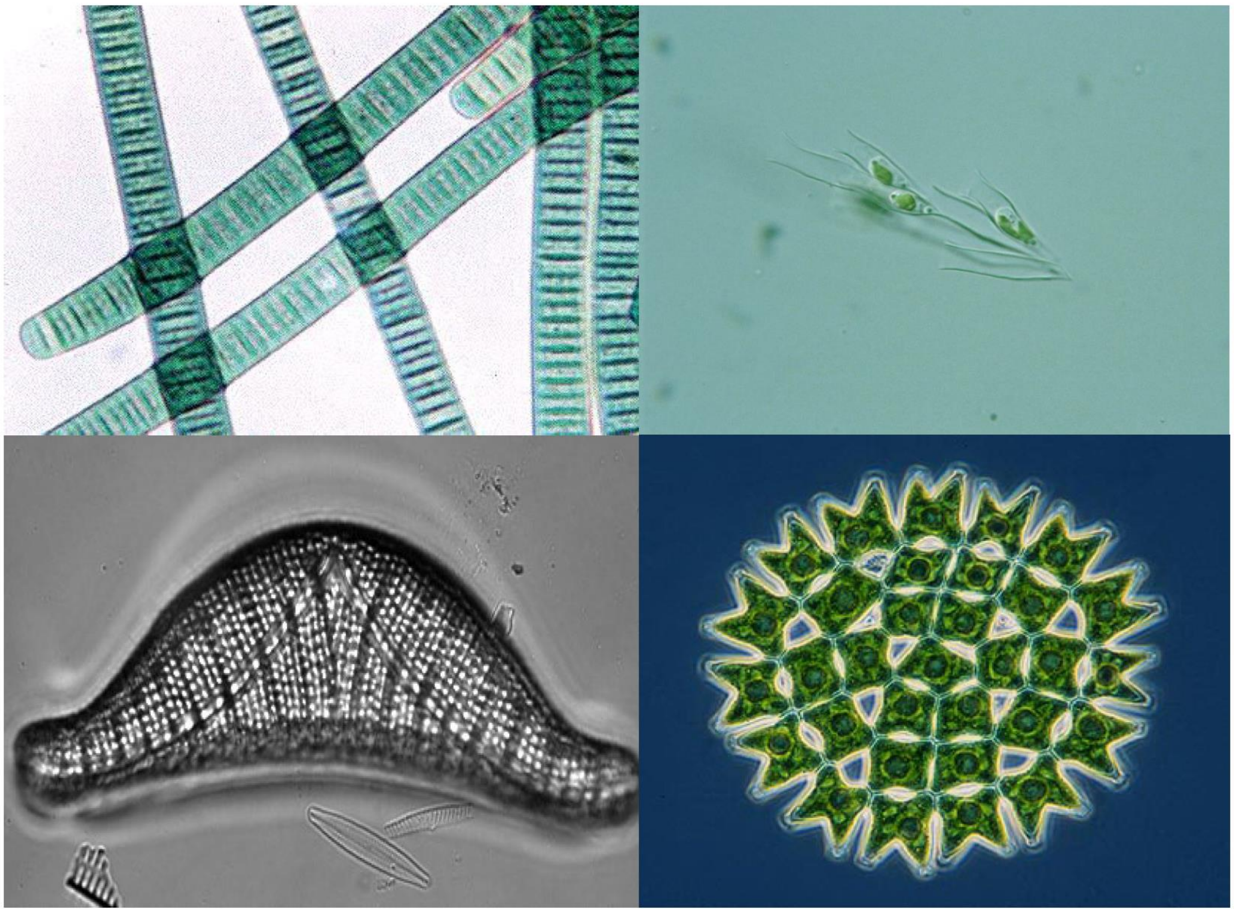
Summary of Leech Lake Phytoplankton Data, 2017-2021



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March 2022

Summary

The purpose of this report was to summarize the 2017-2021 phytoplankton datasets from Leech Lake and examine patterns among years. This analysis includes descriptive statistics of phytoplankton community composition and season dynamics from monthly samples during individual summers.

While the length of this dataset (5 years total) is not enough to describe or quantify trends through time, it provides detailed information about the phytoplankton community early in the establishment of zebra mussels in the lake and as the zebra mussel populations grows to become well-established and widespread.

The phytoplankton community underwent seasonal changes typical of mesotrophic lakes during each summer, switching from an early summer diatom-green alage-cryptophyte dominated community to a community of cyanobacteria (blue-green algae) by July. A marked difference between the two basins in the lake is the higher abundance of cyanobacteria (HABs) capable of producing toxins (although they do not always do so) in the Main Basin of the lake.

