# CORRELATIONS BETWEEN MICROCYSTIN TOXIN AND ENVIRONMENTAL VARIABLES IN THE TENNESSEE STATE UNIVERSITY WETLAND

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## ABSTRACT

Cyanobacteria capable of producing dangerous microcystin toxins flourish in the Tennessee State University wetland, Nashville, Tennessee. The objective of this research was to measure and evaluate trends and correlation in microcystin and water chemistry in the wetland. Multiple samples were collected from the wetland between June 2017 through January 2020 and analyzed for nitrogen, phosphorous, iron, sulfur, turbidity, and microcystin. Microcystin concentrations ranged from less than 0.15 to 25.1 µg/L. Conditional correlations were estimated with a multivariate linear probability model in Stata software using the environmental variables and microcystin concentrations to determine which variables best predicted elevated microcystin levels that exceed the health advisory standard of 0.3 µg/L set by the Environmental Protection Agency, which occurs in 0.18 of the sample. The environmental variables that predicted exceeding this microcystin threshold were: turbidity, with an increase in probability of 0.002 for each NTU increase in turbidity (significant at 1%); total phosphate, with an increase in probability of 0.045 for each additional milligram per liter of phosphate (significant at 1%); and the nitrate-to-phosphate ratio, with a decrease in probability of 0.0087 for each increase of 1 in the ratio (significant at 10%).

# Correlations between microcystin toxin and environmental variables in the Tennessee State University wetland

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## Background

Harmful Algal Blooms are rapid algae growth in a body of water. Harmful algal blooms can occur among different types of phytoplankton. Certain types of blooms can release toxins call cyanotoxins. Even without the presence of toxins they pose risks to the health of ecosystems. HABs pose public healthy and safety concerns. The cyanotoxins have been found in shellfish and fish used for human consumption. HABs have become increasingly common. So, natural resource managers have developed and are developing more efficient ways to track and prevent blooms. At TSU we hope to monitor and predict when HAB will be most abundant on our wetland using environmental variables.

## Methods

Water samples were collected from 4 locations displayed on the wetland map. Upper wetland, mid-wetland, bull pond, and below wetland. Environmental factors (Table 1) and microcystin toxin levels were measured from 2017-2020.


Figure 1. Shown above is a diagram explaining the hydrology of the TSU wetland. With arrows showing water flow.

| Parameter | Method |
|---|---|
| Temperature, C | Field meter, USGS field manual |
| Specific conductance, uS/c, | Field meter, USGS field manual |
| pH | Field meter, USGS field manual |
| Dissolved oxygen, mgL | Field meter, USGS field manual |
| Secchi depth (turbidity) | Secchi tube, US EPA, 2013 |
| Chlorophyll a & Phycocyanin | Field meter, USGS field manual |
| Nutrients, NO3, PO4, Fe | Spectrophotometer, US EPA |
| Microcystin toxin | ELISA, US EPA method |

## Acknowledgements

I would like to thank Rodney Blackwell for contributing to this project, TSU College of Ag for financial support, and TN AWRA for allowing me to present today.

