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Riparian Area Vegetation Response to High and Low Flows in the Platte River Through Digital Imagery

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RIPARIAN AREA VEGETATION RESPONSE TO HIGH AND LOW FLOWS IN THE PLATTE RIVER THROUGH DIGITAL IMAGERY

by

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Abstract

Images can be helpful in explaining different aspects about science that is unfamiliar to some. This study looked at two separate locations on the Platte River through images. High and low flow events were studied at each location. The riparian areas of these two locations were studied. The RGB values of each location and each flow event were used to rank the healthiness of the vegetation and to see how the vegetation responded to the different flows. The results were inconclusive, with no statistically significant answer. It did however look as if the healthiness of the vegetation, as determined by this formula from the RGB values, was higher when the flows in the Platte River were higher. Although no real answer was determined, a new method of studying vegetation was investigated and implemented.

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Introduction

Digital photography has many different applications when it comes to the science. To those who do not understand the various complexities of the scientific field, images help portray ideas that may not be easily understood. All humans can analyze images while only those educated in the field can understand a scientific journal. Scientific jargon can be intimidating, leaving readers frustrated and disinterested in the topic. Images on the other hand can help the general public understand ideas that they may never be confronted with.

A study by Muthersbaugh et al. had elementary students observe environmental changes through images since Lewis and Clark's journey 200 years ago. Two important themes were noted. This process helped the students develop critical thinking skills and helped displace some scientific misconceptions. By learning through the images, the students were able to increase their confidence in learning about science. Although this study was conducted using elementary students, digital imagery has been shown to help develop science-learning strategies in high school students as well (Moore, 2002). A new approach to learning with images can be helpful in educating the general public.

Platte Basin Timelapse formed in 2011 with a mission to educate the general public about the Platte River Basin and to stir a discussion about our water resources within the watershed. Platte Basin TImelapse's mission is to see a watershed in motion. The project has over 40 cameras at different locations on the Platte River. Each camera takes one photo, every hour of sunlight, 365 days a year. Some of these camera locations have been running since 2011 and as of the summer of 2014, one million photos have been collected.

Recently the images of the various locations of the Platte Basin Timelapse have been made available online for the general public. Many of these locations show different areas of the Platte River, focusing on a different aspect of the Platte. Riparian areas are lands that occur along watercourse and water bodies. They are unique ecosystems that surround the banks of rivers and streams (NRCS). These riparian areas provide habitat to various species of animals. They provide many different functions for wildlife such as protection from predators, shade, food, water, and areas to breed and nest. Management of these areas is essential to the livelihood of these certain wildlife.

In terms of land management, riparian areas are important in controlling erosion. Certain plants are used to help hold the soil in place and cause less destruction of the land to the wild variability of rivers. When flows are high, water can flow over the adjacent land areas, pulling sediment and vegetation along with (Gilliam, 1994). When strong vegetation and trees are in place, the flow of water has less of an affect on the land.

Healthy riparian areas improve water quality, reduce erosion, attract beneficial insects and microorganisms, and also provide areas of recreation (Kapproth). Therefore, it is important to make appropriate decisions to take care of these valuable areas.

Methods such as a vegetation indices using NDVI derived from satellite imagery can be expensive and time intensive. Many land managers do not have access to such devices. Photos of the Platte River are available through the Platte Basin Timelapse and the Raikes School at the University of Nebraska-Lincoln. These photos area open and free to the public. By utilizing these photos, land managers can make appropriate decisions to how to manage their land with the varying flows of the Platte, especially since much of the Platte River has been changed due to

creation of upstream dams and infrastructure. This will help land managers both understand how vegetation in the Platte River responds to high and low flows and to also identify the healthiness of the riparian areas.

My goal is for these images to help explain vegetation response to high and low flows. There have been many studies that have already looked at riparian area vegetation response to flows in rivers. Powell et al., looked at NDVI readings to understand the temporal and spatial dynamics of flood pulse. They noticed that high NDVI readings occurred following flooding and was significantly correlated to 40 day inflows. This means that the healthiness of the riparian vegetation increased after a flood and perhaps means that they would be negative after a drought.

Many riparian areas are subject to invasion from non-native plant species. According to the study by Catford et al., the abundance of exotic plants are higher in riparian wetlands most impacted by flow regulations. The hydrological modifications, such as upstream dams and changes in the path of the river, most likely drive the invasion of the invasive species. The flow regulation may inhibit the native species since they are used to the regular flow regime of the river.

Stromberg et al. looked at restoring the flow dynamics in rivers and the response on the vegetation in riparian areas. They noticed that restoring the fluvial dynamics of the river could increase plant species diversity. With that being said, this links back to the idea that high flows make for healthier vegetation along the river. And that flow regulation lowers species diversity. The restoration of the rivers requires unimpeded flows of water, the allowance for overbank

flooding, and to reconnect the riparian areas to groundwater in order to restore surface water to the channel.

