The Effects of Meteorological Variables and Algal Bloom Occurrence in the Missisquoi Bay Region

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Introduction

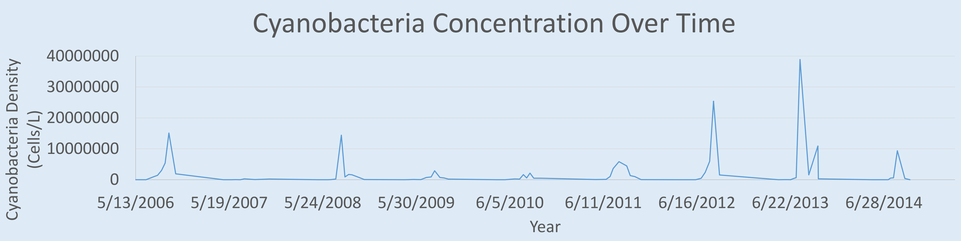
Toxic blue green algal blooms are a continuing problem in the Lake Champlain ecosystem. Many variables affect these cyanobacterial blooms such as phosphorus and nitrogen loading, temperature, rainfall, and wind strength [*Stager,* 2010]. Changes in the pattern and strength of precipitation will become more evident in a warming climate [*Stager,* 2010]. It is predicted that the intensity and strength of rainfall will increase in the future with more snow falling as rain during the winter months, which may lead to the proliferation of cyanobacteria due to the direct nutrient input into the lake. However, if a rain event is particularly intense, blooms will decrease due to flushing and de-stratification of the lake [*Reichwaldt and Ghadouani*, 2012]. It is also predicted that in a warmer climate, the frequency of drought may increase between rain events leading to higher temperatures, and longer periods of stratification which are both conducive for further cyanobacteria growth [*Reichwaldt and Ghadouani*, 2012].
The primary objective of this project is to find relationships between past meteorological data such as precipitation, temperature and wind speed, and the algal blooms that occurred, specifically in the Missisquoi bay area where blooms are found every year due to eutrophication.

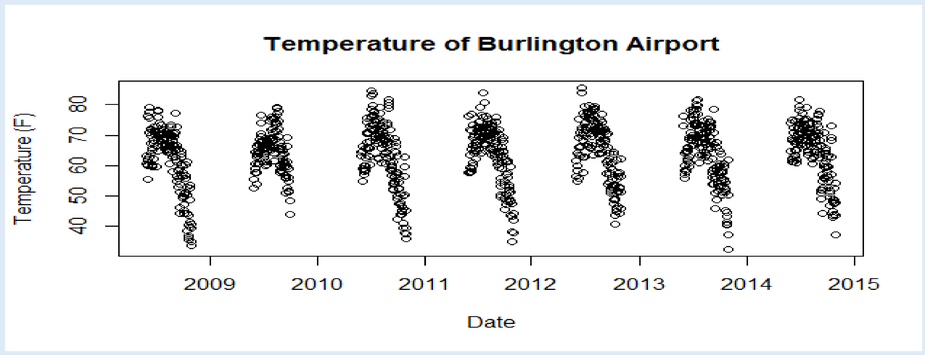
Methods

Hourly weather data from the Burlington Airport was taken from the Weather Underground website. Cyanobacteria and Chlorophyll-A values were from the Lake Champlain Monitoring Project.

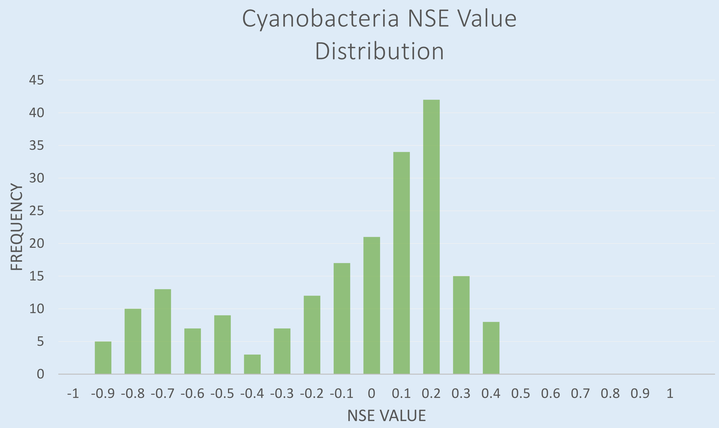
The meteorological variables that were considered are temperature, humidity, precipitation, storm intensity, pressure, wind speed, wind direction, temperature range and gust speed.

