Seasonal Variations in Select Water Quality Parameters in a Southeastern Michigan River

Student Researchers:
Jana Ibrahim, Yasmin Rammal, Aya Soubra, and Layal Zbib

School:
Crestwood High School,
Dearborn Heights, MI 48127

Teacher:
Mrs. Diana Johns

March 6, 2024

Table of Contents

Abstract

This research focused on two sites selected for water quality monitoring along **Ecorse Creek** in the southern portion of Dearborn Heights, Michigan just outside of the Metropolitan Detroit area. These sites are found within nearby residential areas and located upstream of a densely industrial region. The first site is located near a city recreational center and the second site is located in a light industrial and residential area. Water quality parameters tested in this research included nitrates, transparency, **turbidity**, air and water temperature, and dissolved oxygen. All data was collected following GLOBE protocols where applicable. Data collection began during July 2023 and continued until mid-November. A significant rainstorm in August 2023 caused substantial flooding in the surrounding area and resulted in 18.2 mm of **precipitation**. Researchers found that as precipitation levels increased, turbidity levels also increased. Additionally, there was a correlation between precipitation and turbidity, with both parameters significantly increasing after the storm, demonstrating variations among seasons. For future research, this team would like to expand and extend their research to include additional water quality parameters and collect data during different seasons. To extend the range of this research, they hope that future researchers will compare water quality throughout different parts of Ecorse Creek.

Key Words: Ecorse Creek, precipitation, turbidity

Research Questions and Hypotheses:

Initial research question:

1. To what extent does the time of year affect turbidity, total solids, transparency, and nitrate levels at each of the two locations tested along Ecorse Creek?

Additional research question:

2. How do rain events affect each of the water quality parameters tested at each site along Ecorse Creek?

Null Hypotheses:

1. There is no significant difference between transparency, turbidity, nitrates and dissolved oxygen tested and rainfall events.
2. There is no significant difference in turbidity levels following major rain events.

Introduction and Review of Literature:

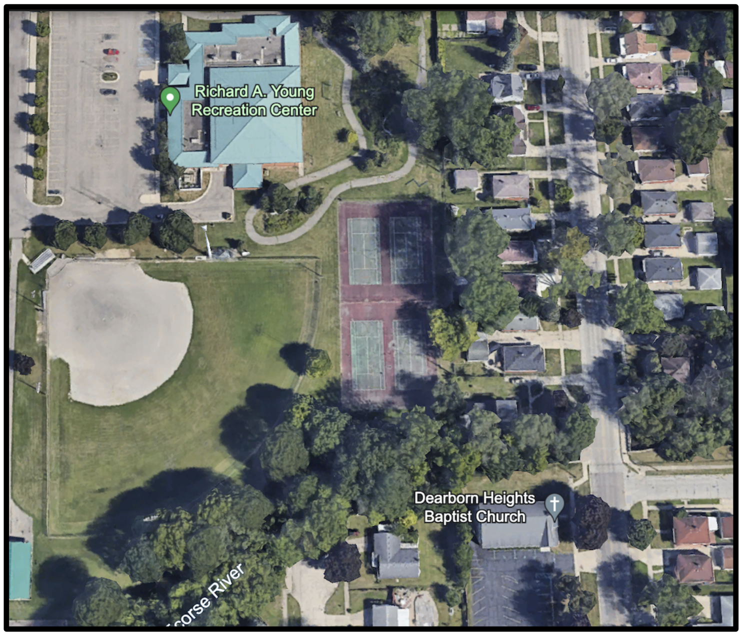
The Northern branch of Ecorse River spans more than 25 kilometers of stream channel, draining an area of nearly 12,000 acres. Flowing through both industrial and residential zones, this creek intersects with the South branch before merging with the Detroit River (Waliczek 2022). With a watershed covering approximately 43 square miles of Wayne County, the health of Ecorse Creek deeply affects the habitat of wildlife species living in the area. Preserving the creek's health is crucial for preserving biodiversity. Along with that, a portion of Ecorse Creek travels through suburban areas, highlighting the importance of effective landowner management strategies. According to the City of Southgate Planning Commission, by ensuring the creek's flow and reducing sedimentation and runoff, the risk of flooding in surrounding residential and commercial areas can be minimized (Southgate 2011). Further research on Ecorse Creek is essential to not only protect homes and buildings from water damage but also enhance the overall protection of the community against increasingly severe environmental conditions made worse by climate change. Additionally, Ecorse Creek offers numerous opportunities for recreational activities. By preserving a clean and aesthetically pleasing waterway, an increase in social and economic benefits can be instantly observed through the implementation of public activities, including parks, rowing centers, nature walks, etc. (Southgate 2011). According to a professor in History at Grand Valley State University, in 1873, Ecorse Creek had its very own rowing club, which served as an enjoyable activity for citizens within the area (Warnes 2014). The management and conservation efforts directed towards Ecorse Creek not only benefit the environment and wildlife but also enhance the quality of life for the surrounding communities. The team's research was conducted to investigate the effects of seasonal variations on the water quality of Ecorse Creek in Southeastern Michigan. Throughout their study, they observed and documented the surrounding conditions at both the Richard A. Young (located on McKinley Street), and Van Born Rd sites along the creek. According to researchers in the Department of