Naiman et al. investigated the importance in natural water flows to the long-term sustainability and productivity of riverine ecosystems and their riparian areas. The characteristics of the natural flows shaped the life histories over millennial time scales as well as the ecological processes and productivity of the aquatic and riparian communities. Extreme events such as uncommon floods or droughts (which have begun to increase more and more as time progresses), are important because they reset or alter the physical and chemical conditions of the biological community in the riparian areas.

In an article by Henszey et al, they looked at linking surface and groundwater levels to riparian grassland species along the Platte River. They learned that for Platte River riparian grasslands, high water levels are more influential than mean, medium, or low water levels. Land management practices affected six species by changing the frequency of their position along the water-level gradient. They determined plant response curves that can help predict how plants responding to riparian grassland water levels might also respond to river management.

The objective of this study is to track riparian vegetation response to a high and low flow event in the Platte through the images of the Platte Basin Timelapse project. Flood disturbance is one of the major factors impacting riparian vegetation on river floodplains (Dzubakova, 2015). To track the response, the green chromatic coordinate (Gcc) formula is going to be used. Gcc is a measure of the percentage of greenness of an area of an image. Gcc uses the RGB values of images, Gcc=G/(R+G+B). All of the images of the Platte Basin Timelapse are in RGB. Green chromatic coordinate has been used to track canopy development in forests (Sonnentag, 2012).

Gcc also has been more effective than other indices in suppressing the effects of change in light due to the movement of the sun. A higher Gcc value would mean healthier vegetation.

Through using the Green Chromatic Coordinate system, I will be able to show how the riparian areas on the Platte River respond to high and low flows. Research has already linked to how riparian areas respond, but I will be able to visual document the response. I will also be able to show a new way of understanding the response. My hope is that I can provide my audience with an insight into vegetation response that is both informative and visually stimulating.

Materials and Methods

Two separate flow events, a high and a low flow, had to be identified in order to conduct this experiment. After investigating discharge rates in the Platte from 2011 and 2014, high and low flow events were picked. The high flow event occurred in September of 2013, and the low flow event occurred in July of 2012. On September 28, 2013, 9,264 cfs was recorded in Kearney, Nebraska and 7,749 cfs were recorded in Overton, Nebraska. On July 14, 2012, 22 cfs were recorded in Kearney and 90 cfs were recorded in Overton (USGS). Once these dates were determined, a span of time was picked that reflected the flow. The high flow dates studied were from September 21,2013 to October 12, 2013. The low flow dates studied were from July 7, 2012 to August 11, 2012.

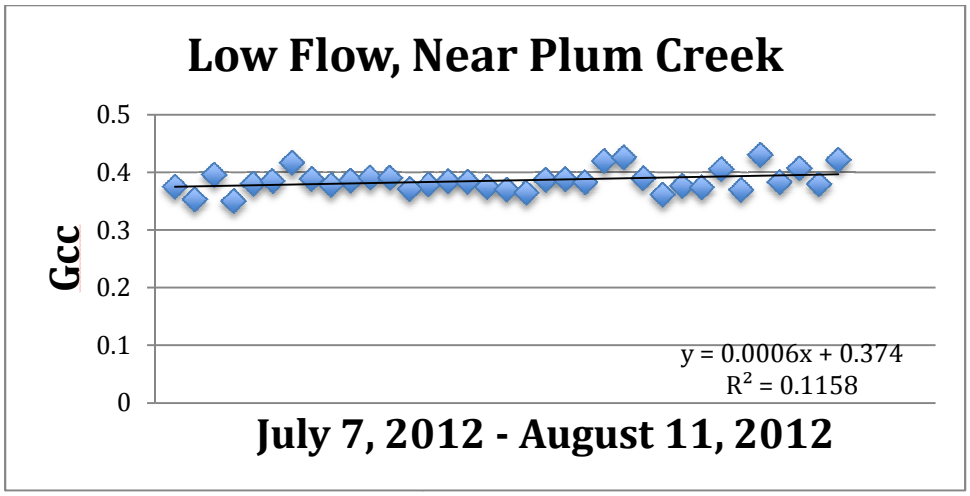
Now that the flow events were determined, locations to study the flow must be picked. Between Kearney and Overton, Nebraska, there are two separate camera locations from the Platte Basin Timelapse located on the Platte River. Near Plum Creek and Near Elm Creek are the two camera locations located on that stretch of the Platte. Both are good choices to study the

vegetation because they show both the flow of the Platte, along with the riparian areas along side the Platte River. Both locations represent a similar portion of the Platte and can be used to study that stretch of the Platte River.

