashe Juniper, Straggler Daisy, and Elbow Bush.

Availability of Water:
Gus Fruh Park follows a large portion of Barton Creek, the water level of this creek is high and, in some parts, quick moving during September 2016. There is no evidence of flooding in this park.

Proximity to Urban or Industrial Areas:
Gus Fruh is adjacent to neighborhoods, major shopping areas, and major roads. These areas surround all sides of the park.

History:
Gus Fruh Park was designated in 1980, 1986, and 1992. This area has been previously an unused green belt area, used by the people of the neighborhood as an activity area (Google Earth).

Research Plan

Design of Study

In order to properly test the effect of distance from a body of water on the abundance of Carolina Wren, two 0.5 kilometer transects will be used. The first transect will be placed adjacent to Barton Creek in order to test the abundance of Carolina Wren near a body of water. This transect will be placed Northwest to Southeast. The second transect will be placed up a ridge, about 500m away from the first transect. This transect will also be placed parallel to the first transect, Northwest to Southeast. This second transect will test the abundance of Carolina Wren distant from a body of water. These transects will cover 22.32% of the total park.

Background Information

The Carolina Wren builds nests in tree cavities, feeds on insects, and is generally considered a ground forager. This bird lives in Southeastern United States year round. Generally, the habitat of the Carolina Wren is an open woodland, and the bird is quite common in its geographic area. The song of the Carolina Wren is often described as sound like the word “teakettle” repeated at a quick tempo. The call of the Carolina Wren is generally a harsher version of this song, sound more similar to an angry squawk (All About Birds, 2015).

Margaret M. Nice and Ruth H. Thomas conducted a study on the nesting of Carolina Wren in Little Rock, Arkansas. This study was run by taking observation data on the nesting of a sample of male and female Carolina Wren in the study area. The

result of this study discovered that the Carolina Wren nests in the cavities of trees and the general building procedures of these nests. This study connects to the location settings of the habitats of the Carolina Wren and the relation between this and distance from a body of water (Nice and Thomas, 1948).

Amelia R. Laskey conducted a study on the nesting of the Carolina Wren in Tennessee. In addition to the nesting of the Carolina Wren, this article also covers the food source of the species. This study was run by taking observation data on the nesting of a sample of male and female Carolina Wren in the study area. The result of this study discovered the location and specific environment of open woodland of the Carolina Wren habitats and nesting, and also notes that the Carolina Wren feeds on insects. This study connects to the location settings and food source of the Carolina Wren and the relation between these and distance from a body of water (Laskey, 1948).

Ola M. Fincke conducted a study on the lifetime mating success of the Damselfly in northern Michigan. This study was run by taking data on the average mating success of Damselfly along with the location of this mating in the study area. The result of this study provided data on different variables that affect lifetime mating success of the Damselfly and that the breeding ground of the Damselfly are often near bodies of water. This study connects to the location of the food source of the Carolina Wren and the relation of this and distance from a body of water (Fincke, 1982).

The Carolina Wren develops nests and its general habitat in open woodlands (Nice and Thomas, 1948). The food source of the Carolina Wren consists of a large range of insects (Laskey, 1948). These insects often breed and live near bodies of water, so Carolina Wren will often live near bodies of water as well (Fincke, 1982). Because of these factors, the expected result of this study is that the abundance of Carolina Wren will be greater near a body of water.

Materials

The materials that will be utilized in this study include binoculars, project notebook, park map, and a pen.

Procedure

1. Travel to park with all required materials
2. Walk quietly to the start of the first transect in order to not disturb bird populations
3. Slowly and quietly walk the first transect
4. When the study bird is noticed, record the type of identification, and perpendicular distance from transect using the estimate ranges 0-5m, 5-10m, 10-15m, 20-25m, 25-30m, 30-35m, 35-65m, 65-95m, and 95-125m.
5. Record all occurrences of animals, people, and other disturbances
6. Record all location information
7. Once first walk is completed, move to the second transect
8. Slowly and quietly walk the second transect

9. When the study bird is noticed, record the type of identification, and perpendicular distance from transect
10. Record all occurrences of animals, people, and other disturbances
11. Record all location information
12. Return to lab
13. Calculate the full detection strip by finding where the number of bird detections drops by 20%
14. Calculate the Population Estimate by dividing the total strip by full detection strip, multiplying by number of detections in the full strip, and dividing by area tested by transect
15. Calculate the Coefficient of Detectability by dividing the total number of detections by the entire strip divided by the full detection strip multiplied by the number of detections in the full detection strip.

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Will Fisher

Introduction

Purpose

The purpose of this study is to assess the biodiversity of woody plants in relation to water at Bull Creek City Park in Austin, Texas. Water concentration in the soil plays a drastic role in a plant's growth and processing of nutrients; distance from water can therefore affect a plant's population.

Hypothesis

The closer a region is to water, the more biodiversity it will have given the necessity of water for plants' cellular processes.

Site Description

Location

Bull Creek Park is located in Northwest Austin, 2.5 km north of the intersection of Loop 360 and RM 2222 as the crow flies.

Size and Shape

The two major portions of the park can be described as rectangles. The entire park has a size of 19.1 hectares.

Topography

The park has a minimum elevation of 158 m and a relief of 104 m. Areas in the vicinity of the creek bed are relatively flat, but extending further out one finds steep hills that allow for water runoff into the creek. Although the steepest drop off occurs at portions of the creek bed, more elevation change occurs along the hills.

