WATER TEMPERATURE VARIATIONS THROUGHOUT THE DAY ARE NOT CORRELATED WITH DISSOLVED OXYGEN IN BLIND BROOK

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ABSTRACT

Blind Brook is a brook that runs through Westchester County in Southeastern New York and runs into Long Island sound by the Marshland Conservancy in Rye, NY. The focus of this experiment was to determine if there are any correlations between dissolved oxygen (DO) and variation in water temperatures at different times of day in Blind Brook. There were two parts to this experiment, an in lab portion where we heated water from the various locations we tested at Blind Brook and a control group. The data collected from this experiment showed that there is an inverse correlation (In that as water temperature increases DO decreases) between water temperature in a controlled setting and DO. The second part of the experiment was an infield study in which we collected water temperature and dissolved oxygen at three different times throughout the day (9 a.m., 12 p.m., and 6 p.m.), and at three different locations along Blind Brook within the Purchase College campus. The data we collected did not suggest that there is any correlation between water temperature and dissolved oxygen. Although the pH was not tested every day, a pH meter was used on the last day of data collection and the data suggest that there a direct correlation between DO and pH (as pH increases DO increases), compared to water temperature and dissolved oxygen where no correlation is observed.

Keywords: Blind Brook, dissolved oxygen, Temperature, pH, Correlation

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INTRODUCTION

The effects of climate change on marine ecosystems are of great importance, as the earth is made of mostly water and play a key role in regulating temperatures which are most susceptible to changes in the environment. Carbonate chemistry, salinity, and temperature are some of the main stressors of interest regarding global climate change in marine environments. Studying the effects of these stressors on physiological processes can serve as a tool to resource managers and policymakers in making decisions addressing climate change (Somero et al. 2016). Temperature and dissolved oxygen (DO) are informative measurements in determining water quality. Studies regarding the effect of climate change on these two factors suggest that as climate change progresses temperature increases and dissolved oxygen decrease, which has profound effect on cool water fish which are pushed closer to lethal habitats (Shahram et al. 2017). DO is the amount of oxygen suspended in water and is determined by physiochemical factors especially temperature, pH, and salinity (Jack et al. 2009). Carbon dioxide (CO_2) the most notorious greenhouse gas also effects dissolved oxygen. Models that double the amount of CO_2 have shown that time of lake anoxia (the absence of oxygen) will be shortened decreasing fish winterkill but there is also projected lengthier summer anoxia (Fang and Stefan 2009). The effects of climate change is also seen in other aquatic ecosystem, increasing oxygen stratification in deep subtopic reservoirs (Zhang et al. 2014).

The alteration of DO by climate change has many projected impacts both worldwide and in local ecosystems (Missaghi et al. 2017). Dissolved oxygen plays a critical role in many aquatic ecosystems, having an effect on animal behavior such as predator/prey dynamics. Low oxygen levels cause prey species to spend more time closer to the surface causing an increase in predation. (Moore et al. 1998). Habitat selection for fish is heavily influenced by the relation of DO and temperature. Alterations to either has caused fish to settle in environments that were either too anoxic or too warm to breed or survive (Creaser 1930). In White Perch (*Morone Americana*) hypoxic environments reduce capacity for development growth and activity which decreases nursery production (Hanks and Secor 2010). Dissolved oxygen also has an effect on human impact, an example of that is the role it plays in the release and absorption of metals from storm sewer sediments (Jack et al. 2009) and runoff (Li et al. 2013) into aquatic environments.

The goal of this study is to determine how temperature and dissolved oxygen interact in Blind Brook throughout the day. Our hypothesis predicts a morning high for dissolved oxygen, a mid-day decrease as temperature rises and an increase in DO as temperature decreases in the evening. Therefore, we expect to see an inverse correlation between temperature and dissolved oxygen.

MATERIALS AND METHODS

Field Study. We chose three locations on Blind Brook to enable us to study Blind Brook as a general ecosystem. We also decided to choose locations within the boundaries of Purchase College because further down it becomes an estuary and salinity effects dissolved oxygen. We accounted for velocity by picking sites with similar velocity, averaging at 16.5 feet per minute. We determined the velocity of the sites by using a ping pong ball dropped into the water and measuring how far it traveled in 30 seconds. We chose 9:00 a.m., 12:00 p.m. and 6:00 p.m. as times to sample. This would allow us to see the trend in dissolved oxygen at different times of day and in turn water temperature variations.

