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Monthly Water and Soil Analysis On Trotter's Creek In Elizabeth, New Jersey And Kean University In The Spring 2019 Semester

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Abstract

Urban waterways can easily be affected by pollution, runoff, and leaching, which can have biological, chemical, and economic impacts. Trotter's Creek, which begins at the Peerless Beverage Company in Union, New Jersey and ends at the Phil Rizzuto Park in Elizabeth, New Jersey, is a local example of an urban waterway currently being impacted by such factors. To assess the overall health of Trotter's Creek, a qualitative assessment was conducted on soil and water samples that were taken once a month from February to April. The samples were taken upstream at the Peerless Beverage Company, midstream at Kean University, and downstream at Phil Rizzuto Park. Water analysis included measuring the flow rate and temperature of the stream in addition to the pH, nitrate, and phosphate concentrations. Soil samples were taken from both inside and outside the creek and were measured for pH, nitrate, phosphate, and potassium concentrations. The results show the Peerless Beverage Company had the highest pollution impacts and thus the lowest amount of nutrients. This data is the first step in understanding how an urban environment impacts local aquatic and soil systems that can be easily monitored and could lead to environmental regulations to decrease pollution rates.

Introduction

Trotter's Creek is a two-mile urban waterway that begins in Union, New Jersey near the Peerless Beverage Company on Floral Avenue and ends at the Phil Rizzuto Park in Elizabeth, New Jersey near North Avenue. In between these two points, the waterway cuts through Kean University which lies on the border of these two towns.

Trotter's Creek's ecosystem services were first used in the 1660s by the first settlers of Elizabeth, New Jersey. The creek was used to water farmland crops and to transport goods and services (R. Diaz, personal communication, June 1, 2019). During this time, it is believed that the waterway was called Trotter's Branch after an early settler, Jon Trotter. As time passed, the creek had many name changes, and because of this, it is difficult to find any historical records of the waterway. However, all known records are available through the Newark Historical Society. Trotter's Creek finally gained its current name during the 1970s when it officially became a part of Union Township and Kean University.

Trotter's Creek is a part of the Arthur Kill Watershed; the waterway drains into the Elizabeth River which eventually connects to the Atlantic Ocean ((R. Diaz, personal communication, June 1, 2019). As such, Groundwork Elizabeth, a local environmental organization centralized in Elizabeth, New Jersey, monitors the creek carefully and performs constant field work. The organization's mission is to improve the physical environment by building healthy, sustainable, and equitable communities, Trotter's Creek is a prime site to accomplish these goals (About Us, n.d.).

Currently, Groundwork Elizabeth is in the process of making more hiking trails along the creek, cutting down overgrown vegetation to make the paths safer, implementing signage to educate about biodiversity, and practicing urban conservation and preservation (R. Diaz, personal communication, June 1, 2019). Groundwork Elizabeth even partnered with Kean University's School of Environmental and Sustainability Sciences (SESS) Senior Capstone during the Spring 2018 semester to see how they could further implement this information and ideas in the most efficient way. Besides making maps and creating and identifying prime locations for the signs, the capstone group also did a macroinvertebrate identification and tree species sampling to better understand the biota living in this ecosystem. Through this assessment, the group found that the surrounding area of Trotter's Creek was polluted from the neighboring urban environments (Gomes et al, 2018).

The two urban pollutants that were a main concern were road salt (to prevent ice from forming on roads during the winter months) and runoff from fertilizers, which could potentially lead to eutrophication. As such, the inspiration for this project was to see if there would be any physical or chemical changes to the water and soil if these two urban pollutants were prominent. In order to assess the health of the water, the temperature and flow rate were measured to understand the physical components while pH, nitrate-nitrogen, and phosphate-phosphorus were measured to give a chemical assessment. Additionally, soil samples were taken from inside and outside the creek to give a broader overview of the ecosystem; the chemical analysis performed included pH, phosphate-phosphorus, nitrate-nitrogen, and potassium. Samples were collected once a month during the Spring 2019 semester (February, March, April) at three locations (upstream, midstream, downstream). Once completed, the results were compared to see if there could be any influences from urban pollutants on Trotter's Creek.

