Using High Frequency Monitoring of Environmental Factors to Predict Microcystin Concentrations in a Multi-use, Inland Reservoir

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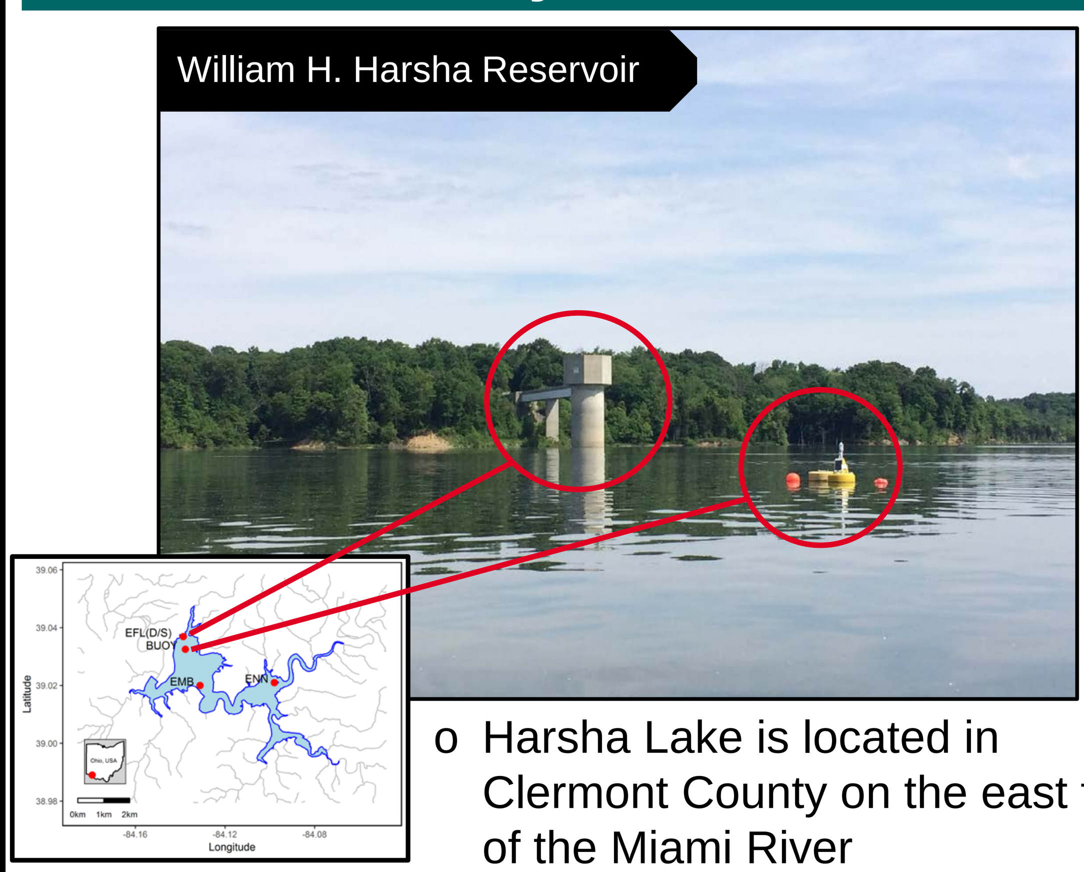
Introduction

- Cyanobacteria are photosynthetic bacteria occurring naturally in freshwater environments.
- Increased temperatures, rising levels of CO_2, and an increase in unpredictable, intense rainfall events, are causing cyanobacteria to expand.
- Eutrophication of inland reservoirs has also resulted in the rapid growth of cyanobacteria.
- The proliferation of cyanobacteria results in harmful algal blooms, also known as HABs or cyanoHABs.
- A serious issue associated with these HABs are the release of cyanotoxins such as microcystin
- Microcystin (MC), the most common hepatotoxin, affects the liver
- EPA has the following advisory levels for microcystin:
  - Drinking water at or below 0.3 µg/L for children younger than 6
  - Drinking water at or below 1.6 µg/L for school age children and adults
  - Ambient water at or below 4.0 µg/L for contact

Objective

The objective of this project is to investigate relationships between water quality parameters and microcystin concentrations in a multiple-use reservoir with a history of cyanoHABs. Significant correlations will aid in future predictive modeling of these potentially toxic algal blooms. Specifically, time lag correlations will be investigated in order to aid in management decisions.