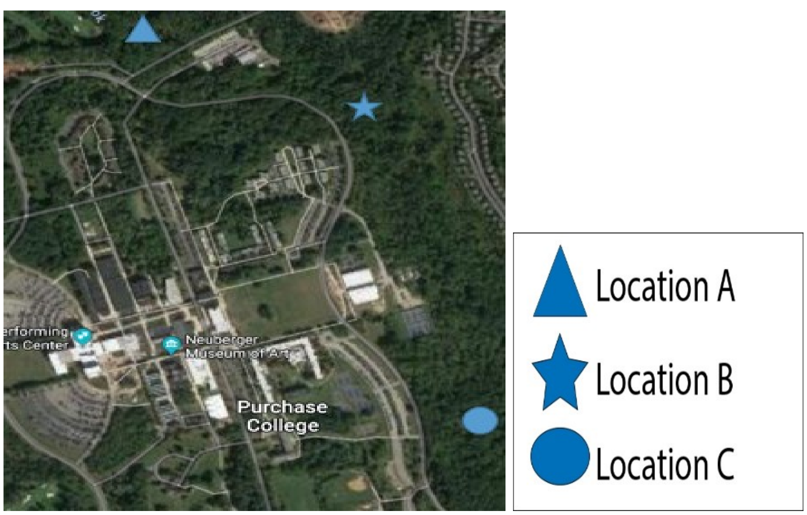

Figure 1: A map of the three locations; the triangle being Location A (located near the intersection of Lincoln Ave and East Rd), the star Location B (located near alumni village parking lot on East Rd), and the circle location C (located near the east 2 parking lot where the painted Rocks are found).

The two data sets that we collected are water temperature and DO. We did this by using the EX-Tech Model DO210, which is a DO meter that also records water temperature. When collecting the data at the different sites we first turned it on a couple of minutes before submerging it into the water this allowed the readings to stabilize. After the readings settled we submerged the probe in the water and stirred it, removing any air bubbles or surface layers from forming on the probe. We allowed the readings to level out and took down the readings. Sadly, we could not organize a pH meter for the duration of the experiment but we were able to organize one on the last day of data collection which was on 10/31/18. To collect the pH reading we used the Oakton WD-35634-30 pHTestr 30 Waterproof pH Test. The pH meter requires 2 points of calibrations to carry out the calibrations we used Oakton pH Calibration Buffer Pouches of pH 7 and 10. After calibrating the pH meter we then submerged the probe into the water and recorded the readings, after we allowed it a couple of minutes for the readings to level out.

Lab Experiment:

We tested the correlation between temperature and DO in lab. We did this by collecting 500ml samples of water from all three locations and used 500ml of tap water as the control group. We then gathered four 500ml beakers and labeled them Location A, B, C, and control. We placed the four beakers on a hot plate (not yet turned on) and poured in the samples of waters into the beakers accordingly. We then took thermometers and placed them in each beaker and powered on the hot plate. The base reading for the four samples was 17 (C°) and every 2 (C°) using the EX-Tech Model DO210 DO meter collected DO until we reached 31 (C°).

RESULTS

Our results show that there is no correlation between water temperature and dissolved oxygen at all three sites. Location A showed a max peak in the afternoon for water temperature 7/10 days, compared to dissolved oxygen showed a max peak at mid-day for 8/10 days (Figure 2). Location B showed a max peak in the afternoon for water temperature 6/10 days, compared to dissolved oxygen which showed a max peak at mid-day 8/10 days (Figure 3). Location C showed a max peak in the afternoon for water temperature 6/10 days, compared to dissolved oxygen in which showed a max peak at mid-day 6/10 days (Figure 4). The results collected on the same day, indicate that there is a correlation between dissolved oxygen and pH with both showing max peaks at mid-day for all 3 locations. This compares to only 1 max peak in the afternoon for location A with temperature and DO (Figure 5, 6, and 7). However the lab data suggests that there is a correlation dissolved oxygen and temperature when the two factors are isolated (Figure 8).