Agriculture and Biological Engineering, in recent years, heightened environmental conditions like more extreme precipitation linked to climate change have led to increased flooding in Ecorse Creek, resulting in runoff that adversely affects both areas. This environmental challenge has been compounded by runoff from impermeable surfaces (Li, Liu, and Engel 2018). Furthermore, threats to the water quality of Ecorse Creek, including sewage overload, logjams, flooding, and illicit discharges, pose significant concerns that need to be addressed to preserve the health and integrity of the creek's ecosystem.

Materials and Method:

The two selected research sites were located within Southeast Michigan's city of Dearborn Heights, one on McKinley St, near a recreational center and housing, and one on Van Born Rd, surrounded by a gas station, housing, and businesses. Upon arrival, the air temperature of the site was tested. A transparency tube with a Secchi disk at the bottom was then filled with around 32 oz of sampled water to test. After this, a sample of another 32 oz of water from each site was collected to test for dissolved oxygen, and water temperature immediately, using Vernier probes. The researchers returned to the lab as soon as possible, to begin testing for nitrates, turbidity, and total solids. To test for nitrates, clear test vials were carefully filled with 10m-L of the sampled river water. Then, NitraVer 5 Nitrate Reagent Powder Pillow was added into the samples, leaving only one without the reagent powder as it serves as the control variable. The samples were then shaken vigorously for 1 minute and left to sit for 5 minutes. The control vial was inserted into the HACH DR 300 Pocket Colorimeter and measured as the zero, then the other sample was placed into the device to test for nitrate levels. After the nitrate concentration levels were evaluated, the data was recorded and transferred to a digital spreadsheet. To test for turbidity a clear test tube was filled with the sampled Ecorse Creek water. The sample was then inserted into the Hach 2100N laboratory turbidimeter and the numbers were analyzed until they remained constant. The data was then recorded and transferred to a spreadsheet. To test for total solids the researchers began by recording the weight of empty 50 m-L beakers. The beakers were then filled with 40m-L of the water sample and carefully placed with tongs into HACH 13U Utility Oven overnight. The following day, the beakers were removed from the oven and weighed again using the Ohaus PX85 Pioneer Semi-Micro Balance. The original weight of the beaker was subtracted from the new weight and recorded the data on the documents, which was instantly uploaded onto the spreadsheet. After all spreadsheets were collected, the data was input into excel and graphs were created to be analyzed.


Figure 1 (Left) and Figure 2 (Right): Figure 1 showcases the collection of a water sample at the Richard A. Young site on July 12, 2023. Figure 2 showcases the collection of a water sample at the Van Born site on October 29, 2023.



