Biology

The Effects of Water Level and Rainfall on West Point Lake Water Quality

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Introduction

West Point Lake (WPL) borders Georgia and Alabama and is part of the Chattahoochee river basin. Like all the other lakes in Georgia, Lake West Point is a man-made lake instead of a naturally occurring one. In 1962, the Flood Control Act mandated that a part of the Chattahoochee River be dammed. The main reasons the dam was authorized was for "flood control, hydroelectric power, navigation, fish and wildlife development and general recreation" (USACE, 2016). According to the Chattahoochee River Keepers, the damming of the river created 525 miles of shoreline and the lake now has average depth of 12 feet deep. Since its creation, the lake has been maintained by the U.S. Corps of Engineers. The dam is able to control flooding by regulating the height of the lake per season. According to the Corps of Engineers, "the powerhouse's three generators produce enough power yearly to serve 24,000 homes" (USACE, 2016).

Since the lake was formerly a part of the Chattahoochee River, it receives all of its water from the Chattahoochee watershed. A watershed is an area surrounding a body of water that actually contributes water to the rivers and lakes. When it rains, all the nutrients from the surrounding areas get flushed into the watershed, eventually making its way into the river and lake. Activities that occur in the watershed can cause lakes to approach a more eutrophic state. A eutrophic state of a lake is detrimental for the health of a lake because it means an excess of nutrients, which reduces dissolved oxygen. The high nutrient levels can cause algal blooms, and then the algae dies and reduces the dissolved oxygen concentration in the lake. This results in a significant fish kill.

The position of the lake in context of its watershed is one of the biggest concerns about the health of lake West Point. West Point Lake is below one of the largest metropolitan complexes in Georgia—Atlanta. The lake gets all the materials that flow down the river from some of the watersheds that primarily drain large urban areas in Atlanta. The biggest threat to the health of the lake is the fact that Atlanta is also part of the watershed. This can be detrimental for the lake because all the waste and fertilizer that leaves Atlanta enters the watershed.

The health of West Point Lake does not only affect the biology and water quality in the lake but it also affects the humans in the surrounding areas and downstream. Many of the cities that surround West Point Lake filter its water and use it as drinking water. If the lake contains too many nutrients, the water cannot be turned into drinking water. West Point Lake is such a valuable source of water for surrounding areas that when a drought hit this region in 2007, a legal dispute broke out between Georgia and Alabama over the water in the lake. Both states rely on the lake for a source of water to give to its citizens. This caused there to be a dispute over which state would receive this highly coveted resource.

The U.S. Army Corp of Engineers (USACE) is taking action to try to ensure that water quality stays high in the lake. One of these actions is managing the forest along the shoreline. The trees act as a filter for many unwanted nutrients and toxins that are leached into the water. This action along with others by the U.S. Army Corp of Engineers (USACE) will greatly increase the water quality of West Point Lake. However, this still leads us to think, if the annual rainfall totals or the water levels of the lake will increase then the water quality of the lake will decrease.?

Methods

To determine the water quality of West Point Lake, nine water quality tests were taken. The first test administered while sampling on West Point Lake was temperature change. This test was taken at two different times, once at the beginning of trip and once at the end. To measure the temperature, a water thermometer on a string was used. The thermometer was held a meter under the surface for a minute. With the two temperatures taken, the difference between them was determined and used to find the Q-Value. The Q-Value allows a measurement to be evaluated on a 0-100 scale.

The next test performed was the pH test. This was done using the bromothymol blue pH kit and an Octa-Slide 2 viewer. First, a test tube was filled with a sample of the lake water collected at the surface. Eight drops of bromothymol blue indicator were then added. The tube was capped and mixed. Following this, the test tube was inserted into the Octa-Slide 2 viewer and the color of the test tube was matched to the colors on the side of the viewer. These colors correlated to specific pH levels and were used to determine the pH. The value that was read was used to find the Q-Value on the scale (LaMotte.com).

Following the pH determination, a dissolved oxygen test was performed. An empty water sampling bottle was opened and capped full of water while it was submerged completely in lake water. Eight drops of Manganese sulfate solution were added to the sample as well as 8 drops of alkaline potassium iodide acid. The sample bottle was capped and mixed together until the precipitate settled. Once settled, 1.0 g of sulfamic acid powder was added to the sample. The sample was capped and mixed until the reagent and precipitate dissolved. Once dissolved, a titration tube was filled with 20mL sodium thiosulfate and was continuously titrated until the sample color turned yellow. Finally, eight drops of a starch indicator were titrated until the solution became colorless. This result was read in parts per million (ppm) dissolved oxygen and used to find the Q-Value for this test (LaMotte.com).

After determining the dissolved oxygen, a nitrate test was performed. A test tube was filled with a 2.5mL sample of lake water. 2.5 ml of a mixed acid reagent was added. This was then capped and mixed. After a two minute waiting period, 0.1g of nitrate reducing reagent was added. This was capped and inverted 60 times in one minute. After waiting 10 minutes, the solution was mixed again and the cap was removed. The test tube was inserted into the low range comparator with the nitrate-N & Phosphate Comparator Bar. The sample color was matched to a color standard. This was recorded as ppm nitrate-N. To convert results to nitrate, we multiplied the reading by 4.4. This value was recorded as ppm nitrate and was also used to find the Q-Value (LaMotte.com).

