Alicia Ramos

David Walker

Planet Earth

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Introduction

Purpose

The purpose of this study is to observe the ways in which proximity to water affects vegetation diversity and abundance. The study will be conducted in Bull Creek Park in Austin, Texas and the source of water the study is over is Bull Creek.

Hypothesis

The group believes that the closer the vegetation is to the creek bed, the more diverse and abundant it will be. This theory stems from the studies the group found over how vegetation has a higher density the closer to Riparian areas they are.

Site Description

Location

Bull Creek Park is located in the Greenbelt in North Central Austin, Texas. The park is 11.290 kilometers north as the crow flies from Texas' Capitol. The park is also 22.19 kilometers north from the Austin-Bergstrom International Airport. Bull Creek is also 13.39 kilometers southeast from Lake Travis.

Size and Shape

It appears to be shaped similarly to a slightly off rectangle or diamond. The area of the park is approximately 135 hectares.

Topography

The park appears to be very rocky and steep with the elevation lowering near Bull Creek itself. The elevation varies throughout the park, though tends to veer in the higher range. The maximum elevation is 286.51 meters and the minimum elevation is 179.83 meters.

Geology

Forms of geology found from the Quaternary period in Bull Creek park include Alluvium and Tributary Terrace Deposits. Forms of cretaceous deposits include Glen Rose, Walnut Formation, and Edwards formation. Alluvium is the most recent and is formed with sand, silt, clay, and gravel and comes in shades of tan to light gray. The Tributary Terrace Deposits look very similar as well, coming in the same colors and forms. Glen Rose is the oldest formation and seems to be the most common and is gray to tan limestone that forms stairstep topography. Walnut Formation seems to be the second most common and is another form of gray to tan limestone, although it can be thicker bedded and medium grained in comparison to Glen Rose's fine grains and thin beds. The final formation formed is the Edwards formation which is a light gray to tan limestone formation and is a solution to a collapse zone near the middle. All limestone formations are from the Cretaceous period. (Bureau of Economic Geology, The University of Texas at Austin, W.L. Fisher, Director).

Areal Extent and General Type of Vegetation

There is dense woodland around the trails with several shrubs. The majority of Bull Creek appears to be covered in dense woodland, so the percentage is likely around 85% woodland, 10% creek bed, and approximately 5% grassland. Vegetation found in the area

includes: *Celtis laevigata*, *Fraxinus texensis*, and *Ligustrum japonicum*. *Toxicodendron radicans* was also found along some trails.

Availability of Water

Bull Creek appears to be the main source of water in the park, and is about a third of a meter deep. It seems to flow all the way around and there appeared to be flood damage in certain areas where vegetation appeared to have been knocked down. Though it did not appear to have risen more than perhaps two meters.

Proximity to Urban or Industrial Areas

There is a picnic area adjacent to one of the trails in Bull Creek. The park is off 360 N. Capitol and is around 1609.344 meters away from one area of the park.

History

Archaeological sites were found to imply that humans had occupied the watershed for thousands of years, mostly dwelling around the area's springs. After Texas gained independence in 1836, Europeans began to settle into the resource-rich area. One of these settlers, Richard Lincoln Preece, killed the last buffalo in the area, giving the park its name, "Bull Creek". Today there are many plant and animal species living in the area, though the total number of plant species is 600, making up twelve percent of all of the forms of plants found in Texas. (The Bull Creek Watershed, Galapogos of Texas, National Park Service)

Research Plan

Design of Study

The group's study area percentage is roughly 10%. The study will be using three fifty meter transects with varying distances from Bull Creek. One of these transects will be directly

parallel to the creek, another will be roughly five hundred meters away, and the third will be nine hundred fifty meters away. By doing this the group hopes to be able to tell how distance from water affects the diversity and abundance of woody plants in Bull Creek Park.

Background Information

The first study the group looked at was a study conducted in floodplain forests in Wisconsin. They used a study from 1950 in the same area to reconstruct plant community changes relating to the water periodically flooding the forests. They found that overall vegetation diversity was highest in the areas that flooded the most frequently and therefore received the most water. They also found that even woody and exotic plants more common in upland forests, further from the flooded areas, saw an increase in diversity and number in the floodplains. According to their study hydraulic connections maintained native plant species diversity and numbers the best. (Johnson, 2016)

The second source the group looked at was a composition of multiple studies connecting diversity and abundance of plants to riparian areas. All of the studies were conducted in the state of Arizona, though no city is listed. They found that there was a higher percentage of vegetation density in these areas in comparison to their upperlands counterparts, including a diversity in woody plants. All of the studies appeared to simply go to their areas of the state and discuss their specific topic, whether it related to pollution, or to that of understanding the root differences in riparian woody plants versus uplands woody plants. (Zaimes, 2007)

The third study the group used was a study done in Gonarezhou National Park, Zimbabwe. They used a study method with three different rivers with varying placements around the rivers in which they studied the vegetation and wildlife in that area. They used the Shannon-Weiner diversity index to calculate the woody plants diversity in each area. They recorded low

density of dead vegetation nearer to the riparian areas, although there was no significant difference between the variability across each river. Areas of large amounts of herbivory were typically found to be closer to the riparian areas, leading them to believe they should be monitored and protected more. (Gandiwa, 2013)

Materials

The materials being used during this project include a fifty meter transect tape and a plant identification book called "Native & Naturalized Woody Plants of Austin & the Hill Country" (Lynch, 1981). The group will also use project composition books to record data.

Procedure

Data Collection Procedure:

I. Set up a straight, fifty meter, transect line in a wooded area (with 5 meter intervals), where the majority of the field space is covered in vegetation.

II. Move along the transect and record overhanging woody plants species. This includes shrubs that may be in the way, and record it in your field data table (Example Shown Below). While doing this, make sure to record the intercept range and length, as well as where the tree's overhang intercepts. Write a simple description of the plant to help in identifying in class.

Species Name	Intercept Range (m.)	Intercept Length (m.)	Intervals	Comments
Pecan	0 – 11.0	11.0	1,2,3	Tree, compound, alternate, scaly bark
Pecan	10.5 - 22.5	12.0	3,4,5	
~~Unknown A~~ American Elm	22.0 - 25.9	3.9	5,6	Tree, simple, alternate, scaly bark
~~Unknown A~~ American Elm	26.4 - 33.1	6.7	6,7	
Poison Ivy	36.0 - 40.6	4.6	8,9	Vine, simple, alternate, no sample taken
Pecan	45.0 - 50.0	5.0	10	Goes beyond 50m

Analysis Procedure:

I. Identify all plants and complete formal specimen pages in project notebook.

II. First you record the relative density of the vegetation in that area, which answers the question of, "How Many?". See the formula below.

$$\text{Relative Density} = \frac{\text{Total \# of individuals of that species}}{\text{Total \# of individuals of all species}} \times 100$$

III. Afterwards you would just record the Relative Dominance which answers the question of "How Much?" of each vegetation found in the park. See the formula below:

$$\text{Relative Dominance} = \frac{\text{Total intercept length of that species}}{\text{Total intercept length of all species}} \times 100$$

IV. The third formula you should use is Relative Frequency which is used to answer the question, "Where is a species located and how common is it?". See the formula below:

$$\text{Relative Frequency} = \frac{\text{Total \# of intervals of that species}}{\text{Total \# of intervals of all species}} \times 100$$

V. The final formula you will use is the Importance Value formula which is used to infer the importance of said species in its environment. See the formula below:

Importance Value = Relative Density + Relative Dominance + Relative Frequency

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Alicia Ramos

David Walker

Planet Earth

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Conclusion

Results

The group's results best express the idea that the farther plants are from water, the more diverse and abundant they may be, at least in the case of the species of Bull Creek Park. For example, the first transect [directly parallel to the creek], was the least abundant and diverse, consisting of only 3 total woody plant species with only ten individuals of those three species (Fig 1 & 2). Meanwhile the second transect had eighteen individuals and seven species, while the third had twenty-three individuals and ten species. It is worth noting that initially the first transect seemed more diverse than the following two, however, the majority of the transect was made up of, non-woody, flowering plants, not woody plants. In comparison, the farthest transect [~ 950 meters away] had ten differing species with twenty-three individuals of those species (Fig 1 & 2). An odd trend to note would that be regardless of distance from water the majority of the relative density and importance value consisted of a species of evergreen, *Juniperus ashei*, commonly found on limestone outcrops (Fig 3 & 4). These results contradict the group's initial hypothesis which was based around the theory that if a woody plant was closer to water, it would fare better, and therefore plant species would be more abundant and diverse closer to water.

Discussion

It was initially hypothesized that the closer woody plants species were to water, the more abundant and diverse they would be. However, the data collected directly contradicts that statement and seems to imply the exact opposite. A trend overall was that the farther the group moved from the water source, the more likely it was that more species, and more individuals of those species, would be noted and collected. Another trend noted is that the majority of the 'individuals' were *Juniperus ashei.*

The first study the group consulted was a study done in north-west Europe. The study's purpose was to examine and analyze the flood survivability rates of varying woody plants species in the European floodplains. They did this primarily by examining the floodplains throughout the year and noting any noticeable patterns. The pattern they discovered was that hardwood plants tended to have lower survivability rates, which were even lower during the dry season, while softwoods tended to show the opposite. (Vreugdenhil). This relates to the study conducted in Bull Creek due to the signs of flooding near the creek at the beginning of the study, as well as the fact that most woody plants collected throughout the park were hardwood plants to begin with. This seems to imply that potentially the lower number closer to the creek could be due to minor flooding that may simply sweep smaller trees away when they're mid growth.

The second study the group consulted was a study done in central Texas relating to Ashe Juniper, Cedar Elm, and Plateau Live Oak. The study's intention was to record species reaction to a dry season by studying them during a fairly dry year with very little rainfall. The group found that Ashe Juniper had the highest survivability rate overall and tended to persist even through the drought, leading them to find that species with less cavitation-resistant xylem actually had a lower likelihood of hydraulic failure due to intense drought. (Kukowski).

When looking at how it relates to the study in Bull Creek, the primary relation is through the high, dense, population of Ashe Juniper. In recent years the majority of central Texas has been going through an intense drought, so species with less survivability in dry seasons may have struggled more to persist through the year, and therefore less individuals of the other species survived, explaining the pure amount of Ashe Juniper scattered along each transect. While the other species did show such increase farther from water, that seems more likely to be related to the earlier study over the way in which floods affected woody plants. However, the drought survivability could also be the cause of Cedar Elm and Plateau Live Oak also being found in areas farther from water, since four Plateau Live Oaks were found farthest from water. There is also a potential that some of the other species studied during the experiment were also drought-hardy in similar ways.

Modifications made during the study were fairly minimal and mostly in relation to transect placement. The first of which was an instance in which the group discovered that one of the transects had somehow managed to be set on the private property of a business across the street. After multiple attempts to see if the group was simply reading the aerial photo map incorrectly, a decision was made to shift it, while keeping it the same approximate distance from the creek. In general, no other modifications were made throughout the process of the study.

Errors that could have led to the negative results include: not accurately reading the aerial photo, since experience with them was fairly minimal, misidentifying evergreen species that may have been different from *Juniperus ashei*, but looked similar, and misinterpreting distance from the creek. The first error is easily explained, as if the map was misread, the group have simply not found the correct location of their set transect. The second error is a bit more shaky, as the considerably large portion of relative density and importance value the evergreen made up could

be fairly easily explained when discussing droughts. However, it does seem odd and out of place when comparing it to the relatively smaller numbers of the other species studied, leading to the belief that if another evergreen had been there, it may have been misidentified as Ashe Juniper in the early, dim-lit, morning. The third error consists of accidental misplacement of a transect, as well as the spread of the transect as there was no clear 'mid' point, since the transects distances varied greatly. Another potential error that could explain the slowly increasing abundance and diversity would be a lack of experience with collecting data, as some species could have been overlooked at first if they were less plainly visible.

There are quite a few modifications that could be made for the sake of future studies being more consistent and accurate in data collecting. The first of which would be, to put it simply, to do more tests across transects varying far more in relation to distance from the water. . For example, instead of doing one that was parallel, one two-hundred fifty meters away, and one nine-hundred fifty meters away, the future group could have a wider range such as: parallel, fifty meters, one hundred meters, one hundred fifty meters, etc. Another modification that may be needed for the sake of future studies would be larger groups, as while more mistakes would be made across two researchers, more mistakes would also be caught throughout. Other studies that could be done in the area that may help support initial data would be to catalog the amount of species in the area which are flood resilient, due to flooding being noted near the creek bed, as well as simply more data being collected along the mid-way point from the creek.

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Cameron Bennett
Sendhil Sridhar

Introduction

Purpose - The purpose of this experiment is to test the abundance and diversity of arthropods relative to their elevation. The organisms will be studied at our 6 transects that are each placed at a different elevations in the Upper Greenbelt portion of Bull Creek Park, Austin, Texas. Different elevations can appeal to certain arthropods' needs in order to help them survive in their environment. For example, areas prone to flooding (near water at the lower elevations) may be home to fewer organisms that travel exclusively on the ground; or areas with short grass may be potentially dangerous for organisms to live due to their visibility. Conversely, trees or large/thick bushes could be helpful in disguising or protecting organisms from predators. The hilly areas that increase in elevation are occupied by many such plants, while the tops of these hills may be covered in grass rather than trees.

Hypothesis - An educated guess on where arthropods are the most abundant and diverse is at the middle-most elevation, where flooding has little effect, but they are sheltered enough from predators like birds, which would be the most suitable environment for arthropods to live in. The middle-most elevation is not flat, but rather climbing (most areas steadily, but some rapidly) at an angle that is rugged in nature. As previously mentioned, the grasslands and creek areas are the most dangerous arthropod habitats, therefore the "happy medium" is the most suitable home for several different type of bugs.

Site Description

Location - Bull Creek Park is located in North Austin, Texas. It is adjacent and to part of the highway Loop 360. Bull Creek Park is located about 14.5 kilometers north of the Texas Capitol building as the crow flies, and is surrounded by neighborhoods on its Eastern and Northern sides. The park is surrounded by famous landmarks such as Lady Bird Lake, and Lake Travis which are 16 kilometers and 13.7 kilometers from the park (as the crow flies) respectively. Some other parks that are near Bull Creek are Emma Long Park, and Walnut Creek.

Size and Shape - Bull Creek park posses a very irregular shape. The closest representation of Bull Creek's shape is a deformed shape of the letter S that follows the creek itself. The area of Bull Creek is about 200 hectares or 200,000 square meters.

Topography - The general topography of Bull Creek is that is very hilly, with lots of flat plains elevating into gigantic hills. The maximum elevation of Bull Creek is 940 feet, about 286 meters.

The minimum elevation in the area is 554 feet, about 169 meters. The topographic relief is about 386 feet, or 118 meters.

Geology - The geographical makeup of Bull Creek consists of four main rock types. The most prevalent is Upper Glen Rose Limestone, which is in the Trinity Group. The Trinity Group, like Upper Glen Rose Limestone (hence the name), is limestone (hard white-gray rock). Both are from the Lower Cretaceous Period, and contain fossils of gastropods, clams, and echinoids. The next rock type is Edward's Limestone, which is in the Fredericksburg Group. Both are limestone from the Cretaceous period. Edward's Limestone contains many fossils, some of which are *Ceritella proctori* and *Toucasia pataciata*. The Fredericksburg Group is typically grainy, while Edward's Limestone is a hard white-gray rock. The next is Bee Cave Marl, which is also in the Fredericksburg Group. Bee Cave Marl is a clay-like Limestone formation which also existed in the Cretaceous Period, and contains fossils such as *Ceratostreon*. The last rock type is Fluviatile Terrace Deposit. Fluvial terrace Deposit has no group, and existed in the quaternary Period. It is typically seen as sand, gravel, silt, clay, or mud. Many fossils of sea animals (mostly mollusks such as those previously mentioned) can be found here. (US Geographic Survey)

Area Extent and Vegetation - At Bull Creek Park, many different types of vegetation can be found. A few examples of such plants are Poison Ivy, Ragweed, Pecan, and American Beautyberry. Due to the hills and rugged terrain of Bull Creek, most of the plants are trees (making about 80% of the park woodland), and large shrubs. When the park evens out in the areas at the tops and bottoms of hills, relatively flat grasslands (which occupy the remaining 20% of the park) can be seen. Most of the plants and trees cave towards one direction (the creek)due to the discharge of water during rain. Only plants with strong roots could survive at Bull Creek and reproduce successfully.

Availability of Water - There is a lot of water running throughout Bull Creek, with a creek running straight through it (hence the name). The main water source to the park is the Colorado River, which branches off into the creek. At its deepest point, the creek is about 3 meters deep, flowing at a very rapid pace. There is a lot of flooding that takes place at Bull Creek. One of the main pieces of evidence for this is the shape of the plants. Many plants, especially the plants located on the hills, are bent towards the creek at a strange angle and appear to be cracked and wilted. The most likely reason for this is the large amount of water discharge from all the rain in Austin, causing violent flooding that ravages the plants and trees. Said plants are littered with trash near the water, further hinting at flooding. The most likely estimate on how the water would have gotten would be around 20 meters, due to the steepness of the hillside right next the creek, and the location of the beer bottle.

Proximity to Urban or Industrial Areas - Bull Creek Park is located adjacent to the highway Loop 360. The park itself snakes around and under the highway, with the creek following suit. The park ends where many major neighborhoods located off the highway begin. The neighborhoods are located about 0.1 to 0.2 kilometers away from the park's border.

History - The history of Bull Creek started a long time ago. When the Comanches settled in the area in the early 1700's, they made a home there, hunted the native animals, and even created some of the trails we see today. Later, under the presidency of Andrew Jackson, the Comanches were forcefully ousted from their homes, leaving Bull Creek undisturbed and ready to grow again. When the south seceded from the United States in 1860, most of the Union loyalists in Texas traveled to Bull Creek Park, and hid there until the war ended. After that, the entire park was bought by the Preece family. Shortly after they settled there, William Preece (the father) killed a male buffalo inside the park borders, giving it its name. In 1971, after the family had lived on the land for some time, the city of Austin acquired the land with federal assistance, and established the park we know today (Zelade, 2006).

Research Plan

Design of Study - The way that data will be collected is by following 50m transects that are to be laid at the designated locations. The plan is to station the transects at two different parts of the park: the East side of the 360 highway (the Upper Greenbelt), and the west side. There will be 2 transects at the minimum elevations (at 600 feet and 700 feet respectively), 2 at the maximum elevations (800 feet and 900 respectively), and finally 2 at the middle of the elevations (700 feet and 800 feet respectively). The transects on the west side gradually get further from the highway in the northwest direction, and are oriented parallel to the highway. The transects on the east side gradually get further from the highway in the southeast direction, with two of them parallel to the highway, and the third (farthest transect) located on a trail. These locations will allow for the production of reliable results at differing elevations, while also giving a sense of how different parts of the park affect the abundance and diversity of arthropods. Through using multiple transects at different locations, about 3-5% of the park will be studied.

Background Information - A study was conducted by Middle Eastern scientists in 2014 for the *Journal of Entomology and Zoology Studies*, the goal of which was to observe and document how certain environments affect diversity and abundance of arthropods. No transects were used, but the scientists studied areas that were perceived by them as "different environments," and collected their data accordingly. Many tests were conducted throughout one year in different weather conditions and temperatures, and they concluded that different environmental factors (biotic or abiotic) can change the abundance and diversity of arthropods in said area, either by forcing them to survive in harsh conditions (therefore decreasing diversity) or by giving them every resource they need to survive and thrive (therefore increasing both abundance and diversity)(Khaliq, Javed, Sohail, Sagheer 2014). As mentioned previously, such differing conditions exist at different elevations in Bull Creek, providing a reliable area of study.

Another study was conducted a year earlier in 2013 by scientists in Asia, the goal of which was to study Altitudinal Zonation (the concept describing the different populations of animals at different

elevations) around the world, specifically the diversity of different animals living at different elevations. 443 elevational gradients were observed in locations around the world, and the scientists concluded that the maximum level of animal diversity appeared below the middle of the elevation gradient (Guo, Qinfeng, Douglas Kelt, Sun, Liu, Hu, Ren, Jun, Wen 2013). This supports the hypothesis by showing that more diversity occurs closer to the bottom of the gradient rather than the middle. However, this study was conducted in different places around the world with conditions not always matching (or even resembling) those of Bull Creek.

Another study was conducted by Swiss scientists in 1999 for the Journal of Applied Geology, the goal of which was to study the effects the environment had arthropod diversity. Among the factors studied was elevation, which was concluded to have a large effect. The scientists mainly studied grasshoppers and butterflies in Switzerland wetlands, and conducted their study by net sampling in 10 different areas each of the 24 wetlands studied. Grasshopper diversity was found to decrease at higher altitudes in heavily grazed areas, while butterflies were found to be more diverse in those areas (Wettstein, Schmid 1999). This supports the hypothesis by illustrating the high diversity of butterflies in higher altitudes, and the lack of diversity of grasshoppers in areas without heavy vegetation.

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Cameron “Greater Twin” Michael Bennett
Sendhil “Sandal Shredder” Sridhar

Conclusion

Results:

When analyzing the results, significant trends can be found throughout the data collected. When focusing on abundance, one can conclude from the data collected that the average number of arthropods is greatest at medium elevations (about 100 feet relative to the low elevation), followed by high elevations (about 200 feet relative to the low elevation), and then low elevations (lowermost surface relative to the surrounding area)(Figure 2). When doing a statistical test comparing arthropod abundance (Anova Test), one can find that the p-value of the data collected is 0.1338. For the p-value to be considered significant, it must be greater than 0.5. Therefore, the p-value of this study is insignificant, meaning that the arthropods caught at the different transects are likely from different populations.

When focusing on diversity, by comparing and contrasting the averages, one can conclude from the data collected that the average number of arthropod orders is greatest again at medium elevations, followed by high elevations, and then low elevations (Figure 1). When performing an Anova Test comparing arthropod diversity, one can find that the p-value is 0.4328. Again, this is insignificant, further indicating that the arthropods at the different transects are parts of different populations.

Another significant aspect of the data is the abundance of arthropods with obvious wings versus arthropods with modified wings. Not only were the average amounts of winged arthropods overall greater than the average amount of arthropods without obvious wings (Figure 4), but the three most abundant orders (in order) were Odonata, Hymenoptera, and Araneida, all of which are winged arthropods (Figure 5). This suggests that the population of arthropods in Bull Creek Park consists of more winged than non-winged arthropods. When looking at these differences within specific transect categories, winged arthropods were notably more abundant than non-winged arthropods at both low and medium elevations, but were slightly less abundant at high elevations (Figure 4).

