Item 5D.
BCWMC 7-15-21

Sweeney Lake 2020 water quality monitoring

Bassett Creek Watershed Management Commission

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 since 1972. The purpose of this monitoring is to detect changes or trends in water quality and evaluate the effectiveness of efforts to preserve or improve water quality

At a glance: 2020 monitoring results

In 2020, the BCWMC monitored Sweeney Lake for:

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

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
MNDNR ordinary high water level	827.9 feet
Normal water level	827.2 feet
Downstream receiving waterbody	Sweeney Lake Branch, Bassett Creek
Location (city)	Golden Valley
MPCA impairments	Chloride and nutrients
Aquatic invasive species	Curly-leaf pondweed
Public access	Yes (non-motorized boat launch)

2020 monitoring results indicate decreasing total phosphorus concentrations and increasing water clarity have improved Sweeney Lake's water quality and overall ecological health. Numbers of plant species and the quality of the plant community improved, phytoplankton numbers declined, and zooplankton numbers declined because fish were better able to see and prey upon zooplankton. Because fish growth is determined by the quantity of food consumed, the increased predation of zooplankton is favorable for fish growth.

Results of 2020 monitoring show that Sweeney Lake met the applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for Secchi disc depth (a measure of clarity), total phosphorus, and chlorophyll *a*. Trend analyses show improving water quality with statistically significant (95 percent confidence level) decreases in total phosphorus concentrations and increases in water clarity (Secchi disc depth) over the last 10 years.

The lake met the MPCA maximum standard for chloride but failed to meet the MPCA chronic standard for chloride. More near-bottom chloride measurements failed to meet the MPCA chronic criterion in 2020 than in 2017, an unfavorable change for the lake.

Phytoplankton and zooplankton numbers were within the range observed since 1982. Both the number of plant species in the lake and Floristic Quality Index (FQI) values (a measure of plant species quality) were better than the MNDNR Plant Index of Biotic Integrity (IBI) thresholds.

In the spring of 2020, an herbicide (diquat) was applied within portions of Sweeney Lake to control curly-leaf pondweed (CLP), an aquatic invasive species (AIS). The successful treatment reduced CLP frequency in the lake (two locations in June 2020 compared with 13 locations in June 2017). Other AIS species observed in 2020 were yellow iris, purple loosestrife, reed canary grass, and narrow-leaved cattail. The appearance of yellow iris is concerning because it spreads rapidly and competes with native shoreland vegetation.

The results of an AIS Suitability Analysis indicate the water quality of Sweeney Lake meets the suitability requirements for rusty crayfish, faucet snail, zebra mussel, spiny waterflea, and starry stonewort and partially meets the suitability requirements for the Chinese mystery snail.

Recommendations

- Identify management measures to reduce chloride runoff from the lake's watershed

- Communicate with landowner to request removal of yellow iris
- Continue to provide education and information to residents and lake users to reduce the chance of AIS instroduction.
- Continue water quality and biological monitoring at a 3-year frequeny

Water chemistry monitoring: 2020

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, too much phosphorus leads to excessive algae, decreased water clarity, and water impairment. Some common sources of phosphorus are fertilizers, leaves and grass clippings, atmospheric deposition, soil erosion, and plant die-off (such as curly-leaf pondweed). Phosphorus can also be released from lake sediments when oxygen concentrations are absent or very low.

- **BCWMC/MPCA standard:** 40 micrograms per liter (µg/L) or less.
- **Range:** Total phosphorus concentrations in the North Basin ranged from a low of 19 µg/L on July 27 to a high of 38 µg/L on August 17. Total phosphorus concentrations in the South Basin ranged from a low of 16 µg/L on July 4 to a high of 32 µg/L on August 17. Fifty-eight percent of North Basin and 60 percent of South Basin total phosphorus concentrations were in the "mesotrophic" category, indicating medium levels of nutrients. All other total phosphorus concentrations were in the eutrophic category, indicating high levels of nutrients.
- **Summer average of North and South Basins:** 24 µg/L (met BCWMC/MPCA standard)

