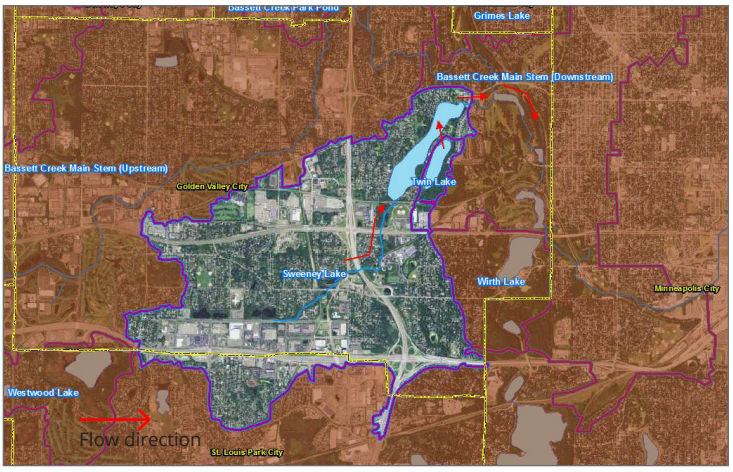
Sweeney Lake 2017 water quality monitoring



About Sweeney Lake

BCWMC classification	Priority-1 deep lake
Watershed area	2,397 acres
Lake size	67 acres
Average depth	12 feet
Maximum depth	25 feet
Ordinary high water level	827.7 feet
Normal water level	827.2 feet
Downstream receiving waterbody	Bassett Creek
Location (city)	Golden Valley
MPCA impairments	Nutrients, chloride
Aquatic invasive species	Curly-leaf pondweed
Public access	Yes (boat launch)

The Bassett Creek Watershed Management Commission
Stewardship of water resources to protect and enhance our communities

Monitoring water quality in Sweeney Lake

The Bassett Creek Watershed Management Commission (BCWMC) has monitored water quality conditions in the watershed's 10 priority lakes and six ponds since 1972. This monitoring is done to detect changes or trends in water quality and evaluate the effectiveness of efforts to preserve or improve water quality. A summary of 2017 monitoring efforts on Sweeney Lake is provided below; more comprehensive information can be found on pages 2–7.

At a glance: 2017 monitoring results

In 2017, the BCWMC monitored Sweeney Lake for:

- Water chemistry (nutrients, chlorophyll a, chloride).
- Water measurements (e.g., clarity, dissolved oxygen).
- Phytoplankton and zooplankton (microscopic aquatic plants and animals).
- Macrophytes (aquatic plants).

Results indicate that, overall, Sweeney Lake does not meet applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for total phosphorus and chlorophyll a. Trend analyses indicate no trends in total phosphorus, chlorophyll a, or Secchi depth over the past 20 years.

Recommendations

- Implement management measures to reduce the internal phosphorus load from sediment (about one-third of the lake's annual phosphorus load). Alum treatment would reduce internal phosphorus load from sediment and improve water quality.
- Continue implementation of Sweeney Lake TMDL, including best management practices and capital improvement projects to reduce watershed nutrient loads.
- Reduce winter/spring chloride loads to Sweeney Lake through road salt management initiatives. Identify and target directly connected impervious areas and other potential locations in watershed that may be contributing high chloride loads.
- Continue water quality and biological monitoring.
- Further investigate possible trends/shifts in the vegetation community and the lower plant IBI scores observed in 2017.

Water chemistry monitoring: 2017

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, excessive levels lead to excessive growth, decreased water clarity, and water quality impairment.

- BCWMC/MPCA standard: 40 micrograms per liter (µg/L) or less.
- Range: Total phosphorus concentrations for Sweeney Lake were in the eutrophic category from mid-May to early September. The low was 16 µg/L in April (North Basin), and the high was 49 µg/L (South Basin) in July.
- Summer average: 39 µg/L in the North Basin (met BCWMC/MPCA standard) and 46 µg/L in the South Basin (did not meet BCWMC/MPCA standard).