No literature that specifically discussed Trotter's Creek could be found, so instead, a broader and more general literature analysis was conducted. Scientists from around the globe have conducted research on aquatic ecosystems impacted by local urban environments, and from here, our results can be compared to others' findings and observations.

Urban waterways can be defined as bodies of water surrounded by a population density of 800 people per km^2 where human activity can affect the local biota through habitat degradation or pollution runoff (Weber, Lautenbach, & Wolter, 2012). With urbanization expected to increase, it is predicted that waterways will further be negatively impacted from storm water runoff due to impervious surfaces and drainage systems (Morison & Brown, 2011).

Two types of urban pollution were observed for the purpose of this study, fertilizers and road salt. There are two types of fertilizers, the first being organic, which is composed of animal manure, compost, leaf manure, and other hydrocarbon-based materials, and the second being inorganic, which is synthetically produced to include essential plant nutrients, such as nitrogen, phosphorus, and potassium (NPK) (Khan, Mobin, & Abbas, 2018). While urbanization and population rates increase, it is expected that fertilizer use will also increase, in addition to leaching, runoff, and deterioration of soils, surface waters, and groundwater. It has been observed that excess fertilizer can not only lower the pH of the soil, but also lead to eutrophication of surface waters from nitrogen and phosphorus through runoff (Khan et al, 2018). Potassium does not seem to be a major concern when it comes to surface water assessments.

Road salt is a major concern with urban environments because it can negatively affect aquatic species, ecosystem quality, and eventually, human health. As the salt dissolves and runs off into local waterways, it can affect the ion concentration and can raise the salinity or leach into the groundwater (Rauch et al, 2017). These consequences can upset an ecosystem balance by making the ecosystem uninhabitable to organisms who cannot adapt to the chemical changes, which can affect the overall biodiversity and food webs.

This research area expands with studies on how these urban pollutants affect the local biota, in addition to measuring other chemical nutrients or physical variables between different seasons. However, the purpose of this study was to get a broad baseline understanding of Trotter's Creek, and as such, only simple, imperative procedures were performed.

Methods

All soil and water samples were taken once a month in February, March and April. February samples were collected on the 15th of the month with an outside temperature of 63°F while the samples in March were collected on the 18th with a temperature of 37°F. April samples were gathered on the 15th with an outside temperature of 63°F. The soil samples were collected in plastic cups without lids to allow them to air dry for at least 24 hours while the water samples were collected in plastic containers with lids to avoid evaporation.

While at each site, the temperature of the water was measured by sticking a thermometer in the center of the creek for two to three minutes and then recording the temperature in degrees Celsius. The flow rate of the water was calculated by measuring the time it took for a floating stress ball to cover a distance of five feet, which was determined using a 100 feet Agora tape measure. These measurements were used to find the flow rate by converting feet to meters and dividing this number by the time.

Water analysis was conducted first with three procedures: pH, nitrate-nitrogen, and phosphate-phosphorus. For pH, a test tube was filled with 10 mL of the sample and 10 drops of wide range pH indicator was added. The sample was then lightly shaken by hand, inserted into an Octa-Slide, and left to sit for 10 minutes. The color of the sample was then compared to the color pH charts provided by LaMotte Company and the result was recorded.

Water nitrates were measured by first filling a test tube with five mL of the sample water and then adding a nitrogen #1 tablet. The test tube was shaken until the tablet dissolved. After this, a nitrate #2 tablet was added and again, the test tube was shaken until it dissolved. The sample sat for five minutes to settle and then was placed into an Octa-Slide to record the results.

Water phosphate-phosphorus measurements were the last water analysis administered. A test tube was filled with 10 mL of sample water and one mL of phosphate reducing reagent was added. The test tube was gently shaken and sat for five minutes to allow the chemical reaction to occur. The result was recorded by placing the sample in the Octa-Slide and comparing it to the LaMotte color chart.