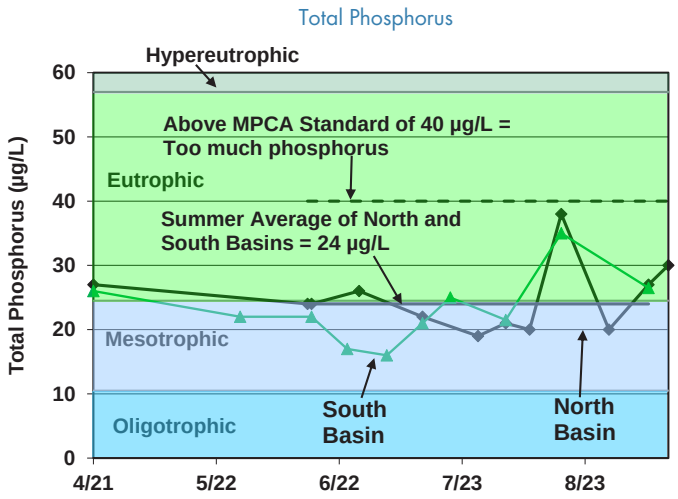
Chlorophyll *a* levels

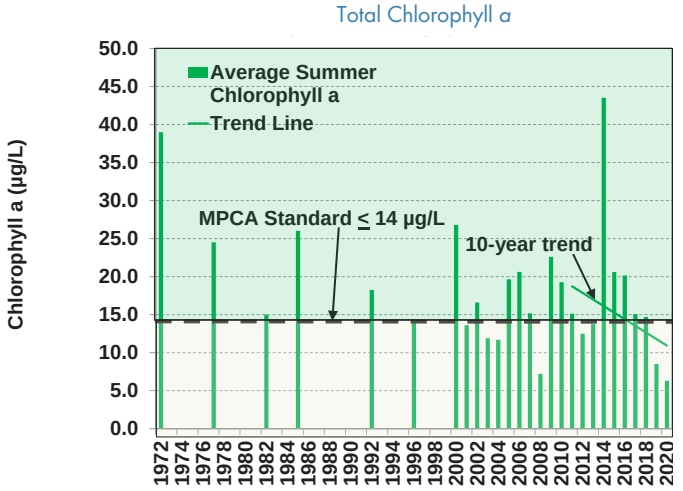
Chlorophyll *a* is a pigment in algae and generally reflects the amount of algae growth in a lake. Lakes which appear clear generally have chlorophyll *a* levels less than 15 micrograms per liter (µg/L).

- **BCWMC/MPCA standard:** 14 µg/L or less.
- **Range:** Chlorophyll *a* concentrations in the North Basin ranged from a low of 1.9 µg/L on June 27 to a high of 12.4 µg/L on April 21. Chlorophyll *a* concentrations in the South Basin ranged from a low of 2.7 µg/L on May 28 to a high of 14.3 µg/L on April 21. Sixty-seven percent of North Basin and 50 percent of South Basin chlorophyll *a* concentrations were in the mesotrophic category, indicating good water quality. All other chlorophyll *a* concentrations were in the eutrophic category, indicating poor water quality.
- **Summer average of North and South Basins:** Summer average of North and South Basins: 6.3 µg/L (met BCWMC/MPCA standard)

Definitions

- **Hypereutrophic:** Nutrient-rich lake conditions characterized by frequent and severe algal blooms and low water clarity; excessive algae can significantly reduce lake oxygen levels
- **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
- **Mesotrophic:** Lake condition characterized by medium levels of nutrients and clear water
- **Oligotrophic:** Lake condition characterized by a low accumulation of dissolved nutrients, high oxygen content, sparse algae growth, and very clear water





Water clarity

Water clarity is often affected by sediment and the amount of algae 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 (or clarity). The higher the Secchi depth, the better the clarity.

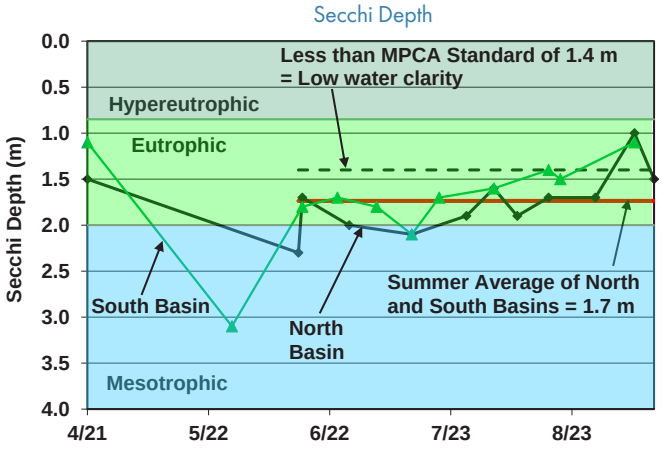
- **BCWMC/MPCA standard:** 1.4 meters or more.
- **Range:** Secchi disc depth in the North Basin ranged from a low of 1.0 meter on September 8 to a high of 2.3 meters on June 14. Secchi disc depth in the South Basin ranged from a low of 1.1 meters on April 21 and September 8 to a high of 3.1 meters on May 28. Twenty-five percent of North Basin and 18 percent of South Basin Secchi disc depths were in the mesotrophic category, indicating good water quality. All other measurements were in the eutrophic category, indicating poor water quality.
- **Summer average of North and South Basins:** 1.7 meters (met BCWMC/MPCA standard).