Chlorophyll *a* levels

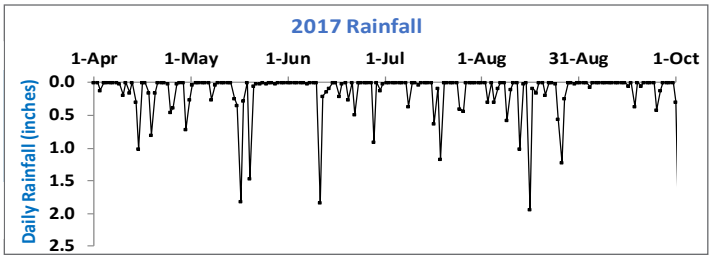
Chlorophyll a is a pigment in algae and generally reflects the amount of algae growth in a lake. Lakes which appear clear generally have chlorophyll a levels less than 15 µg/L.

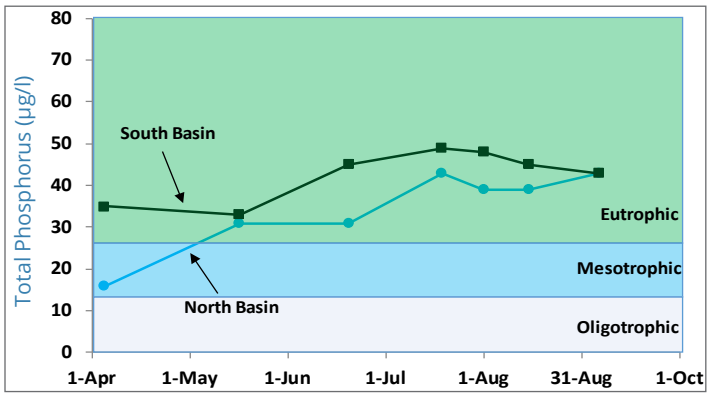
- BCWMC/MPCA standard: 14 micrograms per liter (µg/L) or less.
- Range: Chlorophyll a concentrations ranged from a low of 5 µg/L in June (North Basin) to a high of 26 µg/L (South Basin) in September. Concentrations for both basins were in the eutrophic range for all sample events except for the mid-June event.
- Summer average: 14 µg/L in the Upper Basin (met BCWMC/MPCA standard) and 19 µg/L in the South Basin (did not meet BCWMC/MPCA standard).

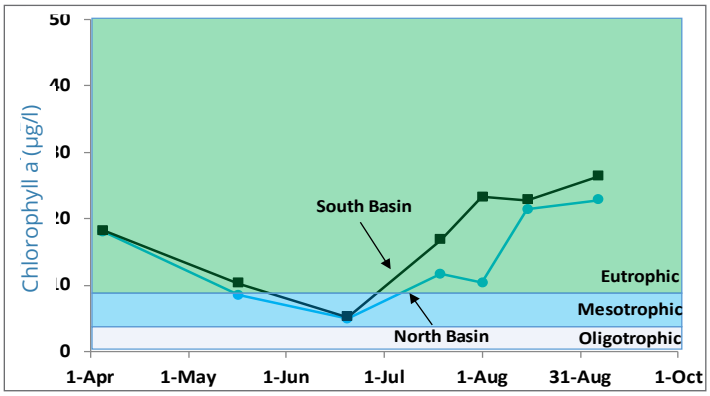
Water clarity

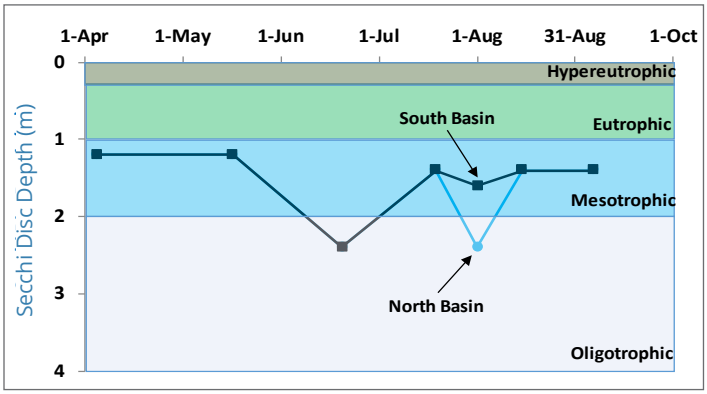
Water clarity is often affected by the abundance of algae or other photosynthetic organisms in a lake. It is usually measured by lowering an 8-inch "Secchi" disc into the lake; the depth at which the disc's alternating black-and-white pattern is no longer visible is considered a measure of the water's transparency.