Geology

The innermost part of the creek bed is composed of Alluvium, which consists of sand, silt, clay, etc., is from the Quaternary period, and is tan to light gray. Farther out from the creek bed on some adjacent portions there is Tributary terrace deposits, which consist of gravel, sand, silt, etc., is from the Quaternary period, and is tan to light gray. Finally surrounding the creek is Glen Rose Formation, which consists of limestone, dolomite, etc., is from Cretaceous period, and is gray to tan (Garner).

Areal Extent and General Type of Vegetation

The areal extent of woody trees tends to be approximately six meters, and the land consists of approximately 20% grassland and 60% woodland, the remaining 20% containing insufficient soil for plant life. Some common plants in the area include Ashe juniper, live oak, cattails, and long grasses.

Availability of Water

Bull Creek runs through the center of the park. At the time of visit, mid September, there was running water which was on average 0.5 m deep. There are signs of flooding in that for a couple of meters to both the left and right of the creek bed there is little to no soil. Moreover, there are signs of erosion at much higher elevations that the creek's current level.

Proximity to Urban or Industrial Area

For the entirety of the park 360 highway borders the land, and at two portions 360 passes over the park and creek. For the majority of the park the highway is adjacent to the west, however in the slim portion conjoining the two major regions of the park 360 is to the east. In the

other directions the park is never more than 1 km away from residential areas and business squares.

History

The park was purchased by the city over the period of 1971-1987 (Crosby). Studies have found that human utilization of the area has been common for as long as the Early Archaic and Late Prehistoric periods and onwards (Mehalchick). The furthest back recorded use of the land revolves around the Preece family from 1838 to the early 1900s: The Preece's used the land for farming (Zelade 165).

Research Plan

Design of Study

Three 50 m transects will be conducted parallel to the creek, with data being collected once on each transect. Two of those transects will be conducted on the northern portion of the park, both on opposite sides of the creek (one 10 m to left of creek, other 150 m to right of creek). The third and final transect will be 75 m to the right of the creek in the southern portion of the park. Transects have been marked in on the aerial map.

This gives approximately a 1.5% coverage of the park in the study. The quantity of species collected will give a good assessment of how varied woody plant life is in relation to water.

Background Information

A study by February and Higgins was conducted in South Africa with the purpose of analyzing soil density in relation to water and nitrogen concentration in the soil. The study was conducted by measuring the proportion of roots to the nutrients of concern, "the proportion of tree and grass fine roots at each soil depth were estimated using the $\delta^{13}C$ values of fine roots and the $\delta^{13}C$ end members of the fine roots of the dominant trees and grasses" (Higgins 1). The main results concluded that there was a positive correlation between root density and nitrogen levels, and a negative correlation to water levels. This shows that areas with high root densities have low water concentrations due to heavy absorption from the roots, suggesting that woody plants need regions with high water concentrations to get adequate nutrients.

A study by Garwood and Williams was conducted with the purpose of seeing how added nutrients affected plant growth (location unspecified). To do this they injected nitrogen samples into regions of plant growth where the upper soil was dry at both 2 in. (5.08 cm) and 18 in. (45.72 cm). When nitrogen was injected into the dry soil at a 5.08 cm depth, there was little to no change in plant growth. However, when the nitrogen was injected into the moist soil at a depth of 45.72 cm there was a significant increase in plant growth (Williams 1). This suggest that plants require moisture/water to properly utilize nutrients, thus suggesting an increase in biodiversity in closer proximities to water.

A study by Dawson had the purpose of analyzing the significance of "hydraulic lift", water brought to the surface soil by roots at lower levels overnight, by seeing what the radius of water dispersal was and how neighboring plants benefitted from it (location unspecified). To quantify this, Dawson used a two-end-member linear mixing model, which used stable hydrogen isotopic data obtained from environmental water sources and xylem-sap, to find that all neighboring plants used 3-60% of hydraulic lift water supplied by sugar maple trees (Dawson 1). This water was dispersed with a 2.5-5 m radius. Moreover, Dawson found that "plants that used a high

proportion of HLW [...] maintained significantly higher leaf water potentials" and "showed greater aboveground growth" (Dawson 1). These concluding suggest that areas of with higher water concentration will allow for more hydraulic lift to occur increasing the amount of woody plants, in turn, high biodiversity and plant density will be encouraged by the benefits to neighboring plants provided by hydraulic lift.

Materials

Materials used are a 50 m transect and *Native and Naturalized Woody Plants of Austin and the Hill Country* by Daniel Lynch (Lynch).

Procedure

1. Transects were laid down according to Design of Study.
2. Specimens that overhung the transect were collected and logged. For each specimen the following information was recorded:
    a. Specimen name.
    b. Intercept range (start and end of overhang in meters).
    c. Intercept length (total length of overhang; length of intercept range).
    d. Intervals (intervals which contain the overhang; a new interval starts every 5 m starting at 0 m).

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CONCLUSION

Results

Upon collecting data, a positive correlation between the distance of a region from water and the number of individuals in that region, with a 38.8% increase in number of individuals comparing close to far distances from water (Figure One). Figure One shows this trend despite the fact that, in this particular study, the transects were laid such that the coverage of the transect (specifically the sum of the intercepts of plants) decreased as distance from water increased (see Figure Two). There also appears to be a slight increase in the number of species with respect to distance from water, with an increase of two species when comparing close and far distances from water (Figure Five).

Moreover, on a different note, the standard deviation of relative dominances of observed species shows a positive correlation with the distance from water (see Figure Three). Tracking the top three most prevalent species, one observes certain species, like *Juniperus ashei*, increasing in importance with distance from water, while other species, like *Quercus fusiformis*, decline in importance (see Figure Four).