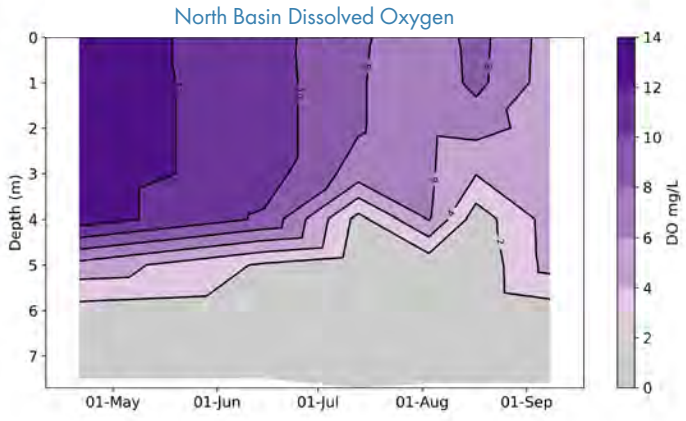
Phosphorus loading from sediment

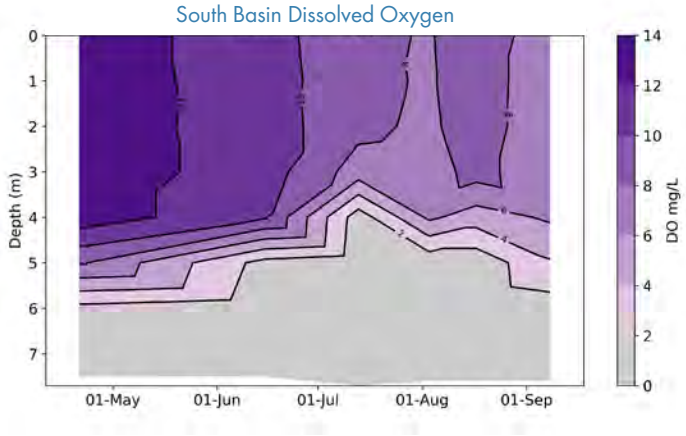
The release of phosphorus stored in lake-bottom sediments when oxygen levels are low is described as internal loading from sediment. The Sweeney Lake total maximum daily load (TMDL) study found internal phosphorus loading from sediment to be a significant source of lake phosphorus—about one-third of 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 in previous years. The aerators were not operated in Sweeney Lake during the 2020 sampling season.

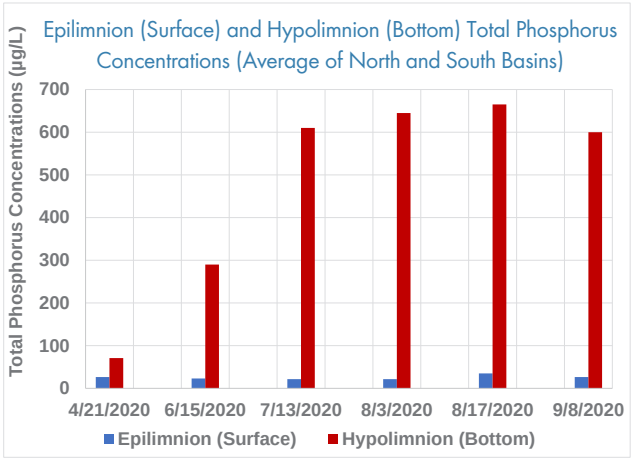
The 2020 data indicate near-bottom oxygen levels were low (<2 mg/L) throughout the monitoring period. Internal phosphorus loading from sediment during this period caused near-bottom phosphorus concentrations to increase consistently. Because the lake remained stratified (separated into layers) throughout the monitoring period, the high phosphorus concentrations were confined to the bottom of the lake. The surface water phosphorus concentrations met the MPCA standard throughout the monitoring period.

In 2020, BCWMC completed an alum treatment in the fall to reduce internal phosphorus loading from sediment. BCWMC also removed 452 carp from Sweeney Lake in 2020 to further reduce internal phosphorus loading. The bottom-feeding fish disturb the phosphorus-rich lake sediment, releasing phosphorus into the water column.







