Item 5D.
BCWMC 7-15-21

Twin Lake 2020 water quality monitoring

Bassett Creek Watershed Management Commission

Monitoring water quality in Twin 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 Twin Lake for:

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

About Twin Lake

BCWMC classification	Priority-1 deep lake
Watershed area	131 acres
Lake size	21 acres
Average depth	25.7 feet
Maximum depth	56 feet
MNDNR ordinary high water level	827.9
Normal water level	827.2 feet
Downstream receiving waterbody	Sweeney Lake
Location (city)	Golden Valley
MPCA impairments	None
Aquatic invasive species	Curly-leaf pondweed
Public access	Yes, via park land

Results of 2020 monitoring show that Twin Lake met the applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for Secchi disc (a measure of clarity), total phosphorus, and chlorophyll *a*. The good water quality in 2020 documented the continued effectiveness of the 2015 alum treatment. Trend analyses show no significant change in water quality over the last 11 years.

Other results include:

- In 2020, Twin Lake chloride concentrations met the MPCA maximum and chronic chloride standards.
- 2020 numbers of phytoplankton were within the range observed since 1982. The 2020 summer average zooplankton number was the highest to date, a favorable change for the lake.
- 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 Minnesota Department of Natural Resources (MNDNR) Plant Index of Biotic Integrity (IBI) thresholds.
- Aquatic invasive species (AIS) observed in 2020 were curly-leaf pondweed, purple loosestrife, reed canary grass, and narrow-leaved cattail.
- An AIS Suitability Analysis indicates the water quality of Twin 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

- 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 frequency

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 Twin Lake ranged from a low of 3 µg/L on August 17 to a high of 50 µg/L on October 1. Twenty-seven percent of total phosphorus concentrations were in the oligotrophic category, indicating low levels of nutrients; 53 percent were in the mesotrophic category, indicating medium levels of nutrients; and 20 percent were in the eutrophic category, indicating high levels of nutrients. Values in the eutrophic category were measured in April and October.
- **Summer average of North and South Basins:** 12 µg/L (met BCWMC/MPCA standard).

Chlorophyll *a* levels

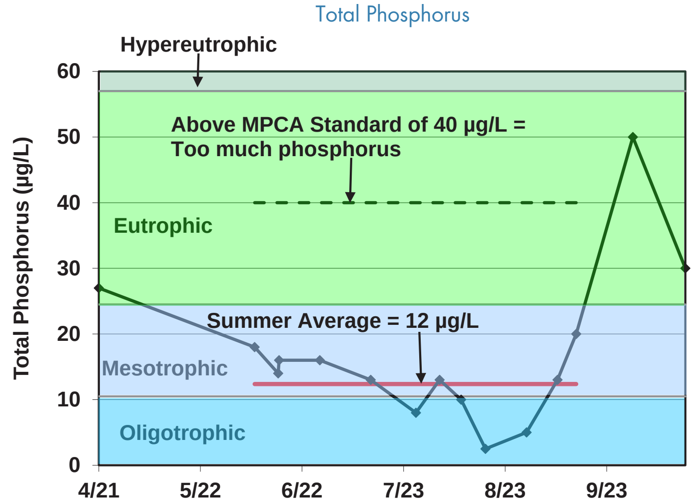
Chlorophyll *a* is a pigment in algae and generally reflects the amount of algae growth in a lake. Lakes which appear clear generally have chlorophyll *a* levels less than 15 micrograms per liter (µg/L).

- **BCWMC/MPCA standard:** 14 µg/L or less.
- **Range:** Chlorophyll *a* concentrations ranged from a low of 1.2 µg/L on August 3 to a high of 6.4 µg/L on April 21. Forty percent of chlorophyll *a* concentrations were in the oligotrophic category, indicating very clear water; 60 percent were in the mesotrophic category, indicating clear water.
- **Summer average:** 2 µg/L (met BCWMC/MPCA standard).