Introduction

In 2016, the Minnesota Department of Natural Resources (MNDNR) confirmed that Leech Lake was infested with zebra mussels (*Dreissena polymorpha*). Zebra mussels affect multiple components of aquatic food webs in lakes and streams they invade. In lakes, zebra mussels are documented to increase water clarity, reduce organisms that live in the water column (zooplankton and phytoplankton), change nutrient cycles, and reduce growth rates for young-of-the-year walleye (Sousa et al. 2009, Higgins and Vander Zanden 2010, Hansen et al. 2020).

Although zebra mussels can affect lakes in multiple ways, the effects in individual lakes can vary. To understand how zebra mussels affect a specific lake, monitoring is required to document changes through time. The Leech Lake Association funded the analyses of phytoplankton data from monthly samples (May-September) in 2021 at two stations in the lake (Main Lake Basin and Walker Bay). Biologists at PhycoTech, Inc. (St. Joseph, MI) identified the samples. This report is a summary of those findings, as well as data from previous years.

Phytoplankton (algae in the water column) are sensitive indicators to changes in lakes. Phytoplankton communities respond to changes in temperature, light, turbidity, nutrients, and invasive species (Dodds and Whiles, 2019). They can respond rapidly to environmental changes, and they are relatively easy to sample, although expertise is needed for the identification of species.

Methods

Volunteers with the Leech Lake Association collected phytoplankton samples from the top 2 m of the lake surface using an integrated sampler. Samples were preserved with glutaraldehyde. Taxonomists at PhycoTech, Inc. (St. Joseph, MI) identified the phytoplankton using a rapid assessment method developed by the Minnesota Pollution Control Agency (Swain and Dindorf 1989, Lindon and Heiskary 2007). This method used relative abundance (instead of density) to describe the phytoplankton community. After identification, I grouped algal taxa into six categories, based on their taxonomy and functional role as described by St. Amand (2015). These groups are described in Table 1. These functional groups are slightly different from previous reports, as cyanobacteria are split into two groups here (BG and HAB) to separate taxa that are able to produce toxins (HAB) from other species of cyanobacteria (BG).

Table 1: Phytoplankton functional group classification and brief description. Adapted from St. Amand (2015).

Functional Group	Description
BG	Non-toxin forming cyanobacteria (blue-green algae)
CP	Cryptomonads and dinoflagellates; common in systems with stained water, regardless of nutrients
CP1	*Ceratium hirundinella*; a dinoflagellate that blooms when other dinoflagellates do not
DY	Planktonic diatoms and chrysophytes
G	Green algae
HAB	Toxin-forming cyanobacteria (blue-green algae)

Results

The phytoplankton assemblage in both the Main Basin of Leech Lake and Walker Bay showed seasonal patterns in all years (Figures 1 and 2), typical of mesotrophic lakes, although the timing of the dominance of different functional groups varied among years. In most years, the communities in both basins were dominated by green algae (G), diatoms (DY), and chrysophytes (DY) early in the summer. By June or July, cyanobacteria (BG), including some toxin-forming species (HABs) were well represented in the phytoplankton communities in both basins (Figures 1 and 2). While the species identified as toxin-forming are capable of producing a variety of toxic substances, they do not always do so, and the exact triggers that initiate toxin production are unknown. Cyanobacteria (BG and HAB) remained dominate through the remainder of the sampling period each year (Figures 1 and 2). The phytoplankton community in Walker Bay mirrored that of the community in the Main Basin of Leech Lake most years, although Walker Bay typically has lower relative abundance of toxin-producing taxa (HABs).