- BCWMC/MPCA standard: 1.4 meters or more.
- Range: Secchi disc depth ranged from 1.2 meters (both basins) in April/May to 2.4 meters (both basins) during the mid-June sample event.
- Summer average: 1.8 meters in the North Basin and 1.6 meters in the South Basin both met BCWMC/MPCA standard.









Definitions

- ***Eutrophic:*** Lake condition characterized by abundant accumulation of nutrients supporting dense growth of algae and other organisms; decay of algae can reduce lake oxygen levels
- ***Hypereutrophic:*** Nutrient-rich lake conditions characterized by frequent and severe algal blooms and low transparency
- ***Mesotrophic:*** Lake condition characterized by medium levels of nutrients and clear water
- ***Oligotrophic:*** Lake condition characterized by a low level of dissolved nutrients, high oxygen content, and sparse algae growth

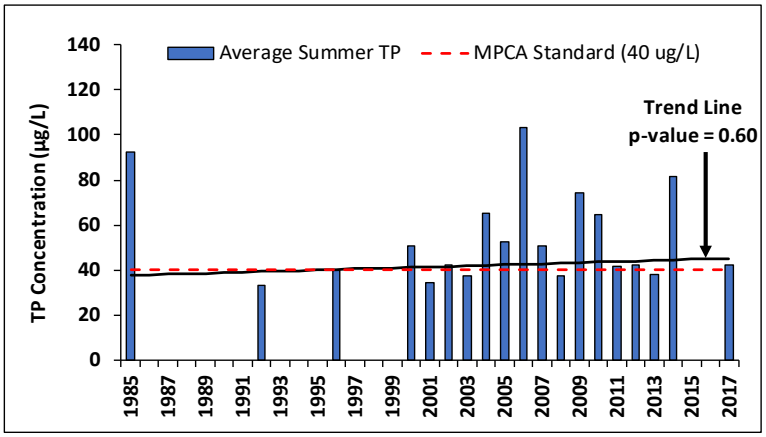
Photo credit: Jane McDonald Black

Water chemistry monitoring from 1985–2017: historical trends

Water quality in Sweeney Lake has been monitored since 1985. Total phosphorus, chlorophyll a, and Secchi disc transparency summer averages (June through September) for years with a minimum of four sample events are shown in the figures to the right. Since 1985, summer averages have not met BCWMC/MPCA standards 74% of the time for total phosphorus, 63% of the time for chlorophyll a, and 42% of the time for Secchi depth. Trend analyses for Sweeney Lake suggests the trend lines presented in the figures to the right are not statistically significant (p-values all greater than 0.05).

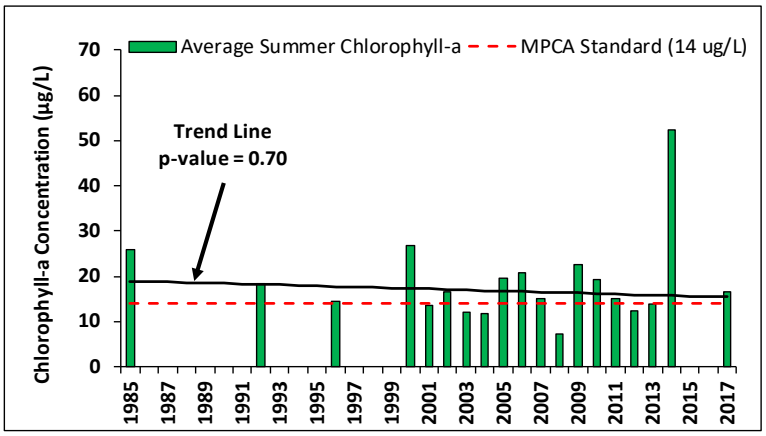
Total phosphorus trends

Note: Graphs and trend lines do not include CAMP data



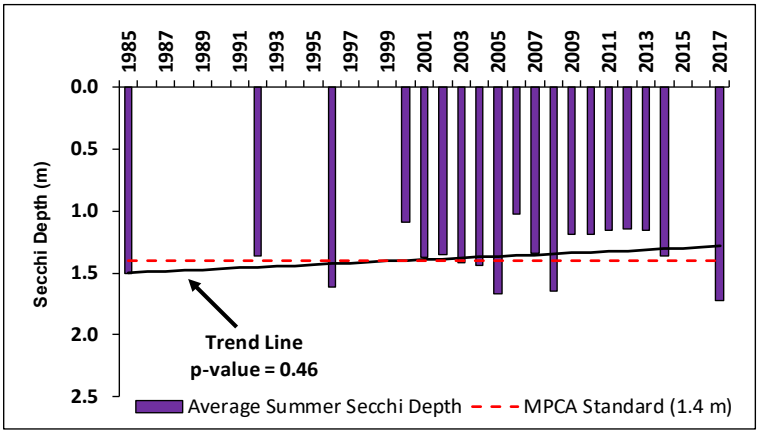
Chlorophyll a trends

Note: Graphs and trend lines do not include CAMP data



Water clarity trends

Note: Graphs and trend lines do not include CAMP data



Phosphorus loading from sediment (2017)