Discussion:

The hypothesis of this study stated that arthropod abundance and diversity would spike at medium elevations, but did not specify the estimated patterns at the low and high elevations. The data collected supports the hypothesis, and includes additional data stating that arthropod abundance and diversity are lower at low elevations than at high elevations (Figures 1 and 2). One potential cause for this would be that the lower elevations are more suitable habitats for birds in Central Texas, which are natural predators of many arthropods. This is because many organisms that birds prey on (most notably arthropods) are more easily accessible in these areas.

This would certainly cause a decrease in abundance, and could potentially have a large effect on diversity as well.
Another potential cause for the greater arthropod abundance and diversity at high elevations than at low elevations is the fact that the thick shrubs and trees at the higher elevations serve as effective arthropod breeding grounds. This is the case for arthropods of many orders, which would certainly increase abundance and diversity.
One potential cause for the highest arthropod abundance and diversity at the medium elevations is the fact that the medium elevations at which data was collected were midway between the areas in which birds were the most abundant (low elevations) and the breeding grounds (high elevations). This gives the arthropods a survival advantage as well as a reproductive advantage. Additionally, one potential cause for the greater number of winged arthropods at low and medium elevations is the larger effect of wind in the high elevation areas. Any arthropod that relies primarily on its wings to travel would struggle more to do so in the presence of wind. Additionally, the highest elevations had more thick shrubs and dirt mounds than the low and medium elevations (possibly because of rain patterns and sunlight accessibility), which serve as effective habitats for non-winged arthropods (Figure 4).

A similar study was conducted in 2006, which compared the abundance and diversity of litter ants at different elevations in the Wayanad region of the Western Ghats in India. The scientists achieved results similar to those of this study, concluding that, "Ant abundance and species richness peaked at mid-elevations influenced by the presence of favourable physical conditions and abundance of prey resources" ("Diversity of Forest Litter-Inhabiting Ants Along Elevations in the Wayanad Region of the Western Ghats," 2007). According to their study, organisms that the arthropods preyed upon were the most abundant at medium elevations, which may have been another potential cause for the results of the Bull Creek study.

Another similar study was conducted in 1976 in the Venezuelan Andes. The results of the study were again very similar to those of the Bull Creek study, stating: "Sweep samples of insects at 200, 1600, 3550, and 3600 meters elevation in secondary vegetation in the Venezuelan Andes near Merida show that the greatest number of insect species and dry weight occurs at the intermediate elevation ... that at higher elevations there are a reduced number of species and an increasingly unequal distribution of the individuals among the species, and that large insects are much less abundant at high than low elevations" ("Changes in the Arthropod Community Along an Elevational Transect in the Venezuelan Andes"). This conclusion is very similar to that of the Bull Creek study, with more additional information regarding the potential reasons.

During the data collection process, certain mistakes occurred that potentially caused biases in the results of the study.

Among these, the most prominent (and perhaps the only truly significant bias) was the struggle to capture every arthropod discovered. This was especially problematic when faced with swift flying arthropods, which occupied the majority of arthropods collected (Figure 4). The results of the study would have likely been different (if only slightly) if all ground-dwelling arthropods were discovered, and if all flying arthropods were successfully caught.

If another group decides to replicate this study, a way that the data collection process could be improved is to change time of day in which data is collected. All data was collected during the warm part of the late morning or early afternoon, and as a result, many arthropods were dormant so as to not suffer from exhaustion. If someone were to repeat the study, the majority of arthropods would likely be more active in the early morning.

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Clara Gibbs, Gracie Smith, Kathryn Christian
Mr. Walker
Planet Earth: 0A/0B

Introduction

Purpose
The organism that will be studied during this experiment will be arthropods. Arthropods will be studied at St. Edwards Park in North Austin, TX. The question being studied will be how does distance from Bull Creek affect the population of arthropods at St. Edwards?

Hypothesis
If the study is being conducted near the water, then there will be a higher population of arthropods. If arthropods are being studied further away from the water, there will be a lower population of them. Arthropods are more likely to live near water because all living things need a source of water to survive.

Site Description

Location
St. Edwards is located in North Austin. It is near Spicewood Springs Road. The park is located 9.48 miles or 15.25 km from the capital as the crow flies.

Size and Shape
St. Edwards is the shape of a triangle with a curved edge to the north. The area of the park is 32.38 Hectares large or 80 Acres.

Topography
St. Edwards Park is generally flat, but it the elevation decreases as the creek nears, so there are a few hills. The maximum elevation of the park is 286.51 meters, and the elevation decreases 73.152 meters. The minimum elevation of the park is 213.36 meters.

Geology
St. Edwards has an array of underlying geologic formations. The park has a good amount of Ked, which is an Edwards limestone formation. This can be thick or thin bedded, fine to medium grain, and is a combination of limestone and dolomite, which is light gray to tan in color. It also has Kgr, which is a Glen Rose formation. This formation is made of limestone, dolomite, and marl. It is gray to tan in color, and has hard and soft beds of medium gray rock. The park also has Kau, which is an Austin group rock. The rock is made of chalk, marly limestone, and light limestone. The rock is soft to hard and can be thick to thin bedded. The last rock found is Kpc, which is limestone gray to tan in color. All of these rocks are found in the lower cretaceous period (Bureau of Economic Geology, Austin, 1992).

Areal Extent and General Type of Vegetation
The general vegetation was about 40% tall trees, 40% tall grasses, and small 20% shrubbery. Plant species found in the area were cactus, grass, and black cottonwood.

Availability of Water
The water source that supplies this area is Bull Creek. The water is actively flowing in the creek and goes from .31 meters to 1.8 meters. The creek length is 18.18 kilometers long with a drainage system of 51.34 kilometers. The trash in the trees indicates that the water in the past has been at

least 3.66 meters tall.

History
The park was acquired by the City of Austin in 1986. Bull Creek is known as the Galapagos of Texas. The park is full of many different species, ranging for armadillos to deer. When the park was first built it was seen as a resort area and a place for recreation. Before the park was built, it was an area with trash and waste. Local volunteers worked hard to clear the trail and make the park a great hike and bike area (The Bull Creek Watershed, National Park Service, NA)

Research Plan

Design of Study
Specifically, transects will be placed along the St. Edward's Trail, the Blue Trail, and Green Trail. Three 50m transects will be placed on each trail, giving a diversity of location within the park. Their orientation in relation to Bull Creek is 4.5 meters from the St. Edwards Trail, 179.1m from the Green Trail, and 79.7m from the Blue Trail. All transects will be placed as parallel as possible in relation to the creek. This design of study serves to address the experimental purpose because the trails are a short, mid, and far distance from the water source. This will allow research to show the effect the proximity of water in relation to insect populations.

Background Information
Multiple studies serve to support the hypothesized results. One study was conducted by Rudolf J. Schwind in August, 1991. The location of the research was not given, but the study was published by Springer Nature. “Light polarized by reflection was tested in the field for its attractiveness to flying insects. Attracted insects include arthropods: some living in water (Corixidae, Notonectidae, Pleidae), others living on its surface (Gerridae) or near it (Saldidae). Beetles were also attracted: some are aquatic (Hydrophilinae, Dytiscidae, Haliplidae, Hydraenidae), others inhabit moist substrates (Sphaeridiinae). Also included are Chironomidae among other nematocerans.” (Rudolf Schwind, year?) The evidence of this study supports supports how light polarization attracts different types of insects. This relates to the study of St.Edwards bug populations in proximity to water because there will be more insects near the water source of the park because of the polarization of light.

Another study was conducted by Timothy D. Schowalter. This scientist studied the effect that biomes have on the life of insects. This article was published in 2011, it doesn’t focus on one biome, but it focuses on many different biomes. It’s not done in one place but it’s done in many. This article found that although some insects thrive in water biomes, others have found ways to survive without it and now don’t depend on water and in fact don’t need much water to survive. The study found this by taking bug data from different biomes, including temperate grasslands, rainforest, and savannahs. The study found that places like rainforests, which have more water sources can have just as many insects as savannahs, which have much less water sources. This is helpful to the study at St. Edwards park because it shows the effect that water has on the population of insects, which correlates with the purpose of the St. Edward's study. The St. Edward’s purpose correlates with this study because this study give us an idea of the effect that water has on arthropods.

Another study was tested in 2011. It was done by Johan Kotze, Stephen Venn, Jari Niemelä and John Spence. These scientists conducted research on the “Effects of Urbanization on the Ecology and Evolution of Arthropods”. In this research, the scientists cover both the positive and negative effects urbanization and new water sources have on arthropods. Positive effects include genetic differentiation in populations and physical/morphological changes in

arthropods. They also talk about how arthropods are more common in places with natural water sources. This directly correlates to the hypothesis and supports it. This helps the study being done at St. Edward's because it shows that arthropods are more likely to live near water sources and they can thrive easier near water, yet they still appear in more urbanized areas (J. Kotze, S. Venn, J. Niemelä, J. Spence 2011).

Materials

- Acetone (nail polish remover)
- Transect line (50 meter)
- Net to catch arthropods in
- Mason jars (7 to 8) per trip
- Forceps
- Cotton balls
- Tape
- Box for storage of mason jars
- Field guide (Insects, Donald J. Borror and Richard E. White, 1970)

Procedure

The first step to this procedure is to prepare killing jars. These jars can be prepared by taking a cotton ball, taping it to the lid of the jar, and then soaking it in an acetone, such as nail polish remover. Next, a 50 meter transect lines will be stretched in the field over the distance farthest from Bull Creek, which has been plotted. The transects will be oriented parallel to the creek. Next, take notes on the transect conditions. Take notes over the date, time, weather, and foliage on the ground. Next, start the timer and begin to collect arthropods over the first 10 meters on the transect. For each 10 meters, set a timer for 7 minutes and collect as many arthropods as possible in that 7 minute time frame. As arthropods are collected, put them in one of the killing jars and store the jars in the collection box. The arthropods will be collected individually. Next repeat the process along each transect, near the water, mid-distance from the water, and far from the water.

The arthropods will be stored in a freezer. The arthropods will be taken into class and keyed to order using a dichotomous key. Next the species will be keyed into morphospecies, which is based on appearance and can be determined using sight and is sorted by the individual. The arthropods will then be pinned onto a board or preserved, based on their order and morphospecies.

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Gracie Smith, Kathryn Christian, Clara Gibbs

Conclusion

Results: In the found results, there was a larger population of arthropods found close distance from water (Figure 2). There were less arthropods found far from water (total of 52) and mid distance from water (total of 62) than arthropods found near water (total of 65). The means of population at each transect were: far away from water transect had the greatest mean out of all the transects (mean of 19.75), mid distance (mean of 14.5), and the close distance (mean of 18.5). Orthoptera represented the greatest percentage of orders found (26.5%), and the most common population being lepidoptera (23.5%) (P=0.13992 , and P=0.7815076).

Graphs:

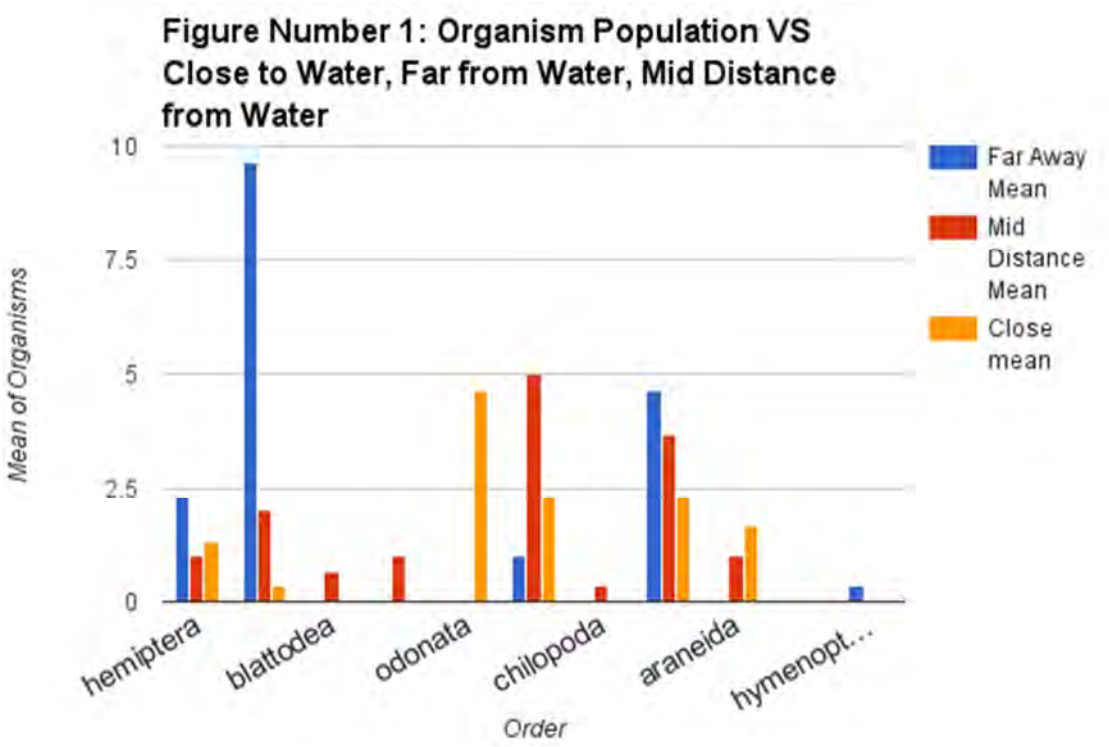


Fig 2: Mean of Species Population VS Distance from Water

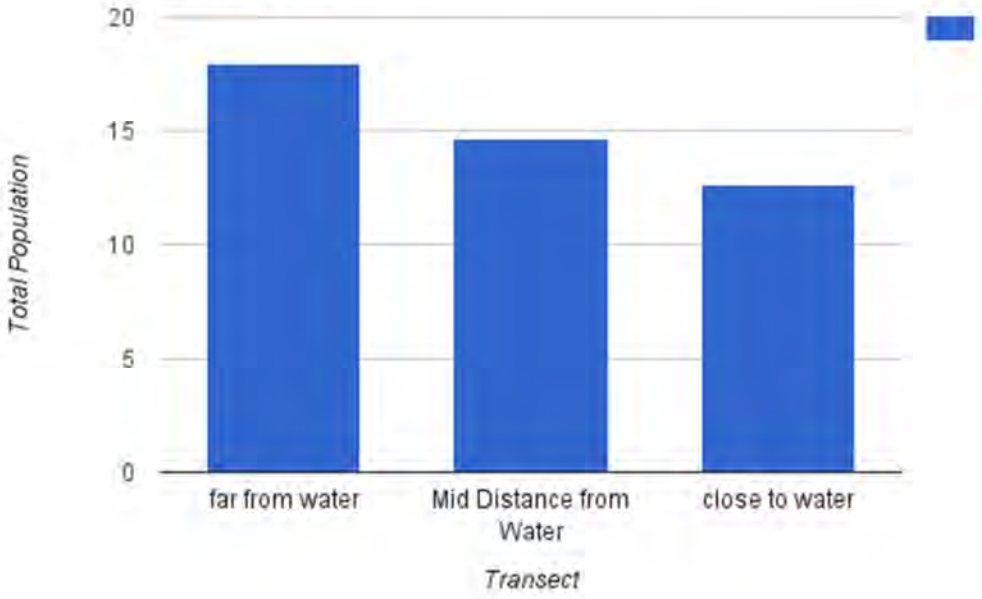


Figure Number 3: Order Diversity vs Transect #

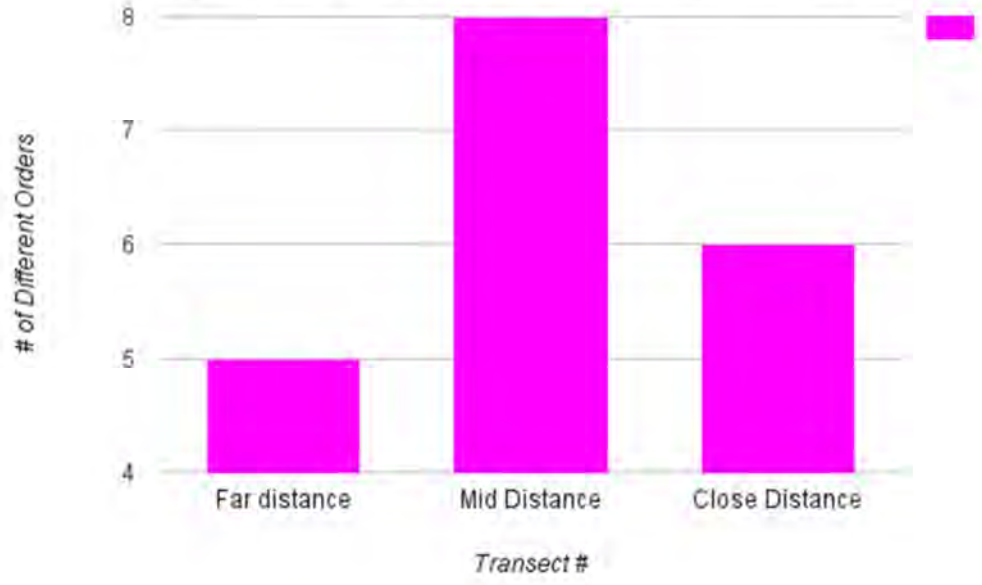


Figure Number 4: Total Number of Organisms

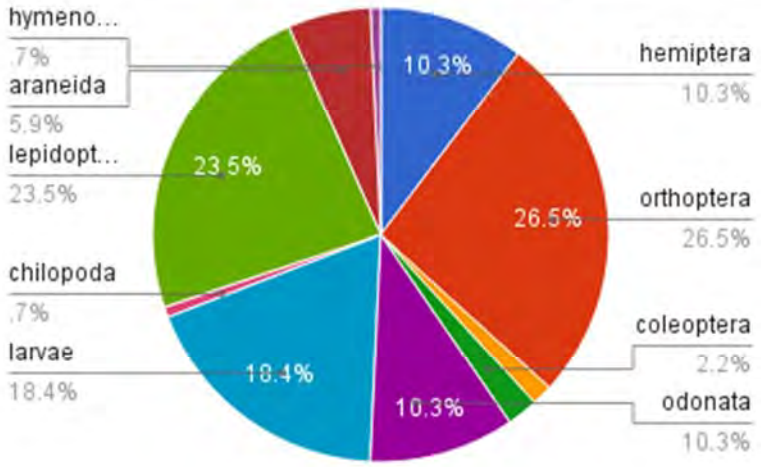
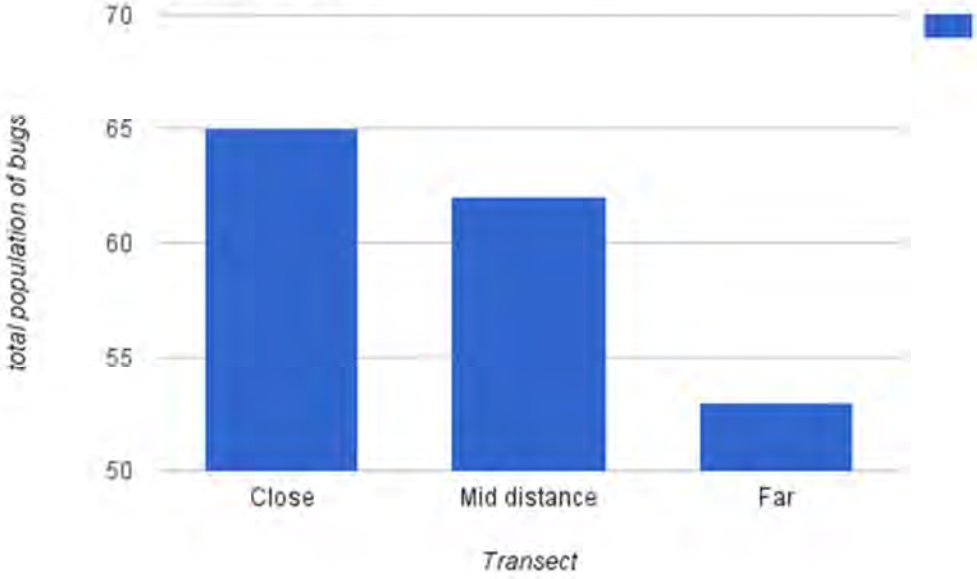


Figure 5: Total Population of Bugs caught at each transect



Conclusions/discussions:

The study conducted tested the population of arthropods affected by distance to water. The conclusion showed varying results. In the found results, there was a larger population of arthropods found close distance from water (Figure 2). There were less arthropods found far from water (total of 52) and mid distance from water (total of 62) than arthropods found near water (total of 65). The far away from water transect had the greatest mean out of all the transects (mean of 19.75), mid distance (mean of 14.5), and the close distance (mean of 18.5). There were the most orders found mid distance from the water (8), then close distance (6), then far distance (5). In another study, the total population of each type of organism was compared (Figure 4). Out of all the orders collected in this study, orthoptera represented the greatest percentage (26.5%). This result could have been caused by the large amount of crickets that were caught far away from water. The second largest population caught was lepidoptera (23.5%), due to abundance of butterflies found at each transect. Both orthoptera and lepidoptera results did not vary, and their P values did not show much of a difference. (P=0.13992 , and P=0.7815076)

Mistakes: If the study could be conducted again, there would be more data collections, and double the transects to ensure more accuracy. There would be controlled variables such as temperature, climate, and time of a day. The data collection would be on days that all the variables aligned. There would be more than three people on the study's team, so multiple people could catch bugs at once along each transect to maximize the amount of arthropods collected.

Rachel Clubine Horowitz
Ava Ponder
Alia Shaukat

Introduction

Purpose:

The purpose of the study is to identify the relationship between proximity to Bull Creek and diversity and abundance of woody plant vegetation at Bull Creek Park, Austin, TX.

Hypothesis:

The closer an area is to a body of water, primarily Bull Creek, the more dense the population of woody plant vegetation will be. Plants thrive in wet, fertile areas, resulting in this assumption regarding their population density and proximity to water. Plants will be more diverse closer to bodies of water because more species of plants will be able to thrive in wetter environments.

Site Description:

Location:

Bull Creek Park is located at 6701 Lakewood Drive, Austin, TX. The park is approximately 11.3 km north-west of the Texas Capitol Building, as the crow flies. The whole park is divided into Upper and Lower Bull Creek, and the two sections are divided by Capital of North Texas Highway.