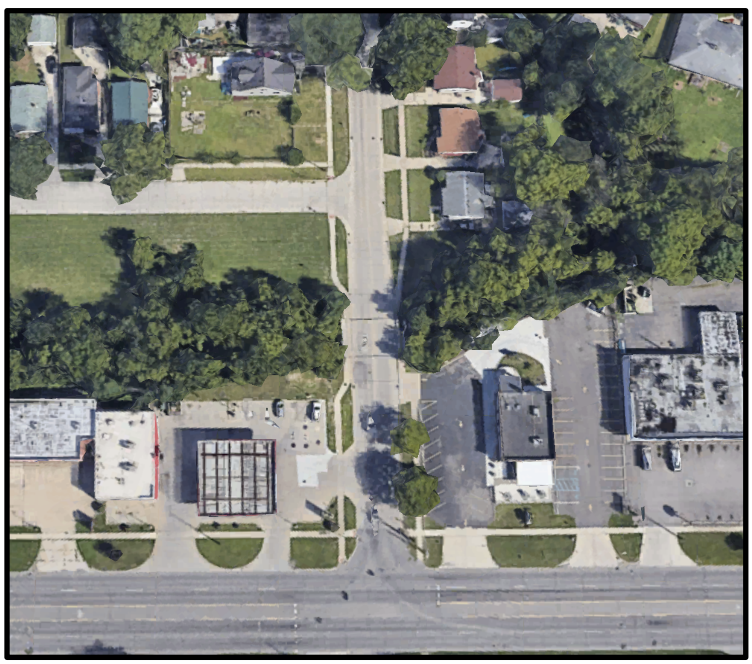
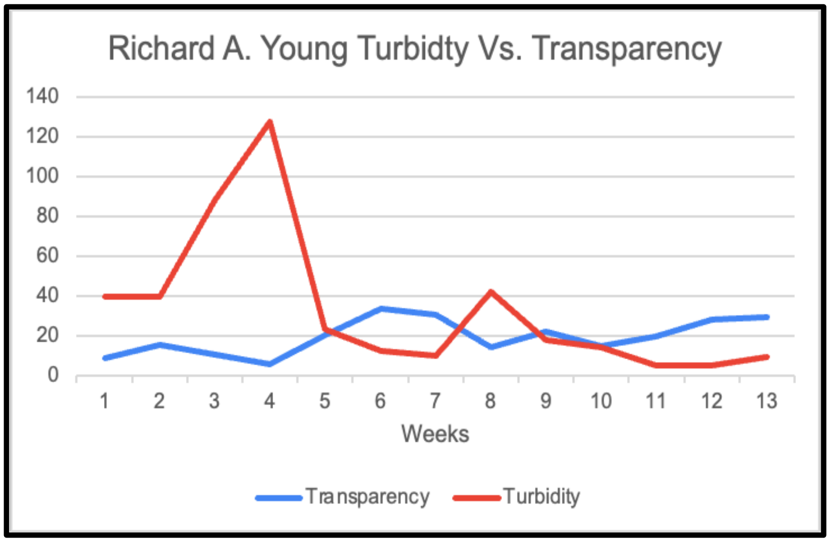


Figure 3 (Top) and Figure 4 (Bottom): Visualization of both sites. Figures 3 and 4 show the sites where water parameters were tested. Figure 3 (Top) shows the Richard A. Young site, and Figure 4 (Bottom) shows the Van Born site. The exact location of the Richard A. Young site (Figure 3): 42° 16 '17” N 83°15’03” W 193m. Exact location of the Van Born site (Figure 4): 42°16’10” N 83°17’04” W 183m.

Data Summary:



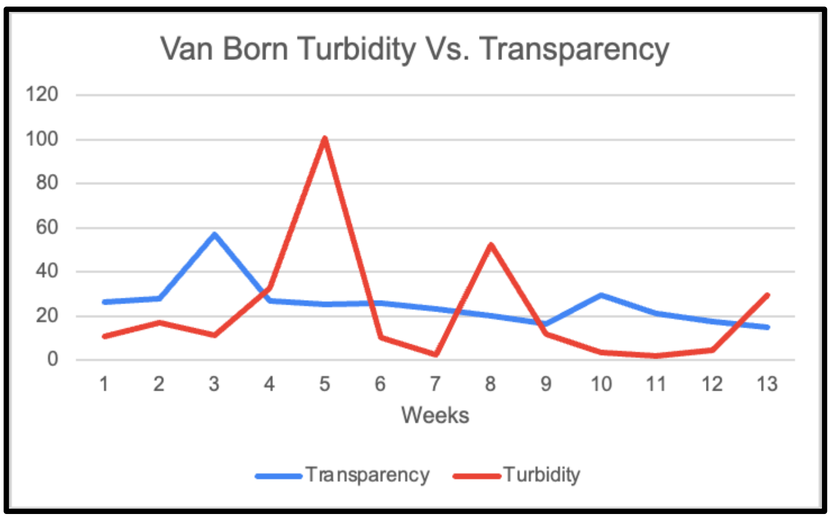
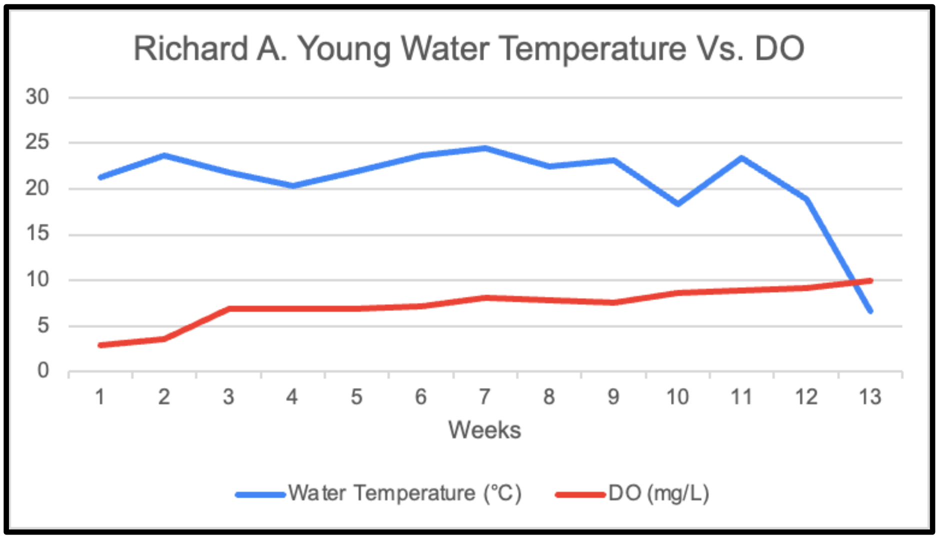


Figure 5 (Top) and Figure 6 (Bottom) Turbidity & Transparency: Transparency levels at the Richard A. Young site (Figure 5) were relatively low throughout the testing period. Typically, low transparency levels lead to higher turbidity levels and the data shows this correlation. Turbidity levels measured in (NTU) were at their highest from weeks 1-5 when transparency was at its lowest. Transparency levels at the Van Born (Figure 6) site stayed pretty consistent throughout the testing period. At the Van Born site, during the early weeks, turbidity levels measured in (NTU) were low while the transparency levels were high, which is the typical relationship between turbidity and transparency.