Discussion

The data collected supports the original hypothesis: “The closer a region is to water, the more biodiversity it will have.” While this is not easily seen from the positive correlation between number of individuals and distance from water, it is demonstrated by figures three and four. The increase in the standard deviation of relative dominances with respect to distance from water shown in Figure Three suggests that certain species begin to dominate the region while other species begin to dwindle in numbers: This corresponds to a decrease in biodiversity. This emergence of dominance, or increased prevalence, of certain species is as mentioned above

expressed by Figure Four. Species like *Juniperus ashei* begin to dominate the region, forcing other species out of the region. These results are supported by those of Caterina in a study conducted in Stillwater, OK. The study concluded that *Juniperus virginiana* populations intercepted on average 37% of rainfall (Caterina, 2012) using data collected on 47 different rainfall occasions using dissipation techniques described by Granier. If the *Juniperus* genera is known to intercept large quantities of water, it would make sense that less species in the surroundings would be capable of surviving. Moreover, results from Van Els provide similar, more direct, support of this phenomenon. This study observed a decline in species richness which, via regression, was shown to be best correlated with *J. virginiana* litter accumulation (Val Els, 2010). This study was conducted in Payne County, OK by measuring vegetation in forest gaps and forest areas without *J. virginiana* at the inner and outer edges of *J. virginiana* canopies.

While the trend between number of species and distance from water does not support the hypothesis, there is a strong chance that this result comes as a byproduct of lack of data sets. While 33% more species occur at the far from water region than in the close to water region, there is only an increase of two species.

As an additional result, negative correlation between sum of intercepts and distance from water (Figure Two) and positive correlation between number of individuals and distance from water (Figure One) suggests that plants decreased in size but increased in abundance: If this decrease in average size did not occur, the increase in number of individuals dictated by Figure One would cause an increase in the sum of species intersects, contradictory to results in Figure Two.

Improvements to this study would include an increase in the number of data sets collected for each distance from water. Having only collected data at each distance once, there

is a high chance of misrepresentation of the populations and some trends may not be as exaggerated as they appear in these figures.

Future studies in the area could include a survey of root depth in relation to distance from water. This would give insight into the characteristics of the plants that allow them to become dominant at further distances from water, as well as access variables other than biodiversity.