Size and Shape:

The Lower Bull Creek Greenbelt is about 135.36 hectares in size. Bull Creek District park has a unique shape, with a square-like shape base with a thin panhandle pointing north along the river. The shape of the park is defined by the creek.

Topography:

The elevation of the park is greatly varied, with the minimum elevation at 91.44 meters and maximum elevation at 274.32 meters. There is flat land on one side of the creek and increasing elevation primarily on the opposite side of the water. Elevation decreases towards the river, creating steep rock walls bordering Bull Creek. On one side of the river with the highway and urbanization, the ground is more flat and well-maintained, whereas the opposite side of the river is lined with cliffs and hills, and is heavily vegetated.

Geology:

Bull Creek Park had a large variety of geologic features. There is a presence of large boulders protruding from the water of the creek, as well as a large rock wall on the opposite side of the creek, across from the park entrance. There are also multiple caves in the cliffs of Bull

Creek. Large portions of bedrock are exposed on the riverbed showing fossilized formations. The type of rock found at the park is primarily limestone from the Cretaceous Period millions of years ago due to deposition ("Geology"). Limestone is porous and has the ability to store water, so many plants can be found near the edge of the creek where limestone is present ("Geology"). Specifically, some large trees grow on the edge of the river with their roots growing in and over the limestone bed. Geologic elements found in and near the water have jagged edges and can be very steep, indicating that the process of erosion formed the unique shapes of the rock.

There are lots of different rock types surrounding the creek, such as Tributary Terrace Deposits (gravel, sand, silt, clay) from the Pleistocene period, Alluvium (sand, silt, clay, gravel) from the Recent period, Lower Colorado River Terrace Deposits (sand, silt, clay, gravel) from the Pleistocene period, Edward's Formation (limestone, dolomite) from the Lower Cretaceous period, Glen Rose Formation (limestone, dolomite, marl) from the Lower Cretaceous period, and Walnut Formation (limestone, marl, marly limestone) from the Lower Cretaceous period (Geologic Map of the Austin Area, Texas, 1992).

Areal Extent and General Type of Vegetation:

The general type of vegetation in the Bull Creek Greenbelt park is poison ivy, texas ash, sugar hackberry, japanese privet, and more. There is a large variety of large trees, tall grasses, shrubs, and flowering plants. The vegetation is well-attended to and is regularly mowed and trimmed down surrounding the trails. The areal extent of the park is mostly woodlands, approximately 87% woodlands and 13% limestone formations, found around or near the water.

The Bull Creek area contains over 600 plant species, which is "equivalent to 12% of all the types of plants in the entire state of Texas." In fact, the rarest plant in Travis county (the Bracted Twistflower) can be found at Bull Creek (*The Bull Creek Watershed: Galapagos of Texas*). Careful maintenance helps contribute to the thriving vegetation throughout the area. Bull Creek's clear waters flow through the center of the park, allowing the growth of plenty of algaes and mosses along the waterfront. Further back from the water, taller vegetation becomes present and grasses weave together, indicating a past of flooding. Based on the observations in the park, mosses and algae grow best near the waterfront.

Availability of Water:

There is approximately 1-4 meters of flowing water that runs through the middle of Bull Creek Park, separating the two sections of park (one is densely vegetated while the other is well-maintained and is more regularly used by humans). There is evidence of flooding of the creek due to trash visible in and around the trees, at about a height of 2 meters above water level.

Proximity to Urban and Industrial Development:

The Bull Creek Park is adjacent to urbanization, specifically the North Capital of Texas Highway (Highway 360).

History:

Bull Creek Park received its name from a Texas Ranger, named Richard Lincoln Preece, who killed the last buffalo in Travis County "on the backs of Bull Creek," giving the area its name. Since Texas' independence in 1836, settlers moved to modern day Austin recognizing the rich abundance of clean water, cedar trees, and fertile land. In fact, wagon wheel tracks are visible in the limestone near the creek. Since the park's creation, it's purpose has always been for human utilization, primarily for recreational purposes (*The Bull Creek Watershed: Galapagos of Texas*). Through the years, many environmental programs have been created to maintain the park's health and natural beauty.

Bull Creek Park has a long history of use by humans, as there is archeological evidence done by the Bull Creek Foundation that describes prehistoric utilization dating back from the early archaic to late prehistoric era. There are lots of fossils encapsulated in the limestone, which indicate other archaeological organisms. Currently, Bull Creek is a well-maintained park with lots of trails and picnic areas for families on the South side of the river.

In 2012, programs such as Grow Zones were created to preserve riparian zones, or areas next to creeks. By preventing human access into these zones, the water quality and land can be preserved. Constant walking and mowing on the riparian zones kills vegetation and compacts the soil, therefore increasing evaporation due to lack of shade and causing erosion because the soil loses its ability to absorb water, which can result in polluting the creek ("Bennet Creek, Cochrane District, Ontario").

Research Plan

Design of Study:

The area of Bull Creek Park is heavily vegetated, with Bull Creek running through the the middle. There are nine transects along which data will be collected, each of which are 50 meters in length. Three transects will be about 15 meters from the water, three transects will be approximately 300 meters from the water, along the Bull Creek Greenbelt Trail. The last three transects will be about 730 meters from the water, also along the Bull Creek Greenbelt Trail. Each transect will be oriented parallel to the creek and spread out throughout the park at various elevations. By collecting data in a wide range of distances from the water source, this allows the group to identify the abundance and diversity of woody plant vegetation in relation to distance from water.

Background Information:

Several studies have been performed around the world relating plant diversity to availability of water. For example, a collection of studies recorded by researchers have supported the hypothesis that wet areas that have constant access to water, either through precipitation or a nearby body of water, often have a more rich variety of woody plants.

An example of such a study is that of which was performed in two 7th-order boreal rivers in northern Sweden, the free-flowing Vindel River and the regulated Ume River, by researchers Andersson, Nilsson, and Johansson. The primary objective of this study was to understand how

rivers contributed to diaspore dispersal dynamics and therefore how the nearby rivers contributed to plant diversity in that area. The results of the study showed that diaspore dispersal heavily depended on the associated water current (Andersson et. al. 2001). The creek at Bull Creek had a very fast flow speed due to the shallow waters and swirling obstacles of rocks and vegetation, resulting in possibly carrying the seeds of plants far distances and contributing to great levels of plant diversity in Bull Creek Park.

In a study conducted in the savanna parklands of southern Texas in 1998, studies were conducted on water use by woody plants. To conduct this study, researchers took samples of each rainfall event and of the groundwater from January to October 1991 to see how the amounts of water affected the plant growth. Researchers found that monthly rainfall amount was inversely related to weighted monthly mean of the precipitation, which increased monthly plant growth (Midwood et. al., 1998). This relates to the hypothesis because it shows that plants thrive in areas with more water.

A study conducted in the wetlands of temperate North America, exhibit diversification of richness in species and plant communities in relation to richness of nutrients. The study showed that nutrient enrichment (too many nutrients) leads to a decline in the plant species composition and diversity. Over broad "nutrient gradients," plant communities change. Therefore, by conducting research at a broad range of locations, the group can study changes in plant species due to proximity of water and nutrient levels (Bedford et. al., 1999).

Materials:

- Woody Plant field guide (Brother Daniel Lynch, 1999)
- 50 meter transect line

Procedure:

<u>In Field:</u> Data Collection Procedure

1. Stretch 50 meter transect line straight through wooded area
2. Walk along transect line and record woody plants that overhang at certain areas of the line (record where they overhang): Record the common name, the intercept range and length, distance that the woody plant overhangs (to nearest decimeter), and the interval that the woody plant is found at
3. Collect leaf samples from each plant that overhangs the transect line. Place flattened plant into back of notebook (DO NOT collect cacti or poison ivy. Just take photo.)
4. Record other descriptions of the plants: leaf type, leaf arrangement, description of the bark, description of fruit/flower, whether plant is shrub, vine, or tree, and if possible, the common and Latin name of plant
5. Record other plants that can be identified that are not overhanging the transect (both woody and nonwoody)

<u>In Lab:</u> Analysis Procedure

1. Calculate relative density
2. Calculate relative dominance

3. Calculate relative frequency
4. Calculate the importance value

Formulas:

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

Importance Value = Relative Density + Relative Dominance + Relative Frequency

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Ava Ponder
Alia Shaukat
Rachel Horowitz

Biodiversity Project Conclusion

Results

The group found that diversity of woody plant vegetation increased at the medium distance from water, 60m. At this distance, certain populations of plants thrived the most. For example, Ashe Juniper made up 34.3% of all of the plant populations at all three transects (Fig. 2), but specifically at the 60m transect, Ashe Juniper had the highest number of individuals compared to any other plant, the average being 5.0 (Fig. 1). At the 25m and 85m transects, Ashe Juniper had averages of 3.67 and 4.0, different from the 5.0 value at the 60m transect, yet not significant ($p=0.67$).

Plateau Live Oak was second most abundant plant that was found, the overall total being 14.4% (Fig. 2). This plant also had a large population at 60m, the average number of individuals being 2.67 (Fig. 1). At the 25m and 85m transects, the averages for individuals found were both 1.33, which is different from the 60m value of 2.67, but not significant ($p=0.17$).

Though the average diversity between all transects was *not significantly* different (very close) ($p=0.080$), one data value between 25m and 60m was significant (0.017). This shows that the first transition/change in distance from water (25m-60m) contains the most difference in species diversity. However, the average abundance was not significantly different between transects ($p=0.94$), showing that as the distance from water increases, abundance of plant species doesn't become significantly different.

Discussion

The hypothesis for the current study was that if distance from water increases, than diversity and abundance of woody plant vegetation would increase as well. This hypothesis was supported by multiple studies that prove that diversity of plants is higher in areas farthest from water sources

A study performed by Alan K. Knapp, et. al., in a Mesic Grassland, observed the relationship between rainfall variability, carbon cycling, and plant species diversity. The study concluded that rainfall and distance from water can drastically affect a plant community composition, just as the group had hypothesized before. The study also concluded that more extreme rainfall patterns, without concurrent changes in total rainfall quantity, increased variability in soil moisture and plant species diversity. This connects to the current research experiment because it is also focused on the relationship of water availability and plant diversity, and because this experiment endured a high amount of rainfall, which could've potentially affected data results (see Potential Errors paragraph).

Another experiment by Y-.N Chen et. al. studied the ground-water level effects on plant species diversity along the lower areas of the Tarim River, Western China. The study results concluded that "plant species become less diverse, the structure of plant communities become simpler, and the diversity and abundance of the plant species decrease moving from the upper to the lower reaches of the Tarim River, corresponding to declining ground-water level," (Y.-N. Chen et. al., 2002). These results are similar to the current experiment's results, as this study concluded that woody plant diversity and abundance increased at further transects from the water.

The group experienced several errors while conducting data collection and analysis. For example, the researchers were unable to collect every plant on particularly dense transects due to multiple challenges, such as accessibility and inability to decipher whether or not a particular plant was woody or not. This could've led to slightly inaccurate data, as this affects the numbers for the values defining average abundance and plant diversity on individual transects. Another potential error is the time period in which the data was collected, between the months of October and November. Over this period, temperatures were gradually dropping as the seasons changed, causing overall plant health to decrease as leaves fell. Also coming with the change of seasons was more frequent rainfall, which lead to fluctuating water levels and, again, affecting the data.

A major modification that the group would make if conducting this study in the future is to take more data, especially at further distances from water. In this study, the group took data from three distances, and believe that it would be more beneficial to increase the amount of transects at certain distances in hopes of more diverse and abundant plant populations.

In future studies, researchers should diversify their distances from water and transects so that the data collection could be more accurate and precise. By collecting more data at different distances from water, the group could identify significant changes/differences between values because more data can show trends and compare significant differences in data; because there was only a total of 3 different data collections at each transect, it was difficult to identify whether new data was simply an error in collection or a significant difference in plant species.

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Rainfall Variability, Carbon Cycling, and Plant Species Diversity in a Mesic Grassland | Science Alan K. Knapp1,*, Philip A. Fay1, John M. Blair1, Scott L. Collins1,2, Melinda D. Smith3, Jonathan D. Carlisle1, Christopher W. Harper1, Brett T. Danner1, Michelle S. Lett1, James K.

McCarron11 Division of Biology, Kansas State University, Manhattan, KS 66506, USA. 2
Ecological Studies Program, National Science Foundation, Arlington, VA 22230, USA. 3
National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara,
CA 93101, USA. - Alan K. Knapp, Philip A. Fay, John M. Blair, Scott L. Collins, Melinda D.
Smith, Jonathan D. Carlisle, Christopher W. Harper, Brett T. Danner, Michelle S. Lett, James
K. McCarron - Science13 Dec 2002 :2202-2205

Andrew Martinez, Alex Loia, Sofia Pineda
Mr. Walker
Planet Earth: Period 2/5
8 September 2016

Introduction

Purpose

The goal of this study is to determine the relationship between proximity to Barton Creek and abundance and diversity of woody plants in Gus Fruh Park in Austin, Texas, United States.

Hypothesis

Diversity and abundance of woody plant species will increase the closer they are to the creek bed. As most plants require ample supplies of water for growth, it is believed that proximity to Barton Creek should positively affect growth and propagation.

Site Description

Location

Gus Fruh Park is specifically located at 2632 Barton Hills Drive in central Austin, Texas, United States. Within Austin, it is approximately 6 km west of the Texas Capitol as the crow flies. The park entrance is located directly adjacent to the Barton Hills Drive.

Size and Shape

The park is shaped like an upside-down triangle with its tip folding inwards with a long line following the creek jutting from the main body towards North. The park contains approximately 168 hectares of land.

Topography

The elevation of the park decreases from approximately 210 meters to 152 meters as one approaches the banks of Barton Creek. The creek bed is the lowest point in the park. The total relief is 58 meters. There are many sharp drops in elevation as the park contains several exposed cliffs and ridges, where elevation can differ by a factor of six or nine meters at times.

Geology

Gus Fruh park has many boulders and loose rocks made of limestone of the Georgetown and Edwards formations from the Cretaceous period. *Neithea texana* from the Lower Cretaceous period was found in the park's limestone. Faults run throughout the park, all running parallel to the Mt. Bonnell Fault to the west. These explain the many cliffs throughout the park. The park is mainly composed of alluvium from the Quaternary period, which is mostly sand, silt, and clay (Fisher, 1992).

Areal Extent and General Type of Vegetation

Approximately 80 percent of the park is woodland with 10 percent grassland and 10 percent creekbed. Woodland is in large part comprised by woody plants of the genera *Juniperus* and *Ulmus*. Woody plants of the genera *Toxicodendron* and *Smilax* are also present.

Availability of Water

Barton Creek runs through Gus Fruh, reaching depths of about 2 meters at its deepest. Water is flowing, but not intensely so. Some smaller pools of more stagnant water are also present. White river rocks present above the water level suggest a variance in water height. Pieces of plant debris and trash, which have been caught in plant branches, indicate an almost 4 meter higher flood height.

Proximity to Urban or Industrial Areas

The entrance is directly adjacent to Barton Hills Drive, a residential area. The area surrounding the park is mainly urbanized, and trash from nearby areas has permeated through the park

History

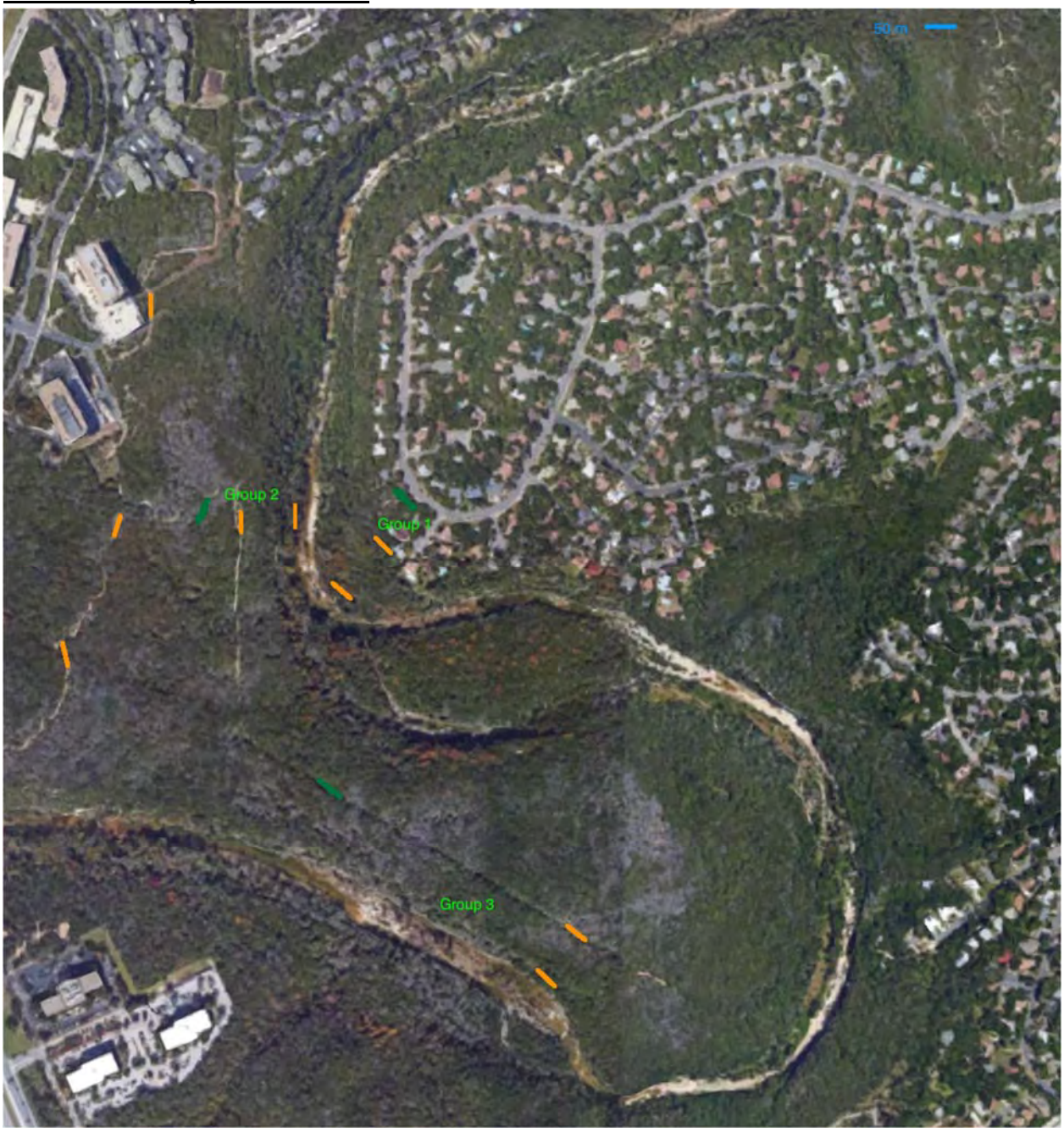
William Barton was the first to settle on the banks of Barton Creek in 1837 and gave his name to it. The Barton Creek Greenbelt was initially resort land and in the 1880's was dubbed "Austin's Eden". It was fenced off and hard for the public to access throughout the early 1900's, but the Barton family has consistently fought to keep it open and free. In the 1930's a swimming hole was built on the creek. Gus Fruh is a central subsection of the Barton Creek Greenbelt. All of its land was acquired by the Austin Parks and Recreation Department in 1980, 1986, and 1992. Currently, it is administered by the Austin Parks and Recreation Department and is open to the public (Smyrl, 2012).

Research Plan

Design of Study

To evaluate the diversity and abundance of woody plants in Gus Fruh park, depending on distance from creekbed, nine 50 meter transect lines will be placed at varied distances from the water. Three transects will be located next to the waterbank (10 meters from water on average). Three transects are a medium distance from water (150 meters from water on average), and the last three are even farther from the water (average 400 meters from water). Each of these transects will be oriented as parallel as possible to the creek. Each person will walk along their transect, taking a sample from each new plant they encounter. While doing so, they will record the amount of transect occupied by the plant, and where that amount is. Members will also write a short description of the plant, noting things such as sap, shape, and branch arrangement. Diversity and abundance will be evaluated back in the classroom.

Transects will be placed as shown:



Background Information

This study revolves around the assumption that there will be a change in biodiversity and plant density as one becomes closer to the bank of Barton Creek. This assumption has been supported by many academic studies.

One study in Arizona in its introduction claims riparian zones allow for nutrients beneficial to plants and water to collect. This study collected plants along trails leading towards West Clear Creek and found plants to be more dense in areas nearer to West Clear Creek. This same study found this to led to an

increase in plant density near creek banks and beds (Anderson 2007). This supports the hypothesis that distance to water affects plant density and diversity.

Riparian landscapes are some of the most diverse habitats. "An infinite variety of plants e.g. herbs, grasses, trees etc. are found to thrive along the riparian landscape and the rivers" (Mubi, 2011). Many plants can only exists close to rivers in riparian zones. A study conducted in Ethiopia found that as the researchers distanced themselves from the riparian zone plant density predictably sharply decreased (Mubi, 2011). In an unpopulated park type area researchers recorded and collected plant density along a creek's riparian zone at distances increasingly far from water. This supports the hypothesis that increasing proximity to water increases woody plant abundance and diversity.

A third and final study conducted in Australia found a decrease in tree cover and tree density as one removed himself from the main water source of the plants. This study was conducted by measuring the amount of trees and the diversity in the tree species as they were farther and farther removed from the creek that served as the water source (Eastham et. al). This supports the hypothesis that more diversity and abundance of woody plants will be found near water and that less diversity and abundance of woody plants will be found away from water.

Material

*Transect Tape: To measure out the proper distance for our transects
*Project Notebook: To record information, and hold samples
**Native and Naturalized Woody Plants of Austin and the Hill Country* Guidebook: To dichotomously key out and identify encountered plant species (Lynch, 1981).
*Pen: To write notes
*Scissors: To cut plant samples for gathering
*Knife: To cut plant samples for gathering

Procedure

Measure out a fifty meter transect, with the transect tape. Starting at one side of the transect, walk across, taking a representative leaf sample from each new plant species that crosses the transect tape. A representative leaf sample is one that corresponds to the general characteristics of all other leaves of a species (Walker, 2016). Be sure to record any other points of interest about the plant, such as sap color, sap consistency, plant shape, and any parasitic plants on it. While doing so, record how far the plant reaches from its first crossing the vertical perpendicular plane of the transect to the point where the plant ceases crossing the transect. Also, record the intervals where the plant intersects the vertical perpendicular plane of the transect. There are 10 intervals and each is one-tenth of the transect length (5 meters). The first interval corresponds to the first 5 meters of the transect, and so on for next 9 intervals. The following statistics will be calculated in order to analyze the abundance and diversity of woody plant species within the study area of Gus Fruh Park for each transect (Walker, 2016).