Study Location



- Harsha Lake is located in Clermont County on the east fork of the Miami River
- It is a 342 mile^2, multi-use reservoir; used for flood reduction, recreation, and a drinking water source.
- History of diverse cyanobacteria taxa present
- Water quality data in 3 week intervals since 2012.
- High frequency data at EFLS and EFLD and the buoy.
- Surface samples were collected at EFLS and buoy.
- Depth samples were collected at EFLD.
- Discrete sampling was also conducted at ENN and EMB locations, shown on map
- Buoy location the focus on analysis presented.

Sampling and Analysis

SAMPLING

High Frequency Collection
- Water Quality Parameters
- Rainfall

High Frequency samples collected every 10 minutes during the sample season, April through September.

Discrete Collection
- QPCR & RT-QPCR
- Microcystin
- Nitrogen & Phosphorus

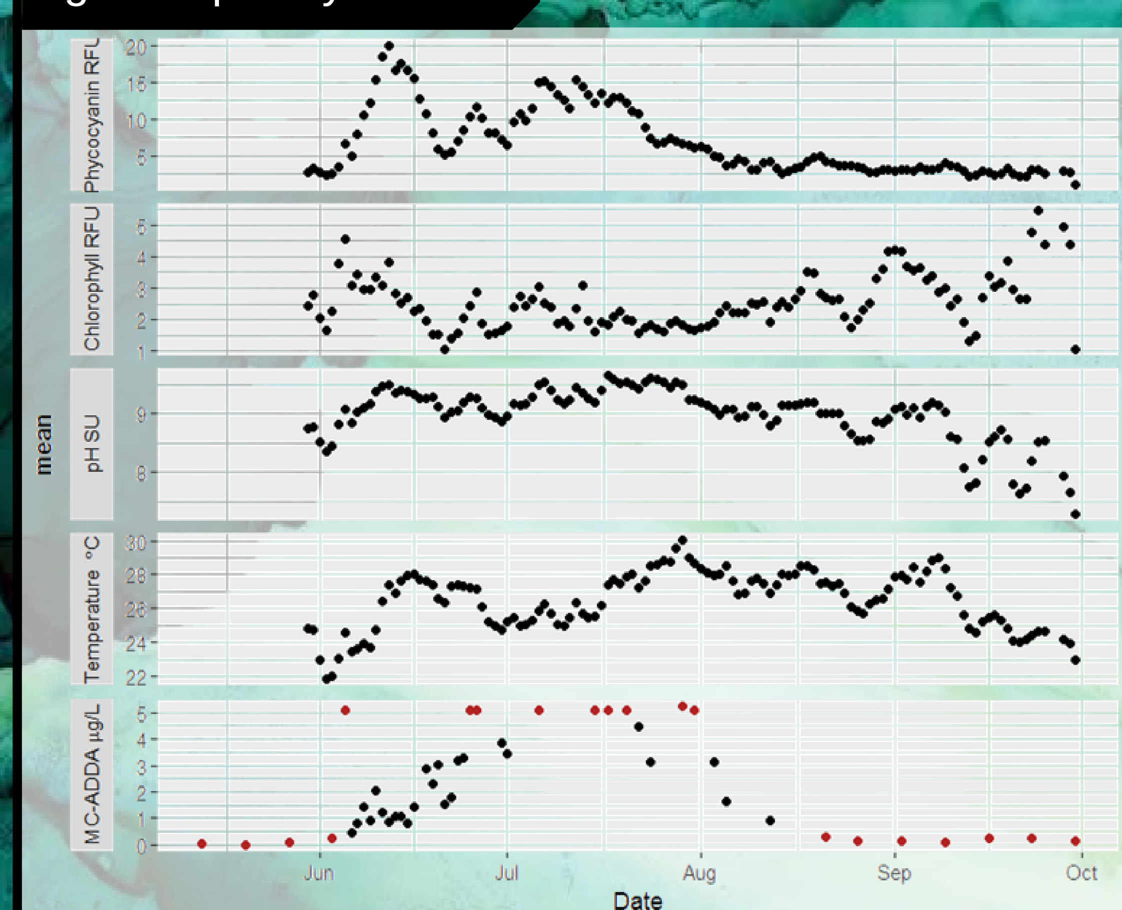
Discrete samples were collected biweekly or weekly prior to a bloom, and then daily or every other day during a bloom event.