Figure 1: Number of Individuals by Distance From Water

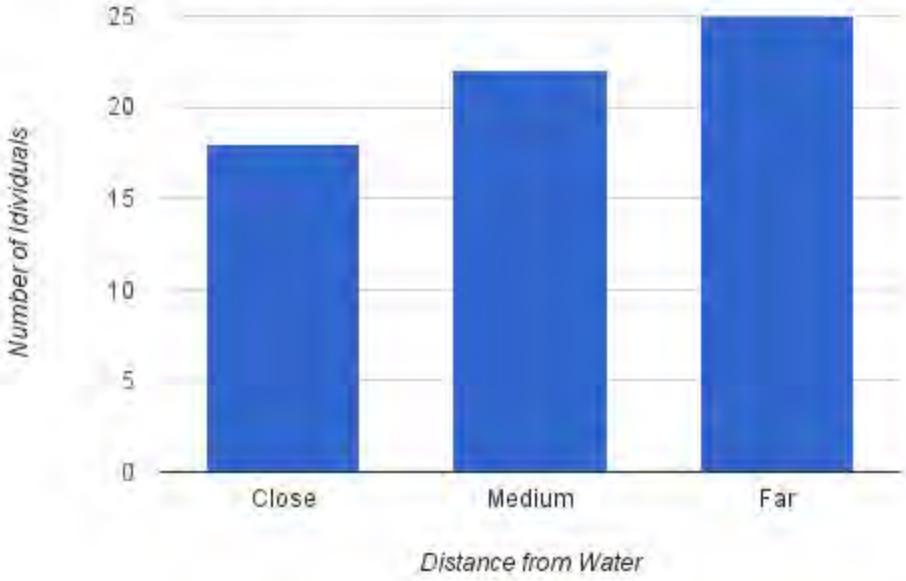


Figure 2: Sum of Intercepts by Distance From Water

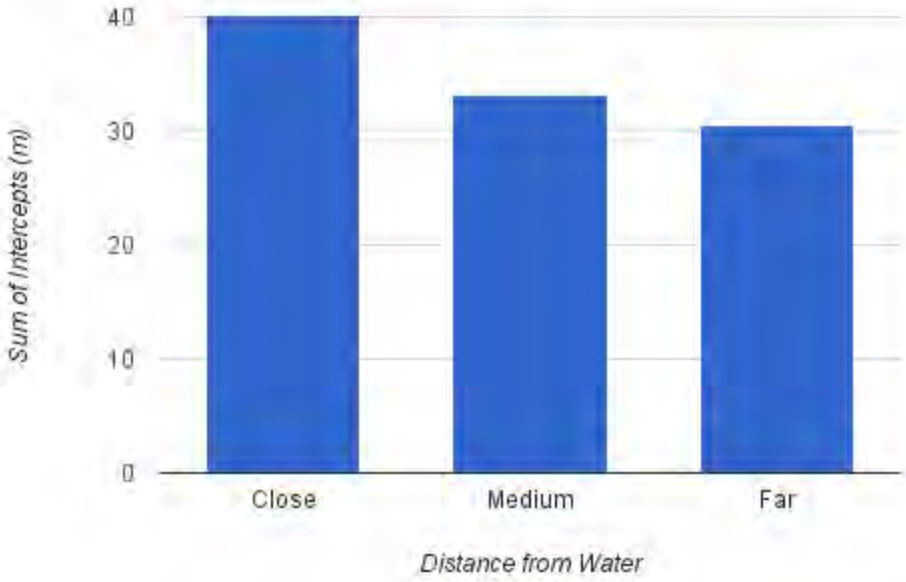


Figure 3: Standard Deviation of Relative Dominance by Distance From Water

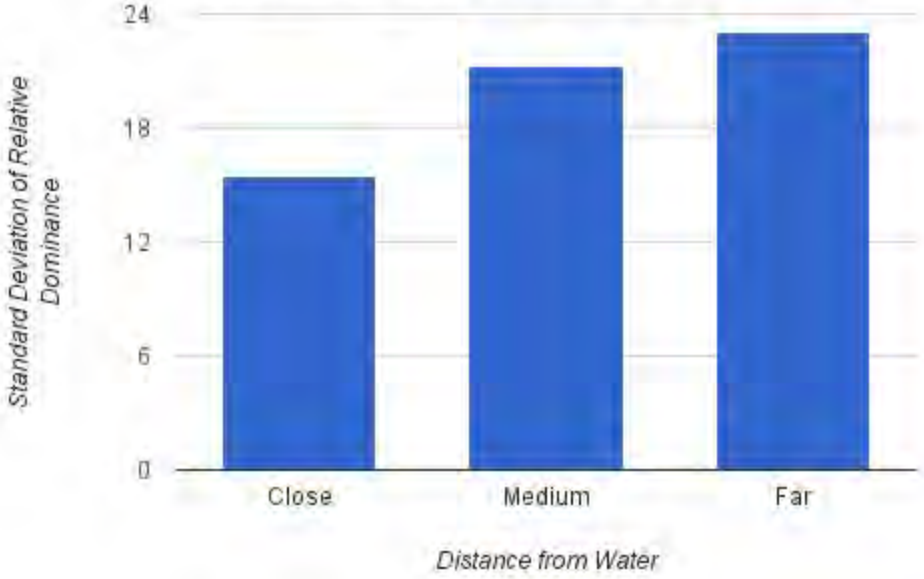


Figure 4: Relative Importances of Most Prominent Species by Distance From Water

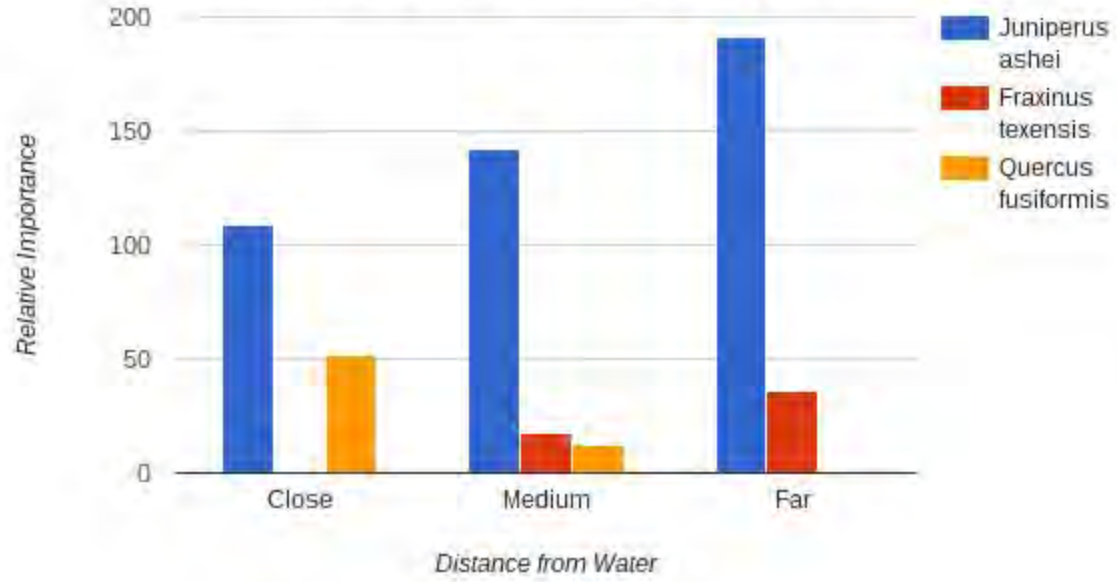
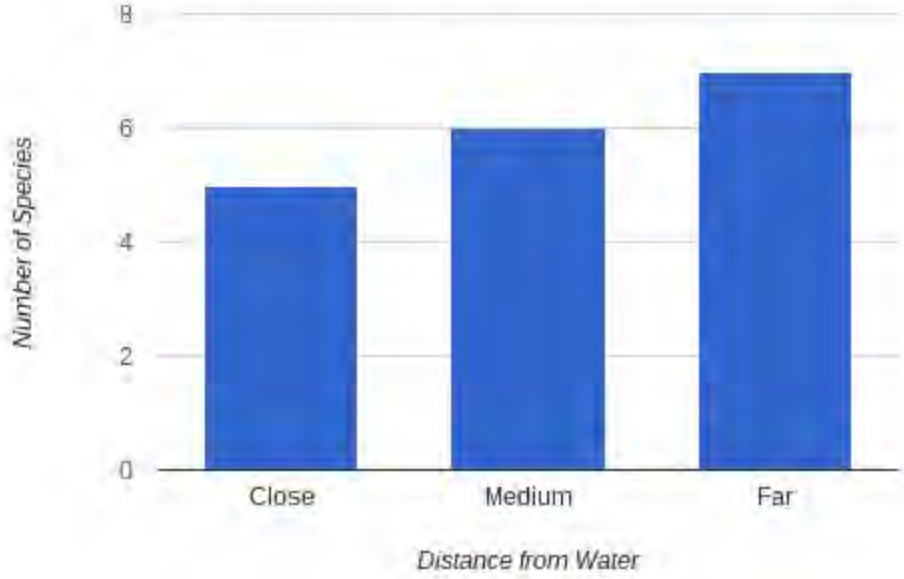


