Seasonal and Historical Trends of Cyanobacteria Dominance in Conesus Lake

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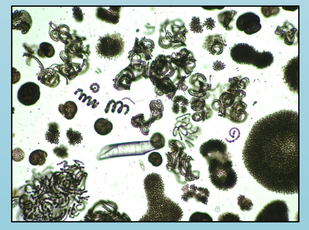
Background

- Cyanobacteria, also known as “blue-green algae”, are photo-synthetic bacteria that make up a significant part of the phytoplankton community along with the microalgae in most lakes.
- Lake cyanobacteria can form blooms that produce allelopathic compounds such anatoxin-a (an alkaloid) and microcystin (a cyclic peptide) that act as neurotoxins and hepatotoxins. Harmful algal blooms (HABs) pose a risk to our drinking water supply and threaten other ecosystem services.
- Many lakes in the region and worldwide experience HABs of especially toxic cyanobacteria in the genus *Microcystis.*
- Observations of the cyanobacteria community in Conesus Lake **(Fig. 1)** indicate that a group of species in the genus *Dolichospermum*, not species of the more toxic *Microcystis* **(Fig. 2),** are the dominant bloom forming cyanobacteria.
- In this study, we build on previous work by Bosch and colleagues[1] and examine historical and 2022 data on the species composition of the cyanobacteria in Conesus Lake to evaluate trends in species dominance.

Fig. 1. Aerial photo of Conesus Lake, located about 6 miles east of Geneseo (circled). Conesus Lake is the source of drinking water for Geneseo and many other towns in Livingston County.



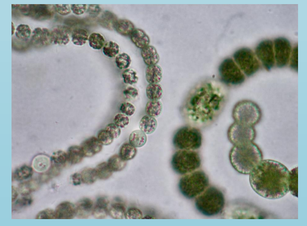


Fig. 2. Left: Image showing high number of cyanobacteria filaments and colonies during a bloom. Right: Close up of a *Dolichospermum* filament showing individual photosynthetic cells, round pearly cells that are Nitrogen-fixing heterocysts and oval akinete reproductive cysts.

Methods

- In 2022, samples were collected from 0-3 m in Conesus Lake every two weeks and preserved in 1% glutaraldehyde.
- We followed the collection methods reported in previous studies by SUNY Brockport dating back to 1993 so we could compare 2022 to the historical record [2].
- Phytoplankton community analysis was conducted by PhycoTech Inc., located in St. Joseph, Michigan.
- For 2022, we also analyzed the abundance of Nitrogen-fixing heterocysts cells in whole filaments of *Dolichospermum* to better understand the nutrient dynamics of the lake.
- Biomass is reported in terms of biovolume, which is a direct function of cell size and an indicatory of biomass.

Results

- Historical analysis of whole phytoplankton community diversity indicated that cyanobacteria were abundant in Conesus Lake since at least 1993. There were no significant long-term trends in the biovolume of cyanobacteria relative to other species of phytoplankton **(Fig 3)**.
- 2022 was one of the lowest years for phytoplankton and cyanobacteria biovolume since 1993, although the relative abundance of cyanobacteria continued to be relatively high **(Fig. 3).**

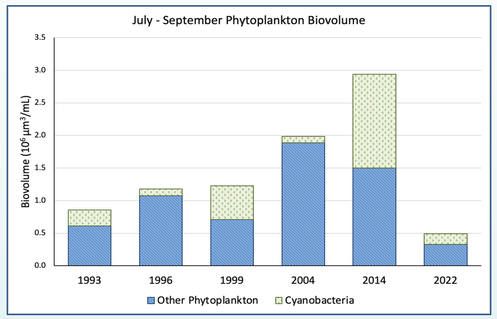


Fig. 3. Historical trends in phytoplankton and cyanobacteria biovolume from July through September.

- More detailed analysis of the cyanobacteria species composition dating back to 1993 showed that Conesus Lake is typically dominated by species of the genus *Dolichospermum,* as shown seasonally in **Fig. 4** for 2014 and 2022.