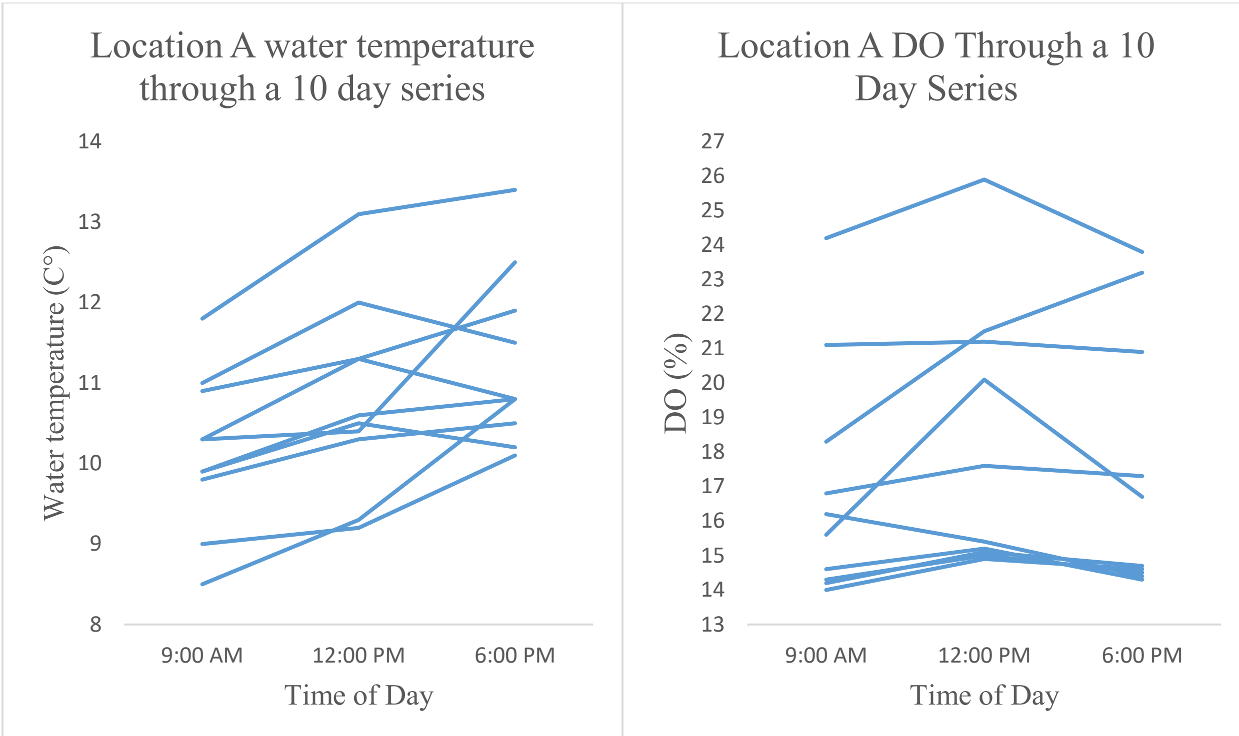

Figure 2: Illustrates water temperature at location A through a 10-day data series and DO at location A through a 10-day series with each line on the graph being a different day.