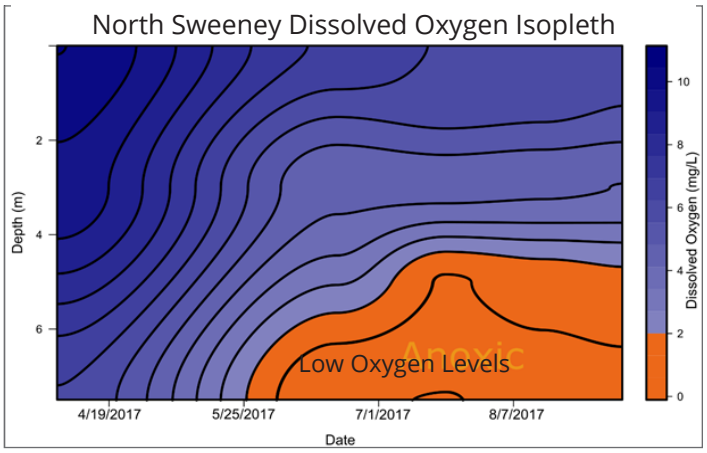
The release of phosphorus stored in lake-bottom sediments when oxygen levels are low is described as "internal phosphorus loading from sediment." The Sweeney Lake total maximum daily load (TMDL) study (SEH 2011) found internal phosphorus loading from sediment to be a significant source of lake phosphorus—about one-third of the lake's total annual phosphorus load. According to the study, phosphorus from Sweeney Lake's sediment is conveyed to the surface by diffusion, wind mixing, and mixing by the aeration system when it is operated.

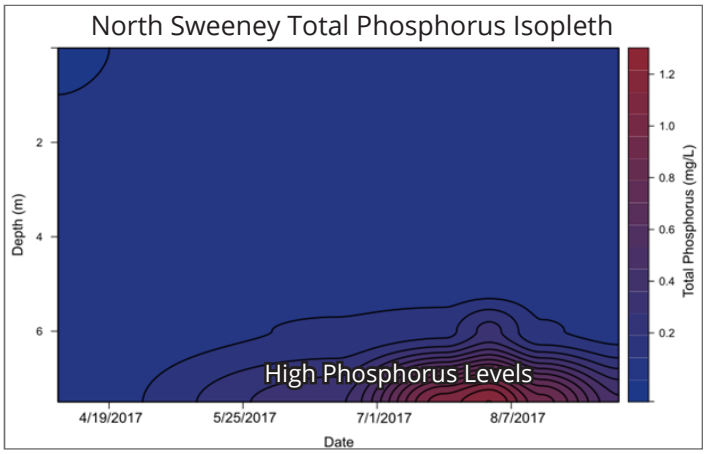
The aerators were not operated in Sweeney Lake during the 2017 sampling season. The 2017 data indicate near-bottom oxygen levels in the North Basin was low from late May through September and in the South Basin from mid-June to early September. Internal phosphorus loading from sediment during this period caused near-bottom phosphorus concentrations to increase consistently; this was correlated with increasing phosphorus concentrations in surface water. Temperature and dissolved oxygen data indicate that oxygen levels in the South Basin began to increase as the water column began mixing with the surface layer in early August. In the North Basin, late summer mixing between the surface and deep water was not as pronounced as the water column remained more stratified throughout the entire sampling period.