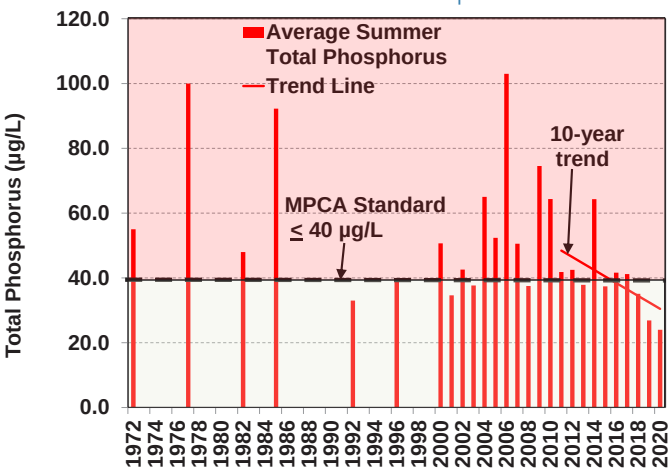


Water chemistry monitoring from 1972–2019: historical trends

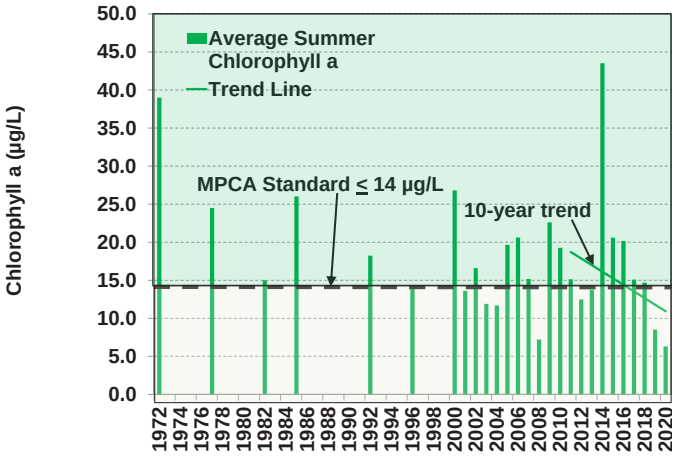
Water quality in Sweeney Lake has been monitored since 1972. Summer averages (June through September) of total phosphorus, chlorophyll *a*, and Secchi disc depth from 1972–2020 are shown in the figures at right. During the period of record, 63 percent of total phosphorus, 70 percent of chlorophyll *a*, and 37 percent of Secchi disc summer averages failed to meet Minnesota State Water Quality Standards for lakes in the North Central Hardwood Forest Ecoregion, as published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4).

Trend analyses show improving water quality with statistically significant (95 percent confidence level) decreases in total phosphorus concentrations and increases in water clarity (Secchi disc depth) over the last 10 years. Chlorophyll *a* concentrations decreased during this time period, but not at statistically significant levels.

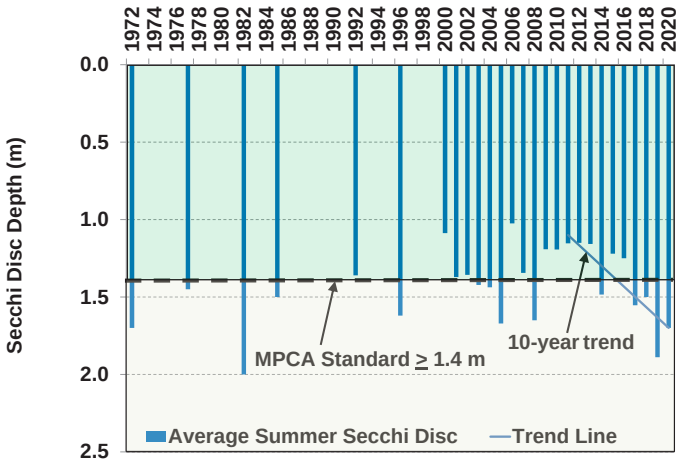
Historical Total Phosphorus



Historical Total Chlorophyll *a*



Historical Water Clarity



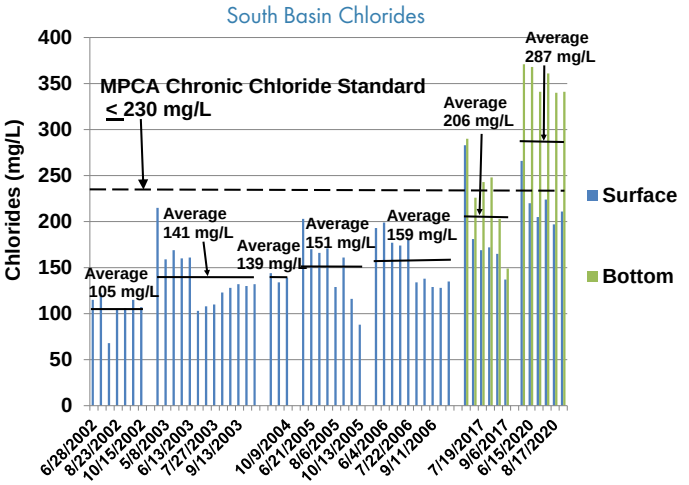
Chloride levels

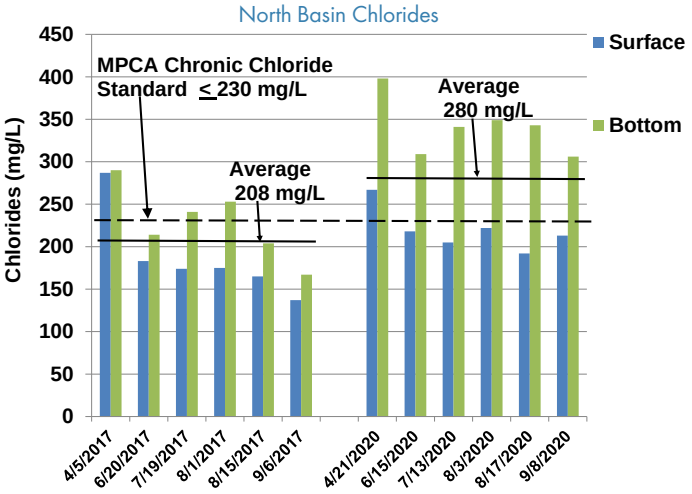
Chloride concentrations in lakes and streams have increased since the early 1990s when winter maintenance practices largely switched from using sand and/or sand/salt mixtures to salt for roads and parking lots. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of salt to permanently pollute 5 gallons of water. And, once in the water, there is no way to remove chloride.

