Monitoring Cyanobacteria Dynamics and Water Quality Parameters in Two Productive Systems – Shelburne Pond and Missisquoi Bay, Lake Champlain

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Background

- Cyanobacteria blooms are characterized by the appearance of a thick surface scum that may produce harmful toxins.
- Blooms occur during the warmest months of the year and are affected by nutrient inputs, temperature, and wind (Paerl and Huisman, 2009).
- Monitoring water quality through the collection of high-frequency data and traditional low-frequency sampling provides information about factors that change in concert with cyanobacteria concentrations in different systems.
- Understanding bloom patterns and their relationship to climate may provide insight into water management strategies, and adaptation and mitigation to climate change.

Methods

- We worked on two water bodies in Vermont: eutrophic Missisquoi Bay, Lake Champlain, and hyper-eutrophic Shelburne Pond (Fig. 1). Shelburne Pond is part of the University of Vermont's Natural Areas Program.
- Both systems share a history of periodic fish kills during cyano-bacteria blooms.

Missisquoi Bay, Lake Champlain

Figure 1. Location of Missisquoi Bay buoy (star; see Fig. 2a) and Shelburne Pond (circle; see Fig. 3).

- Missisquoi Bay is a large (70 km^2), shallow (~3 m) bay located in the northeastern part of Lake Champlain (Fig. 1).
- The bay has been monitored since 2012 with a buoy that contains a weather station, water samplers, and a YSI sonde (Fig. 2a, b, c).
- Weekly manual samples were collected during 2014.

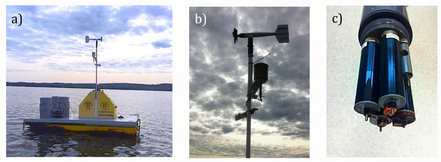

Figure 2. Buoy system on Missisquoi Bay (a) that contains automatic samplers for water, weather station (b) and YSI Sonde (c).

- A YSI 6600 V2 4 multi-parameter water quality sonde (Fig. 2c) is installed in the buoy to monitor water quality.
- The sonde measures temperature, conductivity, pH, dissolved oxygen concentration, chlorophyll-a and phycocyanin fluorescence, and turbidity.
- The weather station measures wind speed/direction, air temperature, air pressure, solar radiation, and relative humidity.

Shelburne Pond

Figure 3. Star indicates location of thermistor chain buoy on Shelburne Pond

- Shelburne Pond (Fig. 3) is a small (2 km^2), shallow (~4 m) pond in the Lake Champlain watershed.
- Monitoring began in March 2014 (Fig. 4a) with weekly manual sampling and the installation of a thermistor chain buoy (Fig. 4a,b) that records water temperature every 30 minutes.
- The same YSI sonde was used during the manual sampling.

Figure 4. a) The thermistor chain is composed of five temperature HOBO® Water Temp Pro v2 u22-001 loggers and was installed when the pond was still frozen. b) HOBO® Water Temp Pro v2 u22-001 loggers (top), and HOBO® Waterproof Shuttle data downloader (bottom). c) Collecting Photosynthetically Active Radiation (PAR) measurements during weekly sampling. d) Cyanobacteria bloom on June 17, 2014.

Results

- Despite similar temperatures (Fig. 5 left), dissolved oxygen profiles were more variable in Shelburne Pond than Missisquoi Bay (Fig. 5 center) in July 2014.
- Cyanobacteria concentrations were more variable and much higher in Shelburne Pond than Missisquoi Bay in July 2014 (Fig. 5 right).

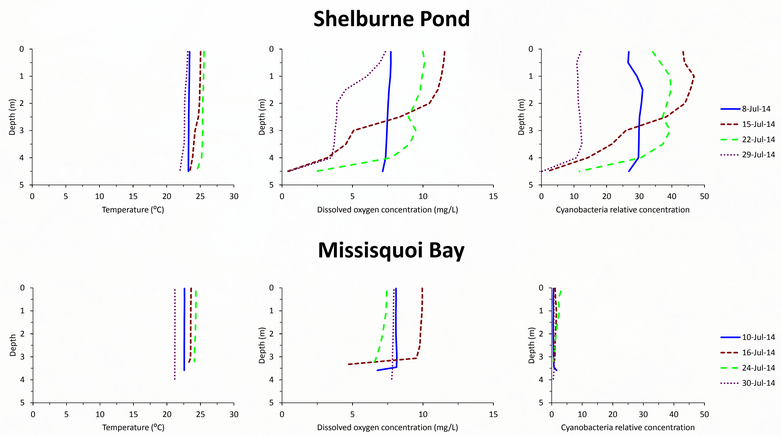

Figure 5. Comparison of temperature, dissolved oxygen, and relative cyanobacteria concentration depth profiles in Shelburne Pond and Missisquoi Bay on four sampling dates in July 2014.

- Cyanobacteria increased greatly in June and remained high through the summer in Shelburne Pond, whereas only modest increases were observed in August in Missisquoi Bay (Fig. 6).

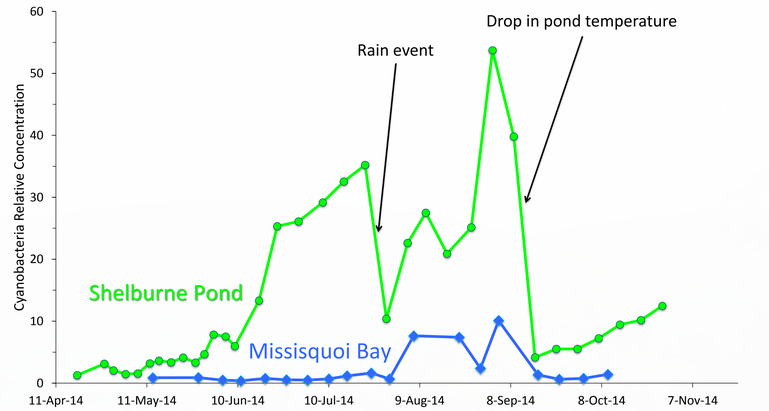

Figure 6. Relative concentration of cyanobacteria in Shelburne Pond and Missisquoi Bay in 2014. Events associated with drastic declines in Shelburne Pond are noted.

Discussion

- Shelburne Pond and Missisquoi Bay are located in the same region (Fig. 1) and provide opportunities to compare and contrast cyanobacteria blooms and the factors that influence them.
- Our preliminary examination of weekly data from both systems suggest a sharp contrast in bloom dynamics.
- Shelburne Pond blooms appear to last all summer and at much higher levels than Missisquoi Bay.
- Given the investment in the research and management of Missisquoi Bay, our results suggest Shelburne Pond could be a cost-effective comparative system to better understand cyanobacteria.

Next Steps

- A new buoy system will be deployed in April 2015 on Shelburne Pond to collect high-frequency data (15 min intervals) on water quality and weather. The buoy will be part of the Global Lakes Ecological Observatory Network (www.gleon.org).
- Comparative analyses of high-frequency data from Shelburne Pond and Missisquoi Bay will enable comparative analyses of the effects of wind, temperature, and precipitation on cyanobacteria blooms in systems with (Missisquoi Bay) and without (Shelburne Pond) major tributaries.
- We plan to engage middle and high school students in Shelburne Pond research, as well as classes across the UVM campus.

Acknowledgements

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References

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