## Results

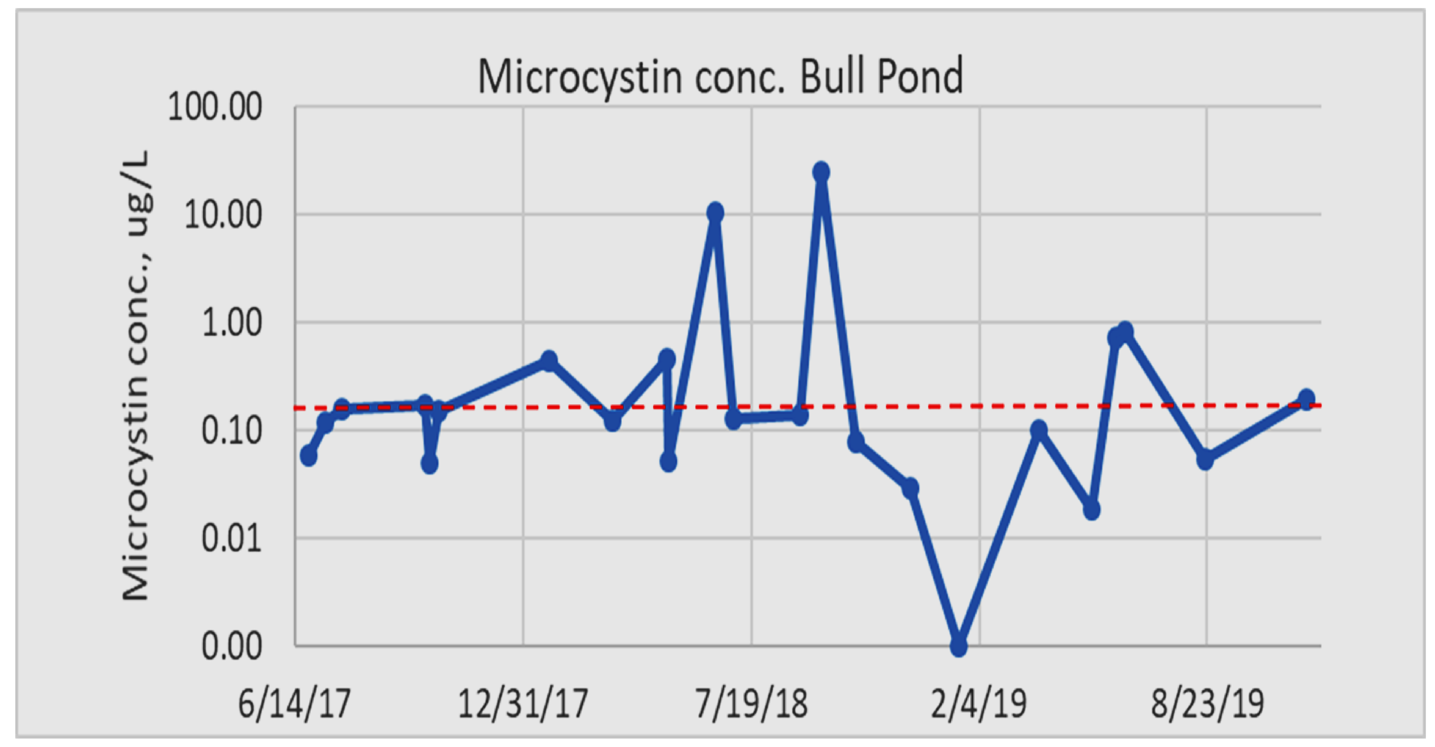


Figure 2. Microcystin levels spike in the warmer months of the year. Drastic decrease in microcystin levels in February 2019.

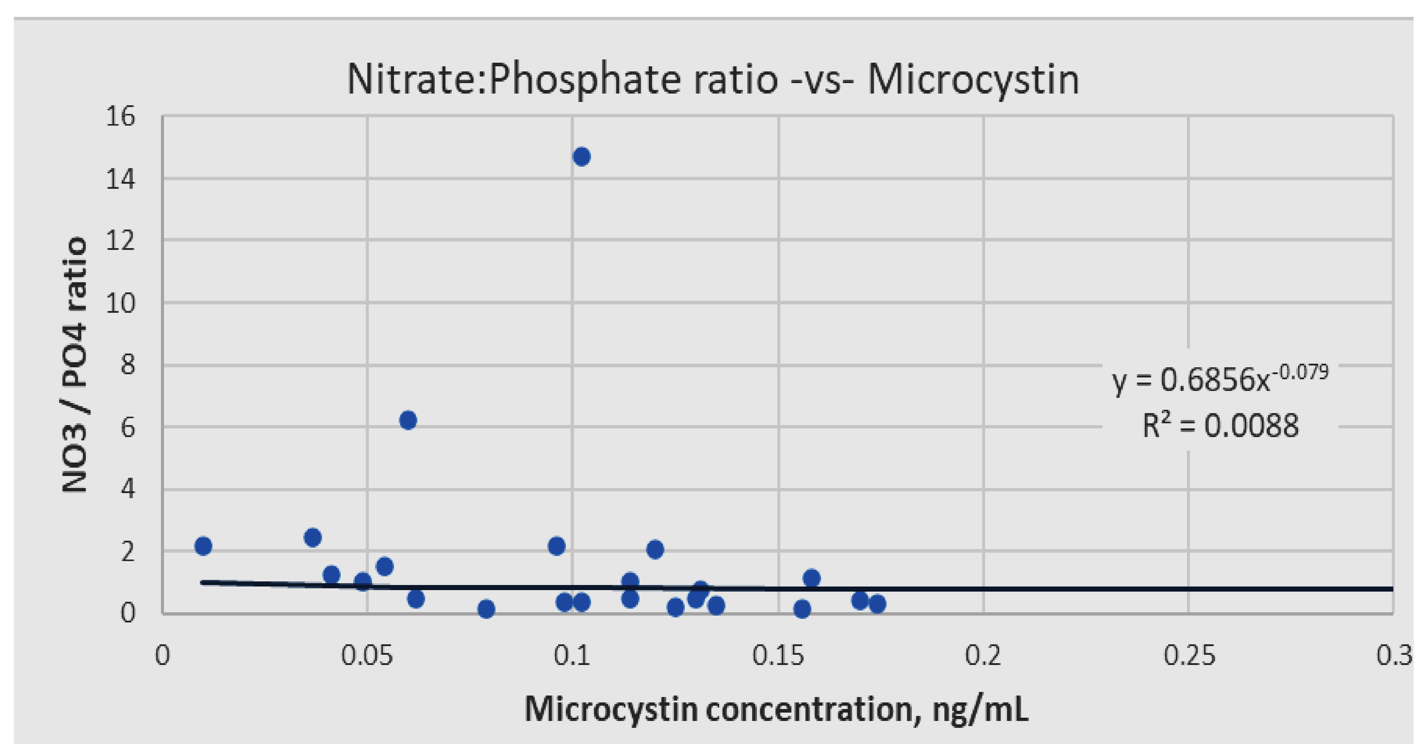


Figure 3. Nitrates and Phosphates did not show a strong correlation with microcystin conc.

