Industrial Hygiene Air Sampling/Analysis of Microcystin in Lake Erie Region

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Background

- Harmful Algal Blooms (HABs)
  - Overgrowths of toxin-producing cyanobacteria in water
  - Most common and toxic toxin microcystin (MC) produced by *Microcystis aeruginosa* (Drobac et al., 2013)
  - Become regular occurrence in Lake Erie (Watson et al., 2016)
  - HABs may generate aerosolized cyanobacteria and associated cyanotoxins (Drobac et al. 2013; Backer et al., 2008; Backer et al., 2010)
  - Atmospheric conditions and recreational water activities may produce aerosols (Stommel et al., 2013; IARC, 2010

Background

- Airborne MC has been detected in smaller inland lakes and reservoirs (Cheng et al., 2007; Backer et al., 2008; Backer et al., 2010; Enviro Team Building Diagnostics & IAQ North America 2016)
  - ELISA analysis is commonly used for MC quantification
  - Standardized filter extraction method does not exist

NORA Priority Area Involved

Out of the ten NORA sectors, application of this research is relevant to Agriculture, Forestry and Fishing

Purpose

- The pilot project was designed to evaluate the application of an industrial hygiene sampling method in the detection of microcystin in the Lake Erie region

Aims

- The specific aims of the project were to
  - Determine the best filter extraction method for the toxin microcystin (MC)
  - Collect air samples from a small inland HAB impacted lake, and Lake Erie under bloom conditions, and analyze for the presence of MC

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Study design: filter extraction

- Microcystin-LR standard (Cayman Chemical, Ann Arbor, MI)
- 25-mm Whatman 41 cellulose filter paper
- 25-mm Millipore filter apparatus connected to an Oberdorfer pump
- 1 ml of 1X PBS/0.05% Tween 20 filtered through spiked 25-mm filter
- Filter extract analyzed by ELISA analysis according to the manufacturer (Abraxis LLC, Warminster, PA)

Results: filter extraction

% Efficiency of extraction experiment

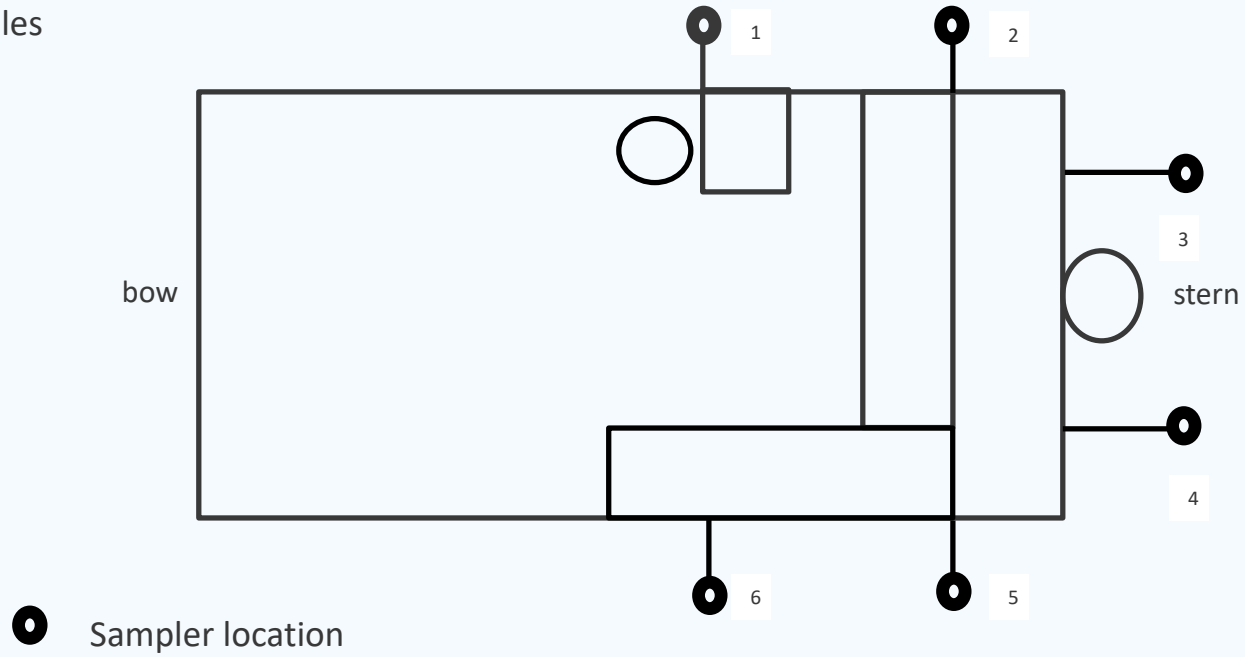
PBS/Tween 20 (mL)	ELISA results of dilution used in filter spike (µg/L)	Theoretical µg/L based on Experimental data	Experimental µg/L	SD	% Efficiency
0.613	0.246	0.040	0.2	0.0325	460.9
1.093	0.895	0.082	0.0673	0.0535	63.9
1.086	0.882	0.081	0.2943	0.0163	344.0
1.043	1.504	0.144	0.17	0.025	107.5
1.074	2.9045	0.270	0.2713	0.1153	94.8
1.115	3.2355	0.290	0.2393	0.0093	77.3