1. Relative density will be measured in order to quantify the amount of individuals of each species in a percentage that is relative to the rest of the observed species. It is calculated like so:

$$\text{Relative Density} = \frac{\text{Total \# of individuals of that species}}{\text{Total \# of individuals of all species}} \times 100$$

2. Dominance is a measure of the size or bulk of woody plants. The size is expressed by the canopy cover which is the intercept length of the plant with the vertical perpendicular plane of the transect line. It is usual to express relative dominance as a percentage. Relative dominance is calculated as:

$$\text{Relative Dominance} = \frac{\text{Total intercept length of that species}}{\text{Total intercept length of all species}} \times 100$$

3. Relative Frequency is a measure of the commonness and distribution of a species within a study area. Relative frequency is expressed as a percentage of the number of intervals within the transect in which a species occurs over the total number of intervals for all species. It is calculated like so:

$$\text{Relative Frequency} = \frac{\text{Total \# of intervals of that species}}{\text{Total \# of intervals of all species}} \times 100$$

4. The importance value gives an overall estimate of the influence or importance of a plant species in a community. It is expressed as a whole number out of 300 and is a function of the three relative measurements. Importance value is calculated as:
   $$\text{Importance Value} = \text{Relative Density} + \text{Relative Dominance} + \text{Relative Frequency}$$

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Andrew Martinez, Alex Loia, Sofia Pineda
Mr. Walker
Planet Earth: Period 1/5
7 December 2016

Conclusion

Results:

The data collected shows a noticeable and significant difference in plant abundance between the near water transect group and the far from water transect group with the average number of plants being 14.0 and 22.0 for close and far transects, respectively. (p=0.01, Fig. 2). The medium distance from water transect group and the far from water transect group with the average number of plants being 12.3 and 22.0 for close and far transects, respectively (p=0.01). The P-value comparing Ashe Juniper population between the medium distance from water transect group and the far from water transect group is significant, with the average number of Ashe Juniper organisms being 0.7 and 11 for medium and far transects, respectively (p=0.03). Ashe Juniper also had an average importance value almost double that of the second most important species, Cedar Elm, with average importance values being 32.3 and 62.2 for Cedar Elm and Ashe Juniper, respectively (Fig. 4, Data Chart 4). No other examined dataset showed any significant variance, i.e. the diversity ANOVA showed insignificant variance, demonstrating that the data collection areas did not contain significantly different plant diversity. However, certain plants were indeed observed to increase in abundance with closer proximity to water, examples being Chinaberry (3.0 close on average, 0.0 far on average), Texas Ash (3.0 close on average, 0.0 far on average), Red Ash (2.3 medium on average, 0.0 far on average), and Indigo Bush (1.7 close on average, 0.0 far on average).

Discussion:

The results of this data analysis consistently display a relative growth in population of Ashe Juniper and Evergreen Sumac, both evergreen organisms, as distance from water increases. These difference mostly account for the significantly larger abundance of plants in far from water transects. According to Wildflower.org, Ashe Juniper grows in dry, well-drained soil, and has a low overall water requirement for growth. This explains why Ashe Juniper is able to reach

such a dense population size away from the area's primary source of water, as well as the trend towards having higher plant abundance (usually Ashe Juniper) in farther transects. A study conducted in Boerne, Texas, U.S.A. discovered that Ashe Juniper is exceedingly drought resistant and stays evergreen all year through observing the moisture in its seedlings, meaning it can survive throughout hot, dry summers, and dark, cold winters (McAuliffe and Dunn). In another study, the mineral and water contents of evergreen plants and deciduous plants in Okefenokee Swamp, Waycross, Georgia, U.S.A. were compared in order to determine which plant type was best adapted to the area. It was concluded that evergreen plants are more efficient with available minerals and water (Schlesinger and Chabot). As such, Ashe Juniper and Evergreen Sumac populations would not usually dwindle with droughts and could continue slow growth over long periods, even those punctuated by intense conditions. The density of Chinaberry increases in conjunction with proximity to a source of water, likely because it requires more water and nutrients from the creek, in order to prosper. The farther transects were shown to have no recorded Chinaberry plants, implying that they do not usually grow as well in areas without a ready source of water, as opposed to the more evergreen organisms, which have been shown to grow well in areas farther from the creek. This same pattern was observed in other plants, such as Texas Ash, and Indigo Bush, suggesting the high water requirement is not an isolated occurrence.

A study more focused on differences in the specific population of a single species, while approaching a source of water, could assuredly reinforce the findings of this study. It would allow an in-depth research of the plant that seems to cause most significant differences in population, and potentially explain the small trend towards higher diversity as one goes farther from water. Ideally, a future study would also factor in variables such as degree of urbanization or elevation, and see how those findings change the results of this study.

If this study were to be redone, it may produce more accurate results if transects were conducted in more heavily wooded areas, rather than along paths, so that more plants may be observed in their natural state, giving a more accurate dataset. It may also be beneficial to conduct studies after periods of prolonged heavy rain, flooding, or drought, to see how different species react to harsher living conditions or an influx of nutrients. Ideally, this could explain the trend towards higher abundance and diversity in the farther transects. Granted, this study could

possibly take years to conduct, if one wanted to observe the full severity of any lasting climatic differences' impact on plant species.

A possible problem with this study, would be that transects were placed along trails. The cleared land and constant foot traffic would discourage plant growth and skew results, even though it is a plants overhang that is measured. Another possible error is that it is at times difficult to distinguish a multi-trunked tree from two trees growing from the same close area. This error would raise or lower the collected abundance/diversity, as compared to the actual abundance/diversity. Additionally, transects should not have been placed in the creekbed, because most woody plants do not seem to grow very well in the alluvial deposits of the creek where this study's transects were placed. This error further misrepresented farther transects' increased diversity, as not all near-water species could be observed.

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Amy Min and Kadyn Weston

Introduction

Purpose

The purpose of this study is to determine the effect elevation has on the amount and diversity of arthropods in Gus Fruh Park, Austin, Texas.

Hypothesis

Arthropod populations at lower elevations will be greater and will decrease with increasing elevation. This assumption is made upon the knowledge that higher elevations result in more extreme living conditions, thus areas at lower elevation should therefore be able to support greater populations of arthropods. Arthropod diversity will also increase as elevation lowers because the environmental conditions available at lower elevations allows a greater range of organisms to thrive more easily than those at high elevations.

Site Description

Location

The park is in the general central Austin area and is about 6.48 km 30 degrees south of west from the Texas Capitol building. It encompasses area to the south of the Mopac and Highway 360 intersection and spans to the Barton Hills neighborhood to the east and feeds into the general Barton Creek Greenbelt on the both the west and northeast.

Size & Shape

The park looks like a circle and triangle attached to two bottom sides of a rhombus. The total area of the park is 137.52 hectares.

Topography

The area has varying steepness near creek, but on both sides elevation descends to creek, ranging from 161.54 m to 207.26 m (45.72 m relief,) on the northern side of the creek, while the southern side is only 161.54 m to 182.88 (21.34 m relief). There is a high cliff face near the creek rising about 15 m from the elevation of the creek. The general terrain is hilly with few flat areas.

Geology

There is considerable alluvium in the creekbed, Tributary terrace outside of the alluvium-dominant areas, mainly Edwards Formation outside of the creek area, and some Georgetown Formation farther away from the creek. Alluvium is a Quaternary formation comprised of mainly sand, silt, clay, and gravel. Tributary terrace is another Quaternary formation, and it is composed of mainly gravel, sand, silt, clay. Georgetown formation originated in the lower Cretaceous period and is composed of limestone and marly limestone and contains abundant fossilized mollusks. Edwards formation also originated in the lower Cretaceous period, and it is comprised of limestone and dolomite and commonly contains fossil

rudist and nodular chert (Bureau of Economic Geology, Austin, 1992). There are large boulders near the creek that are oriented at odd angles, indicating past fault activity in the area.

Areal Extent and General Type of Vegetation

The entirety of the park is covered by medium to large trees and shrubbery. Typical plants include Netleaf Hackberry, Western Soapberry, Roughleaf Dogwood, and Eastern Red Cedar.

Availability of Water

Barton Creek is the area's major source of water, The average depth of the creek is about 1-2 m, however, some areas are much deeper or shallower. Whether or not the creek is flowing heavily depends on the amount of recent rainfall. There is also a water hole that is often used for recreational activities. There is evidence of high flooding at around 5 m above the creek level due to fallen trees and trees bent towards the creek collecting various dead leaves and other ground coverings in their branches.

Proximity to Urban or Industrial Areas

The park's eastern side is directly adjacent to the Barton Hills Rd. neighborhood, and the entire park spans an area underneath highway 360.

History

Gus Fruh Park acquired various areas of land in 1980, 1986, 1992 (City of Austin Records). The Barton Creek Greenbelt was seriously threatened by commercial development since the 1970s and 80s, resulting in the Save Our Springs Citizens Initiative of 1992, which attempts to protect the park from development and pollution. Gus Fruh has been an area of human recreation for decades and continues to be such today (TSHA).

Research Plan

Design of Study

Six transects will be plotted within the park at different elevations to address the experimental purpose. All six are uniform in length (50m), and the group will collect data along each transect once. The transects are oriented parallel to the index line closest in order to ensure that each maintains a uniform elevation while each transect has a different elevation, as they will be at different distances from the index line. The two transects at low elevation are placed at an elevation of 155.5 m, the two transects at medium elevation are at 175.26 m, and the two transects at high elevation are at 187.45 m. This will allow the group to compare the arthropod populations on each transect and then compare their relative difference in elevation to determine a correlation between population size and elevation. The total area evaluated comprises 0.044% of the park's area.

Background Information

A study conducted by Gene D. Amman in northwestern Wyoming analyzed the effects different elevations had on the population of the mountain pine beetle, *Dendroctonus ponderosae*. In conducting this study, the researchers recorded population data from 4 different elevations ranging from 1923 m to

2750 m. In the course of this study, they found that there were higher mortality rates and declining populations in the 3 highest elevations due to exposure to cold temperatures during vulnerable stages of growth. For lower elevations, the beetles exhibited high survival rates and increasing population size. This aligns with the hypothesis that arthropod populations at lower elevations will be greater and will decrease with increasing elevation (Amman 1973).

A study conducted by David Nestel, Franzisca Dickschen, Miguel A. Altieri in coffee plantations in a tropical rain forest located in Veracruz, Mexico analyzed the effects environmental factors had on the coffee leaf-miner *Leucoptera coffeella*. In conducting this study, the researchers recorded data along an elevation transect throughout annual seasons. In the course of this study, they found that "leaf-miner populations were larger at low elevations (where temperatures are high and precipitation low) than at high elevations". This aligns with the hypothesis that arthropod populations at lower elevations will be greater and will decrease with increasing elevation (Nestel et. al 1993).

A study conducted by Daniel H. Janzen in the understory of a Costa Rican forest analyzed the effects environmental factors had on the density of arthropods. In conducting this study, the researchers recorded data along a 3,340 m elevation transect throughout wet and dry seasons. In the course of this study, they found that "the numbers of insects and species above intermediate elevations show a general decrease, and intermediate elevations appear to have the highest insect density". This aligns with the hypothesis that arthropod populations at lower elevations will be greater and will decrease with increasing elevation (Janzen 1973).

The group recognizes that the degree of variance elevation-wise in the studies presented above will not translate over to the Gus Fruh Park, and will therefore not cause variance in factors such as precipitation, humidity, and temperature. However, the presence of subtle differences in temperature, precipitation, and humidity due to elevation differences should still affect the insect populations.

Materials

In order to properly conduct the experiment, the group requires the following:

- Field Guide (Donald J. Borror & Richard E. White, 1970)
- 50 meter transect tape
- Collecting net
- Killing jars (6-10)
- Storage box
- Forceps
- Cotton balls
- Ethanol
- Acetone/ethyl acetate fingernail polish removal

Procedure

The research group will follow the procedures outlined in D. Walker's Arthropod Population Analysis packet, which are paraphrased below.

1. Prepare the killing jars. This process includes coating a cotton ball with the acetone/ethyl acetate based fingernail polish remover such that the cotton ball is not overly saturated, and affixing the cotton ball using tape to the underside of the jar's lid.

2. Once in the park, locate the transect area and orient the transect line along the most linear path possible.

3. Mark the following data in a detailed manner in the project notebook: transect number, transect category (determined by variable, ex. High elevation), date, time, weather and ground cover.

4. Collect arthropods within the first 10 meter area of the transect, extending a net's length (1 m) outward perpendicular to the transect line (a total of 20 sq. m) for a period of 6 minutes. First sweep the area's vegetation with the net for arthropods, without damaging the net or vegetation, then examine vegetation with forceps for the remaining time period. Insert specimens collected into killing jars while proceeding with collection. Repeat for each of the remaining four sections of transect.

5. If possible, consolidate specimens into the least amount of killing jars to allow for greater specimen collection while collecting along the transect. Label killing jars with name(s) of collector, date, and transect number.

6. After returning to one's house, remove vegetation from killing jars and combine all specimens collected from a single transect into one jar, labelled with the collector(s), date, and transect number. Store jars in freezer

7. Once in the lab, analyze the specimens:
    a. Identify arthropods to order
    b. Organize based on morphospecies
    c. Pin the bugs, organized according to order and morphospecies, or submerge them in small jars filled with ethanol (depending on structure).

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Amy Min & Kadyn Weston

Conclusion

Results

In summary, the results of the study were inconclusive. The data reflected that any trends present were due to random error, as all p values calculated were well over the accepted 0.5. Through ANOVA, it was found that the p-value for abundance of organisms according to elevation was 0.91 (Fig. 2), the morphospecies diversity according to elevation was 0.85 (Fig. 4), and the amount of orders according to elevation was 0.86 (Fig. 3). Even with statistical analysis refuting the validity of trends, there were no trends present to refute at all. As seen in Figure 2 and 3, both abundance and diversity had no discernable trends as a result of elevation change, as the average abundance changes from 24 to 31.5 to 23.5 specimens and as the average diversity changes from 6 to 7.5 to 7, both in respect to elevation changes from low to medium to high. This small and non-linear pattern of change demonstrates no trend. Similarly, morphospecies diversity had no common trend across the different orders of increase/decrease as elevation changed; for example, Araneida fluctuated drastically at each elevation, while Hymenoptera experienced increase in morphospecies with increase in elevation (5.5,0.5,2; 1,2,3.5, respectively, changing from low to medium to high) (Fig. 3). In an attempt to discern another possible factor affecting the data, the data was analyzed based on experience and weather, however, abundance and diversity similarly reflected no significant trends as the group's experience increased and as weather changed (Fig. 5). In conclusion, based on the study's results, no conclusion can be made of the effect of elevation on arthropod species diversity and abundance.

Discussion

The hypothesis was arthropod populations at lower elevations would be greater and would decrease with increasing elevation. However, nothing could be concluded from the data due to the variance of the data. For example, in the biodiversity of morphospecies graph, it's shown that there is no correlation between the elevation type and the number of morphospecies per elevation such as with the amount of morphospecies in Araneida, an average of 5.5 were

found at low elevation, followed by 0.5 at medium elevation, and then 2 at high elevation (Fig. 4).

A study conducted by Thomas K. Sabu, P. J. Vineesh, and K.V. Vinod in the Wayanad region of the Western Ghats in Kerala, southern India analyzed the effects habitats at different elevations had on species of forest litter-inhabiting ants. In conducting this study, the researchers recorded population and species distribution data analyzed at five primary forest sites lying between 300 to 1650 meters above sea level. In the course of this study, they found that the effect of elevation had little to do with the population and species distribution, and was more related to the specific habitats present at different elevations. For example, thrived at middle elevations as opposed to one of the extremes as there was an abundance of prey there. This aligns with the results of the current study, which suggest that arthropod populations and diversity are not specifically affected by elevation. The work of Sabu et al. is especially relevant as the elevation differences assessed were fairly small, similar to those in the current study (Sabu 2008).

A study conducted by Walter Wettstein and Bernhard Schmid in 24 montane wetlands in Switzerland analyzed the effects of altitude, habitat quality and habitat fragmentation on diversity of butterflies and grasshoppers. In conducting this study, the arthropod diversity was determined by net sampling at 10 sampling points at each site. The diversity of grasshoppers and butterflies was measured by counting species richness at the site and species density on transects. The diversity of grasshoppers and butterflies was found to be more sensitive to the geographical attributes of the site and by the habitat quality, as opposed to directly elevation. This aligns with the hypothesis that arthropod populations and diversity is not specifically affected by elevation, especially as the study's elevation was over a smaller range (Wettstein 1999).

The lack of trends or patterns present in the data could be due to bias while collecting the specimen on the transects: the tendency to neglect organisms small in size and to focus on arthropods of larger, notable size, as well as to neglect organisms in locations hard to reach. Another factor that contributed to the results could be that the difference between the elevations at which the data collected was too small and insignificant for any changes in arthropod

populations and diversity to occur, unless more data was collected that would be sufficient enough for trends and patterns to appear.

During data collection on some of the transects, people walked through, affecting the data by scaring the bugs into hiding and making it harder for those types of bugs to be collected, contributing to one of the aforementioned factors for the lack of trends in the results. Experience and proficiency in collecting data with the method mentioned in the introduction also increased remarkably as data was collected on more transects, affecting the amount of bugs that could be collected with the acquired skills on each transect.

If redone, the study could be improved through an increase in the amount of data collected by increasing the number of transects in which organisms are collected per elevation and having the study be conducted by people who are proficient in the bug collecting method used in this study at the beginning of the data collection. Other studies done in Gus Fruh Park that could contribute this study's results include looking at the abundance and diversity of arthropods according to proximity to water (especially as proximity to water trends are frequently directly reflected in elevation trends) and abundance and diversity of arthropods according to ground cover.

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Introduction and Research Plan

By Avery Davis and Maya Martinez

Introduction

Purpose

The purpose of this study is to observe how distance from Barton Creek affects the density of diversity of vegetation in Gus Fruh Park in the Barton Creek Greenbelt in Austin, Texas.

Hypothesis

There will be a less diversity and a lesser amount of vegetation as the distance from water increases. This is because vegetation needs water to create glucose, and if there is more water, more plants should be in the area to be able to create more glucose.

Site Description

Location

Gus Fruh Park is located in the Barton Creek Greenbelt in southwest Austin, Texas. Gus Fruh is approximately 6.47 km from the Capitol building and 9.70 km from the Mueller Airport, as the crow flies.

Size and Shape

Gus Fruh is roughly 104 hectares in area. Gus Fruh is oval shaped in the southeastern region of the park, the northern part of the park is shaped like a long rectangle that follows the creek, the southwestern region of the park is shaped like a parallelogram and a trapezoid connects these areas.

Topography

Gus Fruh Park varies in elevation as it gets closer to Barton Creek. Around Barton Creek the elevation reaches its minimum 151.5 meters and the maximum elevation is 212 meters which is at the start of the trailhead (Texas Topographic Map).

Geology

Gus Fruh Park has many different types of rock in the slopes, hills and creek bed. The bulk of the park is Edwards Foundation or Georgetown Foundation with Qlcr in the creek. Both Edwards and Georgetown foundation are limestone or dolomite dating back to the Cretaceous period, there were several fossils of nautilus-esque shells in the limestone. The Qlcr in the creekbed consists of clay, sand and silt, and is much more recent than the Edwards and Georgetown foundation. Qlcr was formed in the Pleistocene period (Texas Geographic Map). Gus Fruh also contains some splinters of the Balcones Fault, making it more geologically varied.

Areal Extent and Vegetation Types

Gus Fruh Park consists of many different types of plants. Approximately 60% of the park is covered in trees and 30% is covered in bushes. Three types of plants found there are Pequin Peppers (*Capsicum annuum)* , American Elm (*Ulmus americana),* American Sycamore (*Platanus occidentalis*), and Ashe Juniper (Juniperus ashei).

Availability of Water

Gus Fruh Park is part of the Barton Creek Greenbelt and follows Barton Creek. Barton Creek is .5 meters at its lowest point and is 2 meters at its deepest point. The flood line was around 3-4 meters in height. This was fairly obvious due to the erosion lines on the sides of the creek.

Proximity to Urban Areas

Gus Fruh is adjacent to the Barton Hills neighborhood, more specifically to the intersection of Barton Hills Drive and Bend Cove Street.

History

Gus Fruh is a part of the Barton Creek Greenbelt, which held Native Americans in past centuries, more specifically the Tonkawa and Comanche tribes. Barton Creek is named after William Barton, who had a house in the area. In 1907, Andrew Zilker bought the property, and in 1918 gave it to the city, creating Zilker Park. It became a popular place to swim in the late 20's, and still is a common spot for recreation today. Prolific development in south Austin at the end of the twentieth century, and added to pollution and flooding in the creek (TSHA, 2016)

Research Plan

Design of Study

This study will be over the distance from water over plants, and the transects will be 50 meters. The transects will be located parallel to the creek from various distances from the water. The transects farthest from water will be 321 m (as the crow flies), 603 m (as the crow flies) and 402 m (as the crow flies.) The transects close to the water will be 20

m (as the crow flies), 25 m (as the crow flies), and 30 m (as the crow flies.) Each transect will be used for data three times. The percentage of the area surveyed is 2.768%.

Background Information

The Ecology of Interfaces: Riparian Zones is a study, written by Robert Naiman, exploring the differences between vegetation that grows farther away from water, and vegetation in riparian zones. Naiman studied this over several years observing the growth of vegetation in riparian zones and that in non-riparian zones in several different riparian zones around the world. Naiman found that vegetation in riparian zones, (vegetation situated on the banks of a river) is vastly more abundant and biodiverse. This is because floods bring the woody plants more nutrients. This relates to the study because, in the study we are researching the effect of distance from water on density and diversity of vegetation and in Naiman's study, he found that in distances close to water there is more diverse vegetation. Naiman (Naiman 1997).

Spatial and Temporal Patterns of Plant Communities Near Small Mountain Streams is a study, written by Lana D'Souza, about the effect of distance from streams on vegetation in Pacific Northwest Forests by assessing the ages of the plants. D'Souza found that there are actually many benefits for vegetation living near and in riparian zones, with increased species richness in shrubs and increased mortality in trees. This relates to the Gus Fruh study because D'Souza studied how the distance from water affects vegetation and that is what ~~we~~ !!! are studying as well (D'Souza, 2012).