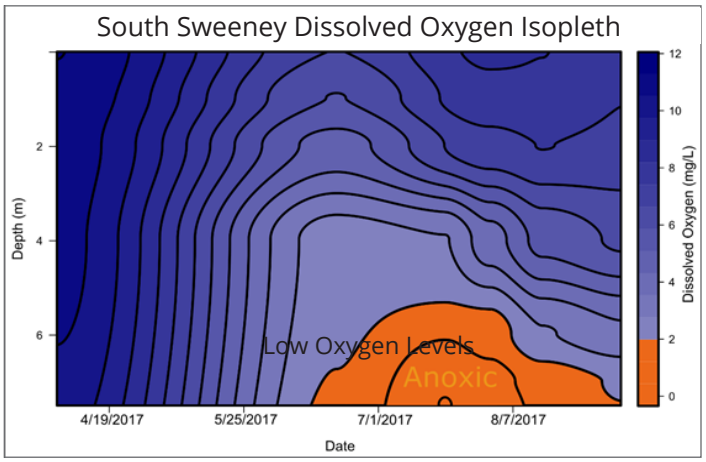
Chloride levels in 2017

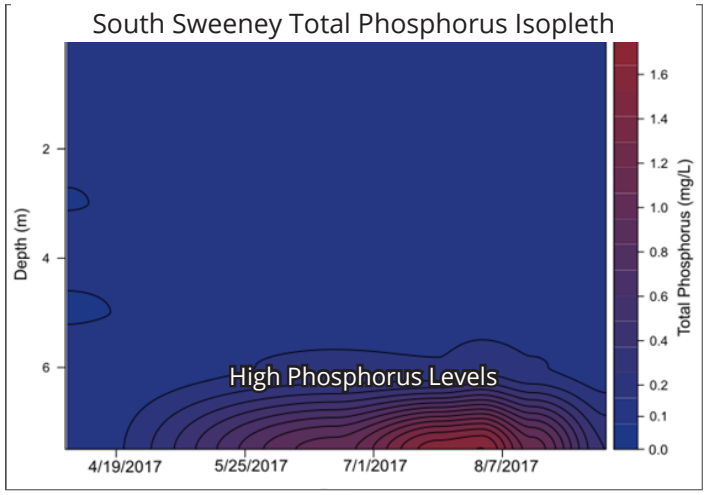
Chloride present in deicing chemicals applied to streets and parking lots in the Sweeney Lake watershed is conveyed to the lake by snowmelt and rainfall runoff. Excessive chloride concentrations have been linked to decreased biodiversity in water bodies. Sweeney Lake was placed on the State's 303(d) list of impaired waters in 2014 for chloride.

- According to MPCA assessment protocol, a lake is considered impaired for chloride if two or more exceedances of the chronic exposure standard (230 mg/l) are recorded within a three year period
- Range: Concentrations in the North Basin ranged from 289 mg/L in early April to 152 mg/L in early September; concentrations in the South Basin ranged from 287 mg/L in early April to 143 mg/L in early September.
- Only one of the six samples (early April) collected in the North and South Basins in 2017 exceeded the MPCA 230 mg/L chronic standard.









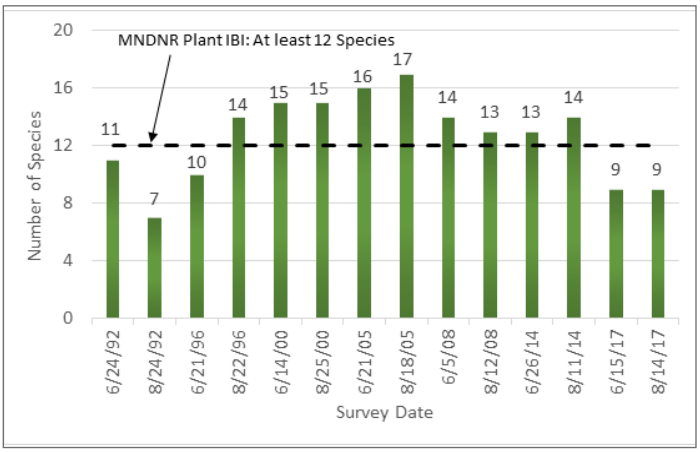
Macrophytes (aquatic plants)