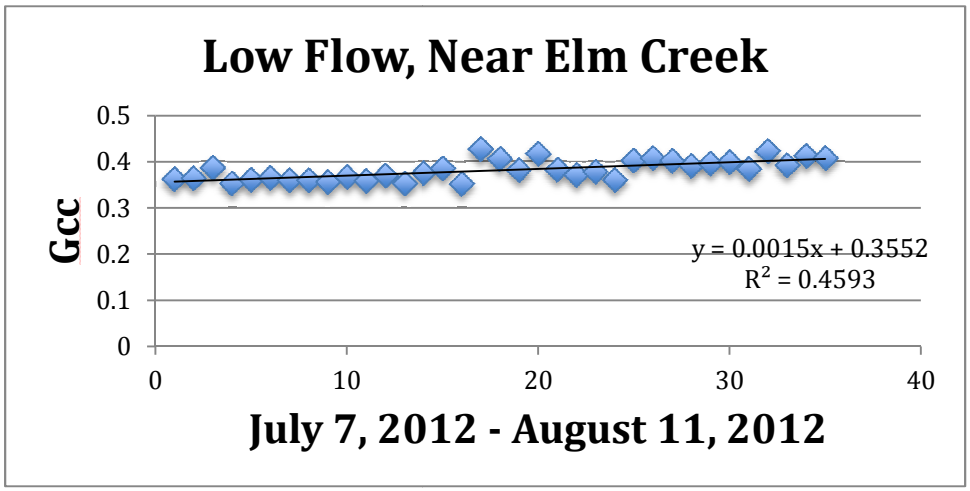
After deciding upon the flow events and the locations, pictures were selected from each day of the flow event and at each location. When selecting photos, photos with similar daylight were chosen. It is important to pick pictures of similar daylight in order to not have shadow skew results. For each location and event, one photo was picked for each day. These photos were then opened in Adobe Photoshop®. At each location, a region of interest was identified. The region of interest was the area of the photo that was to be analyzed. Each locations' region of interest was in the riparian trees in the back of the photo. For each photo, the RGB values of the region of interest were extracted. When placing a tool over the image in Adobe Photoshop®, the RGB values were displayed.

Once the RGB values were extracted for each day of the flow events, the values were placed in Microsoft Excel. These numbers were then placed into the green chromatic coordinate formula. Gcc values were determined for each day, of each flow events, of each location. Once these values were calculated, an average Gcc value was calculated for each location, along with a standard deviation to identify how far values varied from the mean. Also over each flow event, a linear regression was run on the calculations in order to see if Gcc values changed linearly over time.