In the article “Ecohydrological Implications of Woody Plant Encroachment,” the authors propose that the amount of woody plants in an area has “ecological, hydrological, and socioeconomic implications.” They also propose that the encroachment of woody plants can affect the water cycle in an arid or semiarid climate. This relates to the study because readers can use the information to determine how water affects plants in other ways, not just distance.

Materials

- Transect tape, to measure the fifty meter transects
- Scissors, to cut the plant samples
- Biodiversity Field Notebook
- Woody plant field guide (Lynch, 1981)

Procedure

After finding the designated transect location, and setting the transect line (50 meters), data from woody plants hanging over the transect line will be collected. If known, the common name for the woody plant will be written in the data table, if not known, ‘Unknown X’ will be written instead and a sample will be collected and attached to the Biodiversity Field Notebook to dichotomously key in class the next day. After data on the type of woody plant is collected, data on transect intervals (where in the plant lies on the transect line), intercept range (meters plant overhang starts and ends on transect), and the intervals that the plant is on, in accordance to the transect tape. Data will be analyzed in class the next day by looking at the number of plants, calculating the relative density, calculating the sum of intercepts, calculating the relative dominance of each plant species, recording the number of intervals each plant species is in, calculating the relative frequency of the each species, and calculating the importance value.

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Maya A. Martinez and Avery I. Davis
Liberal Arts and Science Academy, Planet Earth
December 2016

Effect of Distance from Water on Abundance and Diversity

Results

According to the data, the abundance increased along with the distance from water. According to figure 4, the average abundance at low distance was .58, medium was .76, and high was .82. This difference was not significant (p=0.44), but it suggests that there is greater abundance of woody plants at a far distance from water, in contrast to a close distance from water. However, data shows that there is more diversity in medium distance from water, according to figure 5. There was 4.5, 7, and 6 different species on average at low, medium, and high distances, respectively, although this difference was not significant (p=0.58). Japanese Privet, one of the more common plants on the studied transects, was found mostly at far transects, about 52% of the notations of Japanese Privet are found at far transects, according to figure 3. There were almost significantly fewer Japanese Privet on close to water transects (p=0.09). Report on results for Cedar Elm here, including results for statistical tests (Figure 6).

Discussion

These are not the results that were predicted. It was hypothesized that there would be less diversity and a lesser amount of vegetation as the distance from water increases. The data directly contradicts the hypothesis, because as the transects got farther away from water both the abundance and diversity of woody plants. These results could be due to the lack of lighter seeded species closer to water. This theory is supported by a study conducted by Donna Streng.

'Woody Seedling Dynamics in an East Texas Floodplain Forest', a study conducted by Donna Streng. This study took place in a Texas floodplain, which is very similar to the Gus Fruh area, as it is in a greenbelt. Streng states, ' During the course of the study, extensive flooding ...resulted in increases in the proportion of water oak (a species of woody plant, that can prevent other seedlings from sprouting) ... while periods of reduced flooding during 1980—1982 allowed several of the more prolific, lighter seeded species...to increase in importance' (Streng, Woody Seedling Dynamics in an East Texas Floodplain Forest). This related to the Gus Fruh Study because the data found, portrays a larger abundance and diversity of plants farther away from water, similar to Streng's Study. Streng found that as distance from the floodplain increased, several 'lighter seeded species' were increasingly abundant, and since there were more species taking root in farther distances from water, the diversity was also increasing as the distance from the floodplain increased. The results could be a combination of these factors, most likely, seedlings being swept away by flooding, or a species preventing the growth of other species close to water.

Interestingly, the number of japanese privets increased semi-linearly as the transects got farther and farther away from water. Notably, 'Ligustrum japonicum commonly forms dense thickets in fields or forest understories. It shades and out-competes many native species, and once established is very difficult to remove. Privet was introduced into the United States in the early 1800' (Invasive Plant Atlas). It is known that Japanese Privet is an invasive species, not native to the United States. It is stated as highly invasive in the southern U.S, however, we didn't find similar numbers of Japanese Privet in the close,

medium, and far transects. This could be from aforementioned flooding, from urbanization in areas closer to water. Flooding could prevent the growth of seedlings because if the river floods, most of the lighter seeded organisms could be swept away in the flood. Urbanization of the area could have caused the lighter seeded seedlings to be uprooted near the trials on the greenbelt by pedestrians or by pollution. Or an unknown plant or organism near the river could be preventing the growth of the Japanese privet seedlings. A similar pattern was seen in Donna Streng's study, as the water oak in Streng's study is thought to have prevented the growth of other species.

In reflection, there are a couple of improvements that could help the study. For example, making the study a year long, to increase the amount of trials/transects to get a more sound piece of data. Or perhaps taking data in two or more diverse parks to get more varied results and to study more regions of Texas. This would aid the study by producing more relevant and realistic results. For example, if, during the study, more transects were analyzed in even farther distances from water, it could be analyzed to see if the interesting plant trends continue. Or if during a data analysis of the number of woody plants in close versus far transects were averaged, and there was a greater number of transects in each category, the results would have been more realistic. In taking more raw data of transects, the study would have portrayed a better comparison between the abundance and diversity of plants in close medium and far distances from water.

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Elias Little
Dmitry Pokinboroda
Planet Earth
A1/B5
Mr. Walker

Introduction

Purpose

The group is studying woody plants in Gus Fruh Park, a section of the Green Belt in Austin, Texas. The group will be investigating transects in the central area, and western ridge of the park. The group will be studying how elevation affects the population and diversity of woody plant species in the park.

Hypothesis

The group, based on their research, hypothesize that as the elevation increases the population of large woody plants (i.e. trees) will decrease more than that of smaller woody plants (i.e. shrubs). All of the studies in their background research came to the conclusion that both population sizes and diversity of woody plant species decreases as elevation increases. Although, because Austin in general is relatively flat, the group hypothesised that there will be a difference, but not a large one.

Site Description

Location

The park is located in South Austin, along the Green Belt. The Gus Fruh park is 6.44 Kilometers away from the Capitol of Austin.

Size and Shape

The park's shape resembles that of the letter "C". Its boundaries are defined by Mopac to the west and Capital of Texas Highway to the south. It covers a total of roughly 87 hectares of land.

Topography

The park has a steep gradient. On the side of the entrance there is a large rock wall. Once crossing the creek it was evident that it became very flat.The maximum elevation is around 212 meters, while the minimum elevation is 149 meters. While approaching the park the creek drops in elevation.

Geology

When heading down to the creek, there is lots of soil. When reaching the creek the geology changes drastically. There are white/grey rocks on the creek. The walls on the code of the creek are layered rocks. The rock types are kfr and some kdg. Kfr also known as Fredricksburg group undivided is a geologic rock formation dating back to ten cretaceous period. Kdg is known as the Del Rio clay and georgetown Formation. It also dates back to the cretaceous. These two formations are the only ones appearing in the park, kdg appearing in center with kfr on the sides. Also, Gus Fruh lies along multiple splinters of the Balcones fault. (Bureau of Economic Geology, Austin 1992)

Area Extent and General Type of Vegetation

When heading down to the creek there are lots of Ashe Juniper trees around the trail. Need two more example species from the park. American beautyberry which is a bush with distinct purple berries on it. Common buttonbush is a plant with a sort of spiky ball on the tip that begins white but ages to a brown. There is 85% woodland, 10% creekbed, and 5% grassland found in the park.

Availability of Water

There is lots of water available for the life as there is a creek (Barton Creek) running through the middle of the park. The water is quite low on higher ground, yet when there is lower elevation the water stays same height above ground. There is also evidence of flooding via clothes and trash hanging up on trees.

Proximity to Urbanization and Industrialization

The park is surrounded by neighborhood. This makes the park very prone to runoff.

History

William Barton settled here 1837 and established the creek. There were many trails the most famous being the hill of life. This hill was blocked off from the public until recently when the parks and rec. Department opened it up (Loder, 2004). Since then, many people have donated land to the Greenbelt. This has really helped the park grow.

Research Plan

Design of Study

In order to collect data that answers their purpose, the group will collect data at three different elevations in order to see how it affects the woody plants. They will walk along their transects and record each time a woody plant is directly above their transect tape. They will record several pieces of data, including how far above the tape the plant is, how much of the tape it covers, where it covers the tape, the interval that it falls in or between, and some notes about the plant. They will take samples to identify the plants at a later date. They will have six different transects in total, with two at each different elevation. Each transect will be 50m long, and data will be collected within 5m on either side of the transect. This means that between all of the transects a total of 0.29% of the entire park will be studied. Data will be collected from each transect a single time, but they will have two sets of data for each elevation. They will have two transects at 152m of elevation on an island area, two transects at 167m of elevation in an area south of the island, and two transects at 195m of elevation on a ridge in the western area of the park. (See aerial map for more detailed transect lines. Transects will be aligned along the relevant elevation contours, such that elevation changes minimally along each transect.

Background

According to a study conducted in the Montane Forest in Bolivia, a group of researchers found that there are lots of factors that affect trees within the forest, but elevation definitely played a part. They found that areas of lower elevation also was denser, and the woody plants were acquisitive and as the forest transitioned to a sparser area of higher elevation, the woody plants became increasingly conservative in their functional composition (Apaza-Quevedo, 2015). This

means that the plants were as large, and they would be less densely packed. They noticed that though they did find a correlation, the correlation is small and not very significant. From this the group understood that there is a correlation between elevation and woody plants, and they do become less dense as the elevation increases, but it won't be a drastic change.

Another study assessed the effect of elevation change on the richness of woody plants in Ethiopia. They split up woody plants into several subsections, such as trees and shrubs. Their results for the most part were very similar between the different subsections, but there were some differences between them. For the most part all of the subsections are richer in abundance at lower elevations and declined in richness as the elevations increased. All of the groups declined as elevation increased, but at what elevation they started to decline and the rate at which they declined differed between the subsections (Berhanu, 2016). It was based off of this information the group hypothesized that there would be fewer large woody plants compared to smaller ones at higher elevations. It also supported the first source that said density decreases as elevation increases.

A third study observed the effects of elevation of plant diversity in the Nubra Valley region in Ladakh, India. They measured diversity at 200m intervals between 4200m and 5000m. At each elevation they studied ten~~10~~ 2m x 2m quadrants. They found that woody plant diversity and species richness both declined as the elevation rose, whereas the herbaceous species increased both in diversity and richness as the elevation increased. They also said that there was no clear correlation between elevation and the other plant groups they studied (Baldock, 2009). This study further backed up the groups hypothesis. The study also showed that herbaceous species took over as woody plants decreased, furthering the sparsity of the woody plants. It also

showed that having multiple data sets for the same elevation was an effective way of collecting data, further reassuring the group on their design of study.

Materials

For this investigation the group will need the following materials:

- Notebooks for recording data in.
- Pens for writing down data and notes.
- A 50m transect tape for measuring transect.
- *The book, Native & Naturalized WOODY PLANTS of Austin & the Hill Country* for identifying plant samples (Lynch, 1981).
- Scissors for collecting samples.

Procedure

In order to conduct the investigation, the group will use the following steps:

1. The group first enters the park and heads to the first transect they will be studying that day. This will be the two 152m elevation transects on the first day, the 167m elevation transects on the second, and the 195m transects on the final.
2. The group will walk along the transect and record when a woody plant is directly above the transect tape. They will record the data mentioned in the "Design of Study"
3. They will take samples of all the plants they take data on, and press them in their notebook.
4. The group will identify the plant species using a dichotomous key, and record that species in their notebook.

5. They will repeat this process for three different days, each one at a different elevation. The first at 152m of elevation, the second at 167m of elevation, and the third at 195m of elevation.
6. They will then organize their data into different spreadsheets in order to easily analyze it.
7. For the analysis the group will use several different calculations:
    a. Relative density- Answers "How many?" It's in the form of a number per square meter.
    b. Relative dominance- Answers "How much?" It is expressed as the percentage of the transect that a species covers compared to that of the other species.
    c. Relative frequency- The relative frequency tells the group how common a species is and it's distribution.
    d. Importance value- The importance value gives the overall importance of a species in an area, and is expressed as a value out of 300.

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Dima Pokinboroda

12/5/16

Mr.Walker

Planet Earth

Conclusion

Results:

After collecting all the data for the project, the group went on to make data tables and graphs of the data collected. To begin the group compared the importance values of the plants to their elevation (Figure 1). The plants that show up in at least two elevations are Ashe Juniper, Elbow Bush, and White Shin Oak. In the data taken for these, Ashe Juniper and Elbow Bush both decrease in average importance value as they increase in elevation[(213.5,206.5,168 i.v.), (16,11,0 i.v.), respectively]. On the other hand, the White Shin Oak increases in average importance as it increases in elevation (0,18.5,59 i.v.) (Figure 1).

More data has shown the group that the average diversity varies most in the highest and lowest elevations (3.5, 4, respectively) (Figure 3). At the medium elevation there appears to be the least diversity. The plants abundance also mostly appeared in the highest of the elevations. The medium elevation seemed to have the least amount of plants. The significant change that the group saw was the difference in trees and shrubs at the park. At all elevations, the abundance of trees were significantly greater than that of shrubs ($P = 0.025, 0.036, 0.026$, for low, medium, and high elevations, respectively) (Figure 2).

Discussion:

According to source 1, they found that in the woodlands of Swat, Pakistan the richness of trees was highest at their lower elevations. They took data in 18 sets of 100m intervals between 1600 and 3400 meters. They took data on trees, shrubs and herbs. They calculated for alpha and beta diversity and the richness of the different types of plants. They also found the diversity of all plants was highest at lower elevations (Naveed, Bergmeier).. This is similar to the results of the current study, though some of the relationships are harder to see in the current study because of the small amount of data collected. In the current study, average diversity was higher at low elevation than medium, but not as high as high elevation. The richness of species for in the current study was also highest at lower elevations, with an average abundance of 18.5 trees, and 3 shrubs, the highest of both categories for all elevations

According to source 2, they found the plant diversity increased but then decreased as elevation increased in the Guancen Mountains, China. They also said that overall species diversity was negatively correlated with elevation. They used 53 quadrats of 10 m X 20 m along an altitudinal gradient. They took data on species present and environmental variables for each quadrat. Overall, these results resemble those of the current study. In the current study, diversity at lower elevations was the highest. However it was found that diversity went down and then back up, opposite of what they found. This is probably because their data was over a much larger range in elevation compared to that in the current study (Dongping, Zhang, Li).

The group had hypothesized that as the elevation increases the population of large woody plants (i.e. trees) will decrease more than that of smaller woody plants (i.e. shrubs). The total average number of plants that decreased as the elevation went up was greater on the tree frontier compared to those of shrubs (4.5 vs 1). Yet when speaking of this data in percentages, the group saw that the decrease of number of plants for shrubs was greater than trees in percentages (33%

vs 22%). Thus both agreeing and disagreeing with the groups hypothesis as quantitatively it agrees, but comparably it disagrees. So it's hard to say whether or not it definitely supports the hypothesis. If more data were to be collected and the same pattern was reflected, the result would be more convincing

The data shows that the lower the elevation the more plants there are, and as one gets higher in elevation the plant population decreases. This is just as the hypothesis speculated. More data points could have also helped with the research, as a larger sample size makes the evidence more significant.

In the future, the amount of transects to be increased would also be helpful for our project as it would give us more data, in addition to increasing the overall change in elevation. Being more vigilant about collecting the data would have helped as well.

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Ella Castro
Lucia Melendez
Emma Pinsky

Introduction

Purpose

The purpose of this study is to determine the relationship, if any, between the proximity to Barton Creek and the number of Northern Cardinals in Gus Fruh Park in Austin, TX.

Hypothesis

It it hypothesized that the count of Northern Cardinals increases as distance to Barton Creek decreases because the proximity to water allows nests to be inaccessible to predators and therefore allows the nest success rates to increase.

Site Description

Location

Gus Fruh is located in South Central Austin. The park is located 6.44 kilometers as the crow flies northeast from the Austin Capitol. The park is also 11.27 kilometers as the crow flies northwest from ABIA.

Size and Shape

The shape of Gus Fruh is an oval shape with three rounded arms protruding from three equidistant points on the oval shape. One of the rounded arms has a soft semi-circle cut out of the rounded edge of the arm. Gus Fruh park is approximately 168.4 hectares.

Topography

Gus Fruh has descending elevation towards Barton Creek, starting at 183 meters and descending to 152.4 meters. Along the trails there are man-made levees to keep the creek flooding the trails and the surrounding neighborhoods. The land going towards the creek stayed flat. The above max/min elevations are in feet.

Geology

The general rock formations in Gus Fruh are the sand, silt, and pebbles of Alluvium, from the quaternary period; parts of the Glen Rose formation from the lower Cretaceous period (such as limestone, dolomite, and marl); and Tributary Terrace deposits from the Pleistocene period (such as gravel, sand, silt, and clay). Gus Fruh is in the zone of the Balcones Fault, which results in geologic features such as the visible separation of limestone and sediment on either side of the fault. Limestone is more prevalent in the west, along with the exposure of older formations like Glen Rose (*Geology of the Eagle Mountains and Vicinity*).

Area Extent and General Type of Vegetation

The general type of vegetation in Gus Fruh Park includes trees such as Plateau Live Oak, Sycamore, and Ashe Juniper. There are also a variety of smaller bushes and vines, including Lindheimer's Silktassel and Poison Ivy. Gus Fruh park is approximately 95% woodland and 5% creekline.

Availability of Water

There is a creek within Gus Fruh called Barton Creek, which runs 20 cm to 1 meter deep. There is evidence of recent flooding, shown in the form of trash along the bank that goes up 5-6 meters. The creek has many rapids sections separated by small sections of calm.

Proximity to Urban or Industrial Areas

Gus Fruh is adjacent and Southwest of the Barton Hills neighborhood and is cut off by State Highway 360.

History

In 1837, William Barton settled on the banks of the soon-to-be-named Barton Creek. The creek was protected by the Greenbelt "River Rats," who restricted access to its water. Hikers found ways over, under, and around the fences put in place. The Trust for Public Land purchased nearly 1,000 acres of land on the Greenbelt between 1992 and 1999. The park has been steadily expanding since the 1970s. (Trust for Public Land website)

Research Plan

Design of Study

This study will be conducted at Gus Fruh park in Austin, Texas. This study will focus on the population density of Northern Cardinals in related to distance from water. There will be three transects - each will be a different distance from water and each will have data collected a total of six times with a week separating data collection dates. The three transects are as follows:

Transect 1 is located on the East side of the park. This transect is 840 meters long and directly follows the shoreline of the east side of Barton Creek. At its furthest point this transect is 20 meters away from the water.

Transect 2 is 781 meters long and begins about 500 meters northeast of Cupid Drive. This transect is located mostly in the Western side of the park, but there is a small area on the Eastern side. The transect continues in a curved fashion and goes under State Highway 360. The transect ends across the creek from the Seismic Wall geologic formation. This transect follows the Barton Creek Greenbelt Trail. At its closest point this transect is located about 80 meters from water.

Transect 3 is located on the Eastern side of the park. This transect is 809 meters long. This transect follows the Via Fortuna Access Trail. At its closest point this transect is about 133 meters from water.
After all these transects have been studied around an estimated 7% of the Gus Fruh park will have been studied.

Background Information
The Northern Cardinal has a geographic range pervasive through the eastern halves of Mexico and the United States. It does not extend north into Canada. The Cardinal prefers woodlands and suburban gardens, and is receptive to birdfeeders. It feeds on seeds and berries. In winter, it relishes seeds from wildflowers, grasses, shrubs, and human provision. It also eats an abundance of insects. The male cardinal fiercely defends its breeding territory, and fighting intruders (even his own reflection!). The female Cardinal builds her nest, by bending twigs around her body and forming them into a cup shape with her feet. Nests are wedged into a fork of small branches, 1-15 feet high and hidden in dense foliage (Houston Audubon Society).

The male cardinal has red plumage, which uses red pigment instead of sun reflection. Because of this, it is always red, unlike the blue jay, whose blue relies on the sun. The male cardinal also has a black mask, extending to the bottom of the crest (Digicams Forums). His beak is a similar shade of red to that on his feathers. The female cardinal is buffy, with tinges of red towards the ends of the wings and tail, and the top of the crest (Museum of American Bird Art). She also has a red beak. Her mask is smaller and more centered around the beak. Juvenile cardinals look like females for the most part, with buffy feathers and tinges of red (Howard Cheek Photography). Males moult off this color and red patches begin to appear. The crest of the juvenile ranges between nonexistent and small, just several feathers. Its black mask doesn't appear in full until maturity, so it may show up in patches or not at all.

The song of the cardinal can be described as two high-pitched, legato chirps followed by staccato, lower-pitched chirps, while its call is a metallic chipping noise. There are more occurrences of call than song, and the cardinal is easily provoked into its call with the manual use of threatening bird calls, such as owls.

A study was conducted in 2004 by Leonardo Chapas-Vargas and Scott K. Robinson in the Kaskaskia River in southwestern Illinois. They studied the relationship between the differentiation in habitat composition around nests and the breeding success of the Acadian flycatcher (*Empidonax virescens*). They found that "[n]est survival increased with increasing nest concealment, and probabilities of brood parasitism increased with increasing distances from anthropogenic and natural water-related openings surrounding nests" (Chapas-Vargas, Robinson, 2004). This article discussed how proximity to water increases

the survival rate of the nest and the further the nest site is from water, the more likely it is for brood parasitism to occur. This study helps with this investigation because it explains how parasitism will decrease the closer to water the bird's nest is, therefore leading to the hypothesis that there will be more bird nests and birds closer to water.

Another study was conducted in 1991 and 1992 by Tamatha S. Filliater, Randall Breitwisch and Paul M. Nealen in southwestern Ohio. The scientists studied the relationship between the choice of nesting site of the Northern Cardinal and the success rate of the nests. According to the study's data, the scientists found that "that nests that are concealed regardless of the particular plant structure will be more successful than those that are not so concealed"(Filliater, et al., 1991-1992). The study defines inaccessible nests as over water, in thorny vegetation, in cane, or at the end of thin branches or twigs. This study helps with this investigation because it explains how parasitism will decrease with the proximity of birds' nests to water, therefore leading to the hypothesis that there will be more bird nests and birds closer to water. Since parasites cannot reach birds, they are more likely to want to nest closer to water. While it is unclear whether birds until data is collected, the information about ease of nesting without parasitism helps educated guesses take place.