Once the water analysis was complete, the soil analysis then began. The four soil experiments were conducted for both the soil inside and outside of the creek for all three sample locations. The first test conducted was to measure pH levels because the sample had to sit the longest for the test. A small test tube was filled with four mL of pH indicator solution and 1.5 grams of soil were added. The test tube was gently shaken by hand for one minute and left to settle for 10 minutes. The solution changed color during this time period and the color was compared to the LaMotte color chart to record the results.

Afterwards soil phosphorus was measured by filling a test tube with six mL of phosphate extracting solution and adding 1.5 grams of soil. The test tube was then gently shaken for one minute and the clear liquid was decanted into another test tube. Six drops of phosphorus indicator reagent were added to the new test tube and gently shaken to disperse throughout the solution. A phosphorus test tablet was then added, shaken until dissolved, which developed a blue color in the process. The intensity of the blue was compared to the LaMotte color chart to record the amount of phosphorus in the sample.

Nitrogen levels were measured for the third test for the soil analysis. To begin, seven mL of nitrogen extracting solution was added to a test tube, in addition to one gram of soil. The test tube was gently shaken for about one minute and the clear liquid was decanted into a separate test tube. Next, 0.5 grams of nitrogen indicator powder were then added and the test tube was then shaken to dissolve the powder. The solution was then left to sit for five minutes, so a pink color could develop and the result could be recorded. The intensity of the pink was compared to the LaMotte color chart to determine the amount of nitrogen in the sample.

The final soil analysis measured potassium levels. To start this procedure, seven mL of potassium extracting solution was added to a test tube with two grams of soil. Once the test tube was shaken and the liquid decanted into another test tube, one potassium indicator tablet was added and the test tube was shaken until it dissolved, developing a purple color in the process. To measure the amount of potassium in the solution, potassium test solution was added to the test tube two drops at a time and gently swirled in the test tube. Once the solution permanently changed from purple to blue, the number of drops added was compared to a chart, which indicated the potassium intensity, and the result was recorded.

Once the data was collected for each soil and water procedure, results were analyzed and graphs were made to visually depict the data.

Results

❖ *Water pH*

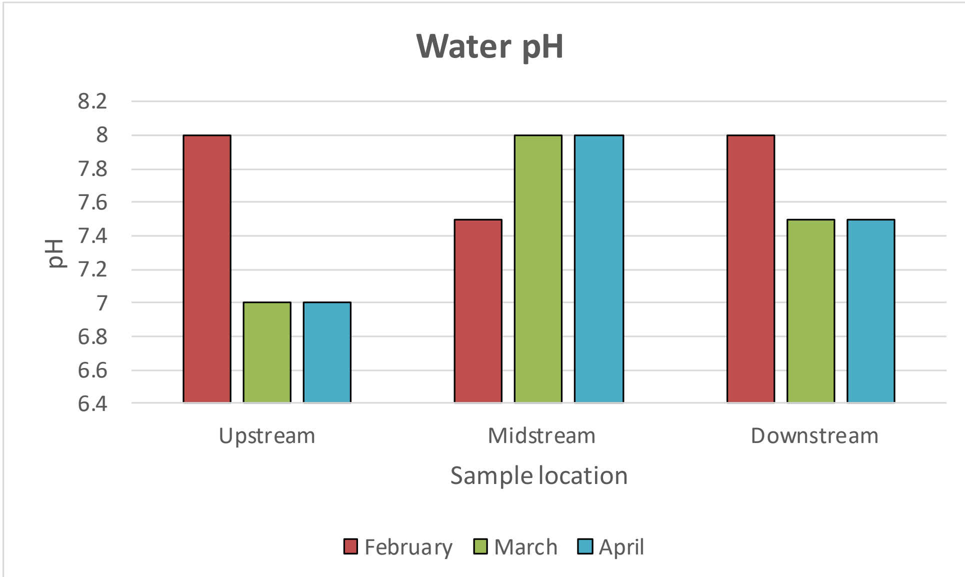

Figure 1.1: Water pH measurements

Figure 1.1 visually represents the data for the pH of the water of the three-month time period. The pH levels determine how acidic or basic a solution is and whether more cations or anions are attracted to the solution, which then provides nutrients for the ecosystem. The results conclude that there seems to be an inverse relationship between the February samples and later months; when the February samples have higher pH levels (as seen in upstream and downstream), the March and April samples have lower pH levels. An inverse relationship can be seen in the midstream data