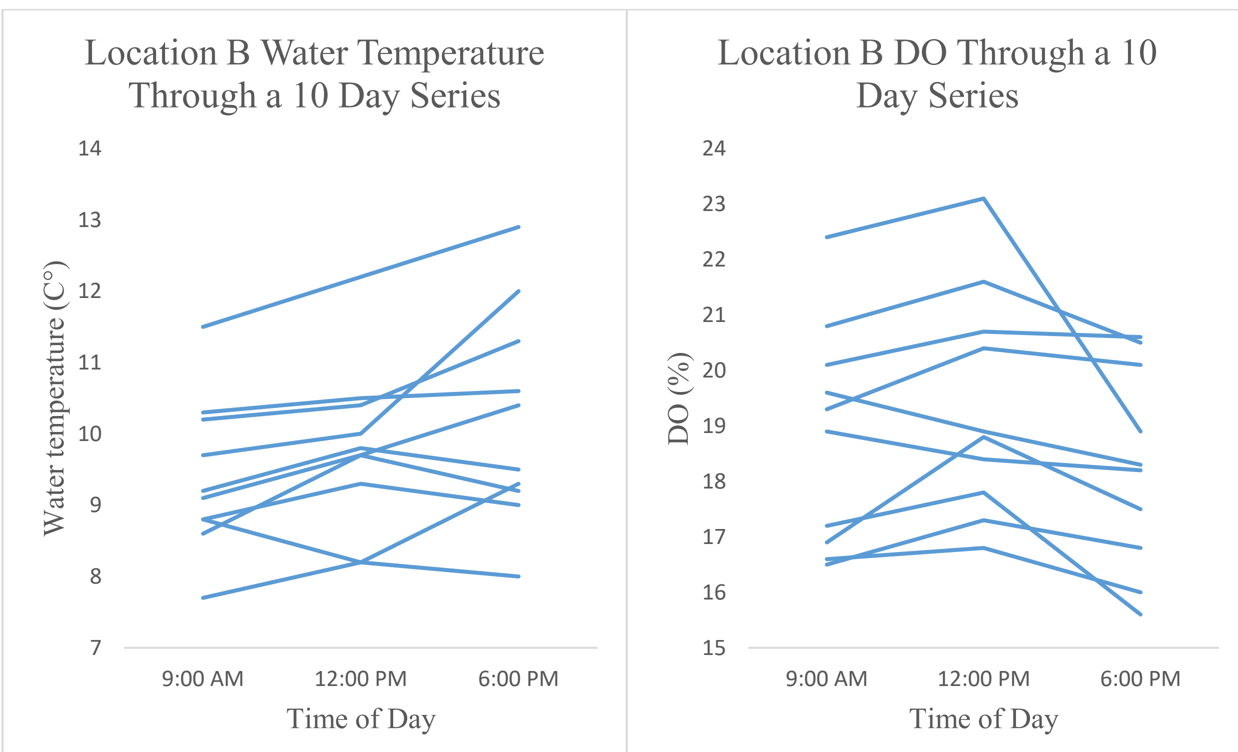

Figure 3: Illustrates water temperature and DO at location B through a 10-day data series and DO at location B through a 10-day series each line on the graph being a different day.

