2021

Importance and Challenges of Monitoring Harmful Algal Blooms in Grand Lake St Marys

Stephen J. Jacquemin
Wright State University - Lake Campus, stephen.jacquemin@wright.edu

M. Morden

C. Ewing

J. C. Doll

Importance and Challenges of Monitoring Harmful Algal Blooms in Grand Lake St Marys

M Morden[1], C Ewing[1], B Strang[1], JC Doll[2], SJ Jacquemin[1]

[1] Wright State University – Lake Campus, Celina, Ohio 45822

[2] Francis Marion University, Florence, South Carolina 29502

Abstract

Harmful algal blooms as a result of excessive nutrient runoff have rapidly become a major focus on water quality around the Midwest as the number of people, economies, and ecosystems affected has risen. However, monitoring HAB activity is challenging because of the myriad of factors which can affect bloom formation, toxicity, and extent. Thus, there is a need for increased study of methodologies that can accurately and rapidly characterize HAB proliferation and effects. The objectives of this preliminary study were to characterize cyanobacteria activity over time in a hypereutrophic system (Grand Lake St Marys, OH) by observing algal cell populations, pigment activity (phycocyanin), and toxin production (total microcystin) to determine the relationships between these parameters to better understand bloom timing and relationships among these factors. Simple correlation analysis of weekly toxin samples, phycocyanin pigment, and cell density taken over the course of a year revealed close relationships between all three of these parameters ($r > 0.70$ and $p < 0.001$ for all 3 comparisons). Future research should expand on the simple relationships documented herein and incorporate additional abiotic criteria into a functional model that could help better predict and determine HAB activity in aquatic ecosystems.

GLSM Signage

Planktothrix 4x

GLSM HAB

Project Background

Cyanobacteria (blue-green algae) are photosynthetic bacteria commonly found in freshwater lakes[1-3]. And while these algae represent an important part of the phytoplankton community, in conditions of high nutrient loading they can rapidly proliferate into a harmful algal bloom. HABs are becoming increasingly frequent in the Midwest and have a highly negative impact on recreation, tourism, biodiversity, and drinking water supplies as these blooms can discolor water, generate unsustainable swings in oxygen levels, minimize the photic zone of the water column, and even generate toxins (such as Microcystin) that can have physiological impacts on fish, mammals, and birds[3]. Nowhere is this more apparent than in Grand Lake St Marys (Mercer Co, OH) where persistent HAB activity spurred by a long history of nutrient rich runoff has generated persistent nearly year-round HAB activity[1].

Given the increasing frequency of HABs and linkages to degraded water quality there is a fundamental need for rapid, real time monitoring of bloom activity (including # of cells, species, photosynthetic activity, and toxin production)[3]. However, monitoring of HABs is challenging because many factors (light, nutrients, temperature, pH, precipitation, etc.) contribute to formation, toxicity, and extent. Moreover, monitoring of HABs can be highly technical and expensive (particularly related to toxin assays, chromatography, etc.). Thus, there is a need for additional studies that characterize HABs and provide model templates of the many parameters that can be studied.

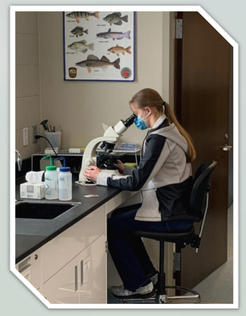
Project Objectives

- Characterize cyanobacteria activity over time in Grand Lake St Marys
- Assess all relationships between algal cells (population density), pigment activity (phycocyanin), and toxin production (total microcystin)

Project Methodology

A 1-liter water sample was collected weekly from a central shoreline point (west side) in Grand Lake St. Marys. This sample was immediately subsampled and a portion of it utilized for cell counts (preserved with 20% ethanol solution) and total microcystin analysis (ELISA assay). Phycocyanin pigment was measured in situ at the time of sample collection using an Algae Torch (bbe Moldaenke). Total microcystin was measured by Celina Water Treatment Plant personnel using an ELISA procedure. Cell counts were done by sub-sampling 10 microliters of water and micro pipetting into a hemocytometer where number of blue-green algae cells present in the grid were recorded and scaled according to volume. Cyanobacteria species were identified using a field guide for freshwater algal blooms and scums[2]. Simple correlation analyses were used to assess relationships between toxin data, cell number, and pigment levels. Toxin and pigment were measured 10/2019 to present and cell counts from 10/2020 to present.