❖ *Water nitrate*

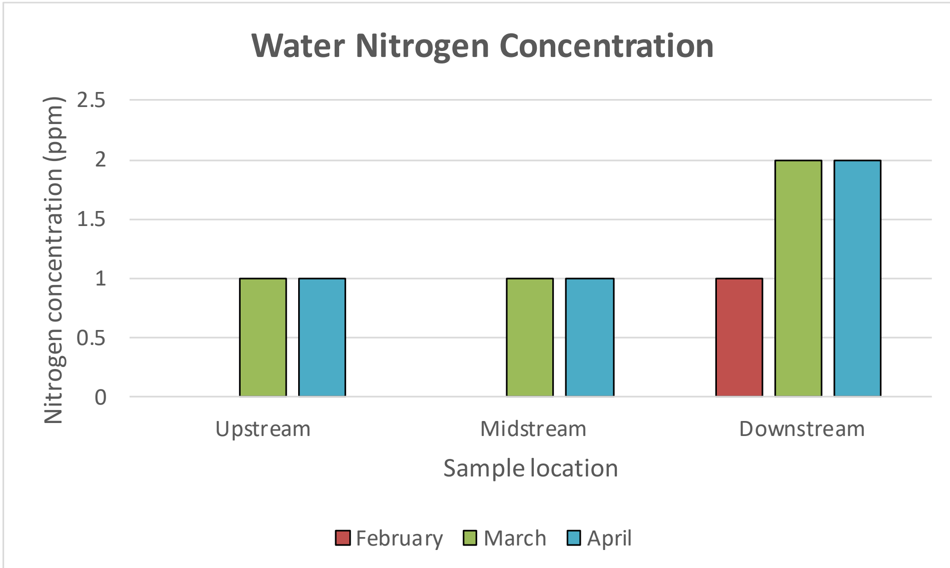

Figure 1.2: Water nitrate concentration

Figure 1.2 indicates the water nitrate concentration for the three-month time period. The March and April measurements at all sample locations are consistent between the 30-day time period. However, this is not the case for the February measurements.

❖ *Water Phosphorus*

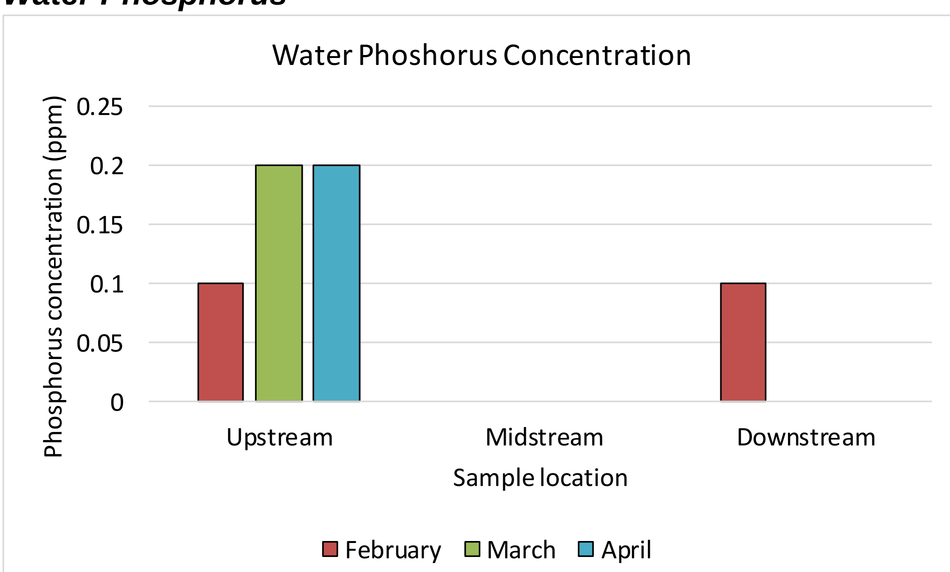

Figure 1.3: Water phosphate concentration

Figure 1.3 depicts the phosphate concentration by month for each sample location. There does not seem to be a correlation between any of the results, but it is unknown why the midstream results do not have any phosphorus concentration. The samples were taken at Kean University where there is ample amount of landscaping and fertilizer applications. With runoff, it is thought that the phosphorus originating from the fertilizers would be washed into the creek. Future research may be necessary to further investigate these results.