Because high concentrations of chloride can harm fish and plant life, the MPCA established maximum and chronic chloride standards. The maximum standard is the highest concentration of chloride that aquatic organisms can be exposed to for a brief period of time with zero to slight mortality.The chronic standard is the highest chloride concentration that aquatic life can be exposed to indefinitely without causing chronic toxicity. Chronic toxicity means a condition that lingers or continues for a long period of time. A chronic effect can be mortality, reduced growth, reproduction impairment, harmful changes in behavior, and other nonlethal effects. A lake is considered impaired if two or more measurements exceed the chronic criterion (230 mg/L or less) within a 3-year period or one measurement exceeds the maximum criterion (860 mg/L). Sweeney Lake was placed on the state's 303(d) list of impaired waters in 2014 for chloride.

All measurements during the period of record were below the maximum criterion. Chloride measurements from both the surface and bottom of the North Basin and South Basin were above the chronic criterion in April of 2017 and April of 2020. Bottom samples from both basins were above the chronic criterion in July and early August of 2017 and during all 2020 sample events . The increased frequency of bottom measurements exceeding the chronic criterion in 2020 is a significant concern for the lake.

Average annual chloride concentrations have increased over the years. At the South Basin, average annual chloride concentrations increased from 105 mg/L in 2002 to 206 mg/L in 2017 to 287 mg/L in 2020. At the North Basin, average annual chloride concentrations increased from 208 mg/L in 2017 to 280 mg/L in 2020.





Macrophytes

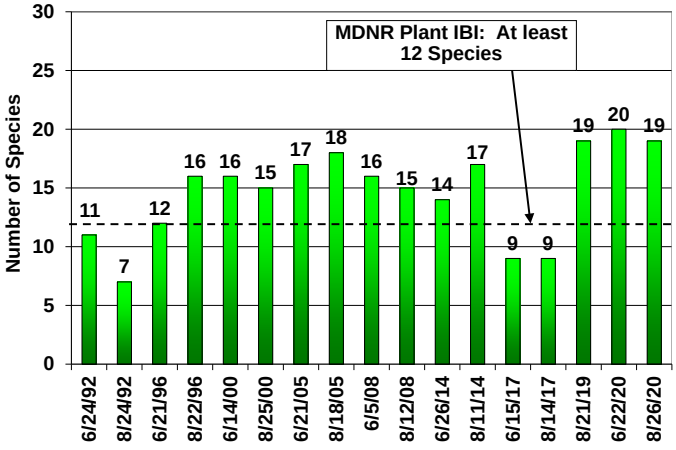
Lake Plant Eutrophication Index of Biological Integrity (IBI)

Eutrophication (excessive nutrients) may have detrimental effects on a lake, including reductions in the quantity and diversity of aquatic plants. The Minnesota Department of Natural Resources (MNDNR) developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Lake Plant Eutrophication 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). The MNDNR has determined a threshold for each metric. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic (human-caused) eutrophication.

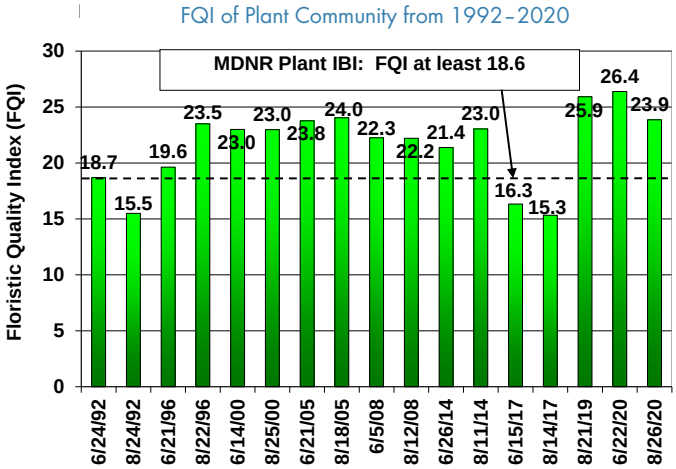
Plant survey data from 1992 to 2020 were assessed to determine plant IBI trends. The figures at right show Sweeney Lake FQI scores and the number of species for that period compared to the MNDNR Plant IBI thresholds.

- **Number of species:** A deeper water lake, such as Sweeney Lake, fails to meet the MNDNR Plant IBI threshold when it has fewer than 12 species. During the period examined, the number of species in Sweeney Lake ranged from 7 to 20, meeting or exceeding the MNDNR Plant IBI threshold from 1996 through 2014 and 2019 through 2020. Nineteen to 20 species were observed in the lake in 2019 and 2020, the highest number to date.
- **FQI values (quality of species):** The MNDNR Plant IBI threshold for deeper water lakes, as measured by FQI, is a minimum value of 18.6. During the period examined, FQI values in Sweeney Lake ranged from 15.3 to 26.4, exceeding the MNDNR Plant IBI threshold in June of 1992, June and August of 1996 through 2014, and 2019 through 2020. FQI scores from 25.9 to 26.4 were observed in August 2019 and June 2020, respectively, the highest scores to date.
- **2020 results:** Both the number of species in the lake and FQI values were better than the MNDNR Plant IBI thresholds. Both the number of species and FQI improved in 2019 and 2020 and, in 2020, the plant community had a greater number of species and a higher FQI score than in previous years.

Species Richness of Plant Community from 1992–2020



FQI of Plant Community from 1992–2020



Aquatic invasive species

In 2020, five invasive species were found in Sweeney Lake.