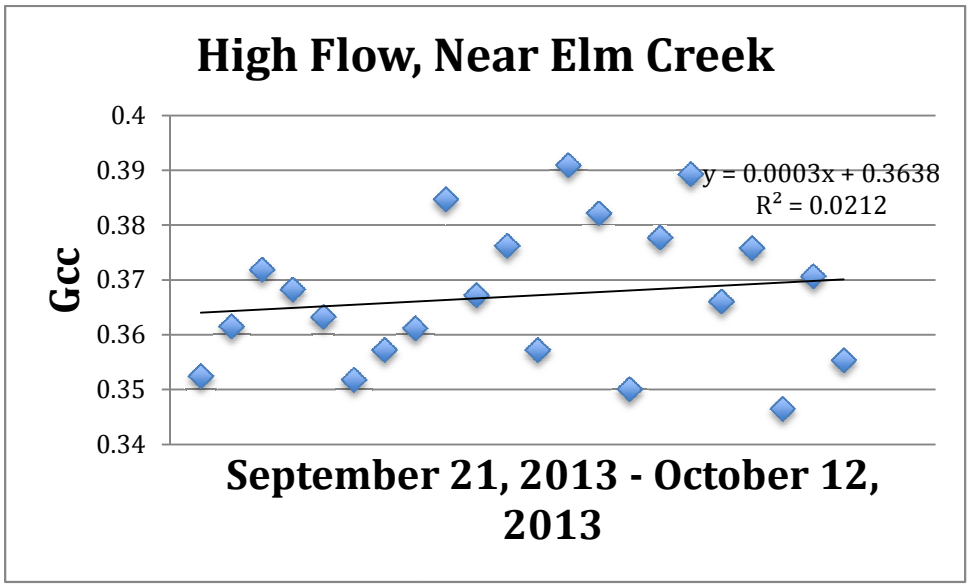
Results



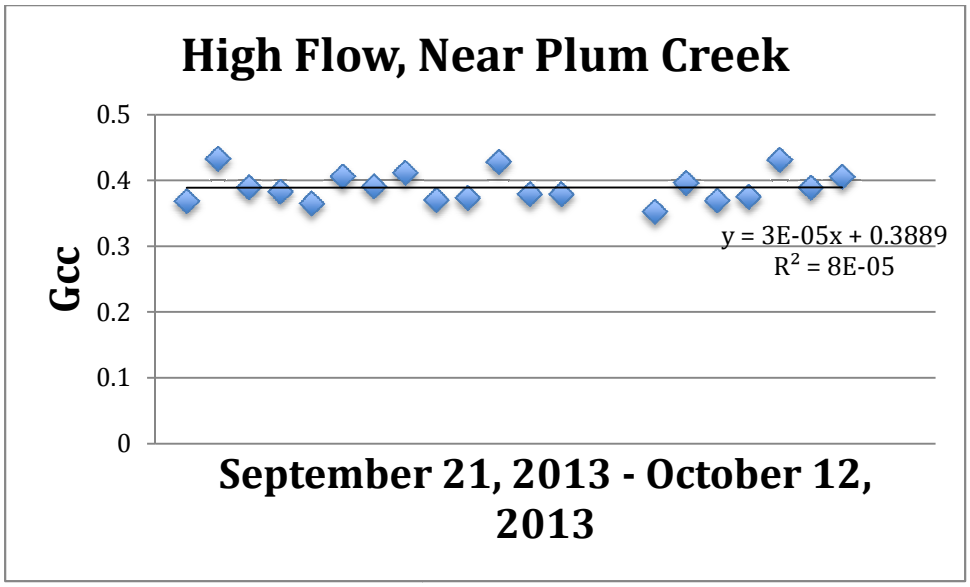
(Figure 1)



(Figure 2)



(Figure 3)



(Figure 4)

High Flow	Near Elm	Near Plum
Average Gcc	0.36708328	0.38923727
Standard Deviation	0.01288164	0.02310599
Slope	0.0003	0.00003
R^2	0.02118	0.000082

(Figure 5)

Low Flow	Near Elm	Near Plum
Average Gcc	**0.38148485**	**0.38559908**
Standard Deviation	**0.02210329**	**0.01934527**
Slope	**0.0015**	**0.0006**
R^2	**0.45933**	**0.11584**

(Figure 6)

During the low flow, the average value for Gcc was higher at Near Elm Creek. The average value was lower at Near Elm Creek but only by 0.004. At all locations, the values did not have much variance from the mean, with no standard deviation about 0.024 (Figure 5 and 6). R^2 values were very low for the high flow events. Near Plum Creek had data points that were highly variable and a R^2 value of 0.000082, reflecting a very low relationship between Gcc and time. During the low flow, the R^2 values were about 0.1, with the R^2 of Near Elm Creek at 0.459, the highest value of them all (Figure 1, 2, 3, and 4). All flow events and locations had positive slopes, reflecting an increase in Gcc over time. However, none of the R^2 values can be determined to be very statistically significant.

Discussion

Initially, higher Gcc values were expected during the high flow events. However, the two separate flow events were very drastic. The low flow event had discharge rates of 20 cfs while the high flow event had discharge rates exceeding 9,000 cfs. This is a pretty drastic

change between flow events. By having such drastically different flow events, it is difficult to determine how vegetation responds.

During high flows, sediment is washed and sandbars shift. When the flows die down and become low, the sediment deposits and sandbars form. As the flow dies down, the sandbars tended to accumulate more and more. As they accumulated, vegetation began to grow on them. The more sandbar area present, the more there was area for vegetation to establish. As seen through the images, the sandbars had much more vegetation during the low flows. This would have resulted in higher G values and a higher Gcc value.

The high flow event chosen was towards the end of the growing season. Some of the vegetation had begun to turn orange as the season progressed. With this time during the end of the summer, the vegetation was not as green as I suspected, perhaps resulting in inaccurate values for what I was looking for.

Although higher values were expected for the higher flow, there are many reasons, like some presented above, which would explain the results. Also it has been shown that higher flows could have been destructive to smaller and weaker plants, resulting in a lower Gcc (Dzubakova, 2015).

Conclusion

Images can be helpful in explaining different aspects about science that one is not very familiar. This study looked at two separate locations on the Platte River through images. High and low flow events were studied at each location. The riparian areas of these two locations were studied. The RGB values of each location and each flow event were used to rank the healthiness of the vegetation and to see how the vegetation responded to the different flows. The

results were inconclusive, with no statistically significant answer. It did however look as if the healthiness of the vegetation, as determined by this formula from the RGB values, was higher when the flows in the Platte River were higher.

This study was able to incorporate free images online to study an aspect of the Platte River with very little expense. If furthered, this study could cover multiple years on the Platte and different flow events. This experiment could be a basin wide study on how the vegetation responds to differing flows in the Platte. Certain plant species could be studied specifically to see how they individually respond to high and low flows. Studies like this could be helpful to land managers since they are relatively easy and are not very expensive.

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