Loading a hemocytometer slide and counting *Planktothrix* cells



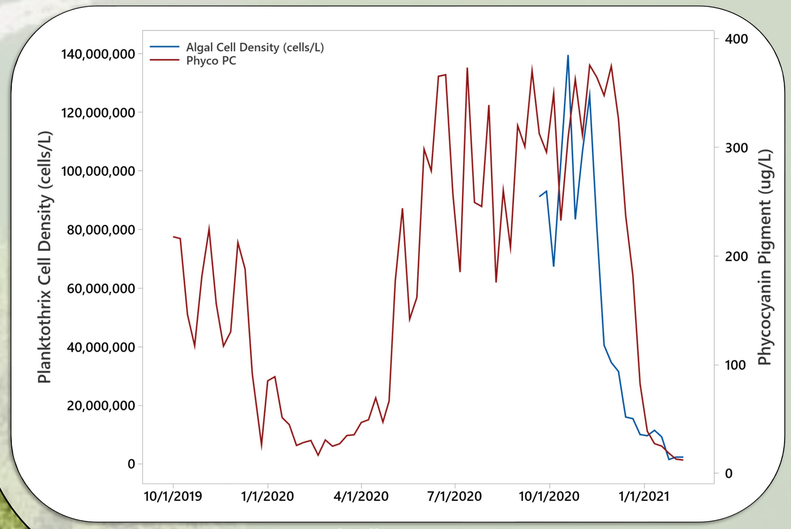


Figure 1: Pigment and Cell Density Over Time

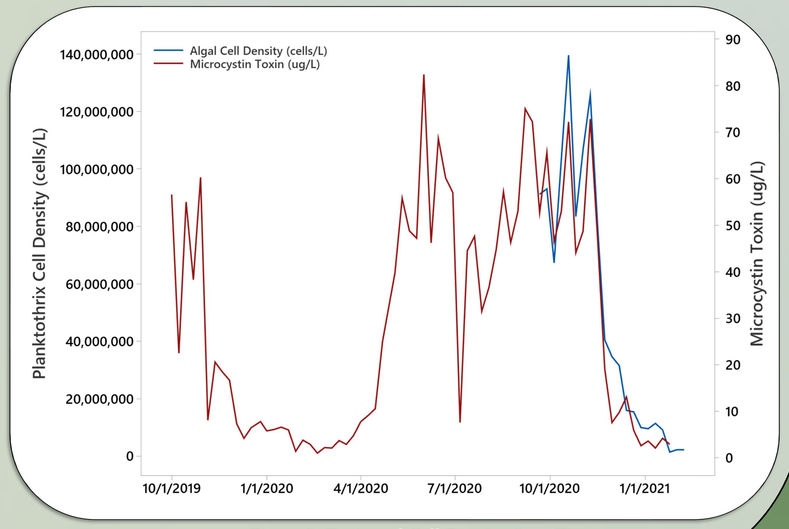


Figure 2: Toxin and Cell Density Over Time

Project Results

Linear relationship with little variation

Good relationship but asymptotes out at ~350 ug/L PC

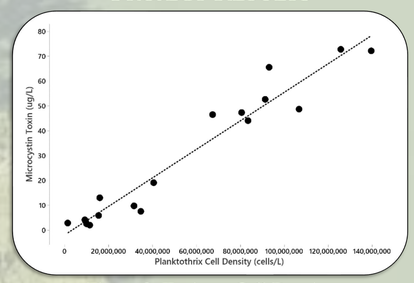


Figure 3: Toxin vs Cell Density

Over 95% algae in samples was BG – of that, 99% was Planktothrix

Linear relationship with lots of variation

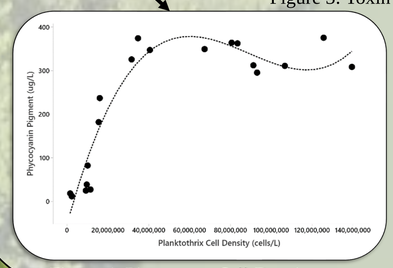


Figure 4: Pigment vs Cell Density

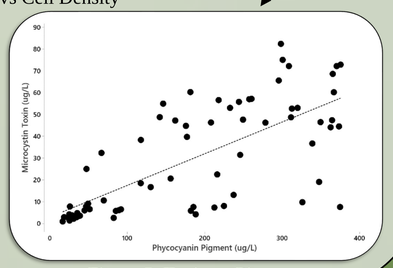


Figure 5: Toxin vs Pigment

Project Implications

- Simple correlation analyses indicated strong significant positive relationships between total microcystin toxin and cell density (r=0.97), phycocyanin pigment (r=0.72) as well as between phycocyanin pigment and cell density (r=0.75).
- However, future research should expand to include more time periods with cell counts and extend this approach to other systems.
- Further examination of the relationships between algal cell populations, pigment activity (phycocyanin), and toxin production (total microcystin) could lead to more rapid and accurate monitoring techniques for Grand Lake St. Marys and freshwater ecosystems across the Midwest.

Acknowledgements

Research funded through a student research grant from the Wright State University Lake Campus Research Initiative

Literature Cited

1. Jacquemin SJ. et al. 2018. Changes in Water Quality of GLSM Watershed Following Implementation of a Distressed Watershed Rules Package. Journal of Enviro. Qual.
2. Kannan MS and Lenca N. 2013. Field Guide to Algae and Other "Scums" in Ponds, Lakes, Streams, and Rivers. Conservation District Doc (Boone, Kenton, Campbell KY).
3. Anderson D et al. 2002. Harmful Algal Blooms and Eutrophication: Nutrient Sources, Composition, and Consequences. Estuaries.