- **Yellow iris (*Iris pseudacorus*):** The first observation of yellow iris occurred in August 2019 at one location along the southwest shore of Sweeney Lake. It was observed at this same location in both June and August 2020. The appearance of yellow iris is concerning because it spreads rapidly and competes with native shoreland vegetation. Its root system forms a dense mat that compacts the soil and inhibits seed germination of other plants. The Commission Engineer recommends that BCWMC ask the landowner to remove the yellow iris. The landowner could either dig it up or spray it with glyphosate. An MNDNR permit would be required for either method of removal.
- **Curly-leaf pondweed (*Potamogeton crispus*):** Curly-leaf pondweed was first observed during the 1992 plant surveys and has consistently been in the lake throughout the monitoring period. In June of 2017, curly-leaf pondweed extent was estimated at 5.6 acres. In May of 2020, an herbicide (diquat) was used within 5.64 acres of Sweeney Lake to control curly-leaf pondweed. The treatment reduced the curly-leaf pondweed from 13 locations in June 2017 to two locations in June 2020.
- **Reed canary grass (*Phalaris arundinacea*):** Reed canary grass has been observed at different locations in the lake since June 2014, when it was first spotted at one location in the channel to Twin Lake. In August 2014, it was observed at a single location in the northwest corner of the lake. In 2020, it was observed at a location along the west shoreline in both June and August and at a second location along the northwest shoreline in June.
- **Purple loosestrife (*Lythrum salicaria*):** Purple loosestrife was first observed during the August 1992 plant survey and has been sporadically observed (1992, 2005, 2008, 2014, and 2020) in different locations during the monitoring period. It was observed at a single location along the northwest shoreline in June 2020 and at two locations along the western and northern shorelines in August 2020.
- **Narrow-leaved cattail (*Typha angustifolia*):** The first observation of narrow-leaved cattail occurred in June 2014 at two locations. It was observed at four locations in August 2014, at one location in August 2019, and at two locations in June and August 2020.

Purple loosestrife on Sweeney Lake

Yellow iris on Sweeney Lake

Phytoplankton and zooplankton

Samples of phytoplankton (microscopic aquatic plants) were collected from Sweeney Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). 2020 results indicate increased water quality in Sweeney Lake has improved the ecological health of the lake. Phytoplankton numbers declined in 2020 due to lower phosphorus concentrations. Zooplankton numbers declined in 2020 due to increased fish predation because fish were better able to see zooplankton in the clearer water. Increased food intake is a favorable change for the fish because it increases fish growth.

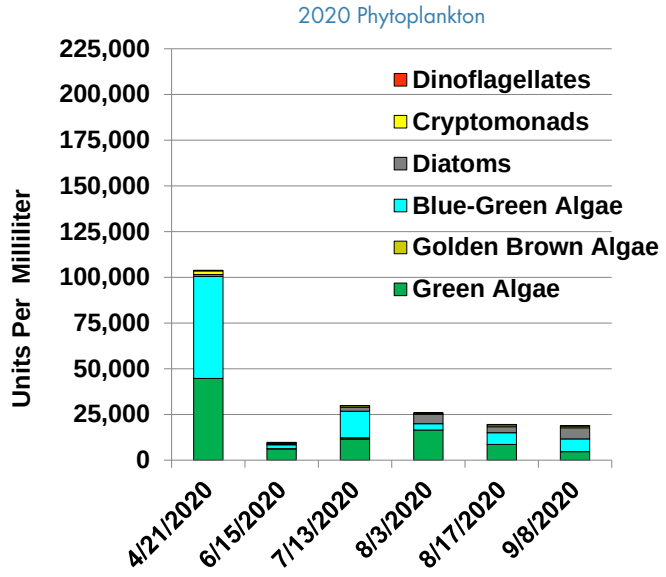
As shown in the figure at right, phytoplankton numbers declined in June, increased in July, and then consistently declined through September. The community was generally dominated by green algae and/or blue-green algae. Blue-green algae are a poor quality food because they may be toxic and may not be assimilated if ingested by zooplankton. Blue-green algae can also produce algal toxins, which can be harmful to humans or other animals. Green algae are a better quality food source than blue-green algae and contribute towards a healthier zooplankton community.

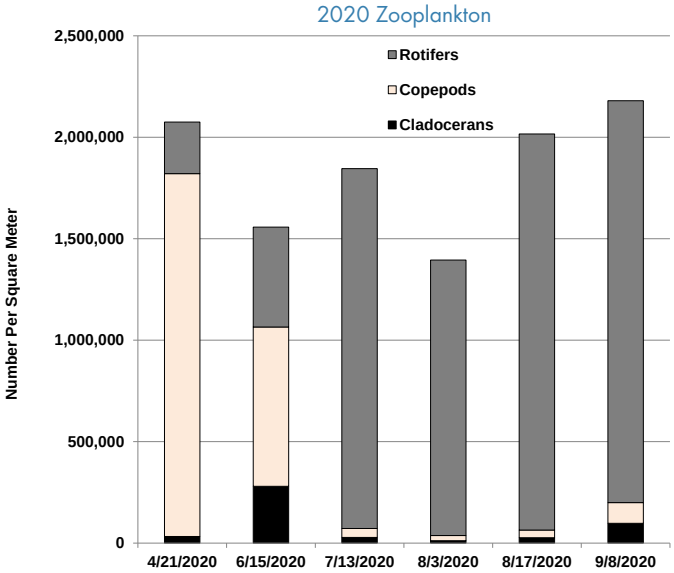
2020 phytoplankton numbers were within the range observed since 1982. Numbers in June through September were lower than those in 2017 (see figure on page 10). The lower phytoplankton numbers in 2020 are consistent with the lower average summer chlorophyll *a* concentration observed in 2020 (see figure on page 3).

Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantities and species, they can filter the volume of an entire lake in a matter of days. They are also valuable food for planktivorous fish and other organisms. Fish generally select the largest zooplankters they see and prefer cladocerans to copepods because they swim slowly and lack the copepods' ability to escape predation by jerking or jumping out of the way.

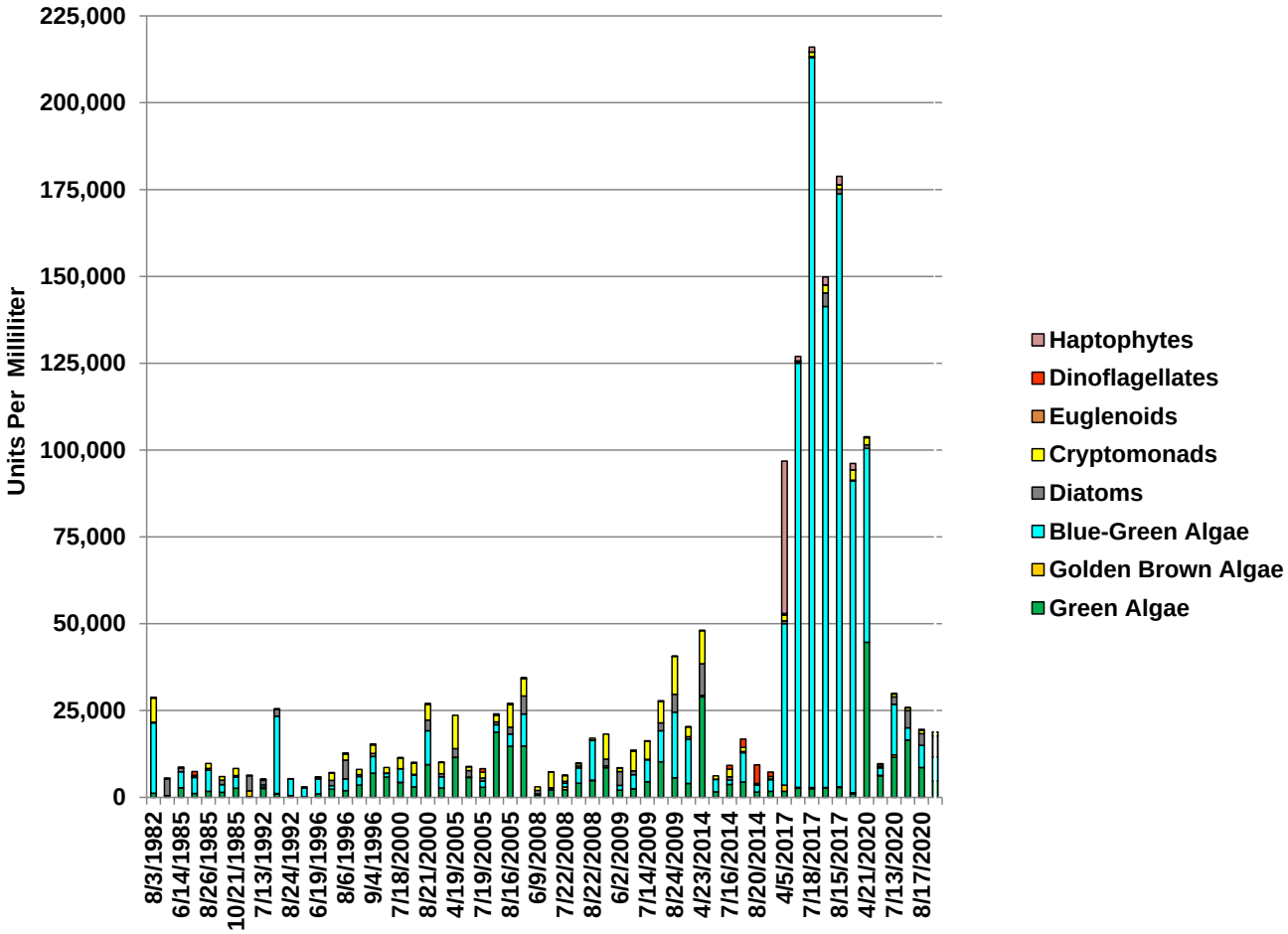
The 2020 community composition reflects the impact of fish predation. Copepods dominated the zooplankton community in April, and the community was fairly balanced between copepods, cladocerans, and rotifers in June (see figure at right). The number of copepods and cladocerans plummeted in July and remained low for the duration of the monitoring period. Small rotifers, the least preferred food for fish, increased in number in July and dominated the community for the duration of the monitoring period.