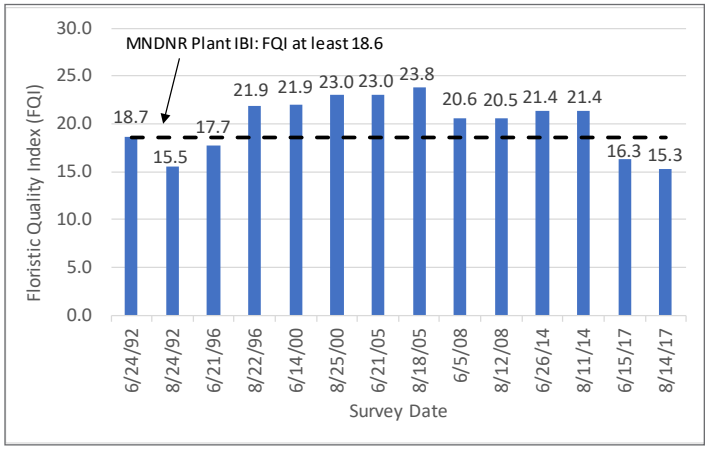
Lake Plant Eutrophication Index of Biological Integrity (IBI)

The Minnesota Department of Natural Resources (MDNR) recently developed metrics to determine the overall health of a lake's aquatic plant community. The Lake Plant Eutrophication Index of Biological Integrity (IBI) is used by the MPCA to determine whether a lake is meeting the federal Clean Water Act standards intended to protect aquatic life. The plant IBI includes two metrics: (1) the number of species in a lake and (2) the "quality" of the species, as measured by the floristic quality index (FQI).

Sweeney Lake plant survey data from 1992 through 2017 were assessed to determine plant IBI. The figures below show the number of species and FQI for that period compared to the MDNR plant IBI impairment threshold. During the period examined, the number of species in Sweeney Lake has ranged from 9 to 17, exceeding the impairment threshold of at least 12 species in 9 of the 14 survey events. FQI values ranged from 15.3 to 23.8, and the lake has met or exceeded the impairment threshold (18.6 minimum) in 10 of the 14 survey events since 1992. In general, the number of species and FQI scores for 2017 were lower than other survey efforts since 2000. Below are a few factors that may have led to the lower 2017 scores:

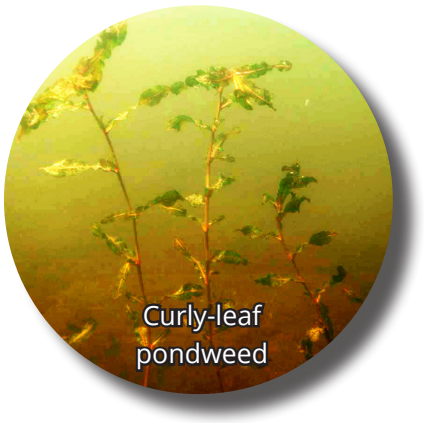
- During the 2014 surveys, there were 9 species that were observed at less than 5% of the sample points. Of these 9 species, only 4 were observed during the 2017 surveys.
- Surveys prior to 2017 noted two different duckweed and one watermeal species. The 2017 surveys only noted one duckweed and no watermeal species.
- Waterlilies (yellow and white) were observed at significantly more sample points (yellow = 16%; white = 38%%) during the 2017 surveys compared to the 2014 surveys (yellow = 2%; white = 22%). Waterlilies, when present in high densities, have the potential to shade and limit light penetration to submerged aquatic vegetation species.





Aquatic invasive species

In 2017, one aquatic invasive species was observed in Sweeney Lake, curly-leaf pondweed. Curly-leaf pondweed in Sweeney Lake was first noted during the 1992 vegetation surveys. In 2017, curly-leaf pondweed was noted at approximately 12% of the sample points during the June survey.



Microscopic plants and animals

Phytoplankton in 2017

Samples of phytoplankton, microscopic aquatic plants, were collected from Sweeney Lake in 2017 to evaluate water quality, determine the quality of food available to the lake's zooplankton (microscopic animals), and estimate the public health risk posed by blue-green algae, which produce toxins.

In general, phytoplankton numbers followed a pattern similar to chlorophyll a, increasing from June through early August and decreasing in late August and September. As shown in the figures on page 7, blue-green algae, a poor food source for zooplankton, were dominant in both basins throughout the 2017 monitoring season.

Sweeney Lake is subject to significant "internal phosphorus loading" during the summer, meaning that phosphorus from the lake's sediment is released to the surface water. This increase in phosphorus encourages phytoplankton growth, particularly blue-green algae.

Blue-green algae can produce natural toxins; in high concentrations, these toxins can be harmful to pet and human health. The World Health Organization (WHO) has established the following guidelines for assessing the risk posed to lake users by exposure to blue-green algae.