Figure 5: Number of Species by Distance From Water



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Ms. Crosby
Planet Earth: Periods 3 & 7
23 September 2016

Introduction

Purpose

The following experiment is a population study of the biodiversity of woody plants in the area as a function of proximity to water in Bull Creek Park in central Texas, USA. The study will specifically look at the prevalence of the organism *Ulmus crassifolia*, commonly known as cedar elm, in each data collection.

Hypothesis

The researchers in this experiment hypothesize that a similar prevalence of the organism *Ulmus crassifolia* will be observed despite changes in proximity to water in Bull Creek Park in central Texas. Woody plants species in central Texas and, specifically, organisms in the genus *Ulmus*, have been observed to have very high survival rates in semi-arid environments despite availability of water.

Site Description

Location

Bull Creek is located in Northwest Austin directly along Loop-360 N Capital of Texas Highway between the intersections of Loop 360 and RM 2222 and Loop 360 with Spicewood Springs Rd.

Size and Shape

Bull Creek covers approximately 67.7 hectares. The park is split into three sections, two larger rectangles on the southern side of the highway and a small arch between the two rectangles on the northern side of the highway.

Topography

At Bull Creek, the minimum and maximum elevations are 158.5 m and 262.1 m, respectively. The park, overall, is very hilly; the lowest points of elevation occur by the creek, and moving away from the water, the land is at first rather flat until about 120 m away from the water, the land becomes much more hilly and abrupt. In addition to the hills that are shown on the topographic map, there are also small bumps in the land whose reliefs are too small to be shown on the topographic map's contour interval of approximately 6.1 m.

Geology

The underlying geologic formations of Bull Creek include recent alluvium deposits (sand, silt, clay, gravel) from the Quaternary Period; Tributary terrace deposits (gravel, sand, silt, clay) from the Pleistocene Period; and the Edwards Formation (limestone and dolomite), the Walnut Formation (limestone, marl, marly limestone), and the Glen Rose Formation (limestone, marl, dolomite) from the Lower Cretaceous Period. The site also includes a creek bed.

Areal Extent and General Type of Vegetation

Approximately 90% of the park is heavily wooded and the remaining 10% of the park is either grassland or exposed rock, which is represented accurately in the aerial photos although there may be difficulty discerning grassland from exposed rock. As the park is heavily wooded, some prevalent examples of vegetation in the park are *Berchemia scandens* (Alabama supplejack), *Rhus copallinum* (the flameleaf sumac), and *Ulmus crassifolia* (the cedar elm).

Availability of Water

Bull Creek is the principle source of water in the park. Currently, water levels in the creek are high and enough to sustain large fish in the swimming areas. Around the creek there is also evidence of flooding; especially at bends in the creek, there is flood debris in the form of knocked over trees.

Proximity to Urban or Industrial Areas

Bull Creek is located directly next to Loop-360 N Capital of Texas Highway and surrounding the rest of the park is residential area.

History

In the 1950s, the land around Bull Creek was owned by the Moore family (Free Fun in Austin) and was open to the public as Lakewood Park (Austin Parks Foundation Blog). Prior to the 1950s, the creek had been used as grazing land (Free Fun in Austin). Parts of the park were then acquired from 1971 to 1987 and since then, the land has been open to the public as Bull Creek Park. Since then, several parking lots and trails have been established, as well as the construction of the Loop-360 N Capital of Texas Highway in the early 1970s and the growth of the residential area, particularly in the early 2000s.

Research Plan

Design of Study

The researchers will place one transect line to run 5 m along the creek bed in the largest rectangular section of the park (the most northeastern section of the park). The transect will be placed in such a way that at any given point along the transect line, the smallest distance from the transect line to the creek will be 10 m as the crow flies. Then, a second and a third transect line will be placed 90 m and 180 m, respectively, from the creek bed in a similar fashion. Data will be collected once along each transect line and in the fall. Since data will be collected in the fall, there should be no new establishment of any seedlings and data can be collected at any time throughout the fall. Approximately 0.04% of the park will be studied.

Background Information

In a study conducted in west-central Texas observing both the desertification of land and the woody species dieback after 2 years of drought, the rate of woody species dieback was found to be slower than the rate of desertification of the land over time. The study was compared to data taken 2 years prior in the same region of land, and the researchers observed that the rate of woody species dieback did not exceed prior levels. For that reason, it would be plausible that in the environment this study was conducted in, woody plants farther away from a water source might be able to survive almost as well, if not just as well, as woody plants much closer to a water source (Wonkk, Twidwell, Franz, Taylor, Rogers, 2016).

Other studies have specifically looked at organisms in the genus *Ulmus*. A study in Northern China measured how different age groups of the organism *Ulmus pumila* attained water by using hydrogen isotope dating from water in the leaves of different *Ulmus pumila* to identify the sources from which the trees had been obtaining water. It was found that younger trees obtained water from the topsoil while older trees tended to obtain water from water reserves greater than 2 m below the ground. *Ulmus pumila* is in the same genus as *Ulmus crassifolia* there may be great similarities between the two organisms, and as Bull Creek Park is in a recharge zone for the Edwards Aquifer, more mature *Ulmus crassifolia* may survive just as well as trees located near the creek bed as there may be water reserves where more mature *Ulmus crassifolia* can gain water (Su, Li, Liu, Xu, Xun, 2013).