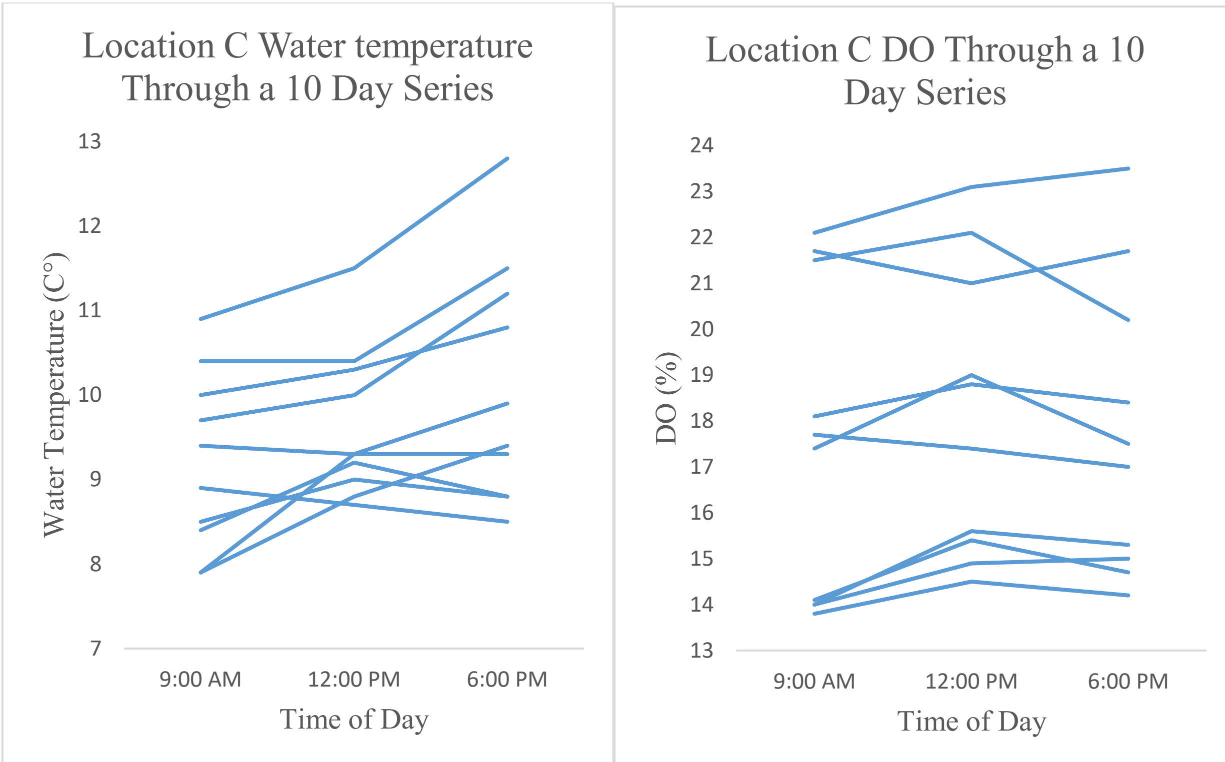

Figure 4: Illustrates water temperature at location C through a 10-day data series and dissolved oxygen at location C through a 10-day series with each line on the graph being a different day.

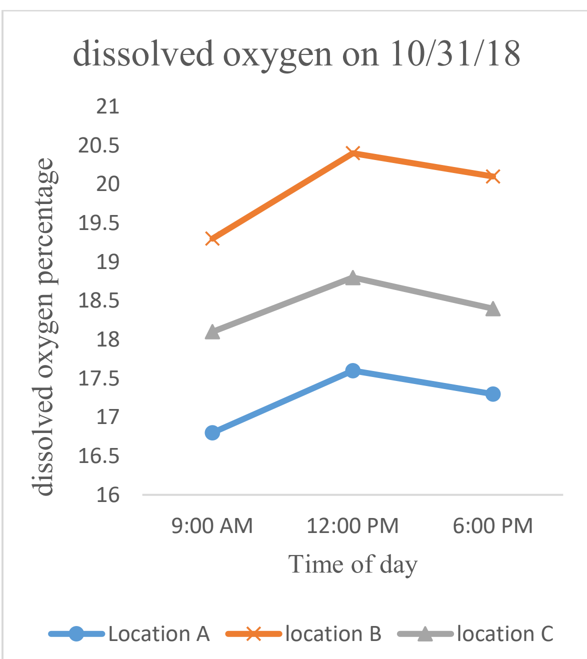

Figure 5: Graph showing the DO at location A (bottom plot), location B (top plot), and location C (middle plot)

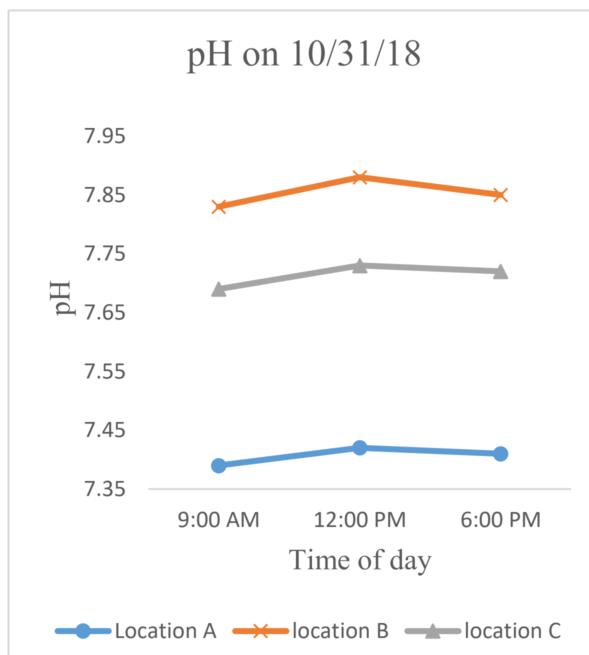

Figure 6: Graph showing the pH at location A (bottom plot), location B (top plot), and location C (middle plot)