- Lakes with blue-green algae densities less than 20,000 cells per milliliter pose no risk to the health of humans or pets.
- Exposure to lakes with blue-green algae density levels between 20,000 and 100,000 cells per milliliter poses a low risk of adverse health impacts (i.e., skin irritation or allergenic effects such as watery eyes).
- Exposure to lakes with blue-green algae densities greater than 100,000 cells per milliliter poses a moderate health risk (i.e., long-term illness from algal toxins is possible).

In 2017, blue-green algae numbers were in the moderate risk category in both basins from mid-June through early September. As noted, higher blue-green algae concentrations correlated with increasing surface water phosphorus concentrations. It should also be pointed out that the South Basin had higher surface phosphorus and blue-green algae concentrations than the North Basin throughout most of the summer in 2017.

Zooplankton in 2017

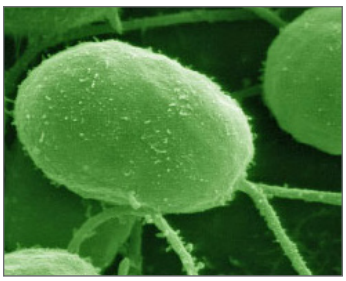
The size and composition of the lake's zooplankton community, as illustrated by the figures on page 7, was consistent with previous years. All three groups of zooplankton (rotifers, copepods, and cladocerans) were represented; however, small rotifers and copepods (which have limited impact on the lake's water quality) generally dominated.

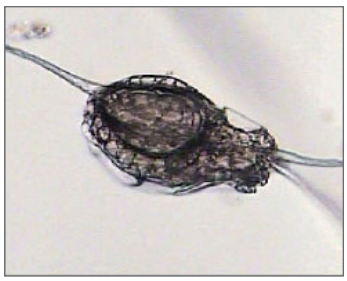
The zooplankton data illustrate the interconnectedness of a lake's food web and its water quality. Of particular interest in 2017 were the large-bodied cladoceran. The numbers of these zooplankton increased from April through mid-June, then declined and remained at relatively low levels throughout the remainder of the summer. The mid-June peak in cladoceran abundance correlated with the lowest chlorophyll a concentration and highest Secchi disc depth (i.e., better water quality) measurement of the summer growing season. This is because the large-bodied zooplankton graze on algae.

While large-bodied cladoceran can improve lake water quality, fish predation limits their impact much of the summer. Another limiting factor is the predominance of blue-green algae, a poor food source for zooplankton.