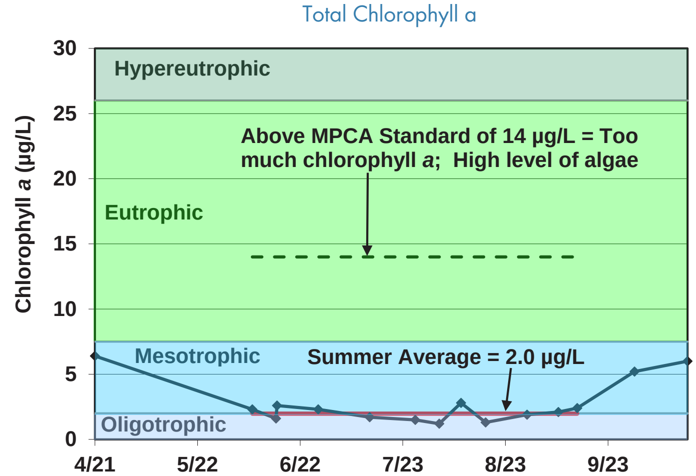
Definitions

- **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

Total Phosphorus



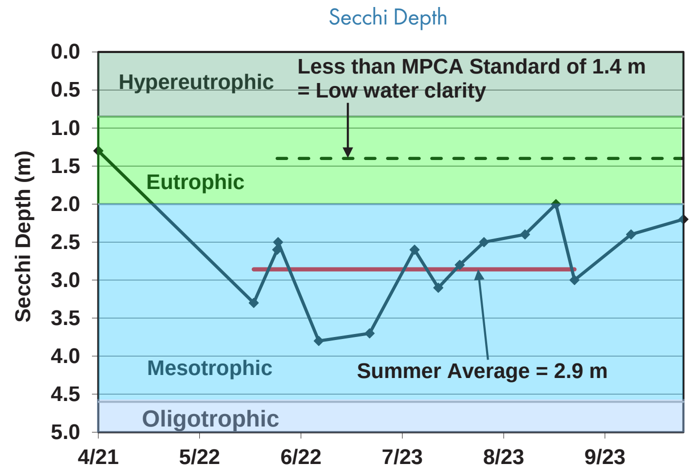
Total Chlorophyll a



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. The higher the Secchi number, the better the water clarity.

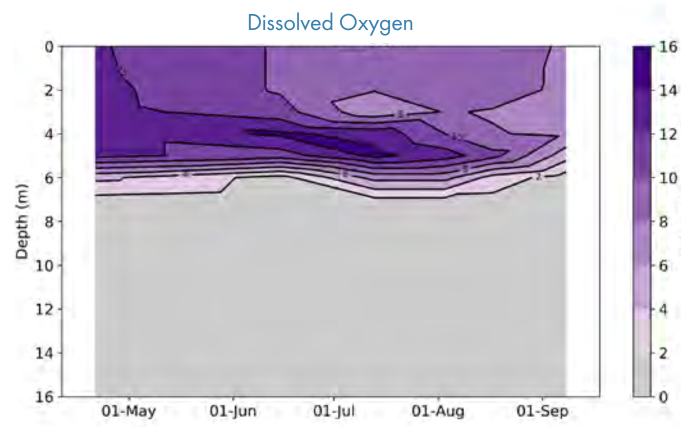
- **BCWMC/MPCA standard:** 1.4 meters or more.
- **Range:** Secchi disc depth ranged from a low of 1.3 meters on April 21 to a high of 3.8 meters on June 27. Ninety-three percent of Secchi disc depths were in the mesotrophic category, indicating good water quality. The single Secchi disc measurement in the eutrophic category occurred in April.
- **Summer average:** 2.9 meters (met BCWMC/MPCA standard).