- ***Water flow rate***

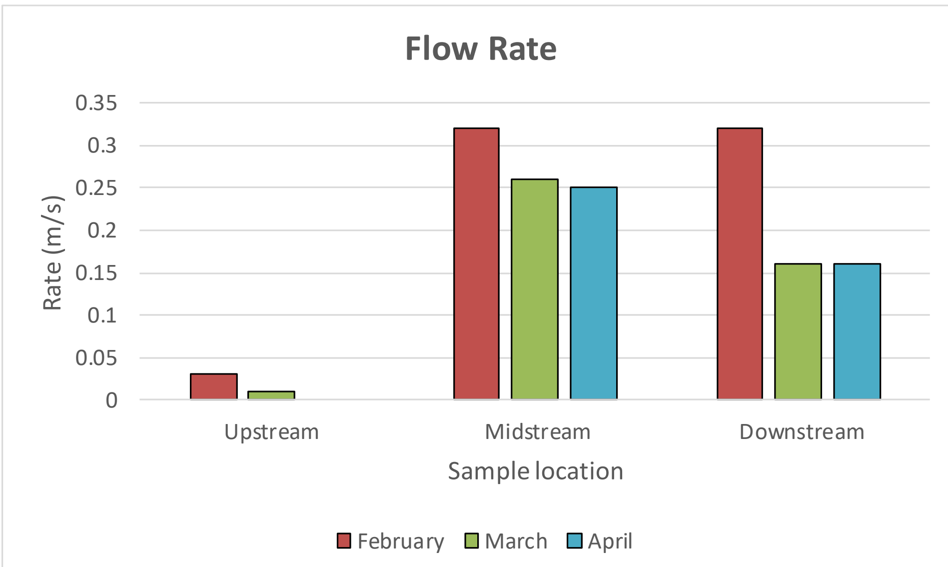

Figure 1.4: Water flow rate

Figure 1.4 shows the flow of the creek at all sample locations during the three-month period. Flow rates indicate how nutrients are transported throughout the stream; the higher the flow rate, the faster the nutrients travel. According to the data, upstream has the slowest flow rate, indicating that there is not much nutrient transport; this matches observations where the creek was either at a standstill or built up with microbial film. February also has the highest flow rate with all samples, but one possible explanation for this could be because that the samples were collected when the outside temperature was 63°F, causing a large input of water into the stream from excess snow melt.

❖ ***Water temperature***

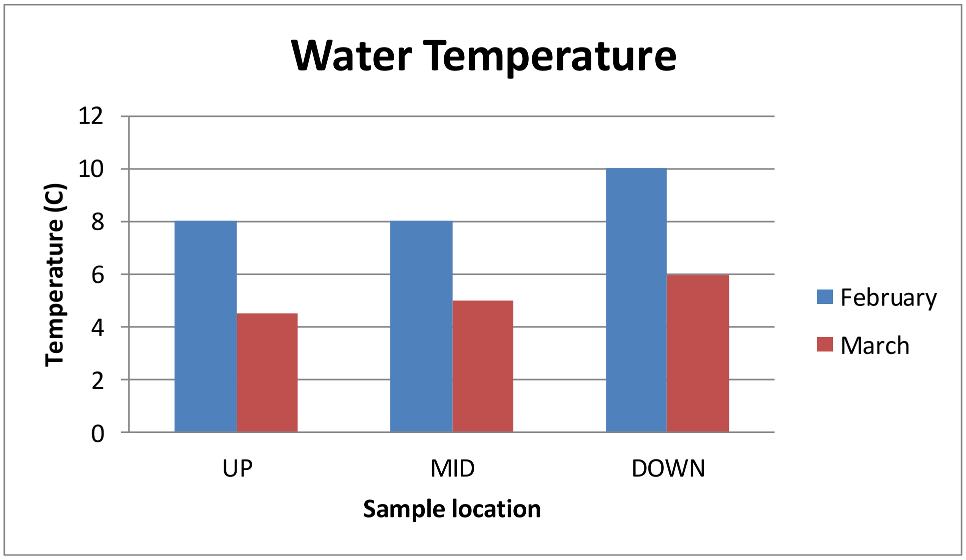

Figure 1.5: Water temperature

Figure 1.5 portrays the monthly temperature (in Celsius) at each location. April results are not shown due to a complication with the thermometer.