Another study also conducted in Central Asia, in the Amu Darya river basin, compared the survival rates of six different woody plants species over the course of two years. *Ulmus pumila* was found to have some of the highest survival rates of all six organisms (between 75 to 90%) and to survive very well in the poorly irrigated, salinity-rich soil. Bull Creek has a very similar arid environment, and *Ulmus crassifolia* can be expected to have similar survival rates as *Ulmus pumila* did in the study when located further away from the creek bed (Schachtsiek, Lamers, Khamzina, 2014).

Materials

Native and Naturalized Woody Plants of Austin and the Hill Country
50 m Transect Tape

Procedure

Data Collection Procedure

1. The researchers placed the 50 m transect tape with the requirements described in the Design of Study.
2. Moving along the transect line, the researchers recorded all woody plants that hung over the transect line. The researchers also recorded the intercept range (the distances at which the plant begins and ends over the transect line) and lengths (the length denoted by the intercept range; the length the plant hangs over the transect line) to the nearest decimeter of each woody plant, in addition to recording which 5 m interval(s) along the transect line the woody plant fell in.
3. The researchers also took representative samples of each woody plants species encountered along the transect line. The researchers also recorded the leaf type and arrangement, a description of the bark, a description of the fruit and/or flower, and whether the woody plant is a tree, shrub or vine for each species. Plant samples were taken for all plants, with the exception of poison ivy and fleshy cacti. For those organism, pictures of the plants were taken.

Data Analysis Procedure

To interpret the data collected using the procedure detailed above, the following calculations were done to find the prevalence of each woody plants species encountered in the data collection.

- **Relative Density** - The percentage representing the number of individuals of a species out of the number of individuals of all species.
- **Relative Dominance** - The percentage representing the sum of all intercept lengths for a species out of the sum of intercept lengths for all species.
- **Relative Frequency** - The percentage representing the number of intervals a species is located in out of the number of intervals all species are located in.

- **Importance Value** - The sum of a species' relative density, relative dominance and relative frequency.

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CONCLUSION

Results

Several trends were observed from the above data in regards to biodiversity as a function of proximity to water. A trend was also observed in regards to the prevalence of *Ulmus crassifolia*, commonly known as cedar elm, as a function of proximity to water.

Firstly, a decrease in the number of species observed at each site was seen as the transects were placed increasingly farther from the creek bed. This data can be seen clearly in Figure 2, as at the closest transect, placed 5 m from the creek bed, 15 species were observed; at the medium transect, placed 90 m from the creek bed, 9 species were observed; and at the farthest transect that was placed 180 m from the creek bed, 7 species were observed.

This trend did not correlate with the abundance of organisms. There was no trend observed in regards to the number of individuals across all species and proximity to water, as can be seen in Figure 4. At the closest transect, 45 individuals were observed, while at the medium transect 64 species were observed and at the farthest transect, 57 species were observed.

However, there did appear to be a correlation between the abundance of a particular species and its importance at the site. This can be seen when comparing Figures 3 with Figure 5. The greater the abundance of a species, the more important the species was in the data set.

It was also observed that the prevalence of *Ulmus crassifolia* decreased as a function of proximity to water. In fact, at the closest transect, 2 individuals were observed and at the medium and farthest transects, 0 individuals were observed. The prevalence of *Ulmus crassifolia* at each site can be seen in relation to the abundance of all other species in Figure 1.

Although there was a decrease in biodiversity as transects were placed increasingly farther from the creek bed, there were a number of species, specifically *Juniperus ashei* (Ashe juniper), *Garrya ovata ssp.* (Lindheimer silktassel), *Ilex vomitoria* (yaupon), *Quercus shumardii* (Shumard oak), and *Fraxinus albicans* (Texas ash), that were abundant and remained important throughout all sites. The abundance and importance of these species in relation to all other species at each site can be seen in Figures 3 and 5.

Discussion

A possible explanation for the decrease in the number of species as a function of proximity to water is an increase in resources, namely water. More plants will be able to survive when they have more access to water, whereas farther away, specific species that are better suited to drier environments will dominate the area. This could be seen with species such as *Juniperus ashei* in Figure 5. In Figure 5, it can be seen that *Juniperus ashei* became increasingly more important as sites grew farther away from water.

The abundance of plants as a function of proximity to water may be explained by the closest transect's proximity to the creek bed and the farthest transect's proximity to urban

development. The closest transect was placed nearest to the creek bed and at the bottom of a small valley, which during heavy rain is likely to see erosion. In fact, there was evidence of flooding in the park when initial site visits were made (see Site Description). This susceptibility to erosion is a possibility for the lower number of individuals at the close transect. At the farthest transect, the lower number of individuals may be explained by the site's proximity to urban development and its lack of water. Urban development would impede the growth of many species and the site's distance from the creek would only further keep many species from growing abundantly.

The correlations between abundance and importance are quite clear, as the more individuals of a specific species, the greater the importance value would be. This is a result of how calculations for importance values were done. However, the abundance of a species in an area is a very important indicator of that species's importance.

The decrease in the prevalence of *Ulmus crassifolia* as a function of proximity to water is possibly due to the organism's wood density.