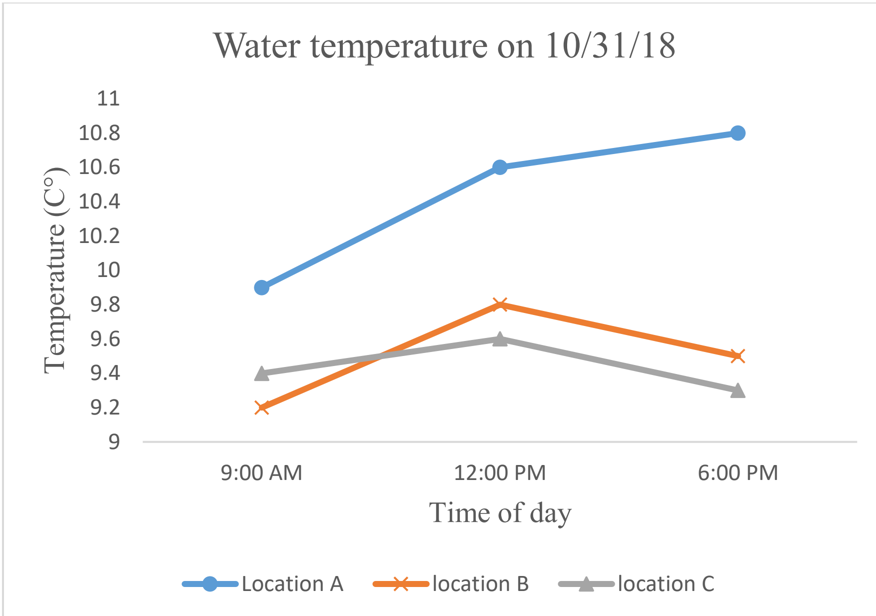

Figure 7: Graph showing the water temp at location A (Top plot), location B (Middle plot), and location C (Bottom plot). Only data for October 31st is present due to the lack of access to a pH meter