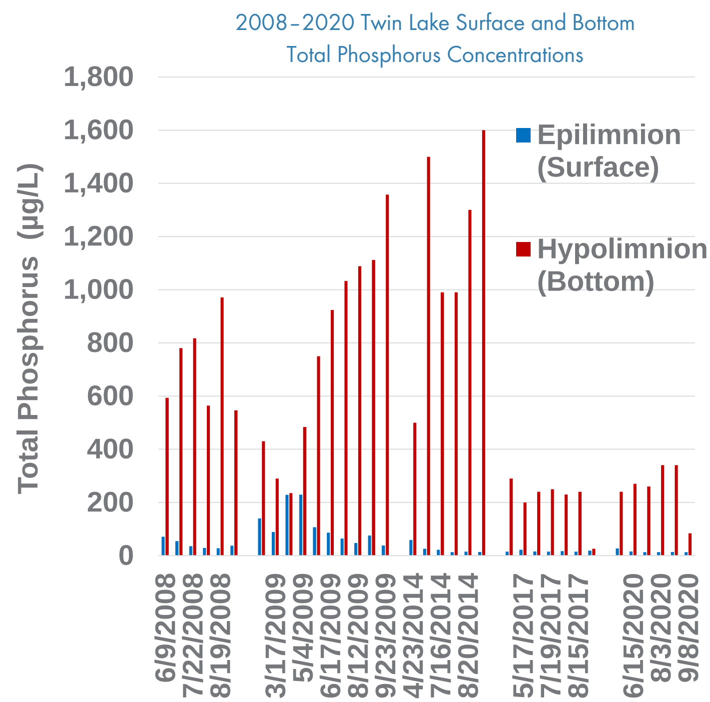


Phosphorus loading from sediment

When oxygen levels are low, phosphorus stored in sediment is released (internal loading), causing higher total phosphorus concentrations in near-bottom waters. In 2008 and 2009, summer-average surface water concentrations of phosphorus in Twin Lake increased significantly. This increase prompted the BCWMC to conduct a study to determine the causes. The study, Twin Lake Phosphorus Internal Loading Investigation, March 2011, identified internal loading from sediment as the primary cause. In response, the BCWMC performed an alum treatment on Twin Lake in 2015 to reduce the internal loading.

Monitoring since the alum treatment indicates good water quality and reduced phosphorus levels, documenting the continued effectiveness of the treatment. Even though the 2020 near-bottom oxygen levels were low (<2 mg/L, figure middle right), the 2020 near-bottom total phosphorus concentrations remained lower than concentrations measured prior to the treatment, documenting the treatment's continued effectiveness (figure bottom right). From 2008 through 2014, average near-bottom total phosphorus concentrations measured during the April through September period ranged from 712 μg/L to 1,147 μg/L. Average concentrations after the alum treatment were 211 μg/L in 2017 and 256 μg/L in 2020.





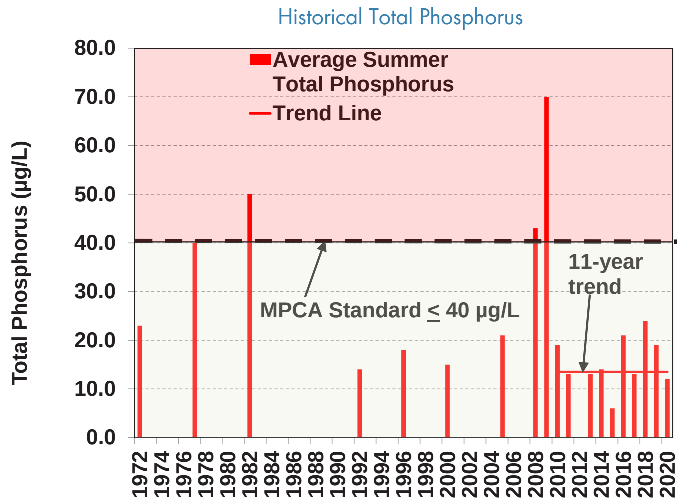
Water chemistry monitoring from 1972–2019: historical trends