A study conducted in the Edward's Plateau in Central Texas comparing the water use of *Ulmus crassifolia*, *Juniperus ashei*, and *Quercus fusiformis* during acute drought found that *Ulmus crassifolia* experienced greater mortality rates than *Juniperus ashei* and *Quercus fusiformis* and provided the explanation that *Ulmus crassifolia*, having a more cavitation-resistant xylem, was more susceptible to lack of water than the other organisms in the study (Kukowski et al., 2013). That explanation aligns with the observations in this study, as *Ulmus crassifolia* was observed to be less frequent farther from a water source whereas *Juniperus ashei* and trees in the genus *Quercus* thrived.

A study conducted in coastal California woody plants analyzing trends between plant traits and abundance observed similar occurrences. Changes in the wood density of organisms was found to be directly related to changes in the soil water content. This relation, along with the results of the study done in Central Texas, could give a possible explanation for the decrease in the prevalence of *Ulmus crassifolia* as a function of proximity to water.

However, there are several major problems with this study. Firstly, the area of the park covered in the study covers only 0.01% of the entire park. To have more substantial data, more of the park needs to be studied. Additionally, this study was conducted on a large hill. Elevation was not taken into account in this study but in order to conduct a better study, the factor of elevation must be eliminated as much as possible so to measure biodiversity as a function of proximity to water without other variables.

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Introduction

Purpose

This research will study the effect of distance from a body of water on woody plants. This study will take place in the Bull Creek District Park in Austin Texas.

Hypothesis

The expected result is that woody plants won't be affected by distance from water. This is because plants can survive off rain so they would not die off if they are not near a water source.

Site Description

Location:

Bull Creek District Park is located in Northwest Austin. The park is about 2.1 kilometers Northwest of where Highway 360 crosses the Colorado River.

Size and Shape:

The park has the approximate shape of a two rectangles connected by an arch. The area of Bull Creek District Park is about 194 hectares.

Topography:

The minimum elevation is about 152m and the maximum elevation is 273m. The relief of this area is 121m. The area is generally flat but has steep limestone cliffs and waterfalls throughout the park and has creek running through it.

Geology:

The geology of Bull Creek District Park is made up of Alluvium, Tributary Terrace Deposits, Glen Rose Formation, Edwards Formation, and Walnut Formation. The Alluvium is composed of sand, silt, clay, and gravel (tan to light gray), and was created recently. The Tributary Terrace Deposits are composed of gravel, sand, silt, and clay, tan to light-gray, and was created in the Pleistocene time period. The Glen Rose Formation is made up of limestone, dolomite, and marl, grey to tan, alternating hard and soft beds forming stairstep topography, thick to thin bedded, fin to medium grained, and created in the Lower Cretaceous time period. The Edwards Formation is made up of limestone and dolomite, light gray to tan, hard to soft, thin to thick bedded, fine to medium grained; fossil rudist and nodular chert common; solution collapse zone near middle and created in the Lower Cretaceous time period. The Walnut Formation is made up of limestone, marl, and marly limestone, gray to tan, soft to hard, thick to thin bedded, massive to nodular, fine to medium grained and created in the Lower Cretaceous time period.

Areal Extent and General Type of Vegetation:
Woodland makes up 70 percent of the park, grassland makes up 20 percent, and shrubs make up the remaining 10 percent. Plants in the area include Buffalo Grass, Cedar Elm and Roughleaf Dogwood.

Availability of Water:
Bull Creek runs through Bull Creek District Park, the creek's water level currently (as of 9/18/16) is low, less than a 1 foot deep water in most areas but up to 3 feet deep in others. There are woody debris and human pollution/trash in some of the trees branches indicating previous flooding.

Proximity to Urban or Industrial Areas:
Bull Creek District Park is adjacent to an urban neighborhood. These urban areas are to the Southeast side of the park.

History:
Bull Creek District Park, was acquired in 1971, it had no previous use before when it was acquired. It is mainly used for recreation like swimming and hiking (https://austintexas.gov/bullcreekplan).

Research Plan

Design of Study

In order to properly study the effects of distance from water on woody plants, three 50 meter transects will be used. One of these transect lines will be 10 meters away from the creek along the Northernmost section of the park. The second will be 110 meters away from the Northernmost section of the park, and the third 210 meters away. The transects will be parallel to the creek. Data will be collected 1 time on each of these transects, for a total of 3 times over the course of 3 weeks. The total study area will equal 0.3 hectares, which is 1.5 percent of the total study area.

Background Information

R. J. Elkington, K. T. Rebel, J. L. Heilman, M. E. Litvak, S. C. Dekker and G. W. Moore conducted a study on species-specific water use by woody plants on the Edwards Plateau in Austin, Texas by monitoring Sap fluxes, leaf water potentials, soil moisture and meteorological information and comparing the data. The study found that at two relatively deep-soil savanna sites, the dominant tree species had similar water use behaviour and that their water use is restricted by soil depth. This relates to the hypothesis because identifies how plants use water, they conserve water so they wouldn't be affected if they are closer to water or not. (Elkington et al., 2012).

R. Daniel Smith conducted a study on composition, structure, and distribution of woody vegetation on the Cache River Floodplain in Arkansas by sampling trees, saplings and shrubs in 249 plots with 28 environmental variables. The study found the distribution of species to be significantly correlated with flood depth and flood duration (fewer species in flooded areas) as well as geomorphic position and soil texture. This relates to the hypothesis because this study states that there would not bemore species near water because of floods. (Smith 1996).