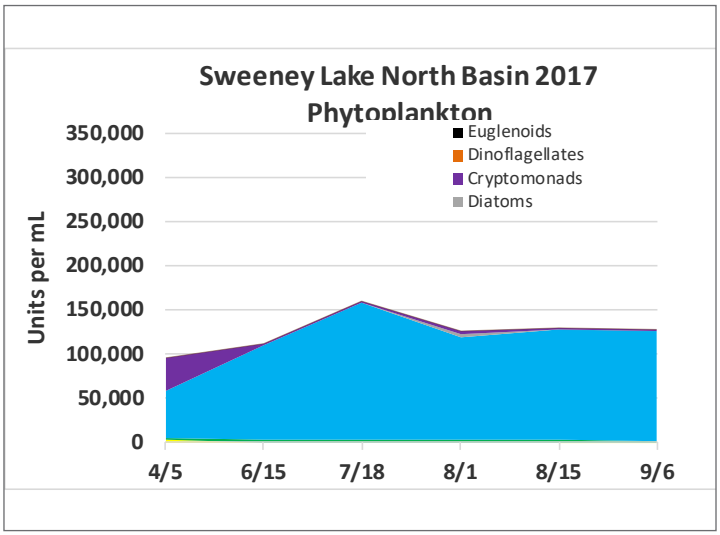
The importance of monitoring

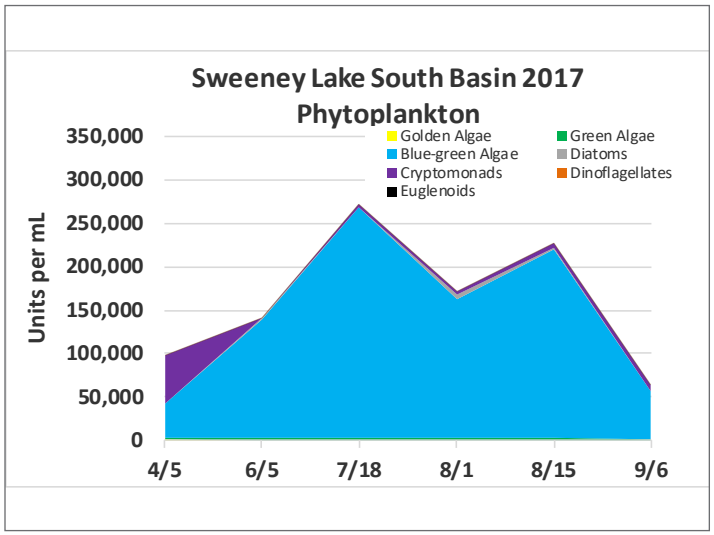
Both the phytoplankton and zooplankton data affirm the importance of reducing phosphorus loading to the lake to prevent increases in blue-green algae. The data also highlights the importance of monitoring the phytoplankton community to ensure that blue-green algae density levels do not threaten the health of lake users.

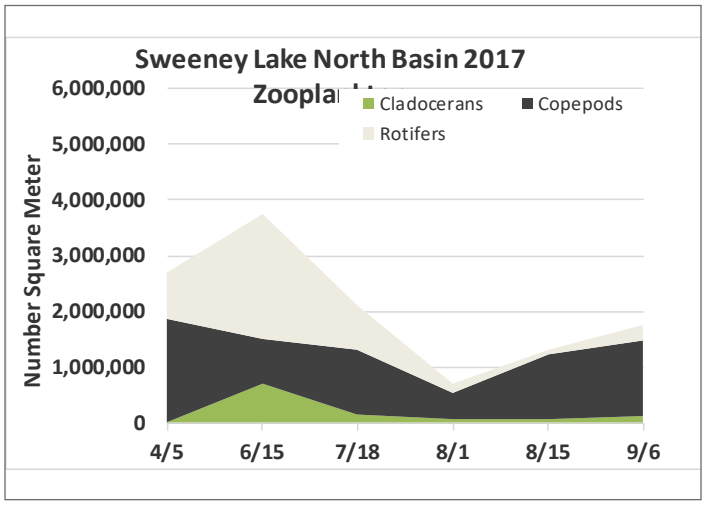


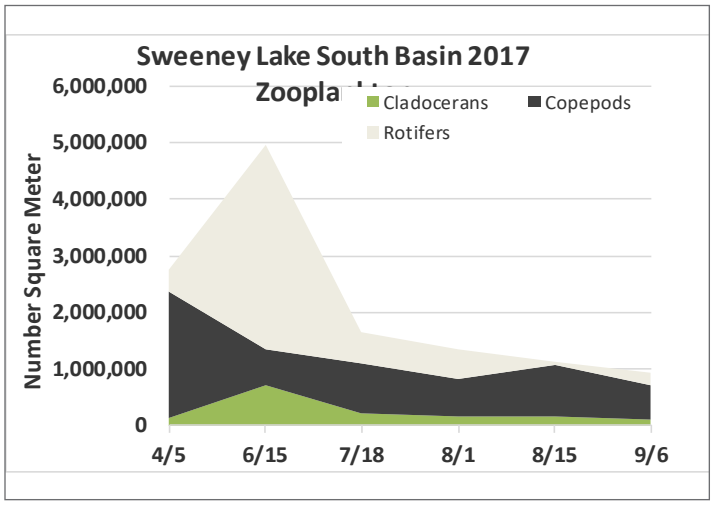


Above: Left—Chlamydomonas, a type of green algae found in Sweeney Lake. Right—Filinia longiseta, a rotifer found in Sweeney Lake; the phytoplankton and zooplankton communities in Sweeney Lake are represented in the figures on page 7.









Sweeney Lake fish

Recent fish surveys for Sweeney Lake include an electrofishing assessment conducted by the MNDNR in late August 2013 and a trap net survey performed by Blue Water Science in September 2013. A total of eleven fish species were sampled during the trap net survey with bluegill sunfish and black crappies being the most abundant species. Gamefish species included largemouth bass and northern pike. Overall, the number of fish per net were at the upper end of the MnDNR normal range for a lake like Sweeney. Certain fish species such as common carp, in high abundance, can cause adverse water quality impacts in lakes. The 2013 study concluded that the impacts of fish on water quality in Sweeney Lake appears to be low to moderate (Blue Water Science, 2013).

Photo credit: Jane McDonald Black

Bassett Creek Watershed Management Commission
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