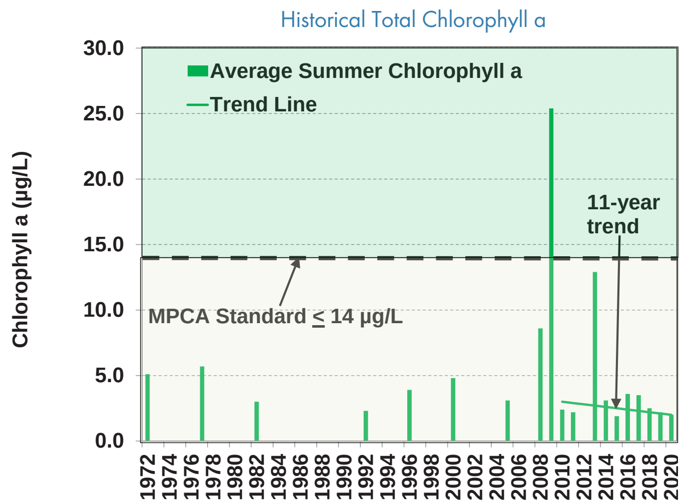
Water quality in Twin Lake has been monitored since 1972. Summer averages (June through September) of total phosphorus, chlorophyll *a*, and Secchi disc depth from 1972–2020 are shown in the figures at right. During the period of record, 16 percent of total phosphorus, 5 percent of chlorophyll *a*, and 5 percent of Secchi disc summer averages failed to meet Minnesota State Water Quality Standards for lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). All values measured after the 2015 alum treatment have met the MPCA standard.

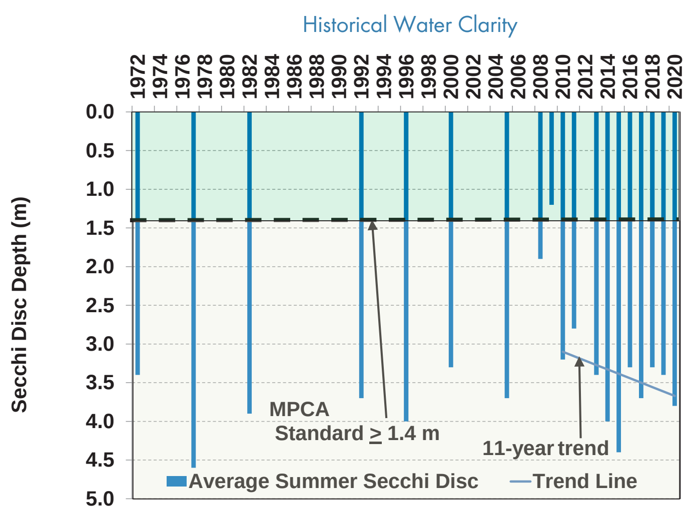
Trend analyses indicate no significant change in water quality over the past 11 years, showing:

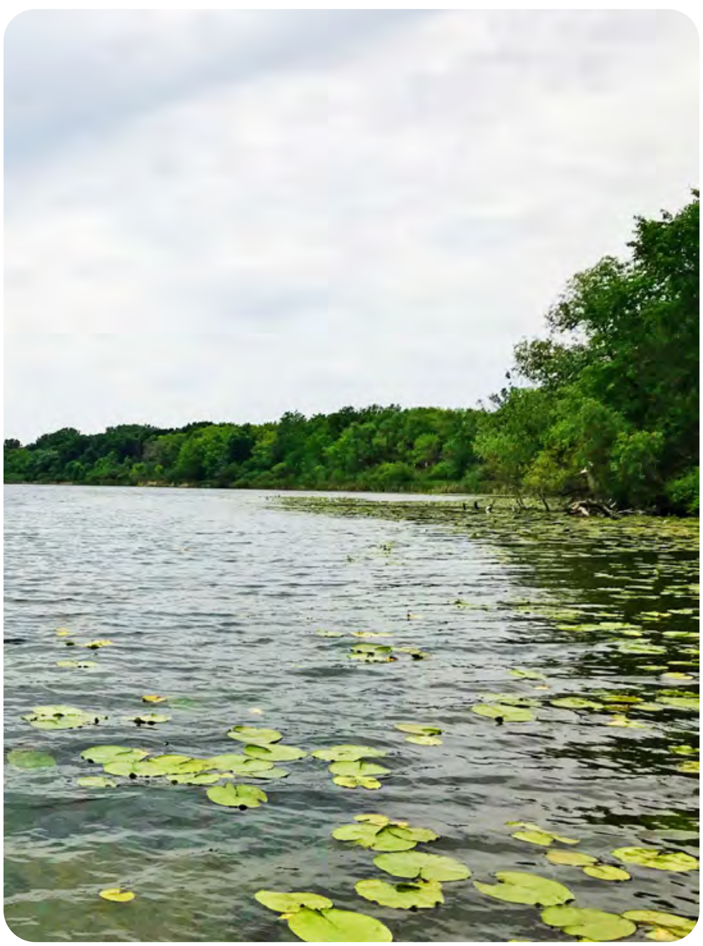
- No change in summer average total phosphorus concentrations.
- Declining summer average chlorophyll *a* concentrations.
- Increasing summer average Secchi disc depths.