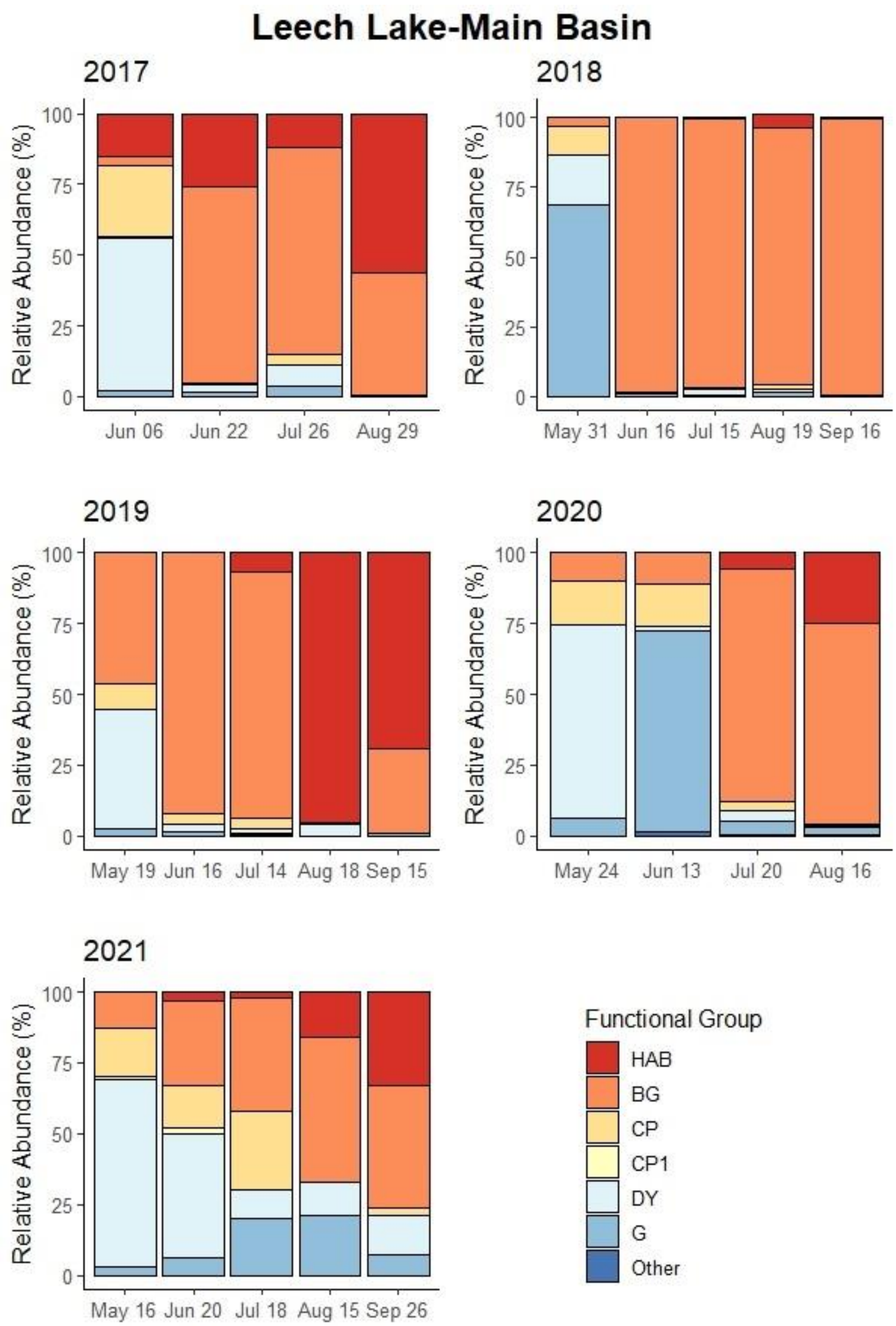

Figure 1: bar graph showing the relative abundance of major phytoplankton functional groups in the Main Basin of Leech Lake, MN, from monthly samples (May-Sep) in the summers of 2017-2021.