Another study was conducted in 2011 by Jessica Gorchow, Taylor Forrest, and Angela Rondon-Begazo in Michigan. They studied the relationship between insect's distance from water, and population density of birds in relation to that distance. The study found that " The average abundance of Red-eyed Vireo at the shoreline was 1.6 compared to 1.5 birds per site at upland sites. The average insect density was 1.17 in the shoreline and 1.0 in the upland sites" (Gorchow, et al. 2011). The population density had a small difference between close to water and distanced and the insects had a significant difference. Even though the change was small in the bird's population density, the significant change in insects can prove to cause a bigger gap in warmer areas such as Texas. This study helps with the Gus Fruh investigation because it helps explain the different reasons birds will live closer to water, and even though the change was small in the bird's population density, the significant change in insects can prove to cause a bigger gap in warmer areas such as Texas. So this study helped come to the consensus in the hypothesis to still claim bird's population density will increase closer to water.

Materials

- Binoculars
- Roger Tory Peterson Eastern Bird Field Guide (Peterson, 1998)
- Ears
- Merlin Bird Guide (app) for songs and calls (Cornell Lab of Ornithology, 2016)
- Pen
- Paper

Procedure

- A data table to record bird observations with distances and call or song columns is to be brought to Gus Fruh park
- Once arrived a minute will be taken to tune the ear to the quiet environment
- Walk 1.5 km/hr across the transect, listening for Cardinals
- Stop occasionally to record the birds around the park
- The data will be broken into two different parts: Distance from transect, and song or call.
- The distance from the transect will stretch from 0-125m to either side. When a bird is located its distance from the transect will be estimated and recorded in the column for that distance.
- When birds are located it will be determined if they were calling or singing. Once that is determined, the data for that bird will be placed in the column for calls or songs.
- While walking the transect, the amount of human and animal activity that could disturb the birds will be recorded
- Data will be taken from the transect six times, all separated by a week.
- After walking the transect a data analysis with Full Detection Strip, Population Estimate, and Coefficient of Detection will be calculated.
- A Full Detection Strip is calculated by finding the first 20 percent drop in data. The information from before the drop is considered the full-detection strip (the area in which most or all birds can be detected).
- A Population Estimate is calculated by taking the full-detection strip and extending it to the entire field of the transect (length multiplied by 125 meters). It shows the population of the Northern Cardinal estimated to live in the transect area.
- Coefficient of Detection is calculated by taking the number of detected birds from the data over the population estimate, and shows how many of the birds the data collectors are able to detect on average.

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Conclusion

Emma Pinsky, Lucia Melendez, Ella Castro

Results:

On average, this data indicated that the closer a transect was to water, the higher the population of *Cardinalis cardinalis* (fig. 1). It has been ruled, through t-testing and ANOVA testing, that *Cardinalis cardinalis* in Gus Fruh park was in two populations, over three transects. The population on the transect furthest from water, 2.14 birds per hectare, was significantly different from that closest to water, 7.70 birds per hectare, (p-value 0.003) and significantly different from that a middle distance from water, 5.96 birds per hectare, (p-value 0.009). However, the populations a middle distance and furthest from water were non-significant in their difference (p-value 0.300). The most striking pattern in the data collected in this study was expressed in the graph comparing the calculated population estimate versus the transect distance from water (fig. 1). . This trend is expressed once again in the graph comparing the mean of population estimate per transect(fig. 6). The mean of the population estimate of the closest transect to Barton Creek, 7.7 birds per hectare, is the greatest mean of the three transects studied (fig. 6).

Out of the two different types of *Cardinalis cardinalis* audio that was collected (song and call), all three transects detected more calls than songs (fig. 4). Additionally, there were at least three times the number of calls than of songs on each transect. The highest of these contrasts was on the furthest transect from water, with 3 instances of songs to 38 instances of calls (fig. 4), at 12.67 calls per song. The lowest of these contrasts was on the middle transect from water, with 17 instances of songs to 55 instances of calls, at 3.24 calls per song (fig. 4).

There was little correlation between more severe weather (higher winds and overcast skies, as determined by Weather Code) and population of *Cardinalis cardinalis* on all transects (fig. 3). The Weather Code, created by normalizing data from the Beaufort Scale and Sky Code, hovered around an 8, which reflects a trend towards overcast skies and low winds.

There was little correlation between temperature on transects and *Cardinalis cardinalis* population estimate on any of the transects during the study (fig. 2). One anomaly in this data is the temperature of 46 degrees, well below any of the other temperatures.

Discussion:

It was hypothesized that the count of Northern Cardinals would increase as distance to Barton Creek decreases because the proximity to water would allow nests to be inaccessible to predators and therefore allows the nest success rates to increase. This hypothesis is supported by the data collected.

Reflection:

High concentrations of birds near water is likely to be correlated to the tendency of birds to nest in riparian (riverbank) habitats. This population estimate change most likely reflects a change in vegetation (songbirds tend towards riparian vegetation; RC Szaro, 1980), a change in predation protection (cardinals build their nests over water; see Introduction and Research Plan), and a change in edible insects (insects eaten by cardinals are more common closer to water; see Introduction and Research Plan).

A higher number of audible calls than songs (fig. 4) is likely to be correlated to the proximity of the transect to Texas State Highway Loop 1 (MoPac). Calls are aggressive sounds made by aggressive birds, and a high number of calls indicates that the birds were distressed or defensive being so near civilization.

The lack of correlation between population and either temperature or Weather Code (fig. 2) (fig. 3) is likely to be due to the small amount of data collected over a period of several subsequent weeks. Without a major change in either weather or temperature, these data areas are not likely to reflect change.

Results and Background:

Factors Influencing Bird Populations in Southwestern Forests

As discussed in Robert C. Szaro's study into factors influencing bird populations in southwestern forests, "Most birds show a remarkable dependency on water related habitat for breeding areas, wintering areas, and migratory corridors" (RC Szaro, 1980). Riparian habitats are localized around water sources. In the southwest, they include vegetation such as Cottonwood Willow (Populus Trichocarpa) and the Flowering Dogwood (Cornus Florida), which cardinals nest in. The study was done in Arizona, the western edge of the habitat of the Northern Cardinal, for the USDA Forest Service.

Northern Cardinals in Gus Fruh park were hypothesized during this study to live in riparian communities, nest in riparian vegetation, and congregate around local water sources. This hypothesis is supported both by data showing higher bird counts near water and by Szaro's study.

Abundance and Variety of Birds at Point Sources of Water

Another study was conducted by Carl E. Bock in 2015 that discusses the abundance and variety of birds at point sources of water. Bock found on 300m transects at point sources of water compared the 300m transects without water the "total birds were nearly three times more abundant on transects with water" (Bock, 2015). This change in abundance was more evident in the winter and spring seasons and less evident in the humid summer. These seasons are more dry and arid than the summer season, suggesting the birds were more heavily drawn to the water in dry seasons. Bock found "twenty-two of 25 common species trended toward greater abundance on transects with water, eight of [which] at statistically significant levels" (Bock 2015) over the course of the year.

The hypothesis of this study was that as the distance to Barton Creek decreased, the amount of Northern Cardinals would increase. The hypothesis of this study is supported by the increase in bird abundance and variety found by Bock.

Modifications and Biases:

During the study, data had to be taken early in the morning, which led to several possible or distinct issues in the data collection:

- One of the data collectors did not wear contact lenses for two of the six data collections, rendering her vision possibly subpar. It is possible that this affected the number of birds collected through vision.
- One of the data collectors did not bring binoculars for three of the six data collections. It is possible that this affected the number of birds collected through vision.
- Several of the data collectors had issues hearing, both due to congestion and to genetic predisposition for poor hearing. It is possible that this affected the number of birds collected through audio.
- One of the data collectors got lost on the second data collection, and briefly changed route. It is possible that this affected the number of birds total for the transect furthest from water.
- A large music festival took place during the data collection period, a loud group of people relatively close (~2 miles) to the data collection sites during two weekends (6 points of data). It is possible that this affected the number of birds total collected over data collections 1 and 2.
- The data collectors collected their data for the same collection number on different days (usually both days of the weekend; occasionally one data collector would collect on weekdays). It is possible that this affected the number of birds total collected over the project due to changing weather conditions.

Since the middle and close transects in this study were ruled by t-testing to be non-significant in their difference from one another (p-value 0.300), this study has negative results. It was hypothesized that these transects would be from different populations, and since the result was negative, it is important to work on modifications for further studies and to continue to explore reasons for these results.

Possible Future Studies:
One change that could be made to this study is more simultaneous data collection. Throughout this study, data collections were taken at different times of day (while remaining in the morning) and often on different days of the week. This inconsistency changes the weather conditions, amount of human activity and interference on transects, and activity of a specific population. Another change to be made is an increase in the amount of data points collected. In this specific study data was only collected in each transect six times, in only one length of time. In order to make significant conclusions about weather data, means, and standard deviation, the data points should be increased - possibly to a year instead of six weeks, to account for all seasons.

Another study that could be conducted in this area is the study of the difference in *Cardinalis cardinalis* population with the changing elevation of the area. There is a marked drop in elevation across this park heading towards the creek and there are birds in each area that could be studied.

Any studies could be conducted with *Thryothorus ludovicianus* (common name: Carolina Wren) instead of *Cardinalis cardinalis*. There is a predominant population of *ludovicianus* in Gus Fruh park, which could affect the number of *cardinalis* in the population.

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H Quill

Introduction

Purpose

The organisms that shall be studied are woody plants. The study shall take place in Gus Fruh Park, Austin, Texas. The question that this study shall answer will be “How will the frequency of Ashe Juniper be affected by an increased distance from a water source?”

Hypothesis

When the distance from water changes, the frequency of Ashe Junipers and Live Oak shall change inversely as Ashe Junipers are more adapted to drier environment due to their ability to keep a higher capacity of water, higher amount of cavitation in the xylem, and the ability to withstand lower soil water potentials in shallower soils than that of its Live Oak counterpart..

Site Description

Location

Gus Fruh is located in Southwest Austin, TX. Gus Fruh is 5.34 km from the Capitol. It’s part of the Barton Creek Greenbelt.

Size and Shape

The park has an area around 300 hectares. From what is presented on the Gus Fruh Trail Map, the trail seems to be contained within a very strangely-shaped pentagon.

Topography

The elevation of Gus Fruh ranges from 134 m to 213 m. The elevation steadily decreases from the Barton Creek entrance to the stream.

Geology

The park appears to be a valley with the center being the stream. There are large amounts of Del Rio Shale, as well as Edwards Limestone and Georgetown formation.

Del Rio Shale is a softer formation, originating in the Cretaceous era. While Edwards limestone is a much harder material, it originated in the same era.

Areal Extent and General Type of Vegetation

From what was observed, the area appears to be 90% Woodlands and 10% Grasslands.
Samples of Red bud, Ashe Juniper, and Japanese privet were found at the site.

Availability of Water

The area surrounds the Barton Creek Stream, so water is easily accessible. At the elevation of the stream, many trees along the banks are bent. A large amount of those trees were around 5 meters long, and they bent at a 40-50 degree angle. This suggests that the flood levels would reach at least three meters above the current level.

Proximity to Urban or Industrial Areas

An entrance to the park is right next to a suburban neighborhood.

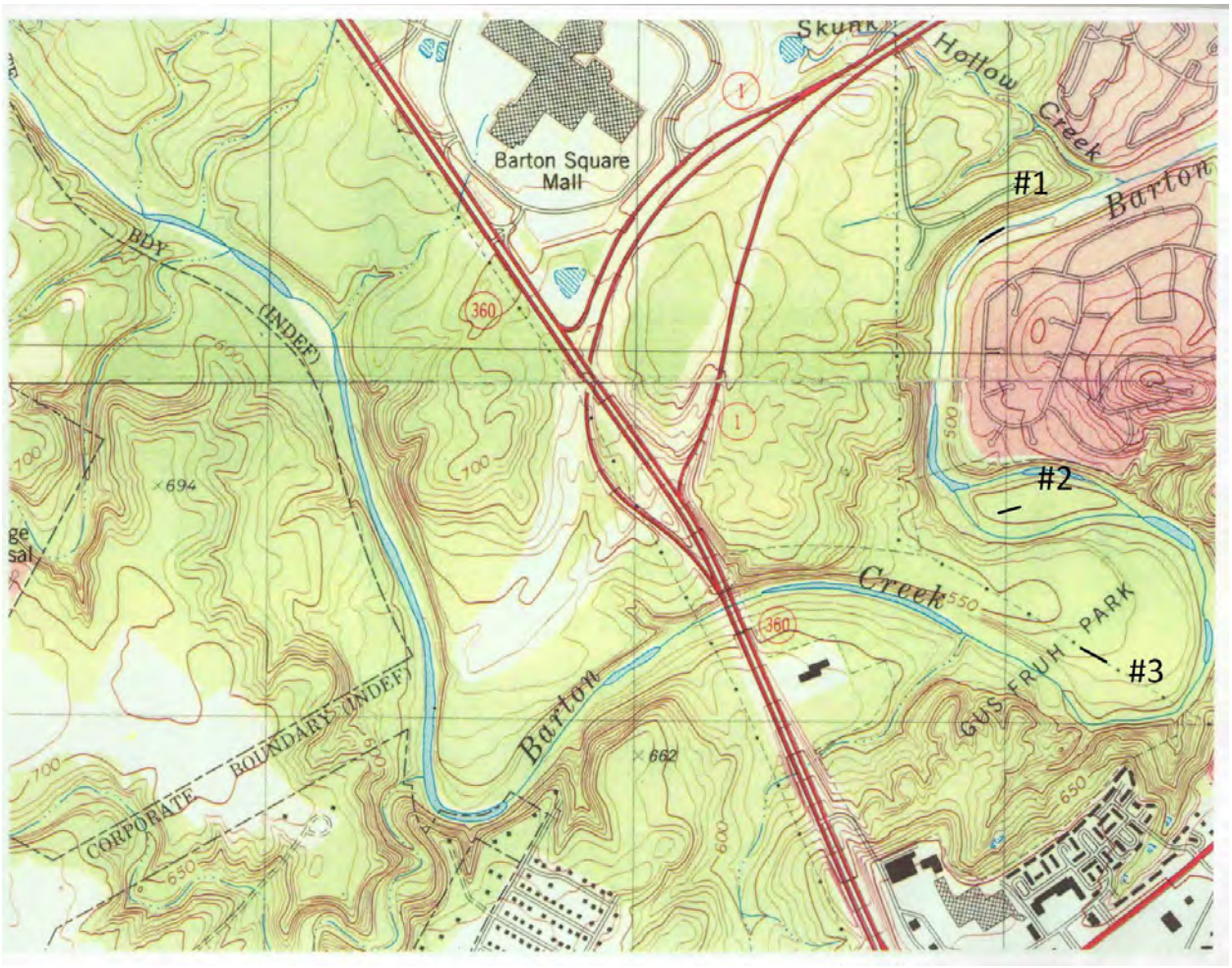
History

Between 1992 and 1999, the Trust for Public Land purchased around 1,000 acres of the Greenbelt to help protect the Edwards Aquifer as well as a location to help conserve local wildlife (TPL). Also between 2007 and 2009, the TPL donated another 58 acres.

Research Plan

Design of Study

For the project, three separate transects, each 50 meters long, shall be taken. This first transect will be placed around 10 meters from the water, the second 50 meters, and the third 100 meters in order to address the purpose question. In the field, one transect shall be observed for each data collection for a total of three data collections. Each transect is shown on the map next page. The distance is not exact due to each transect following the trail of Gus Fruh.



Background Information

In multiple studies of Ashe Juniper in the recharge zone of the Edwards Aquifer, multiple reasons have been linked to the success of the plant. One of which was that a location was cleared of 90% of its Juniper population, and then the area's transpiration rate was observed and compared to an adjacent site without the removal of any Junipers. Although transpiration rates were obviously higher in the wooded area, but in the drought of 2011, tree transpiration in the wooded exceeded the precipitation inputs, therefore suggesting a high water capacity (Dammeyer). This would be useful in explaining why areas further from water would have a higher frequency of Ashe Juniper Trees due to their higher water capacity.

Another study was conducted on three tree species that coexisted on the Edwards Plateau; cedar elm, live oak, and Ashe Juniper. The study was based on the sap flow velocity of each species. The year of study was unusually dry, which caused the sap flow velocity to decrease simultaneously for all species, but the rate of decline was lowest in Ashe Juniper, therefore showing that Ashe Juniper partitioned water by time when there was no source. But the more important phase occurred 2 years later,

after the severe 2011 drought, the mortality rate of each tree was recorded with Ashe Juniper having the lowest 6%, while oak had 34% and elm had 14%. The interesting part of this was that the mortality rate correlated with wood density, which lended support to the hypothesis that species with more cavitation in the xylem were better suited to acute drought (Kukowski).The smaller wood density as well as the cavities in the xylem would help the Ashe Juniper retain more water and therefore give it an advantage in areas with less water, while the Live Oak would be much less likely to prosper.

The last study compared Ashe Juniper and honey mesquite with live oak. The study took place at three sites with differing soil depths, but all were underlain by fractured limestone bedrock on the Edwards Plateau to ascertain whether soil depth or species specific water use were more important. The study was based on transpiration. While in the two deeper soil depths, the transpiration rate between the species was similar The important results were found at the shallowest soil depths which contained Ashe Juniper and live oak. The Juniper transpiration was much higher early in the Spring than that of the oak, showing that the Juniper benefited much more from the early spring rainfall than its counterpart. The species performed similarly in most soils and their water use was restricted by soil depth.The one species specific advantage found was the Juniper's ability to withstand low soil water potentials in shallower soils (Elkington). Once again, this will show that Ashe Junipers would be more fit to survive further distances from water, whilst showing that the live oak would be much less fit than its counterpart.

Materials

This study will only require a transect line and the Project notebook to take and record data as well as the woody plant field guide (Native and Naturalized Woody Plants of Austin and the Hill Country by Brother Daniel Lynch and Nancy McGowan) to identify any species that are not recognized.

Procedure

On each transect, samples will be taken of any plant that hangs over the transect line. Each sample shall be taped or hardpressed into the project notebook so the sample can dry out without damage to the structure. Notes will be taken on the plant that a sample was taken from, such as the distance on which it intersected the transect line, the amount of the transect that the plant covers, and any information to help identify the plant (i.e. leaf arrangement, leaf type, and what type of plant the sample is from). If the plant is already known, then its common name shall be written in the graph of the notes. If not, the next few days in class shall be dedicated to the identification of the taken plant samples. Using the dichotomous key, the plants will be identified by taking notes

on each step in the process. When a plant very similar to the sample taken is found, then its common and latin name shall be copied and it shall also be researched to make certain it is the same plant. If not, then steps shall be retraced in hopes of finding a mistake in the process of identifying. Upon the identification of the plant, then notes taken shall be edited to include the actual name of the plant. Then, using the completed data, calculations shall be taken to analyze said data. Each type of calculated data shall take a certain equation: *x* of certain species divided by x of all species. The resulting value would then be multiplied by 100. For relative density, x would be equal to total # of individuals; For relative dominance, x would be equal to total intercept length; for relative frequency, x would be equal to total # of intervals occupied. Importance value is just the sum of the answers from the previous equations. Once those tasks have been completed, the procedure is completed for that data collection.

Bibliography

Topographical Map of Gus Fruh

Native and Naturalized Woody Plants of Austin and the Hill Country by Brother Daniel Lynch and Nancy McGowan.