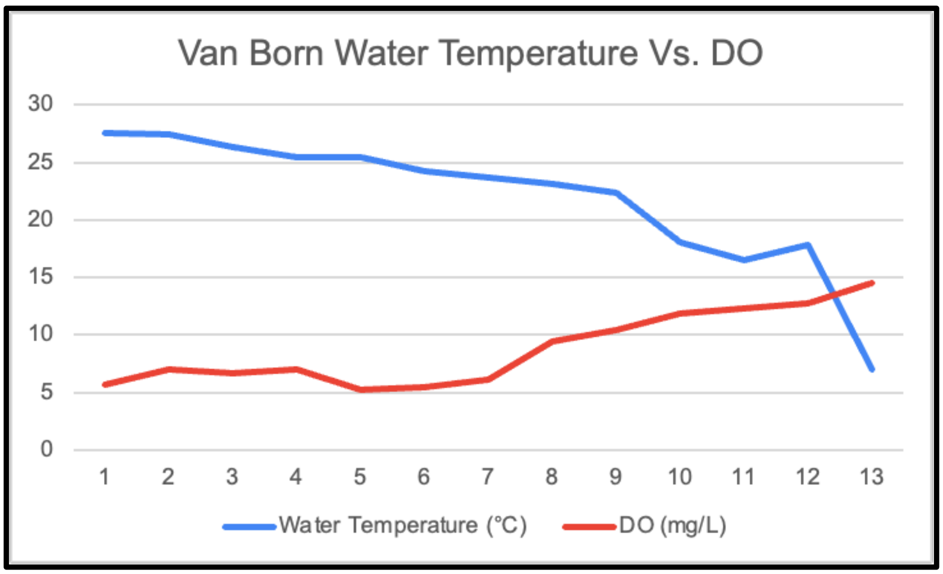


Figure 7 (Top) and Figure 8 (Bottom) Water Temperature and Dissolved Oxygen: Water temperature measured in (°C) and dissolved oxygen levels measured in (mg/L) stayed consistent throughout most of the testing period for both sites. However, by weeks 11 and 12 there was a decrease in water temperature, following seasonal changes, which led to an increase in dissolved oxygen level, as demonstrated in the graphs above.

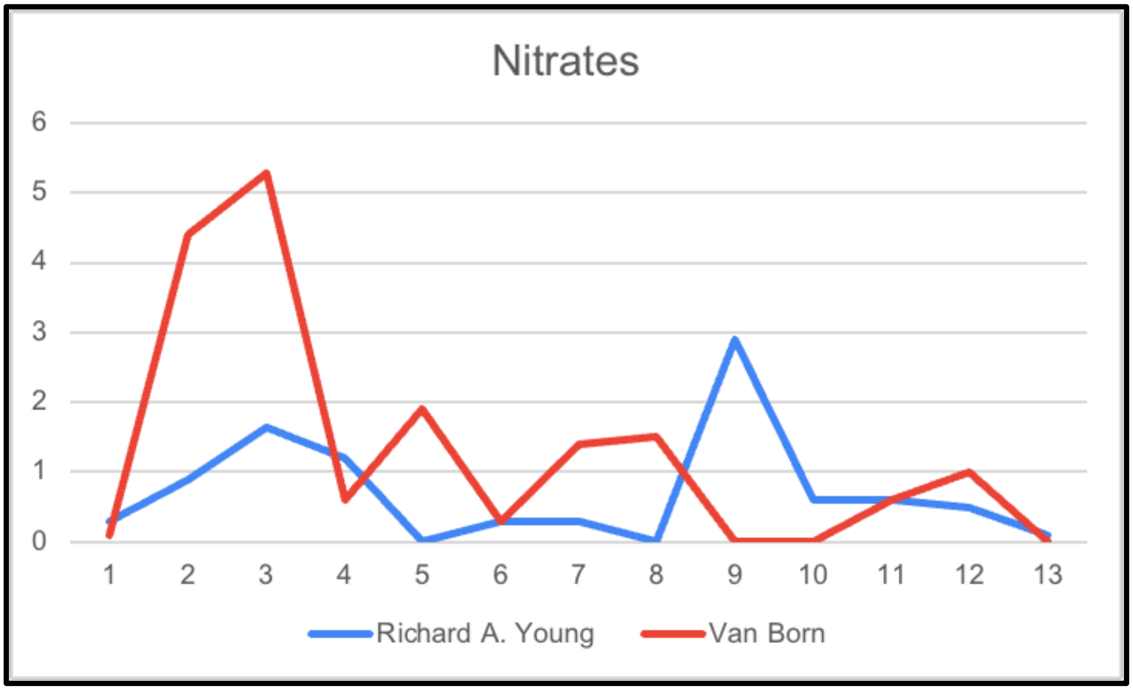
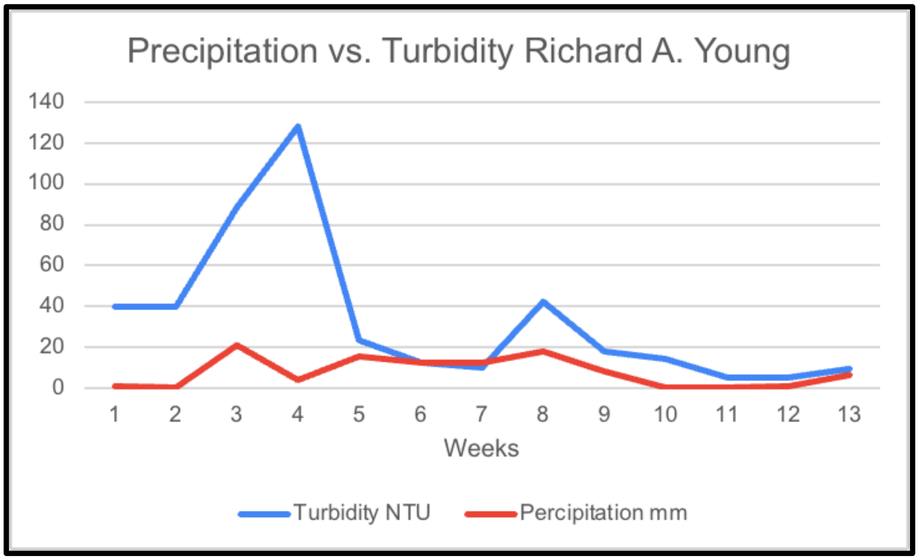