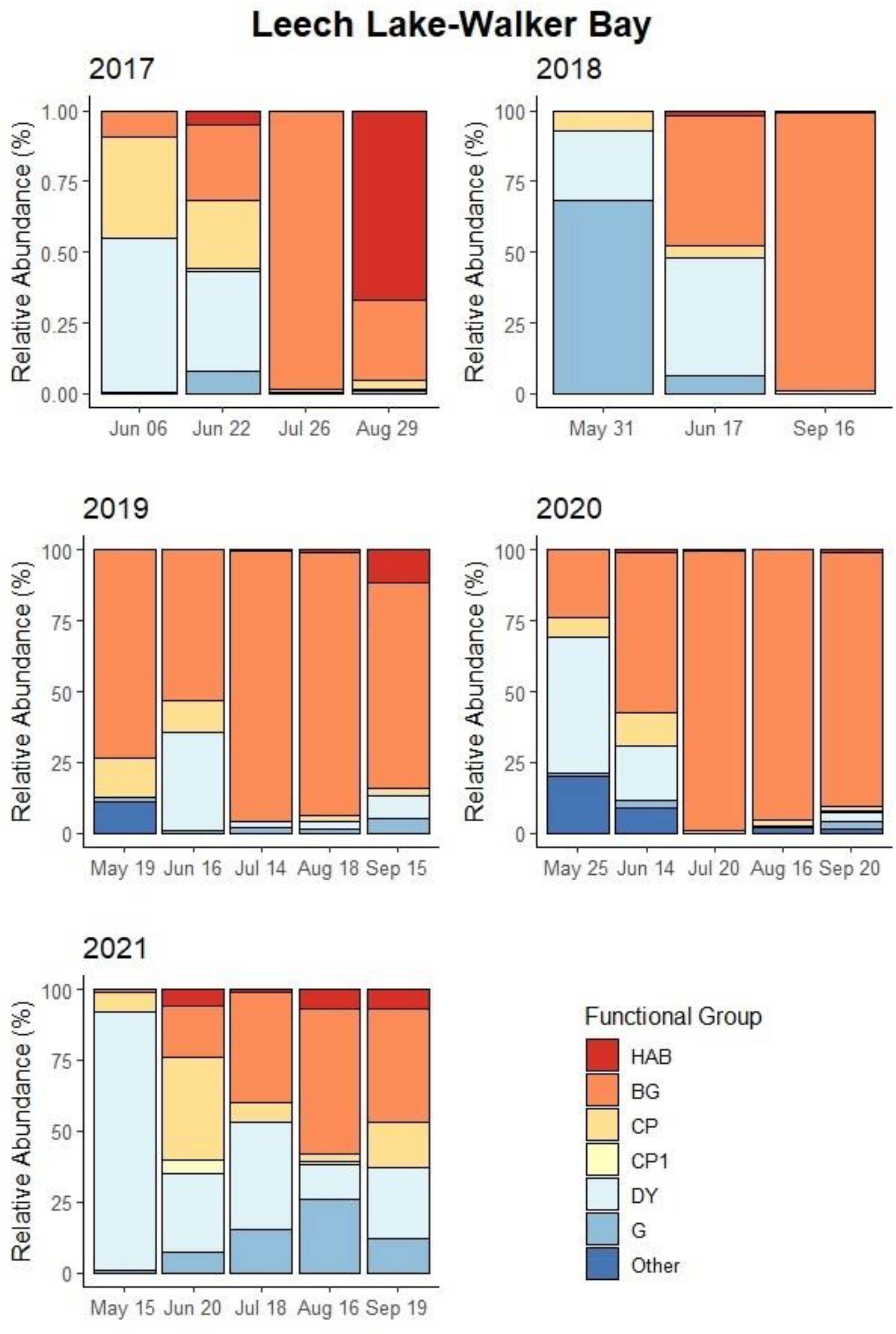

Figure 2: bar graph showing the relative abundance of major phytoplankton functional groups in the Walker Bay, Leech Lake, MN, from monthly samples (May-Sep) in the summers of 2017- 2021. Note that only May, June, and September were sampled in 2018

The annual changes of the phytoplankton community in 2021 is typical of what we would historically expect as typical seasonal fluctuation in mesotrophic lakes in Minnesota, driven by changes in light, nutrients, and temperature throughout the year (Figure 3), as well as competition, predation, and other interactions (Sommer 1990, Kalff 2002). In other years, this pattern is not as clear, and warm air temperatures or precipitation patterns in early summer that favor cyanobacteria (BG and HAB) may have influenced the abundance of these algae. It is possible that the early season blooms of diatoms and green algae occurred before the first sampling event.

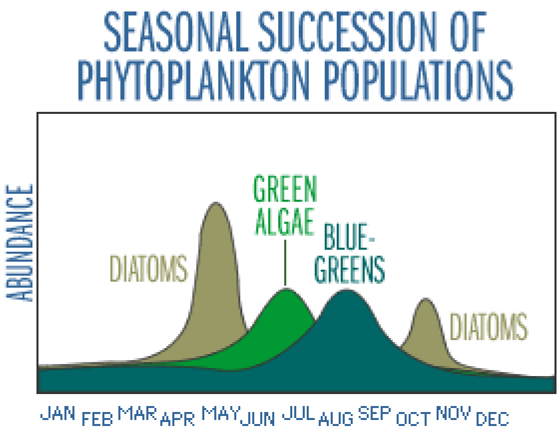

Figure 3: Schematic showing the changing abundance of phytoplankton groups through the year, as phytoplankton groups respond to their favored conditions. Source: https://www.waterontheweb.org

The abundance of toxin-forming cyanobacteria (HABs), which increase in August and September of many years, is an increasingly common complaint in Minnesota lakes. This group of phytoplankton like calm, warm, nutrient-rich water, and there are human and animal health concerns related to exposure to HABs. While these phytoplankton groups are capable of producing toxins, they do not always do so, and scientists are working on understanding the conditions that trigger toxin production. Zebra mussel infested lakes with low total phosphorus (<20 µg/l) are associated with increased levels of the algal toxin microcystin (Knoll et al. 2008). It should be noted that the cyanobacterium that produces this algal toxin, *Microcystis,* was not detected in Leech Lake in 2021 but was present in the lake in 2017-2020.

Phytoplankton communities are sensitive to changing environmental conditions at multiple temporal scales (i.e. seasonal, inter-annual, long term). To detect long-term trends in the community due to invasive species, land cover change, warming water, or other stressors, additional years of data are needed.

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