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Gus Fruh Trail Map

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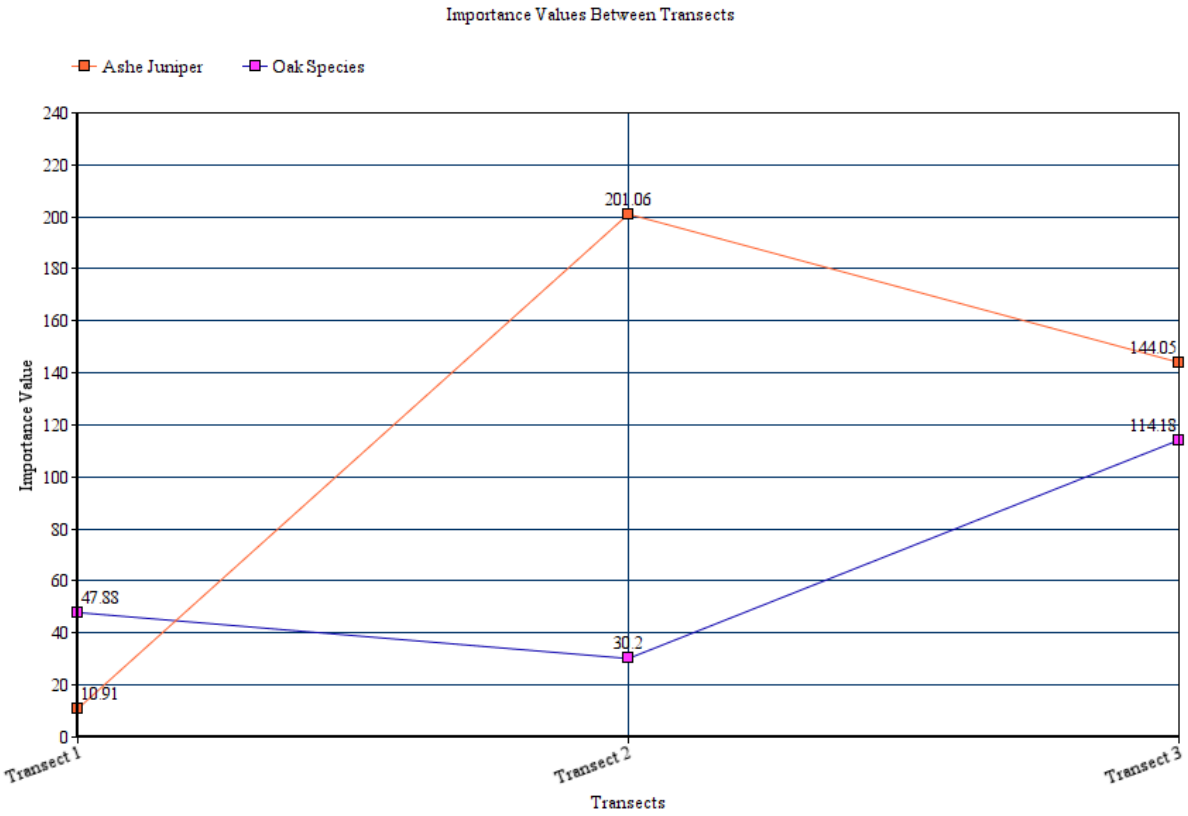
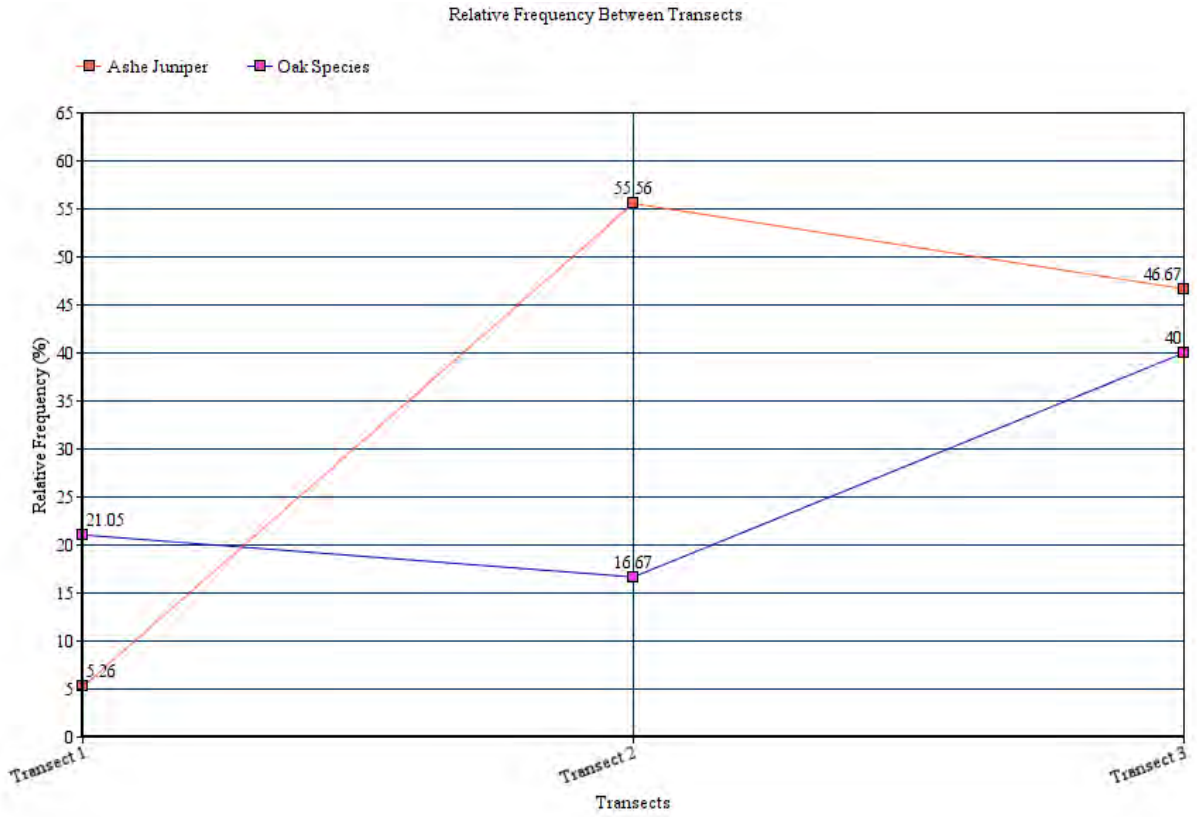
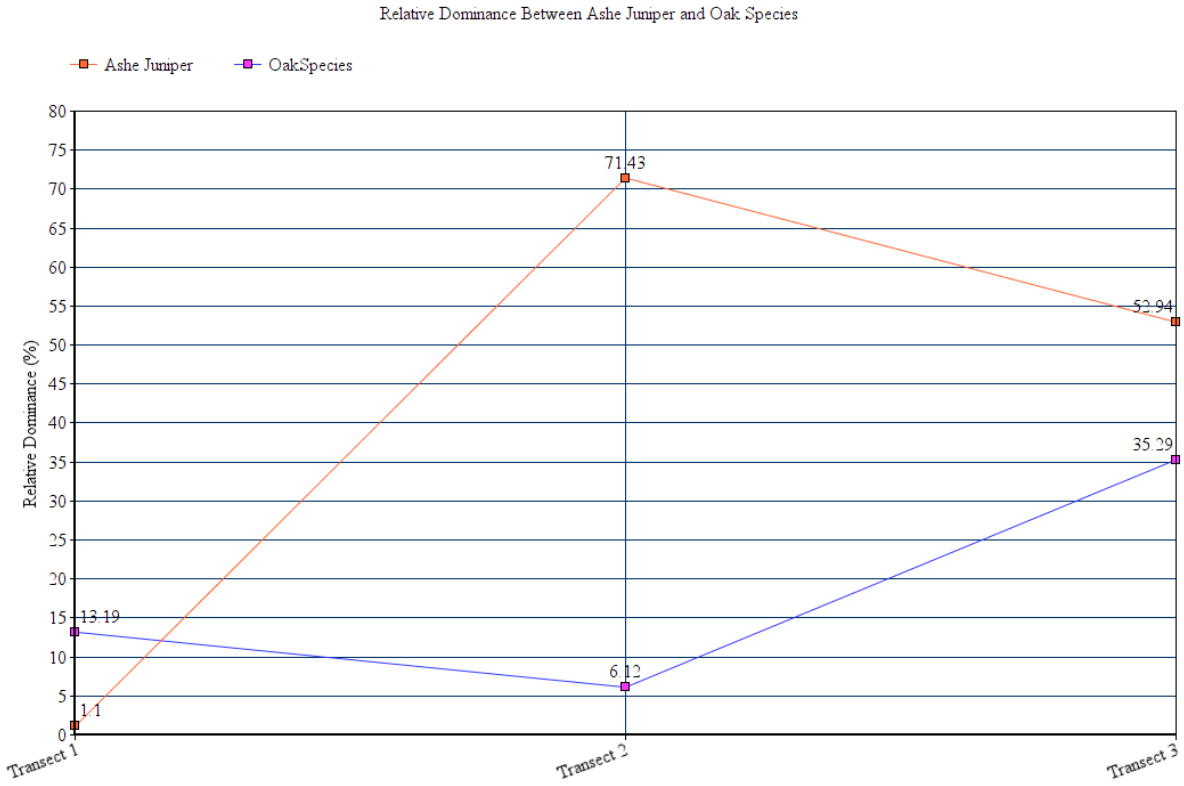
H Quill

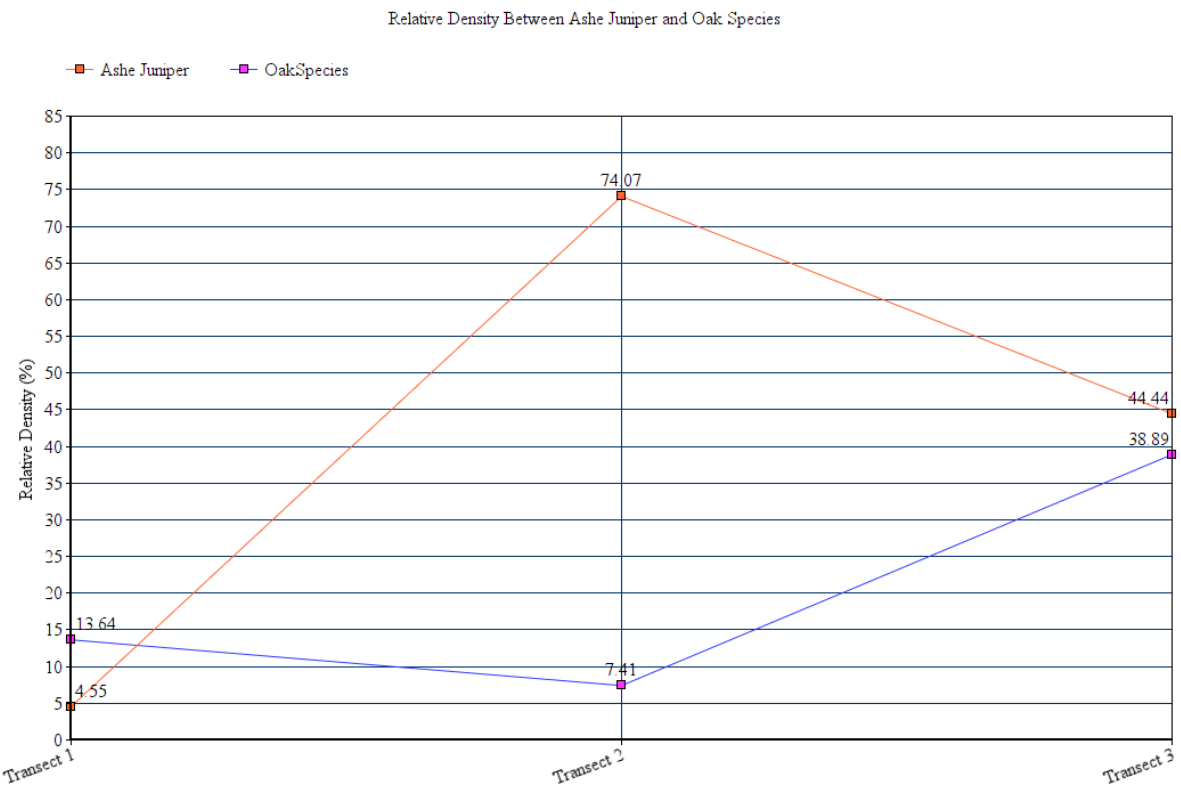
Conclusion

Through the three transects taken, the data produced has shown to support the hypothesis that Ashe Juniper and Oak shall inversely change as the distance from water increased, as one can see through the two graphs below that represent the relative frequencies and importance values between *Juniperus ashei* and two Oak Species: *Quercus funiformis* (Plateau Live Oak) and *Quercus shumardii* (Shumard Oak). The values shown show a trend of inversing upon a change in distance from water, although in a way that went against predictions.


Importance Values Between Transects
Ashe Juniper
Oak Species
240
220
200
180
160
140
120
100
80
60
40
20
0
Importance Value
201.06
144.05
114.18
47.88
30.2
10.91
Transect 1
Transect 2
Transect 3
Transects


Relative Frequency Between Transects
Ashe Juniper
Oak Species
Relative Frequency (%)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
55.56
46.67
40
21.05
16.67
5.26
Transect 1
Transect 2
Transect 3
Transects


Relative Dominance Between Ashe Juniper and Oak Species
Ashe Juniper
OakSpecies
Relative Dominance (%)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
71.43
52.94
35.29
13.19
6.12
1.1
Transect 1
Transect 2
Transect 3



Analysis

The data did support the hypothesis (When the distance from water changes, the frequency of Ashe Junipers and Live Oak shall change inversely), but in the way that was against expectations. The researcher found that the number of individuals of Oak Species did at some level inversely change from the Ashe Juniper, but it happened with the Oak increasing upon distance from water when the expectation was that the frequency of Ashe Juniper individual would greatly increase while Oak individuals would decrease. This explained though, as it has been found that live oak species have deeper roots, which would not be as successful in lower elevation areas underlain with limestone (Schwinning). They also act as nurse trees for the juniper with different light and temperature conditions (Gass). So perhaps on the third transect a rise of Junipers will occur soon enough.

This happening was not the only strange occurrence to present itself during the recording of data. Such was a very large amount of Ashe Juniper species on Transect #2 (Data analysis 2), the species had accounted for over two-thirds of the importance value of the transect, which did support the original prediction in respects to increasing in further distances from water, but over two thirds of the importance value, 55% of the

relative frequency, and accounting for over 74% of on Transect 2 brings up some concerns for the health of that ecosystem.. Perhaps the reason for such strange data was due to an ineffectiveness of recording observations by the researcher. If data was correctly taken, then the second transect should bring up some concerns, so it would be recommended for further observation.

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Macy Nelms

Becca Brackin

Introduction

Purpose:

The purpose of this experiment is to compare the population density of northern cardinals, at different proximities to water.

Hypothesis:

We hypothesis that there is going to be a higher population density of northern cardinals that have a closer proximity to water.

Site Description:

Location

Gus Fruh is located in Southwest Austin, Texas adjacent to Barton Hills Dr.

Size and Shape

Gus Fruh is about 90 hectares, and is in the shape of a thin rectangle parallel to Mopac with a round protrusion to the southeast.

Topography

The minimum elevation is about 150m and the maximum is about 210m. In the middle of the park it is flat, but in the eastern part of the park there is a steep incline, and in the western part of the park there is a gradual incline.

Geology

The creek is constantly depositing alluvium due to deposition (Geologic Map of The Austin Area, Texas, 1992). In the area there is also Lower Colorado River terrace deposits which were created in the Quaternary era (Geologic Map of The Austin Area, Texas, 1992). The last main

geologic formation is the Edwards Formation, which was created in the Lower Cretaceous time period (Geologic Map of The Austin Area, Texas, 1992).

Areal Extent and General Type of Vegetation

Gus Fruh is about 95% woodland, and 5% grassland/other. The group observed species of hackberry, cedar, oak, elm, poison ivy, and american sycamores, among many other species of trees and shrubs. There isn't much grassland- the majority of the park is forest.

Availability of Water

Gus Fruh is part of the Barton Creek Greenbelt. There is a large creek running through the whole park, giving water access to a variety of different organisms. During floods, water levels can reach up 2-3 meters above the regular water levels.

Proximity to Urban or Industrial Areas

Grus Fruh is directly next to the Barton Hills neighborhood, and is close to other places such as shopping centers and the Barton Creek Mall (about 1.3km.)

History

Barton Creek was a popular recreation spot in the 1970's, and still is to this day. In 1907, Andrew Jackson Zilker bought the Barton Springs property (which includes Gus Fruh), and in 1918 he gave it over to the city. Gus Fruh Park has always been a place where people can hike, rock-climb, and take a dip into the deep water holes that the park has. It is a great habitat for many different organisms.

Research Plan

Design of Study:

There will be two transects, each about a kilometer. One transect will be closer to the water than the other, so the group can see the differences in population densities.



Data will be taken on 6 separate occasions to be sure that the data is accurate and doesn't have any biases due to events that may occur. This design will help to discover if the proximity to water affects the populations of birds in a specific area.

Background Info

(and Natural History)

The Northern Cardinal is a fairly big bird, with a long tail. They have thick beaks, and a prominent crest. Male cardinals are usually red, while females are typically a more tan, with hints of red. They both have black faces and reddish-orangish beaks. Cardinals do not migrate, and they don't mult. Northern Cardinals tend to sit lower in tree branches, or near the ground. They often do this in pairs often as well. Northern Cardinals typically live in backyards, parks, woodlands, and shrubby forest areas. Cardinals eat seeds and fruit, and the occasional insect.

Bird need water to survive, just like every other animal. According to a study by the Cornell Lab, homes with bird baths have a larger populations of birds than homes without it/no water access. Although the study being composed at Gus Fruh Park is different than this one, it still relates. These two studies connect together because they are both studying the population of birds near water, whether it be a creek or a birdbath. The study from Cornell shows that birds are attracted to the water for drinking purposes, and other purposes such as bathing, and getting rid of any parasites. This relates to the hypothesis that there will be a greater abundance of birds near water.

According a study by the University of Arizona, looking at specific species, especially avian's in Mexico, and near the Colorado River. This study mentioned that surface water was the most important habitat feature for birds. They quickly swoop down and take short gulps, so they can easily have access while still watching for predators.

Another study from a book, "Attracting Birds to Your Garden", by Stephen Moss and David Cottridge, says that birds get most of their moisture from the food they eat and ponds of water. Water is necessary for the survival of birds, but bathing is very important to them too, so they can clean themselves and keep their feather in good condition.

Materials:

- Project Notebook
- Field Guide
- Binoculars
- Writing utensil
- Internet

Procedure:

Begin by creating data a chart in a field notebook, before going to the park. Begin to start tuning into to the different bird songs and calls. Start walking the transect at a slow pace watching and listening for the birds. In a notebook record each bird seen or heard on the chart, and estimate how far the bird is away in meters. After walking the whole transect find the population estimate and coefficient of detectability.

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Becca Brackin

Macy Nelms

Conclusion

Results

One of the most important trends noticed was that there tended to be a larger amount of birds per hectare, on average, on the transect closer to water. Looking at the data at transect 1, the group saw that the lowest number of birds per hectare detected was 2.5, and the highest was 4.38. In transect 2, the lowest number of birds per hectare detected was 1.48, and the highest was 2.6. Looking at Figure 5, one can see an obvious pattern that there are typically more birds near the transect near water. The average population estimate of the transect closer to water was 3.61 birds per hectare, and the average estimate for the transect farther from water was 2.1 birds per hectare. A ttest was conducted and found that the difference was significant ($p=0.003$)

Another trend noticed was that overall, the more disturbances detected lead to a large number of birds detected. For example, looking at Figure 1, when 4 disturbances were detected, 5 birds were detected. However, when 7 disturbances were detected, 12 birds were detected. Also, figure 1 is just comparing disturbances to number of birds detected- not comparing the two transects. Figure 2 shows that there were more disturbances at transect 1 (the one closest to water, opposed to transect 2, the one farther from water).

A third trend noticed in Figure 4, was that the COD for each transect is about the same, indicating that both people collecting data detected about the same percentage of the overall population of the birds in the area. The average coefficient of detectability for the first transect was 0.15 and the average of the second transect was 0.16. After conducting a Ttest, it was found that this difference was not significant ($p=0.28$).

In Figure 3, it depicts how the temperature affected the population estimate on each transect. There is no obvious trend in this graph indicating that the weather had any effect on the amount of Northern Cardinals population estimate. In the chart it shows that when the temperature was between 60-70 degrees the average birds per hectare was 2.59, and when the temperature was between 70-80 degrees the average population estimate was 3.12 birds per hectare. A ttest conducted indicates that this difference is not significant ($p=0.40$).

Discussion

The group hypothesis was that there would be a higher population density of Northern Cardinals in closer proximity to water. This is because birds need access to water, and it was speculated that there would be more vegetation near the water, causing more birds to be attracted to the area. This hypothesis was supported by the data collected, which indicates a greater cardinal average population estimate on the transect closer to water.According to a study by Cornell Lab and other similar studies, such as one by RSPB, birds are typically attracted to water. It is obvious in the sense that all animals need water to survive, but going into more depth, the logic behind it makes sense as well. Birds like water for drinking and bathing- a creek, such as Barton Creek at Gus Fruh, provides easy access to water for both of these things. Birds can easily swoop down and take sips of the water, and also be able to bathe, which is very important for most bird species (Cornell Lab).

The trend that disturbances tend to increase the number of birds detected was one that surprised the group. They originally expected that if there were more disturbances there would be fewer birds because they would scared away. However, according to the data, this seemed to be false; in fact, the opposite trend was supported. According to the Wild Birds Guides by Gary Ritchison, (in Northern Cardinals section), the birds can often be aggressive, especially towards

each other (typically males), and their territory (Ritchison, 2013). If the cardinals heard these noises they might come out ready to defend themselves, and then possibly back away after a while when they realize that it isn't another bird, but a human or animal. Also, when they making the "chip" noises, it shows aggression.

In Figure 4 the trend that the C.O.D of both transects was about the same shows how there was consistency in data collection. This is something that one would hope to happen in a study, as it helps the data collected to be more precise. If a study is conducted and the data is not consistent, it would indicate that there was an issue while collecting data or the data collected is not accurate.

The lack of any obvious trends in Figure 3 suggests that the temperature does not affect the amount of birds that can be detected in an area. This may be due to the fact that Northern Cardinals live in many different climates in the country, so small changes in the temperature did not have any effect on the birds' daily activity.

The study performed went quite smoothly- there were no significant problems that really affected the data. The transects were about 100 meters off in length, the transects were sometimes difficult to reach, and the weather could be an issue at times, but other than that the study went fairly well in terms of data collection.

The study performed was actually quite fitting since there was a fairly large creek running through the park, making the study comparing distance to water a fairly easy one. However, other things that could be studied is elevation, because there were parts of the park that were higher than the other. One could also study how the proximity to urban life affects the amount of birds detected, as the park was near a neighborhood.

To conclude, there were various trends noticed in the study comparing the population of birds in a transect close to water and one far away, one of them being that there were indeed more birds near water, like originally predicted. The study went fairly well, and there were few problems that affected the data.

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Sanjana Aluru, Marlen Avila

Mr. Walker

Planet Earth Period 0A/0B

21 September 2016

Introduction

Purpose

The purpose of this study is to determine how the distance from Barton Creek affects the density and diversity of woody plants in Gus Fruh Park, Austin, TX.

Hypothesis

Vegetation will be more dense and diverse as transects approaches the park's water source, Barton Creek, because the water from the creek will help the plants grow more lavish and abundant.

Site Description

Location

Gus Fruh Park is located in south-central Austin, in the Barton Greenbelt. The park runs parallel to Mopac (Texas State Highway Loop 1) and is directly adjacent to U.S Route 290 and Texas State Highway 360. Gus Fruh is approximately 6.37 km from the Texas State Capitol building as the crow flies.

Size and Shape

The park is in the shape of a right trapezoid with a small isosceles triangle cut out from the bottom side. The area of this park is approximately 164 hectares.

Topography

The maximum elevation is about 212 meters while the minimum elevation is 151.5 meters. In the park, the elevation descends towards Barton Creek because the water has cut itself a path through the land (Topographic Map). The park is very hilly and rocky.

Geology

Gus Fruh contains alluvium, Tributary Terrace deposits, Georgetown formations, Buda formations, Del Rio formations and Edwards formations. Alluvium is a mixture of sand, silt, clay and gravel, formed recently. Its color varies and it is primarily found next to the creek. Similar to alluvium in composition, Tributary Terrace was formed in the Pleistocene time period. Georgetown formation is limestone which has an abundance of fossil mollusks. Buda formation has limestone and abundance of fossil mollusks. Edwards formation is limestone and dolomite; and Del Rio formation which is clay and has an abundance of *Exogyra arietina* fossils. Georgetown, Buda, Edwards and Del Rio were all formed during the Lower Cretaceous (Geological Map). The creek is surrounded by small cliffs and there are large boulders at the base of the cliffs. There are faults through the park which are splinters of the Balcones fault.

Areal Extent and General Type of Vegetation

The majority of the vegetation in Gus Fruh is trees and shrubs. 90% or more of the park is covered in vegetation (most, if not all woodland), while the cleared trails and river cover roughly 10% or less of the park. There are Pequin peppers (*Capsicum annuum 'Pequin'*), American elm (*Ulmus americana*), American sycamore (*Platanus occidentalis*), and Ashe Juniper (*Juniperus ashei*) in the area.