Figure 9 (Above) Nitrates: During the testing period, the amount of nitrates found varied. For the Richard A. Young site (Blue line), the levels of nitrates stayed relatively constant until weeks 8-10 where it increased and then returned to its original levels. At the Van Born site (Red Line), nitrate levels were much higher than the Richard A. Young site; however, during weeks 8-10 when the Richard A. Young levels spiked up, the Van Born nitrate levels dropped significantly.



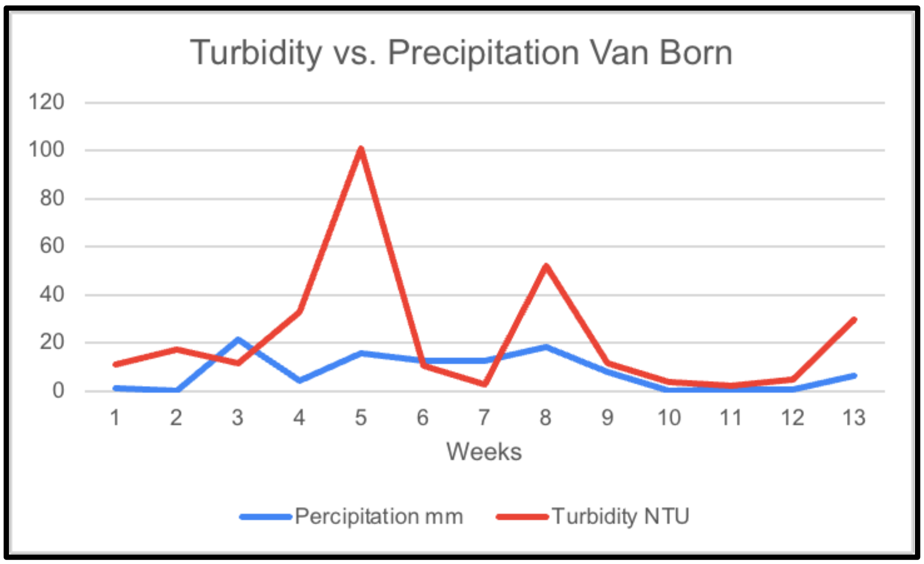


Figure 10 (Top) and Figure 11 (Bottom) Precipitation vs. Turbidity. In Figure 10 (Top), the team measured turbidity levels to the amount of precipitation at the Richard A. Young site. It is evident that from weeks two to four when precipitation was at its highest peak, turbidity was also at its highest peak, showing a direct correlation between the two. In Figure 11 (Bottom), they measured turbidity levels to the amount of precipitation at the Van Born site. Although turbidity was relatively higher in this site than in Richard A. Young, you can also see that when precipitation was at its highest, turbidity was also high, again showing the direct correlation. Increased precipitation leads to runoff which overall higher the levels of turbidity.

Analysis and Results:

The data collected showed a direct correlation between seasonal changes and water quality in Ecorse Creek. In the summer months they saw that turbidity, nitrates, and temperature increased, while in the fall these water parameters decreased. Water measures such as DO and transparency increased in the fall. This is most likely due to the fact that colder water holds more dissolved oxygen. Also, there were less large precipitation events leading to stream erosion which would increase turbidity.