ANALYSIS

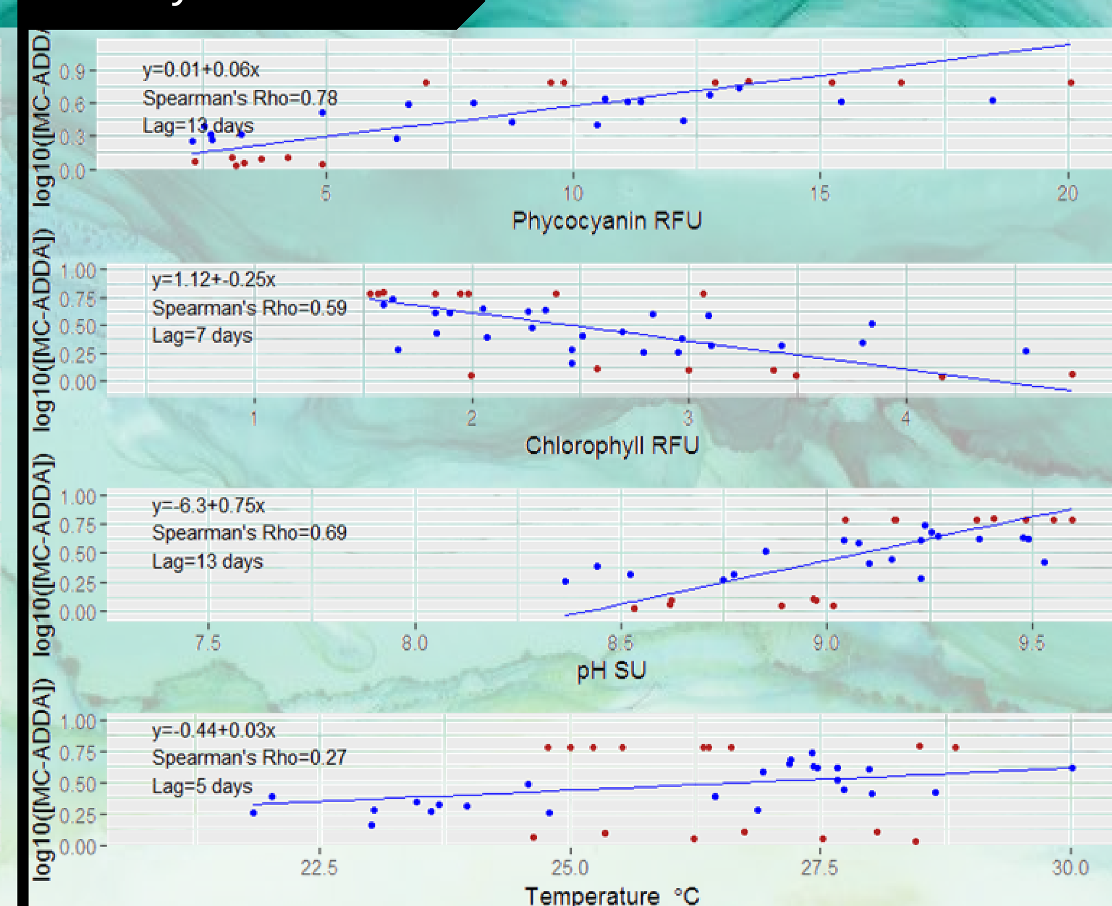
Microcystin	Nitrogen & Phosphorus	Water Quality	Rainfall	MC Gene	Time Series & Pearson's
ELISA	Latchat	YSI Sonde	Weather Station	QPCR RT-QPCR	R