Availability of Water

The main water source of Gus Fruh is Barton Creek. It crosses through the park horizontally. The level of flow of the creek varies as one travels further west, away from the neighborhood. The flow of the creek south of the entrance is the slowest. Towards the west, following the creek, the flow gets progressively faster and small rapids start to form. The water level is close to ½ meter when not flooded, and the creek is close to 35 meters at its widest. There is evidence of flooding as shown with the erosion lines on either side of the creek. The erosion lines indicate that the degree of flooding is approximately 3 to 4 meters.

Proximity to Urban or Industrial Areas

The entrance to Gus Fruh Park is located in a residential neighborhood and there are major roads running parallel to the park. There is also a large shopping center to the north, about 1.45 kilometers from the entrance to the park, and other commercial areas border the park to the southeast.

History

Gus Fruh has had an interesting past. It has had multiple acquisition dates which pertains to the complicated relationship it has with many preserves. The dates of acquisition include 1980, 1986 and 1992 (“Parkland”). The park has a history of being a popular recreation spot, with its climbing walls and swimming hole. Barton Springs Pool is north of Gus Fruh Park, and the Barton Creek River flows from it through Gus Fruh. The park trail was also resurfaced in 2008 with road base and granite gravel (“Surfacing”).

Research Plan

Design of Study

In order to conduct this investigation, six transect lines will be laid down in Gus Fruh. Each transect line will be 50 meters in length. There will be pairs of transect lines that will correspond to the approximate closeness (i.e. close, medium, far) and parallel to Barton Creek. The transects lines, labeled "Close," will be laid west of the Gus Fruh Entrance on the primitive trail. There is approximately 737 meters of distance between these two transect lines. The distance from Barton Creek to these transect lines are about 46 meters each. The second pair of transect lines will be labeled "Medium" and they will be located on two different trails but with the same good trail conditions. One of the transects will be laid more south than the other but still being parallel with Barton Creek. There is approximately 553 meters of distance between these two transects. The distance from Barton Creek for these transect lines are about 276 meters and 138 meters, respectively. The final pair of transect lines will be placed the farthest away from Barton Creek. They are east of the Loop 360 Access Entrance. The distance between these two trails is 737 meters. The distance from Barton Creek for these transect lines are about 500 and 736 meters, respectively.

The locations of these transects will allow for clear measurements of how the proximity to Barton Creek will affect the diversity and density of woody plants in each transect. There will be a total of three separate data collections, each partner will be responsible for three transects (close, medium, far) for data collection. Over the course of the next six weeks, data will be collected from these transect lines, allowing the conductors of the study to observe if and how the data changes over time. An estimate of 0.37% of the total study area will be sampled during the study.

Background Information

The first study is titled *Woody plant population dynamics in response to climate changes from 1984 to 2006 in Sahel (Gourma, Mali)*. The study monitored the patterns of changes in woody plants' population density, size and species. Data was collected by sampling sites in the North-South bioclimatic gradient on each of the main soils. The study showed the effects of a drought that struck the study area in 1983-1984. This caused an increase of drought-induced mortality and competition among the woody plant populations. There was active increase of recruitment of woody plants after the drought, beginning with smaller shrubs (Hiernaux, 2006). The results of the study indicate that the abundance and diversity of woody plants can vary greatly around drought times, and the plants that do not need much water will be more likely to survive. This study connects to the hypothesis because the investigation being conducted is located in Central Texas, which is an area that can get very arid. This study shows that there may still be an abundance of plants farther away from water, which shows that the hypothesis may be false.

The second study is titled *Optimization of plant coverage in relation to water balance in the Loess Plateau of China*. The study supports the claim that soil water does affect the density of plant coverage. From the study, data was collected through four cover treatments during the growing seasons of each studied plant species. The study demonstrated that soil water storage decreased with increasing plant coverage, and that the degree of soil desiccation was greater when there was more plant coverage (Fu, 2011). The study is relevant because it displays substantial support for an optimal range of water in soil relating to vegetation abundance and diversity, supporting the hypothesis that woody plants will be more dense and diverse closer to water.

The third study referenced is titled *Plant-water Relations and Adaptations to Stress*. It was conducted mainly in the United Kingdom, Australia, and Syria, and measured how the amount of water and rainfall affected crop yields. The scientists conducting this study compared the amount of rainfall different areas in each country got and the amount of crops harvested in those areas. The study showed that the UK, which got the most rain, also yielded the largest harvest while Australia and Syria, which got very little rain, yielded very little crops (Turner, 1981). This study is relevant because it shows that the amount of water in an area does affect the amounts of plants and plant yield, supporting the hypothesis that vegetation will be more abundant in areas that receive a lot of water.

Materials

- Transect Line (50 meters)
- Woody Plant Field Guide ("Native")
- Project Notebook

Procedure

1. Stretch the 50 meter transect line as straight as possible in a wooded area.
2. Move along the transect line and record the woody plant species found that overhang the transect line in the prepared field data table.
3. Collect a representative field data sample from each species encountered and press in the back of the notebook.
4. Repeat every other weekend for three total times. Each investigator should have three different data tables for a total of six.
5. Identify the plants using a dichotomous key and calculate, using the field data table, the relative density, dominance, frequency, and importance value of each plant.

$$\text{Relative Density} = \frac{\text{Total \# of individuals of that species}}{\text{Total \# of individuals of all species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Total intercept length of that species}}{\text{Total intercept length of all species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Total \# of intervals of that species}}{\text{Total \# of intervals of all species}} \times 100$$

$$\text{Importance Value} = \text{Relative Density} + \text{Relative Dominance} + \text{Relative Frequency}$$

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Sanjana Aluru, Marlen Avila
Mr. Walker
Planet Earth Period 0A/0B
06 December 2016

Conclusion

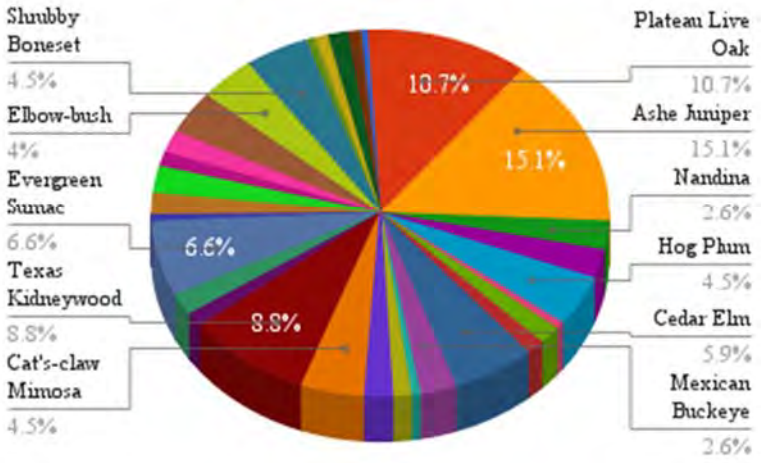
Results

Four tests were conducted involving the sets of data collected at Gus Fruh park: the total average number of individuals in species (Figures 1), the average relative frequency of the species (Figures 2), the average relative density of species (Figures 3), and the average diversity (Figures 4).

Species	Total Average
Plateau Live Oak	10.67%
Ashe Juniper	15.08%
Nandina	2.56%
Brasil	2.52%
Hog Plum	4.49%
Cat Brier	0.64%
Mountain Laurel	1.58%
Encinilla Bush Croton	1.28%
Cedar Elm	5.85%
Mexican Buckeye	2.56%
Poison Ivy	0.64%
Chinese Privet	1.28%
Shumard Oak	1.92%
Cat's-claw Mimosa	4.49%
Texas Kidneywood	8.80%
Yaupon	1.28%
Orange Zexmenia	1.92%
Evergreen Sumac	6.62%
Possumhaw	0.64%
Lindheimer Silk Tassel	1.92%
White Shin Oak	2.39%
Netleaf Hackberry	1.28%
Japanese Privet	1.92%
Japanese Honeysuckle	3.85%
Elbow-bush	3.97%
Shrubby Boneset	4.49%
Texas Persimmon	0.64%
Coma	0.94%
Fragant Sumac	1.41%
American Beautyberry	0.94%
Rattlebush	0.47%
Agarito	0.94%

[Figure T1: Average No. of Individuals as a Percentage of Total No.]

Figure C1. Total Average of No. of Individuals per Species

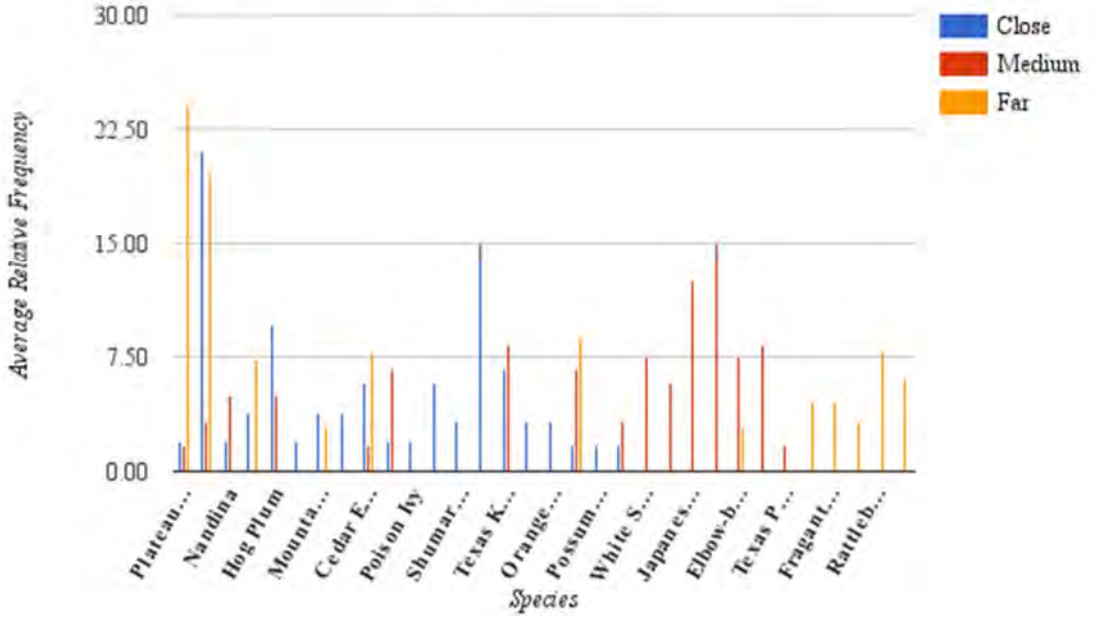


The species with the largest percentages of individuals were as follows: Ashe Juniper (15.08%), Plateau Live Oak (10.67%), Texas Kidneywood (8.80%), Evergreen Sumac (6.62%), and Cedar Elm (5.85%) (Figure T1).

Species	Close	Medium	Far
Plateau Live Oak	1.93	1.67	24.02
Ashe Juniper	21.03	3.34	19.61
Nandina	1.93	5.00	0.00
Brasil	3.85	0.00	7.36
Hog Plum	9.62	5.00	0.00
Cat Brier	1.93	0.00	0.00
Mountain Laurel	3.85	0.00	2.94
Encinilla Bush Croton	3.85	0.00	0.00
Cedar Elm	5.77	1.67	7.75
Mexican Buckeye	1.93	6.67	0.00
Poison Ivy	1.93	0.00	0.00
Chinese Privet	5.77	0.00	0.00
Shumard Oak	3.34	0.00	0.00
Cat's-claw Mimosa	15.00	0.00	0.00
Texas Kidneywood	6.67	8.34	0.00
Yaupon	3.34	0.00	0.00
Orange Zexmenia	3.34	0.00	0.00
Evergreen Sumac	1.67	6.67	8.83
Possumhaw	1.67	0.00	0.00
Lindheimer Silk Tassel	1.67	3.34	0.00
White Shin Oak	0.00	7.50	0.00
Netleaf Hackberry	0.00	5.84	0.00
Japanese Privet	0.00	12.50	0.00
Japanese Honeysuckle	0.00	15.00	0.00
Elbow-bush	0.00	7.50	2.94
Shrubby Boneset	0.00	8.34	0.00
Texas Persimmon	0.00	1.67	0.00
Coma	0.00	0.00	4.61
Fragant Sumac	0.00	0.00	4.61
American Beautyberry	0.00	0.00	3.34
Rattlebush	0.00	0.00	7.94
Agarito	0.00	0.00	6.08

[Figure T2: Average Relative Frequency]

Figure C2. Average Relative Frequency of Species by Distance from Water

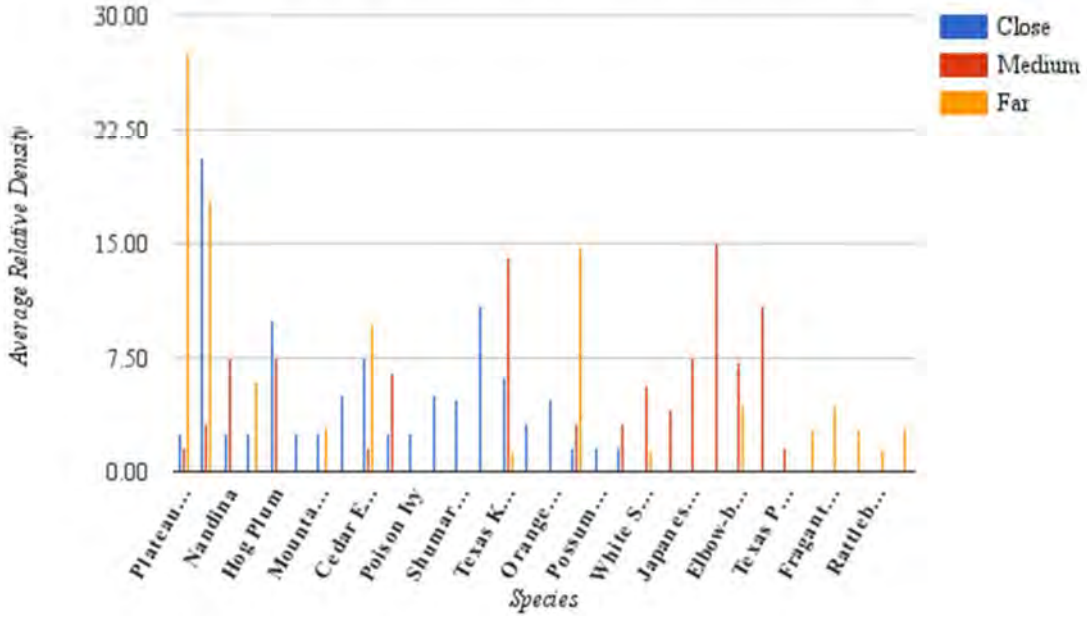


In the close-to-water transects, Ashe Juniper had the highest average relative frequency (21.03%). In medium transects, Japanese Honeysuckle had the highest average relative frequency (15.00%). In the farthest transects, Plateau Live Oak had the highest average relative frequency (24.02%) (Figure T2).

Species	Close	Medium	Far
Plateau Live Oak	2.50	1.57	27.50
Ashe Juniper	20.63	3.13	17.93
Nandina	2.50	7.50	0.00
Brasil	2.50	0.00	5.88
Hog Plum	10.00	7.50	0.00
Cat Brier	2.50	0.00	0.00
Mountain Laurel	2.50	0.00	2.94
Encinilla Bush Croton	5.00	0.00	0.00
Cedar Elm	7.50	1.57	9.70
Mexican Buckeye	2.50	6.57	0.00
Poison Ivy	2.50	0.00	0.00
Chinese Privet	5.00	0.00	0.00
Shumard Oak	4.69	0.00	0.00
Cat's-claw Mimosa	10.94	0.00	0.00
Texas Kidneywood	6.25	14.07	1.35
Yaupon	3.13	0.00	0.00
Orange Zexmenia	4.68	0.00	0.00
Evergreen Sumac	1.57	3.13	14.71
Possumhaw	1.57	0.00	0.00
Lindheimer Silk Tassel	1.57	3.13	0.00
White Shin Oak	0.00	5.63	1.35
Netleaf Hackberry	0.00	4.07	0.00
Japanese Privet	0.00	7.50	0.00
Japanese Honeysuckle	0.00	15.00	0.00
Elbow-bush	0.00	7.19	4.41
Shrubby Boneset	0.00	10.94	0.00
Texas Persimmon	0.00	1.57	0.00
Coma	0.00	0.00	2.82
Fragant Sumac	0.00	0.00	4.29
American Beautyberry	0.00	0.00	2.70
Rattlebush	0.00	0.00	1.47
Agarito	0.00	0.00	2.94

[Figure T3: Average Relative Density]

Figure C3. Average Relative Density of Species by Distance from Water



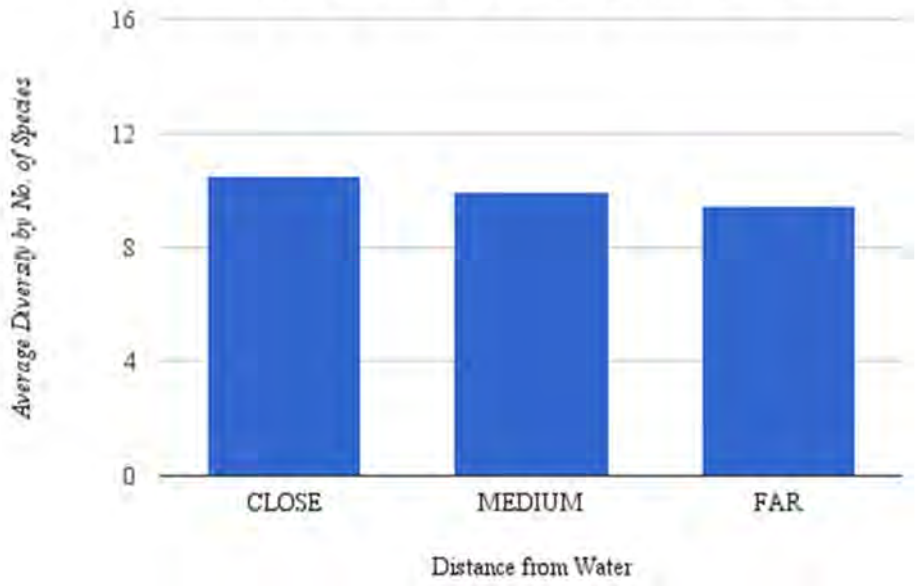
The average relative density was highest in Ashe Juniper in the close transects (20.63%). In medium transects, Japanese Honeysuckle was the most dense on average (15.00%). In the far transects, Plateau Live Oak was the most dense on average (27.50%) (Figure T3).

Type	Close	Close	Medium	Medium	Far	Far
Transect No.	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
No. of Different Species	12	9	8	12	8	11

Averages		
	Close	10.50
	Medium	10.00
	Far	9.50

[Figure T4: Average Diversity]

Figure C4. Average Diversity of Species by Distance from Water



In the close transects, the average diversity was 10.50 different species. In the medium, the average was 10.00, and in the far, the average diversity was 9.50 (Figure T4). These differences were not significant (p=0.86, 0.68, 0.86). On the close transects, the average number of individuals was 26. On the medium distance transects, the average number of individuals was also 26. On the far from water transects, the average number of individuals was 35.5. These differences were not significant (p=1, 0.26, 0.26).

Discussion

One notable finding is that only 5 plants appeared in all three transect types: Plateau Live Oak, Ashe Juniper, Cedar Elm, Texas Kidneywood and Evergreen Sumac. This shows that there was some consistency between the transects, but is still evidence that the transects are quite diverse.

It was hypothesized that there would be greater plant diversity and density closer to water. The findings from the data collected at Gus Fruh seem to indicate no distinct pattern of increasing relative frequency of the most prevalent plant on transects closer to water (Figure C2).

The relative diversity of species did decrease as transects got further from water (Figure C4). This could support the researchers' hypothesis, but the t-tests indicated that this was not a significant difference. Also, the trend regarding plant abundance suggests that overall plant abundance increases further from water, which seemingly goes against the hypothesis.

The first study referenced is titled *Seasonal water availability predicts the relative abundance of C3 and C4 grasses in Australia*. The study supports the claim that the amount of water throughout the year has a clear impact on the relative abundance of the plants. Although water was the main factor in concluding the abundance of the plants, there is also the addition of climatic influences. The study utilized 168 locations and measured δ13C (the abundance of 13C relative to 12C) to obtain the proportional abundance of plants. The results indicated a relationship between the abundance and richness of the plants tested. (Murphy, 2006). The study connects to the hypothesis of this report as it provides evidence that seasonal availability was a more reliable indicator for a plant's abundance. The results demonstrates that one of the main factors that impacts the abundance of a plant species is water availability.

The second study is titled *Effects of the planting density on water relations and production of 'Chemlali' olive trees (Olea europaea L.)*. The study takes place in central Tunisia and focuses on specific water relations with the Chemlali tree because it was believed that water would provide substantial evidence of significant effects on the plant's density over time. The study experimented on an orchard and monitored the photosynthesis rate and moisture content of the area. However, after the study finished, it was concluded that there were far more important factors that greatly affected the density of the plant, rather than the water amounts. (Guerfel, 2010). The study is relevant because it demonstrates that there are multiple variables that need to be taken into account when considering water sources as a critical factor in plant density.

Furthermore, the study acknowledges that although water is a factor that should be taken into consideration, there are other factors, such as, climatic conditions and human interference. This relates to the study because the hypothesis was not supported by the data collected since the frequency did show any critical evidence for support.

The errors reflected in the study were directly related to bias. In Gus Fruh, there are many possible areas that could have been used as transect locations for this study; however, the researchers chose transects that were relatively parallel to the Barton Creek and distanced enough from each other so as to not face a potential overlap. Additionally, data was collected three times, on two transects each, throughout the span of approximately six weeks which is not a sufficient amount of time to obtain accurate data. Another issue with this study is that very small amounts of data were collected, so it is difficult, if not impossible, to get a realistic representation of the plants in the park.

For future studies in Gus Fruh, there are other methods to analyze the plants in the area that could provide better results. It would be recommended if the data was collected in a consistent environment and time frame throughout the day because climatic factors could alter the plant's' availability since the weather was progressively turning colder as the study continued. From the issues brought by the original study, collecting more data on multiple transects would raise the chances of receiving more accurate data.

Works Cited

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