❖ ***Soil inside the creek (NPK)***

Soil inside Trotter's Creek									
	Nitrogen February	Nitrogen March	Nitrogen April	Phosphorus February	Phosphorus March	Phosphorus April	Potassium February	Potassium March	Potassium April
UPSTREAM	N/A	Trace	Trace	Trace	Medium	Low	Very low	Medium low	Medium
MIDSTREAM	Trace	Low	Low	Low	N/A	Low	Very high	Low	Medium
DOWNSTREAM	Trace	Trace	Trace	Trace	Low	Trace	Medium	Medium low	Medium low

Table 2.1: Soil nitrogen, phosphorus, and potassium results for inside the creek

Table 2.1 highlights the macronutrient concentration at all sample locations for the three-month time period. The nitrogen and phosphorus analysis indicates that there are low levels at all sample locations. This matches visual observations because no signs of eutrophication could be seen in the nearby water. At the upstream location the potassium intensity increases over time.

❖ ***Soil outside the creek nitrogen, phosphorus, and potassium (NPK)***

Soil outside Trotter's Creek									
	Nitrogen February	Nitrogen March	Nitrogen April	Phosphorus February	Phosphorus March	Phosphorus April	Potassium February	Potassium March	Potassium April
UPSTREAM	N/A	Trace	Trace	Trace	Medium	Trace	Medium low	Medium low	Medium
MIDSTREAM	Trace	Medium low	Trace	Trace	N/A	Trace	Medium low	Medium low	Medium high
DOWNSTREAM	N/A	Trace	Trace	Trace	Trace	Trace	Medium high	Medium high	Medium

Table 2.2: Soil nitrogen, phosphorus, and potassium results for outside the creek

Table 2.2 shows the macronutrient concentration at the sample locations for the three-month time period. Like the inside samples, the nitrogen and phosphorus analysis indicates low levels of these nutrients for the entire duration of the experiment, indicating little sign of eutrophication in the nearby water. However, the potassium concentration increases upstream and midstream throughout the months but decreases downstream.

Conclusions

Overall, the purpose of the experiment was to perform a qualitative assessment of macronutrients in Trotter's Creek during the winter season in order to understand how an urban community could affect both the physical and chemical aspects of an aquatic ecosystem. The water nitrate procedure concluded that the amount of nitrogen was consistent at all locations in March and April, but not February. Similarly, an inverse relationship between the February and March/April water pH levels was observed. While there seemed to be some sort of correlation between these two chemical procedures, the phosphorus data did not seem to have any correlations, but an anomaly was observed at the midstream location. The temperature and flow rate were highest in February, but a possible explanation is that the temperature was highest on this day and an unusual amount of snow melt was added to the creek.

For the most part the soil results were consistent between the samples taken inside and outside of the stream. The nitrogen and phosphorus concentrations were low at all locations for the entire time, but the potassium amounts differed. Generally, potassium increased upstream over time both inside and outside the creek yet decreases downstream.

After performing all the procedures, it is unclear how much urban pollution is affecting Trotter's Creek and the surrounding ecosystem. A salinity experiment was not performed so it is difficult to analyze how much the road salt affected the stream. Additionally, a biological assessment was not performed, so it is unclear if there any microalgae present for eutrophication. However, with observations and the results that are present, the upstream location at the Peerless Beverage Company seems to have the most impact on urban pollution.

To further expand this study, further research could include performing the same analysis for September, October, and November to see if there are any differences in physical and chemical results between spring and autumn. This project could also be expanded to study how these properties affect the biology of the stream by performing a macroinvertebrate or microbial analysis.

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