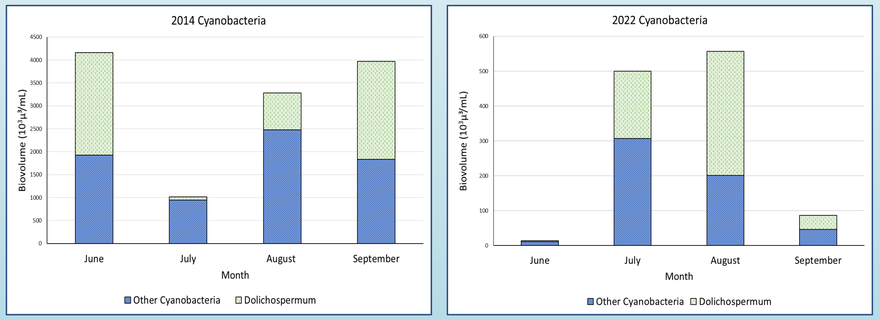


Fig. 4. Representation of *Dolichospermum* in the cyanobacteria community for 2014 and 2022. Biovolume of *Dolichospermum* is often over 50% of the whole cyanobacteria biovolume. The data from 2014 was taken from a report by SUNY Brockport [2].

- Heterocysts are specialized cells in which molecular Nitrogen (N_2) is converted to usable forms of N such as nitrate (NO_3^-). We found that species of *Dolichospermum* consistently produced heterocysts through July and August. This was an indication of significant N_2 fixation activity in surface waters **(Fig. 5)**

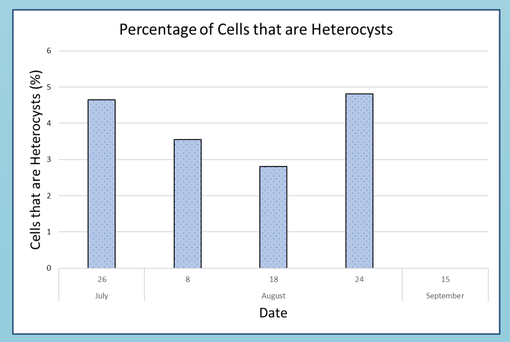


Fig. 5. Seasonal heterocyst production (as % of all cells) by *Dolichospermum* in Conesus Lake for 2022, showing consistent activity in July and August ending by early September.

Discussion

- Cyanobacteria have been a significant native component of the phytoplankton community in Conesus Lake since studies were first carried out in the early 1970’s [3]. Seasonal biomass data reported since 1993 indicate that cyanobacteria are typically 10 to nearly 50% of the phytoplankton biomass but to date do not appear to be consistently increasing in representation.
- Harmful (toxin producing) cyanobacteria blooms (HABs) are not common in Conesus Lake. The dominant bloom forming species are typically of the genus *Dolichospermum* that do not typically produce high concentrations of toxins.
- *Dolichospermum* species typically produce anatoxin-a and saxitoxin. Microcystin toxins produced by the genus *Microcystis* that seem to trouble may of the lakes in the region are not usually a concern in Conesus Lake. The Livingston County Department of Health monitors HABs in Conesus Lake for production of microcystins. Procedures should also be in place to assay for anatoxin and saxitoxin production by blooms.
- *Dolichospermum* blooms could alter the nutrient and bloom dynamics of Conesus Lake by producing biologically usable nitrogen. This seemed to be the case this past year **(Fig. 6)** when Nitrate-nitrite concentrations in surface waters spiked on August 24, which is typically a time when N is in very short supply for the surface phytoplankton of Conesus Lake [1].

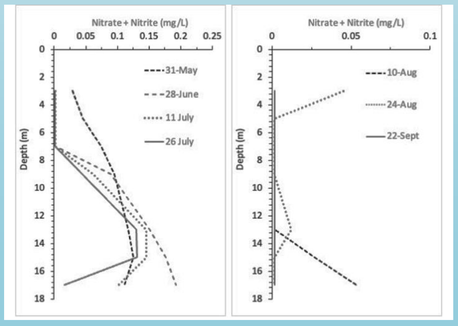


Fig. 6. Profiles of nitrate-nitrite mg/L showing near-surface spike on August 24,2022, when nutrient levels in surface waters are typically in very short supply.

References

1. Bosch I., Chislock M. and Colleagues. 2022. Seasonal and Long-term Trends in Phytoplankton Community Structure and Water Column Characteristics. Technical Report Submitted to the Livingston County Planning Department.
2. Makarewicz, J. C. and Lewis, T.W. 2014. Trophic Status of Conesus Lake 2014: Long-term Trends in Lake Chemistry and the Plankton Community" Technical Report Submitted to the Livingston County Planning Department.
3. Mills EL. 1975. Phytoplankton composition and comparative limnology of four Finger Lakes, with emphasis on lake typology [dissertation]. [Ithaca (NY)]: Cornell University.

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