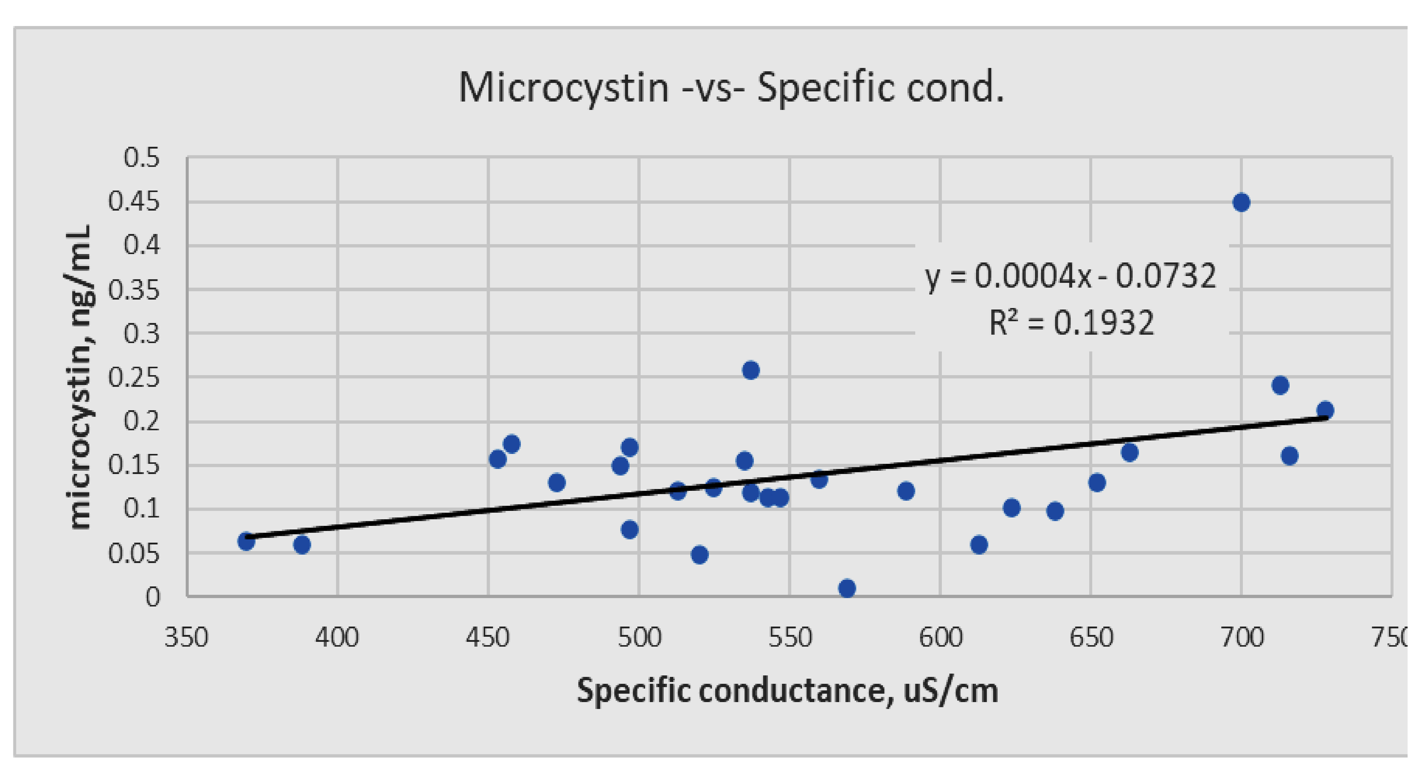


Figure 4. Microcystin conc. had a weak correlation with specific conductance.

Figure 5. Gathering field measurements and sampling the upper wetland.

## Discussion

Simple regressions were not successful in showing a significant connection between parameters and microcystin concentrations. Multivariate analysis were useful in understanding correlations between probability of high microcystin levels and environmental factors. Conditional correlations were estimated with a multivariate linear probability model in Stata software using the environmental variables and microcystin concentrations to determine which variables best predicted microcystin levels greater than 0.3 µg/L (EPA's advisory limit), which occurs in 18% of the samples.

The environmental variables that predicted microcystin >0.3 ug/L were: turbidity, with an increase in probability of 0.002 for each NTU increase in turbidity (significant at 1%); total phosphate, with an increase in probability of 0.045 for each additional milligram per liter of phosphate (significant at 1%); and the nitrate-to-phosphate ratio, with a decrease in probability of 0.0087 for each increase of 1 in the ratio (significant at 10%).

## Conclusion

The bull pond has the highest & most frequent excessive amount of microcystin. This can be attributed to the presence of livestock that supplies excess nutrients to the area. Simple correlations did not identify parameters that could predict toxins. Multivariate stats found turbidity, phosphate and N:P ratio could predict when microcystin exceeded 0.3 ug/L. Future research aims to continue collecting data to strengthen trends and apply this statistical model in other wetlands.