Results

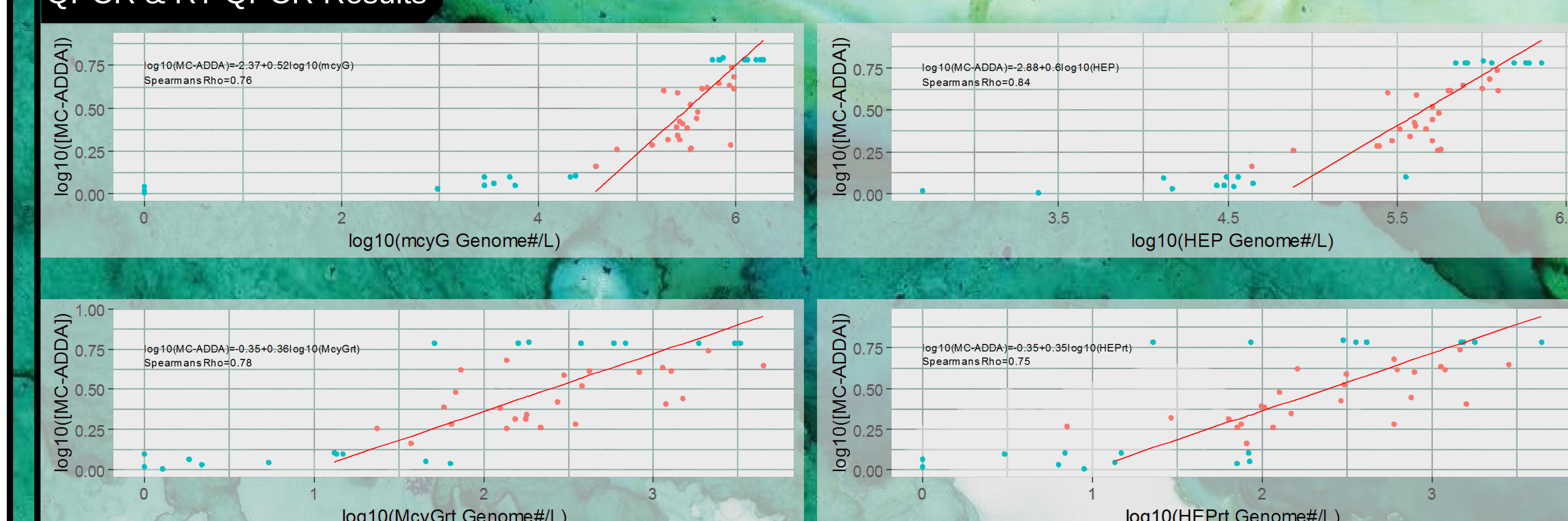
High Frequency Results



Microcystin Results



QPCR & RT-QPCR Results



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Statistical Analysis

- High frequency data filtered using a 24-hour moving average.
- Concurrent QPCR data correlations were not lagged
- Tobit analysis
  - Censored data
  - Lagged time-series to optimize correlation
- Spearman's ranked correlation also performed with similar results.

Discussion

- High Frequency Data
  - *In-vivo* fluorescence phycocyanin
    - Strongest relationship with microcystin concentration at a lag of 13 days suggesting a strong candidate for prediction modelling
  - *In-vivo* fluorescence chlorophyll
    - A negative relationship was observed at a lag of 7 days
  - pH
    - Strong relationship with microcystin concentration was observed at a lag of 13 days suggesting a role in predictive modelling
  - Temperature
    - Weakest relationship but a positive trend observed
- QPCR and RT-QPCR
  - Indicated presence of cyanobacteria taxa capable of cyanotoxin production
  - A high correlation with microcystin concentration was observed
- Further Research
  - Investigate relationships in year over year data
  - Develop time-series model for cyanotoxin risk

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