To further test the level of nutrients, a phosphate test was performed. A test tube was filled with 10 mL of a sample of lake water. A 1.0 ml pipet was used to add 1.0 mL of phosphate acid reagent to the tube. This solution was capped and mixed. 0.1g of phosphate reducing reagent was then added to the tube. This solution was capped and mixed and was left to dissolve for 5 minutes. After this time period, the cap was removed, and the tube was placed into the low range comparator with the phosphate low range comparator bar. The sample color was matched to a color standard. This value was recorded as ppm orthophosphate and was used to find the Q-Value on the scale (LaMotte.com).

The next test conducted was the total dissolved solids. The conductivity of the water was determined in a sample using an Oakton WD-35462-35 EcoTest EC High Meter (Queensland, 2012). The number was calculated on the conductivity meter tool, which was in uS/cm measurement. This number was then multiplied by 0.67 to get the final result and then used to find the Q-Value on the scale.

The final test performed while on the lake was total suspended solids (TSS). This test was performed by using a secchi disk, which is used to measure turbidity. The disk was lowered into the water on a rope, which was marked with a marker by the meter. The disk was lowered until the white/black contrast was no longer visible. The number of meters deep was recorded and was used calculate the Q-Value.

While in the lab, the number of fecal coliform colonies in a sample was determined. Two capped off bottles of water with no air bubbles were sampled from the lake. 1ml of these samples and another sample of distilled water was put on a petrifilm dish. There were two replicates per treatment. After putting the water on the petrifilm, each were placed in the incubator for 24 hours. After 24 hours, the number of fecal coliform and E. coli was counted in in each of the samples. The number of colonies was divided by 100 ml to determine the Q-Value.

The final test performed in lab was a biochemical oxygen demand. A sample of water from the surface of the lake was placed in a BOD bottle. After 5 days, the amount of dissolved oxygen was determined. This amount was compared to the dissolved oxygen that was calculated out on the lake by subtracting the amount of DO before from the amount of DO after. This was used to find the Q-Value.

Finally, after calculating the Q-Value of each test, they were multiplied by the weighing factor each had. This yielded the adjusted values for each test. The sum of these values resulted in the total adjusted value. The total adjusted value was divided by the sum of the weighing factors. The final value was the water quality index.

Using the result of these tests, a comparative statistical analysis was used to determine if the differences in our water quality measurement were due to rainfall or lake levels that preceded our sampling measurements.

Results

Samples were taken once in February (2/25/2016) and twice in March (3/10/2016 and 3/17/2016) at three different locations at West Point Lake, Georgia. Following the procedures explained above, the q-values and water quality index for each of the samples was determined (Table 1).

	Boat Ramp	Boat Ramp Q-values	Water Intake	Water Intake Q-values	Bridge	Bridge Q-values
Temperature Change	0	91.5	0	93	2	88.5
ph	6.5	67.5	6.5	70	7	90
DO	9.4	87	8.8	95	8.325	100
Nitrates	4.4	85	4.4	85	4.8	98.5
Phosphates	0.1	99	0.4	80	0.1	97.5
TDS	46.9	85	93.8	85	53.6	87
TSS	0.3	60	0.7	74	0.95	76.5
Water Quality Index		80.85		83.195		92.545

Table 1

The water level and rainfall is determined, monitored, and published by the United States Geological Survey (USGS). The average water level two weeks prior to the sampling dates was calculated using the historical data recorded on their website (Figure 2). A statistical analysis was used in order to determine if these results were significant. The average rainfall two weeks prior to the sampling dates was calculated (Figure 3). A statistical analysis was used in order to determine if the results were significant. There was a significant difference between the water level of sample one and other samples (p=.05). There was not a significant difference between the samples based on rainfall.

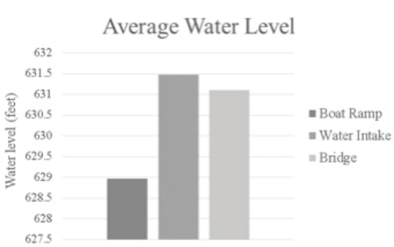

Figure 2

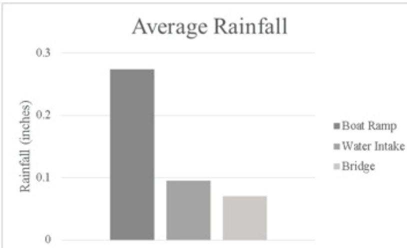

Figure 3

Discussion

Our investigations of the multiple water quality tests during the month of February yielded our lowest water quality index at 78.63. The other sampling of the water quality indices throughout the month of March showed much higher water qualities of 92.67 and 82.12. When looking at individual tests such as pH, we can see differences between samples taken during February and the samples during March. The Q-value of pH of the lake samples taken during the month of February was 65 while during the month of March it was at 90. The Q-value of total suspended solids during February was at a value of 60, while the Q-value during March was 76 and 77. From the rest of the results we can see that Q-values recorded in February are less than the Q-values recorded in March. The quality of water found in ponds, lakes, and streams can be affected by many different environmental factors. Rainfall can especially play a role in changing the quality of water in lakes, as it allows different contaminants or products from the ecosystem to be brought into watersheds. Such pollutants that can be brought into the body of water can be sediments, animal waste, fertilizers, and anthropogenic debris. However, our comparative statistical analysis did not show that rainfall was correlated to water quality. These results can lead to questions about the water level contributing to water quality. To further our study, additional longitudinal tests need to be conducted. An investigation of the regulation of water levels during high rainfall periods should also be conducted.

Works Cited

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