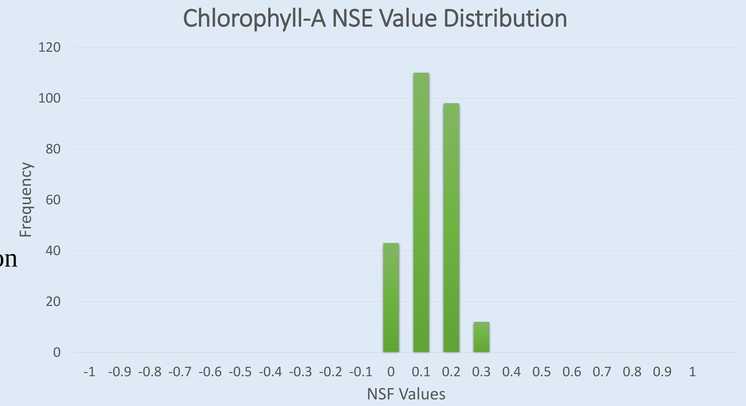
The cyanobacteria and chlorophyll-a data sets were analyzed through the statistical LOESS model. LOESS allows up to 4 variables to be related to the dependent value. Every combination of variables was ran for a total of 1122 trials. The Nash-Sutcliffe efficiency value was calculated for each run to determine how well the selected variables explain algae blooms.

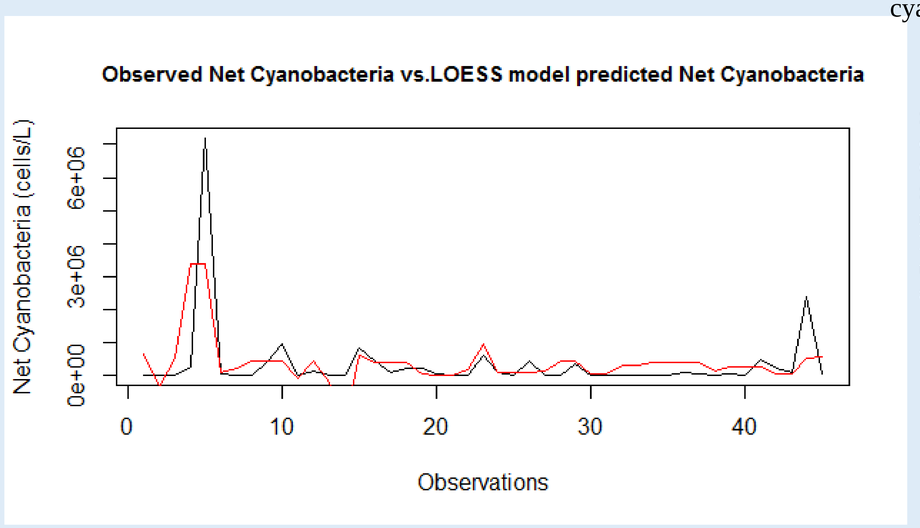




Results







The black line indicates actual cyanobacteria observations while the red line represents the best predicted fit out of all the variables.

Discussion/Conclusion

- The range of NSE values for the cyanobacteria data set was -28097.89 to 0.397903.
- The average NSE value for cyanobacteria was -104.0527.
- The range of NSE values for the chlorophyll-a data set was -258.067 to 0.27088.
- The average NSE value for chlorophyll-a was -2.45.
- The histograms of NSE values only consist of those values that range from -1 to 1 due to the fact that the positive values are of more importance because they indicate a relationship between the weather variables and the blooms.
- 203 out of 561 values for the cyanobacteria data fell in between the -1 to 1 range.
- 263 out of 561 values for the chlorophyll-a data fell in between the -1 to 1 range.
- The cyanobacteria NSE histogram has a wider spread than the chlorophyll-a graph.
- Both data sets exhibit weak relationships between weather variables and bloom density.
- The highest NSE value was 0.397903 and occurred in the cyanobacteria data set when stream discharge, gust speed, and duration of rain were the weather variables.
- The highest NSE values for the cyanobacteria dataset all contained either temperature range, duration, stream discharge, or temperature which indicates that these variables influence bloom growth.
- Similarly, the highest NSE values for the chlorophyll-a dataset all contained temperature.
- It can be concluded that there is no strong significant relationship between meteorological variables and bloom intensity. However, temperature, duration of rain events and stream discharge all seem to exhibit a relationship between cyanobacteria bloom.

Literature Cited:

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Stager, T. (2010) Climate change in the Champlain Basin: What natural resource managers can expect and do.
Reichwaldt, E.S. and Ghadouani, A. (2012) Effects of rainfall patterns on toxic cyanobacterial blooms in a changing climate: Between simplistic scenarios and complex dynamics. Water Research 46(5), 1372-1393.

Acknowledgements

Thank you to my mentor Dr. Ibrahim Mohammed as well as the entire faculty involved with the EPSCoR program. Funding provided by NSF EPS Grant #1101317