The 2020 numbers of zooplankton in Sweeney Lake were within the range observed since 1982 (see figure on page 10). Copepod numbers in July through September 2020 were lower than during July through September of 2014 and 2017. The lower numbers are likely a result of increased fish predation in 2020 due to improved water clarity, a favorable change for the lake's fishery since fish growth is directly related to the quantity of food they consume. As noted previously, trend analyses showed improving water quality with significant increases in water clarity. Summer average Secchi disc increased from 1.5 meters in 2014 to 1.6 meters in 2017 to 1.7 meters in 2020. Improved water clarity in 2020 helped fish to see and prey upon zooplankters.

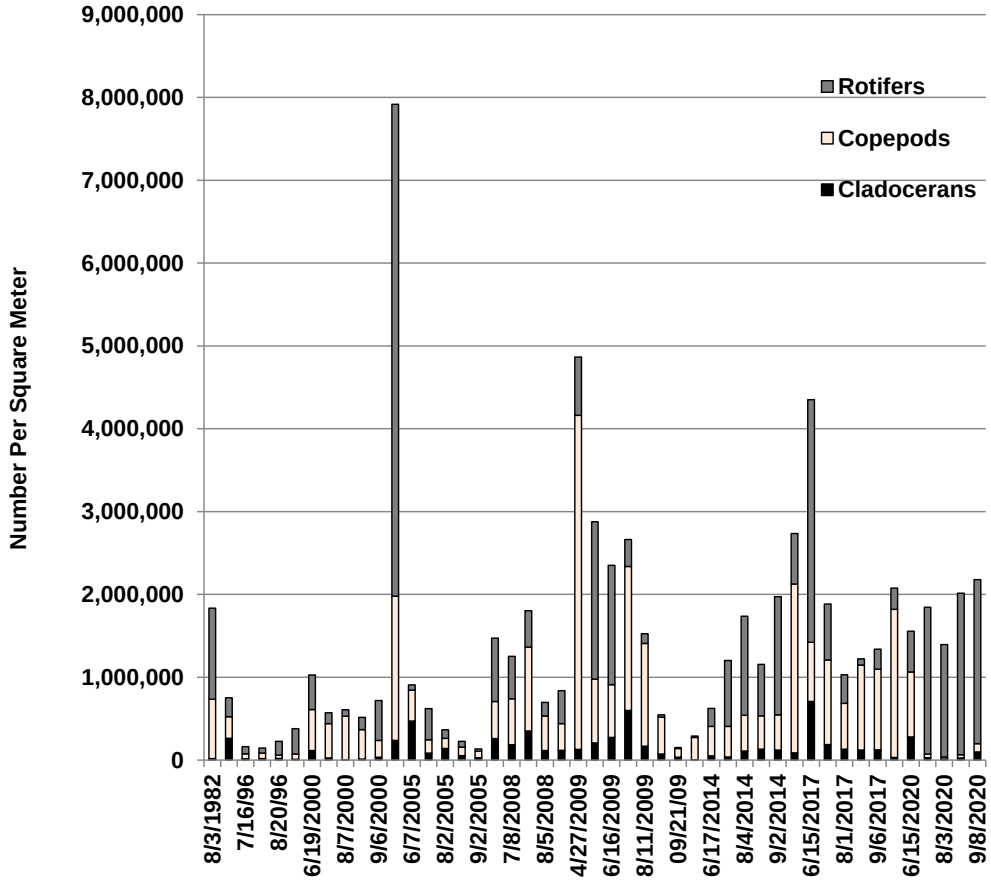




Historical Phytoplankton



Historical Zooplankton



Suitability of Sweeney Lake for Aquatic Invasive Species (AIS)

A large number of AIS residing in Minnesota have not yet been observed in Sweeney Lake but could be introduced. For example, both zebra mussels and starry stonewort are present in nearby Medicine Lake but have not been observed in Sweeney Lake. To evaluate whether Sweeney Lake water quality would support the introduction of six AIS (starry stonewort, zebra mussels, spiny waterflea, faucet snail, Chinese mystery snail, and rusty crayfish), a suitability analysis for each species was performed.

The analysis compared water quality data collected during 2020 and April of 2021 with the water quality conditions required for each species, specifically evaluating total phosphorus, chlorophyll *a*, Secchi disc depth, trophic state index, water temperature, dissolved oxygen, specific conductance, calcium, magnesium, sodium, alkalinity, hardness, and calcium carbonate. The results indicate the water quality of Sweeney Lake meets the suitability requirements for rusty crayfish, faucet snail, zebra mussel, spiny waterflea, and starry stonewort. However, the water quality of Sweeney Lake only partially meets the suitability requirements for the Chinese mystery snail. This species would likely survive but may not thrive in Sweeney Lake.


Starry Stonewort


Zebra Mussels


Spiny Waterflea


Faucet Snail


Chinese Mystery Snail


Rusty Crayfish

Channel from Sweeney to Twin Lake

Bassett Creek Watershed Management Commission
bassettcreekwmo.org

Cleaner, healthier water for a growing community