Study design: field study

- Air sampling equipment
  - Whatman 41 filter paper
  - IOM sampler
  - Battery operated sampling pump with sampling flow rate of 9.0 L/min
- Approach
  - Area samples
  - Breathing zone height
  - Samplers positioned into wind
- Study sites
  - Inland HAB impacted lake in the Midwest over two sampling events (positive control)
  - Lake Erie during HAB conditions (one event)

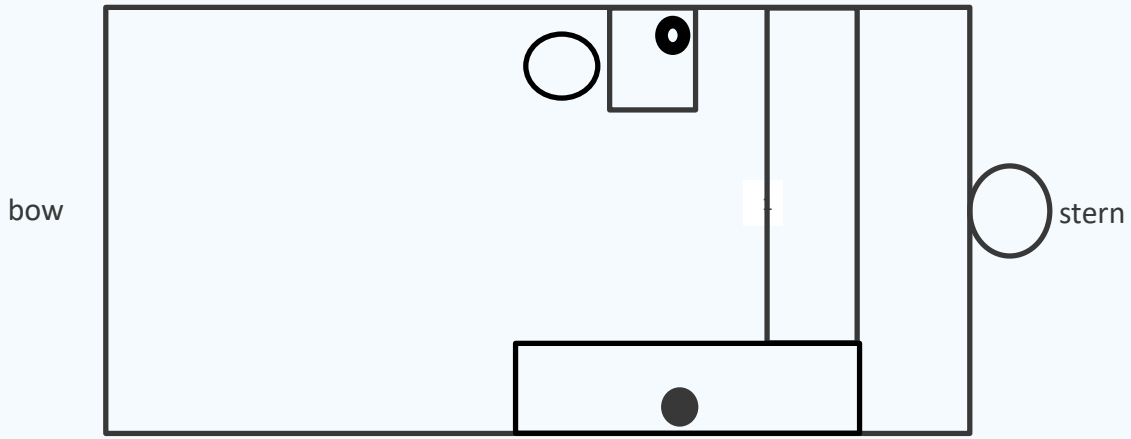
Study design: field study

HAB impacted lake
Event 1: 240 min
Area samples



Study design: field study

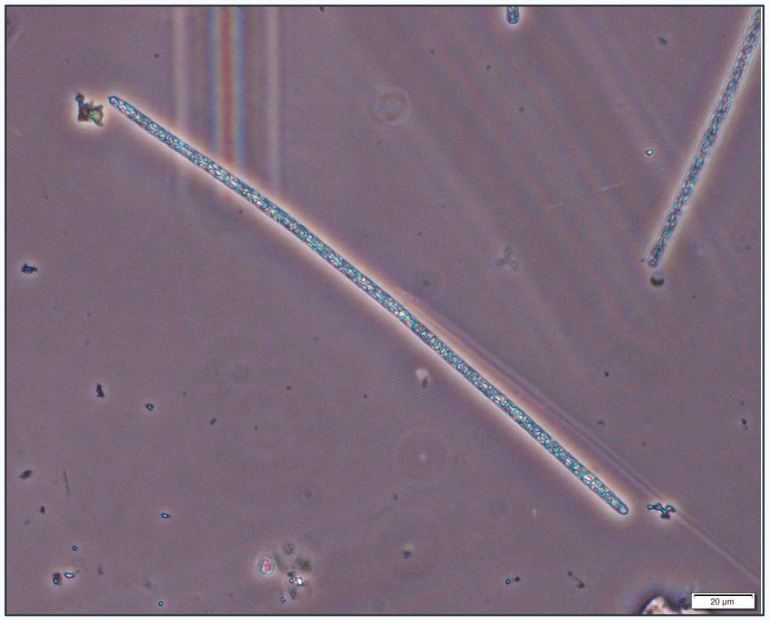
HAB impacted lake
Event 2: 30, 60, 120 min
Area samples



Location of samplers 1, 2, 3
Location of samplers, 4, 5, 6

Results: field study

- Qualitative algae analysis completed on a composited water sample and blue-green algae (Cyanobacteria) was the dominant algal group
- The most visually abundant species was *Planktothrix agardhii* which produces multiple toxins
- MC was detected on filters from Events 1 & 2 at the HAB impacted lake under conditions to maximize aerosol collection



Planktothrix agardhii

Study design: LE field study

- Samples have been collected from Lake Erie under bloom conditions. Analysis is forthcoming upon further refinement of the filter extraction method.