The researchers reject the first null hypothesis, as the data has shown a significant difference between transparency, turbidity, nitrates and dissolved oxygen in relation to rainfall events. Week 9 marks the change in seasons from Summer 2023 to Fall 2023 which is exemplified in the data above. Connected with this, shown above in Figures 5 and 6, levels of turbidity were much higher with extremely low transparency levels during the summer months (Weeks 1-9). Also, as water temperatures decreased, seasons changed from summer to fall, and an increase in the levels of dissolved oxygen in both sites tested was shown. Along with that, according to Figures 5 and 6, shown above, levels of turbidity were much higher with extremely low transparency levels during the summer months (Weeks 1-9). In addition, nitrate levels seemed relatively higher during the first few weeks of the testing period, specifically in the Van Born site.

A significant aspect of seasonal change is closely linked to variation of precipitation levels in an environment as can be observed in the team's collected data. The researchers reject the second null hypothesis, as the data has also indicated a significant difference in turbidity levels following major rain events. As displayed in Figures 10 and 11, weeks with the highest levels of precipitation also had the highest levels of turbidity. Throughout weeks 1-13, the graphs illustrate a corresponding change in turbidity following the change in precipitation. Overall, the data disproves the hypotheses that there is no correlation between variables.

Richard A. Young

Taking a look at the graph, one may note that Nitrates in the Richard A. Young site faced a massive increase right as the season changed in Week 9, spiking from slightly over 0 mg/L to nearly 3 mg/L in just one week. By the beginning of the summer in week 1, the dissolved oxygen levels were approximately 2.5 mg/L, however, approaching the middle of fall at week 13, the dissolved oxygen levels had drastically increased, reaching nearly 10 mg/L.

Van Born

Looking at the graph one may observe that during the first week nitrate levels were low but approaching weeks 2 and 3, levels of nitrates increased dramatically. During that time nitrate levels reached a high of 5.28 mg/L. The following weeks nitrate levels decreased and remained at levels between 0 mg/L and 1.9 mg/L. At week 9 Richard A. Young had its highest levels of nitrates of 2.9 mg/L while Van Born had its lowest nitrate levels of 0 mg/L.

Discussion:

Originally, the intention was to compare the differences between water parameters near industrial vs. residential areas, but the researchers saw a greater difference in seasonal changes. Moreover, the locations of the water that were tested can not be compared as industrial vs. residential areas, as they are both near industrial-based areas.

Over the 5 months that data was collected, they saw changes in temperature, dissolved oxygen, and nitrates. During the early summer months, they observed that temperature, level of nitrates, and transparency were high. Closer to the fall months water parameters began to decrease. Observing that with seasonal changes water parameters such as nitrates, transparency, turbidity, temperature, and dissolved oxygen change. Moreover, the discussed research led the researchers to reject the null hypothesis.

Improvements of this study would include testing for water elevation to monitor the impacts of flooding. Although they have utilized thorough testing methods with reliable equipment such as HACH and Vernier LabQuest, it is important to acknowledge the potential factors that may impact the validity of the data. Despite the systemic protocols during the collection of such data, improper calibration of equipment can interfere with the accuracy of t0he data, leading to skewed or impaired results.

Due to the inadvertent use of expired nitrate reagent powder, this could have led to potential error in the documented nitrate levels. This may have caused a variety of issues due to chemical degradation of the nitrate, along with error in calibration that may have made it difficult for the nitrate machine to regulate precise measurements. Through using the HACH DR 300 Pocket Colorimeter, other human error may have occurred during the accumulation of nitrate sample data, this includes fingerprints or smudges on glass tubes may have impacted the device's analytic reading. Although efforts were made to clean the tubes before readings were taken, there is still a possibility that smudges or debris could have influenced the results. An additional point that could have induced flawed values is the Hach 2100N laboratory turbidimeter, which was the instrument used to evaluate turbidity measures. The numeric digits fluctuated heavily as they tried to obtain correct quantitative measurements. The team determined the value by using the most frequent testing values to include in the dataset; however, they cannot confirm the validity of this procedure.