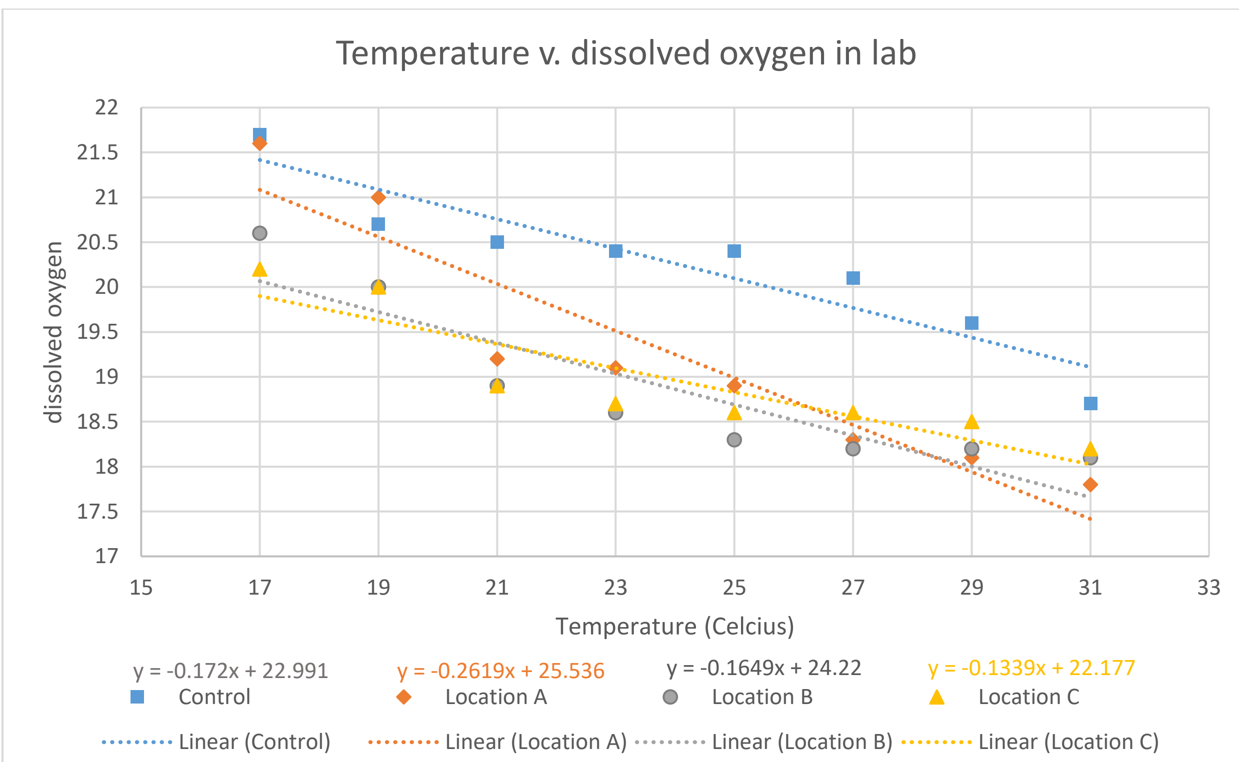

Figure 8: Graph showing the relationship between dissolved oxygen and Water temperatures in a laboratory setting each plot illustrating the different locations and the control

DISCUSSION

Water temperature and DO discussion. Although we predicted that DO would be the lowest at mid-day when the temperature was the highest, we actually found that in all 3 locations the majority of the data series collected showed that the DO was the highest at mid-day, despite water temperature not being the highest at mid-day in all 3 locations like we predicted. The majority of the data series for water temperature showed that it was the highest in the afternoon suggesting that there is no correlation between water temperatures and DO (Figures 2-4). This is despite a strong inverse correlation between water temperature and DO in a lab setting (Figure 8)

Correlation between DO, pH, and water temperature discussion. Due to limited access to the pH meter we were only able to sample pH one day. We would have preferred to use it for every data series collected because pH is a physiochemical factor that affects DO (Joel et al. 2009). The data collected on 10/31 suggest that there is a correlation between pH and DO all three locations showing a max peak at mid-day for both pH and DO. The order of which the three locations are organized is also the same with location B being the highest and location A being the lowest with no data series intersecting one another (Figures 5 and 6). The data regarding the same day for water temperature and dissolved oxygen suggests that there is no correlation with DO, max peak for all three locations being at mid-day and one of three locations showing a max peak in the afternoon while two of three showing a mid-day peak. Whereas for water temperature location A is the highest and the data series for location B and C intersect (Figures 5 and 7). Contrary, to correlation that is seen between pH and DO for that specific day with having the same order and no intersecting data series.

Sources of error. A possible source of error for this study could be that we didn't take into consideration tree cover in the locations we sampled. Studies have shown that an increase in tree cover leads to an increase in stream health (Gotez et al. 2003) and that shade from tree cover has a greater effect on the gross primary production and ecosystem respiration in a stream than agricultural intensity (Burrell et al. 2014). Tree cover could affect the water temperature and in response the DO, specifically in location A where there was less tree cover and had the least amount of DO compared to the other two locations being an indicator for an unhealthy marine ecosystem (Shahram et al. 2017). Our results could also have been influenced by the fact that we only sampled pH on the last day of sampling. Considering this experiment was carried out during the fall season the falling foliage and decomposition of the organic matter could be an influence in pH, therefor influencing DO. This is similar to what is seen after algae blooms begin to die being detrimental to aquatic species due to a decrease in DO and a decrease in pH.

Improvements for future studies. The accuracy of this study could be greatly improved by the sampling of pH values over the course of the sampling period, an option that was not available to us due to technical limitations. Rainfall events and changes in stream velocity could also be incorporated into the study in order to increase the validity of the data. Tree cover and the rate of photosynthesis of aquatic plants present in the brook could have also been tested for which might explain why DO is the greatest for the majority of the days sampled at mid-day as the sun's rays became strong it provides aquatic plants with the light needed to carry out photosynthesis. The interaction between pH and photosynthetic activity warrants further study due to photosynthesis effect on increasing dissolved oxygen in marine environments.

CONCLUSION

Our findings show that there is no correlation between water temperature and DO in Blind Brook in contrast to the results from the in lab study. Our results also show that there is a possible correlation between pH and DO, however further experimentation should be done. Considering Blind Brook is surrounded by human development such as golf courses, airports, and other industrial complex further research should be done in order to protect this important aquatic ecosystem. The well-being of this ecosystem can have profound effects on the distribution and abundance of fish, amphibian, invertebrate, and plant species who call Blind Brook their home.

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