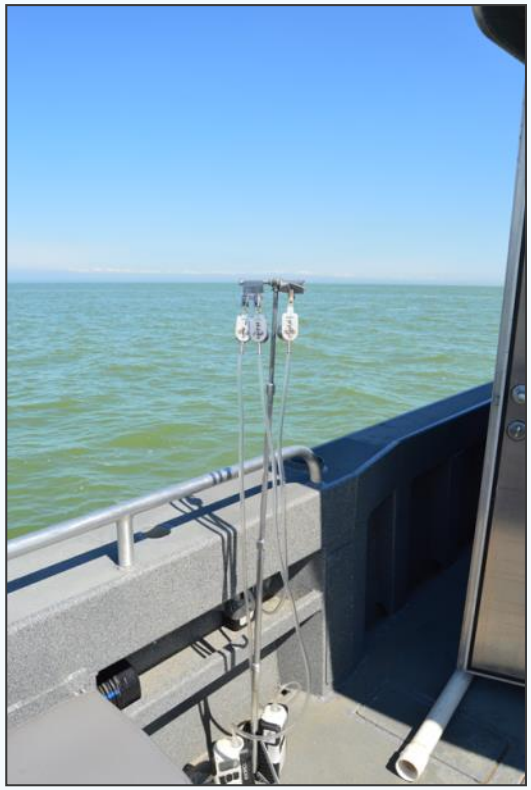



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Photo: John Rees

Aerial Associates Photography, Inc. by Zachary Haslick

Discussion/Limitations

- Area sampling was performed under conditions that maximized aerosol collection potential
- Limited sampling events which were affected by bloom conditions and timing
- Further study is needed to determine the optimal filter extraction protocol of MC from Whatman 41 filters
- Possible variation within the method includes length of time to filter the extract, the cleaning procedure of the filter apparatus in between filter samples, the impact that Tween 20 has on the test

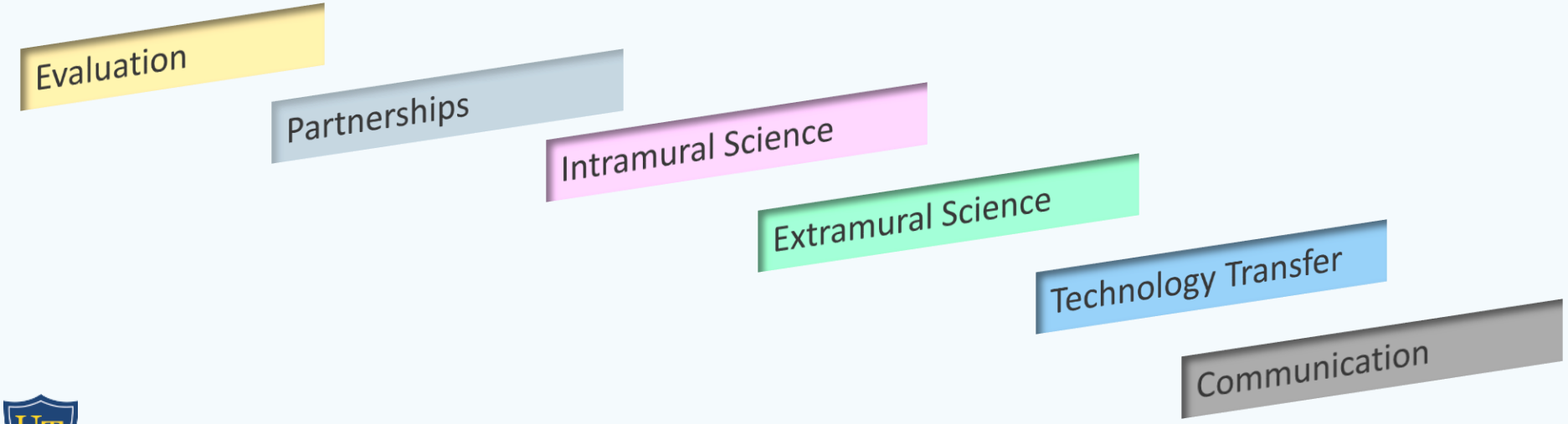
Next steps

- A gage R&R study which will assist in
  - Validating the extraction method and
  - Determining the variables that contribute the most variation
- Subsequent analysis of remaining field samples
- What environmental variables may affect the presence or concentrations of airborne MC?

Impact

- The results from this study will impact occupational safety and health through pilot information on an industrial hygiene method/analysis for sampling MC in air

- Currently, there is no standard filter extraction method from filters for airborne microcystin. This project evaluated different filter extraction methods for MC and identified the one with the best extraction efficiencies



Acknowledgments

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