The Effects of Phosphorus and Nitrogen on Microcystin Production in Lake Erie

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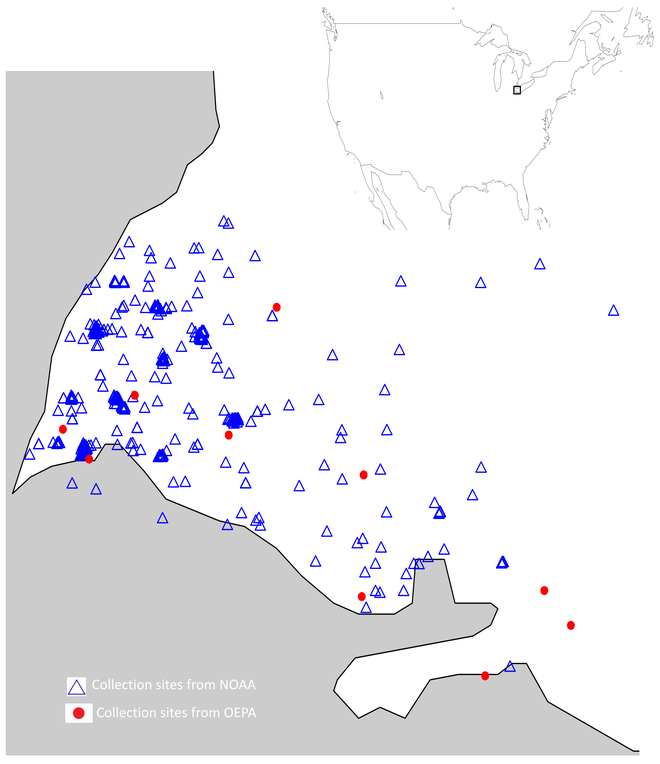
Introduction:

- The Laurentian Great Lakes provide fresh water for over 26 million people in the United States, making lake eutrophication a major concern regarding water quality
- Common sign of eutrophication is the reoccurrence of harmful algal blooms (HABs)
- These HABs produce microcystin, which is harmful to humans and animals if consumed
- Various studies have been conducted and has considered phosphorus to be the main culprit of lake eutrophication
- Nitrogen is also important in some areas, but needs further exploration
- This study reviews existing research and conducts exploratory data analyses on microcystin monitoring data from the Ohio Environmental Protection Agency (OEPA) and the National Oceanic Atmospheric Administration (NOAA)

Methods:

- Online literature search and review of the most up to date information for the role of microcystin in HAB development, focusing primarily on how nitrogen and phosphorus loadings into Lake Erie affect the cyanobacteria and microcystin levels
- Initial data analysis using the open source program R to plot the relationships
- Exploratory data analysis using R
    - Various summary plots
    - Tree Model developed based on summary plots in order to better predict microcystin levels in the future



Map 1: Locations of water samples in Western Lake Erie

Exploratory Data Analysis:

- Method used to investigate data
- Similar to a "detective" using clues to uncover what "story" the data is trying to tell
- Highly graphical method with virtually no rules
- Used to better understand large sets of data by looking for patterns in plots and charts rather than long lists of numbers

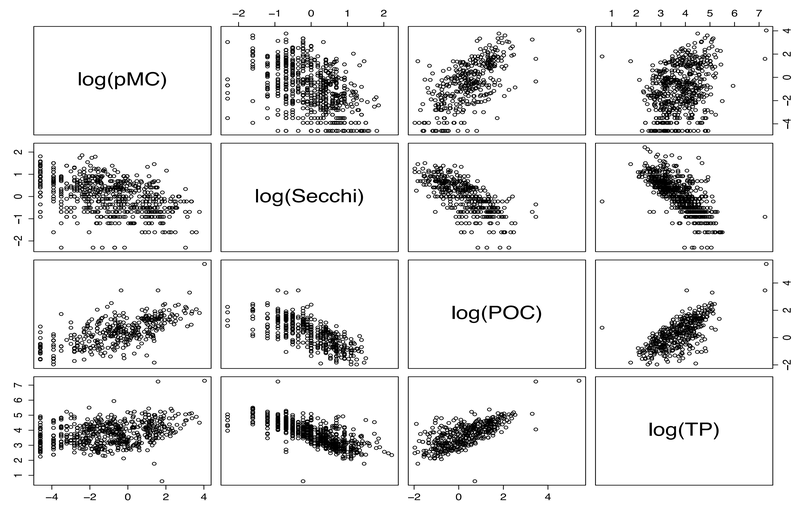


Figure 1: Pairwise scatterplot matrix showing how microcystin levels are related to different variables.