If they analyzed the water levels they could add those levels to different water parameter measures and the changes that occurred.

The research conducted can be used to improve the quality of the water for recreational and habitat use. For example, the increased levels of nitrates could be from the runoff produced from industries affecting both sites and decreasing the quality of water.
Further studying Ecorse Creek would require information on water levels, considering other locations to monitor further levels of flooding, and testing at a downstream location to assess the difference between upstream and downstream water measures.

Conclusion:

September 23, the start of fall of 2023 and week 9 in the research, created a change in water parameters observed. The changes analyzed were a decrease in temperature, nitrates, and turbidity. There was also an observed increase in transparency and dissolved oxygen. This concludes that seasonal changes impact the adjustment of water parameters.

After completing 13 weeks of research, transparency, turbidity, nitrates, and dissolved oxygen levels varied significantly in both the Richard A. Young and the Van Born sites as the seasons changed. This not only presents the differences in water parameters during different seasons but also shows that more research should be done to find out what other effects changing seasons have on water parameters. Part of seasonal change includes variation in precipitation levels. The research found a correlation between high amounts of precipitation and increased turbidity levels. Such high turbidity levels associated with low transparency causes less light to penetrate Ecorse creek overall leading to a lower level of photosynthesis produced by underwater vegetation.

Bibliography:

Li, Fahzi, et al. "Green Infrastructure Practices Simulation of the Impacts of Land Use on Surface Runoff: Case Study in Ecorse River Watershed, Michigan." *Journal of Environmental Management*, Academic Press, 29 Dec. 2018, www.sciencedirect.com/science/article/abs/pii/S0301479718315007.

Warnes, Kathy Covert. *Ecorse: Along the Detroit River*. *Google Books*, Arcadia Publishing, 1 Sept. 2014, books.google.com/books?hl=en&lr=&id=NtuRBAAAQBAJ&oi=fnd&pg=PA6&dq=Ecorse&ots=2vMA3qWUhK&sig=6BV66_HEVkN8ymqkYGJ4DGX0bD0#v=onepage&q=Ecorse&f=false. Accessed 4 Mar. 2024.

"Ecorse Creek Support." *Friends of the Detroit River*, www.detroitriver.org/ecorse-creek. Accessed 4 Mar. 2024.

Kuspa, Joseph. "Master Plan - City of Southgate." *Master Plan*, 2011, www.southgatemi.org/Master Plan Southgate 2-14-14.pdf.

Acknowledgement:

Thank you to their teacher and mentor, Mrs. Johns, for providing them with the knowledge and materials to conduct this research. Thank you to the Dearborn Heights Watershed Commission for all the support and assistance given.

Badges:

I AM A DATA SCIENTIST

Over the course of 13 weeks, two different sites of Ecorse creek were tested. The team analyzed the data by using Excel spreadsheets and making graphs to determine the differences and correlations between different water parameters. Numerous correlations and relationships were found prior to testing for turbidity, dissolved oxygen, total solids, transparency, and temperature.

I AM A STUDENT RESEARCHER

The team created a research report on seasonal changes in water parameters. Their research was compiled and analyzed for all correlations between variables. Gathering data on the water quality can help them better understand the environmental factors that influence the quality of the Creek, as well as ways to improve it.

I AM A STEM STORYTELLER

Aya Soubra, a member of her team's GLOBE research, documented the steps of her research on Ecorse Creek through social media. Their Instagram page dives into the heart of environmental science - water quality in particular- as they analyze and collect data on this waterway. From images of their work at the Van Born and Richard A. Young sites, alongside images and descriptions of their research at the lab, the page offers a look into the discoveries of their journey. Their efforts to understand and preserve Ecorse Creek are displayed on their Instagram account @Nitrate_traveler04!

I AM A PROBLEM SOLVER

As their research determines the seasonal changes of water parameters, the data analysis can help discuss the negative effects of runoff leading to flooding in residential areas. By addressing this issue, they can discover ways to mitigate flooding and increase the water quality of Ecorse Creek!