Solomon Tefera, H.A. Snyman, and G.N. Smit conducted a study on woody vegetation structure in relation to land use and distance from water in semi-arid Borana rangelands in Southern Ethiopia. They conducted the study by identifying 54 woody plants species. The study found that most of the woody species had the highest abundance in the height class 40–2 m regardless of land use and distance gradient from water. This is important to the hypothesis because it identifies the effect distance to water has on woody plants (Tefera, Snyman, Smit, 2006).

Materials

- 50m transect line
- Aerial photo of park
- Topographic map of park
- Project notebook
- Pencil
- Clippers

Procedure

1. Stretch out the 50 meter transect line as straight as possible in a wooded area.
2. Move down the transect line and record the woody plant species found overhanging the transect line in the field data table.
3. Record the intercept range and length (the distance that the woody plant overhangs the transect line) to the nearest decimeter.
4. Record the intervals that the woody plant is found. (Every 5 meters on the transect line is an interval)
5. Collect a representative leaf sample for each species encountered. Tape the sample into the back of the project notebook on the unnumbered pages. (Be sure to get a sample that is a good representative of the woody plant
6. For each species sample sample tape the sample in the back of the project notebook on the numbered pages and write the leaf type, leaf arrangement, description of bark, description of the fruit/flower on the plant, latin name, common name, and other information that may be relevant.
7. For each transect line prepare a data analysis table with the relative density (total # of individuals of that species/total # of individuals of all species x 100), relative

dominance (total intercept length of that species/total intercept length of all species x 100), relative frequency (total # of intervals of that species/total # of intervals of all species) x 100) and importance value (relative density + relative dominance + relative frequency) for each species.

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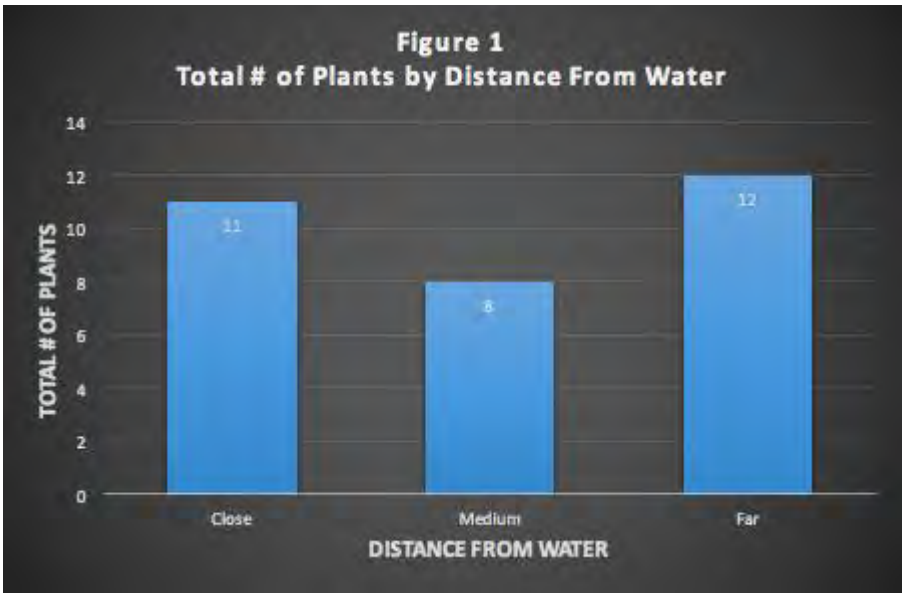
Conclusion

Results:

_____11 plants were found along the closest transect to water (transect #1), 8 plants along the medium distance transect (transect #2), and 12 along the farthest transect from water (transect #3) as seen in Figure 1. The average number of plants for each transect is about 10 and due to the limited sample size, no analytics were conducted on the data. The difference in between the number of plants per transect is not meaningful since the greatest difference is only 4 and the lowest number of plants per transect being 8 is still close to the average of 10.



Discussion:

_____The data as seen in Figure 1 does not represent a meaningful enough difference in trends to contradict my hypothesis, that distance from water does not affect the distribution of plants.

Larissa Hotra, Ellen Kolasky and Jenna Voss conducted a study on abiotic factors influencing the abundance and distribution of Marsh Marigolds along Carp Creek in Pellston Michigan by testing the effects of specific abiotic factors upon distribution and density of Marsh Marigolds, they found that soil pH and soil nitrate concentrations may determine distribution of C. palustris but other tested abiotic factors did not significantly influence marsh marigold distribution (Larissa Hotra, Ellen Kolasky and Jenna Voss, 2003). This is important to my hypothesis because it verifies that distance from water does not affect the distribution of plants.

Tenna Riis Kaj, Sand-Jensen, and Søren E. Larsen conducted a study on plant distribution and abundance in relation to physical conditions and location within Danish

stream systems in Hillerød Denmark by recording data on the distribution of plants along the stream systems, they found that there was no difference in distribution for terrestrial and amphibious plants and downstream increase species can be explained by the increase of habitat area and the dispersal of plants (Riis, T., Sand-Jensen, K. & Larsen, S.E., 2001). This is important to my hypothesis because it proves that distribution of plants less to do with distance from water and more to do with habitat area and dispersal of plants.

Something that could have contributed to the inaccuracies in this study is the inaccurate placement of the transects based on distance from water, the transect placements were roughly as far away as they needed to be from the creek but not to an accuracy I would've liked. Another thing that could've posed a problem was the data collection, it is entirely possible that I overlooked some data on any of the transects and made the data somewhat inaccurate.

If this study were to be replicated I would like to ensure accurate placements of transects and very exact data collection to make the study more accurate and valid. If another student were to later conduct a study on factors that determine plant distribution that would make this more valid.

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