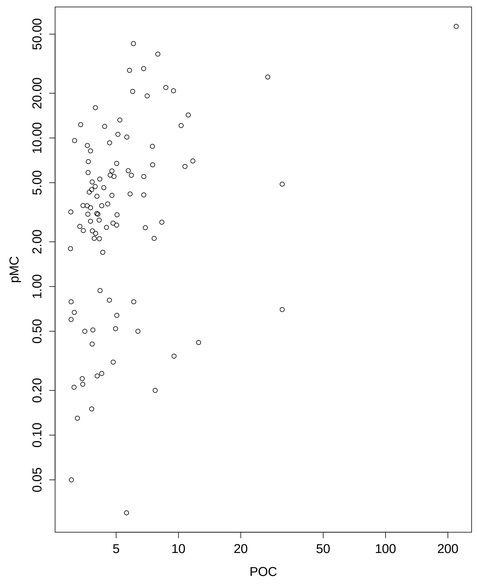


Figure 2: Scatterplot showing pMC concentrations versus POC levels greater than three

Results:

Figure 1:

- As the log of the Secchi depth levels increase, both the log of particulate organic carbon (POC) levels and the log of the total phosphorus (TP) levels decrease
- Particulate microcystin (pMC) concentrations show no direct correlation to the Secchi depth levels
- As the log(POC) levels increase, both the log(pMC) concentrations and the log(TP) levels increase

Figure 2:

- As the POC levels greater than three increase, the concentrations of pMC increase as well

Figure 3:

- The regression tree model shows that when the POC is high (above 5) the effect of NH4 becomes prominent
- If the POC level is less than 5.075, the estimations for the levels of microcystin are vastly different

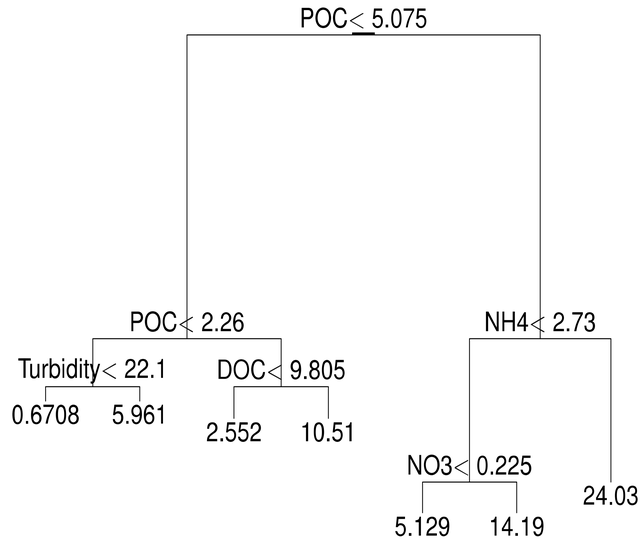


Figure 3: Microcystin Tree Model

Conclusion:

- Phytoplankton, measured as particulate organic carbon (POC), largely controlled by phosphorus levels (Xu et. al., 2010), is necessary to support high microcystin levels in Lake Erie
- Phosphorus is the main factor affecting the levels of particulate organic carbon (POC) (Pond or lake water chemistry…c2015)
- When phytoplankton is high, ammonium (NH4) appears to become the trigger for microcystin production
- Both Phosphorus and Nitrogen play critical roles in the growth and development of harmful algal blooms
- Reducing phosphorus loading in the spring can effectively reduce the growth of phytoplankton (Chaffin et. al., 2013)
- Reducing nitrogen (NH4 in particular) in late summer should be tested as a means of controlling microcystin toxin production
- It is necessary to consider both factors when attempting to predict future microcystin concentration levels
- Further research is still necessary to discover how exactly the NH4 triggers the production of microcystin

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