None of the changes are at statistically significant levels.









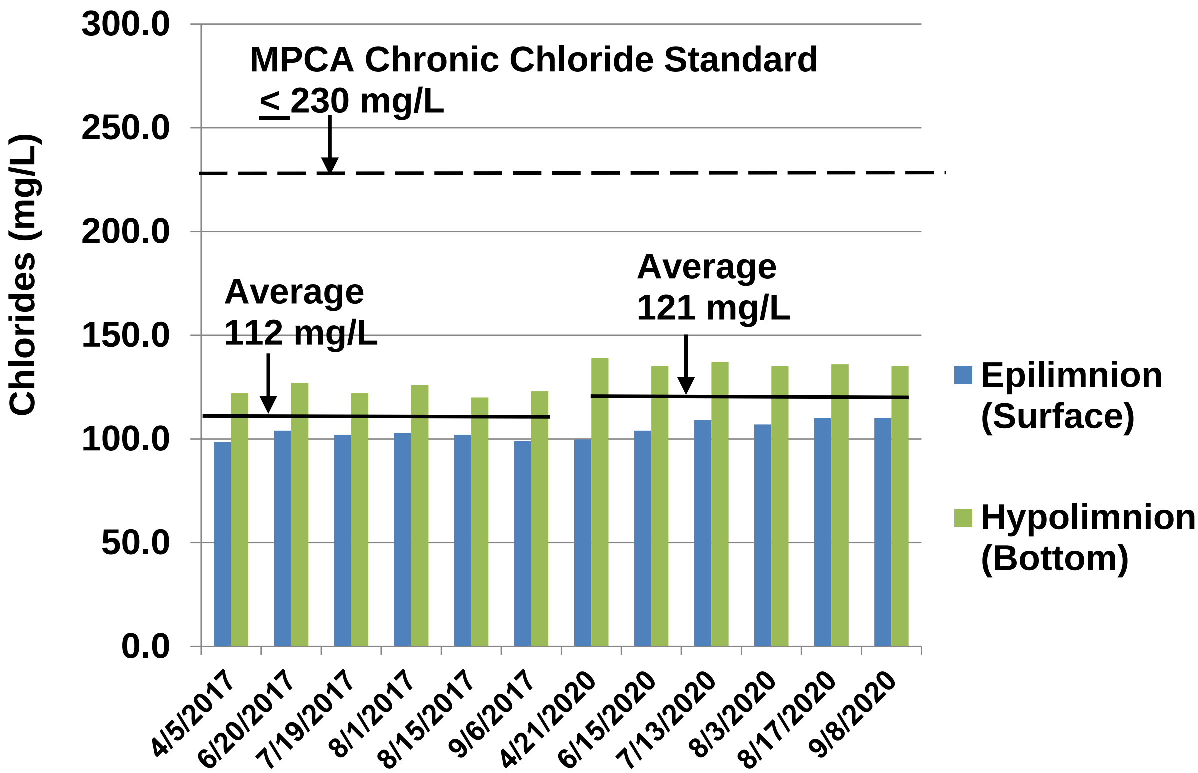
Chloride levels

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 has 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 time with zero-to-slight mortality. The chronic standard is the highest chloride concentration that aquatic life can be exposed indefinitely without causing chronic toxicity. Chronic toxicity is defined as a stimulus that lingers or continues for a long period of time, often one-tenth the life span or more. 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 chronic criterion (230 mg/L or less) within a 3-year period or one measurement exceeds maximum criterion (860 mg/L).

All measurements during 2017 and 2020 were well below both the maximum and chronic chloride standards. Although not significant, there was an increase in chloride between 2017 and 2020. The 2020 average annual chloride concentration (121 mg/L) was eight percent higher than the 2017 average (112 mg/L), but well below the maximum and chronic chloride standards.

Surface and Bottom Chlorides



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 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.

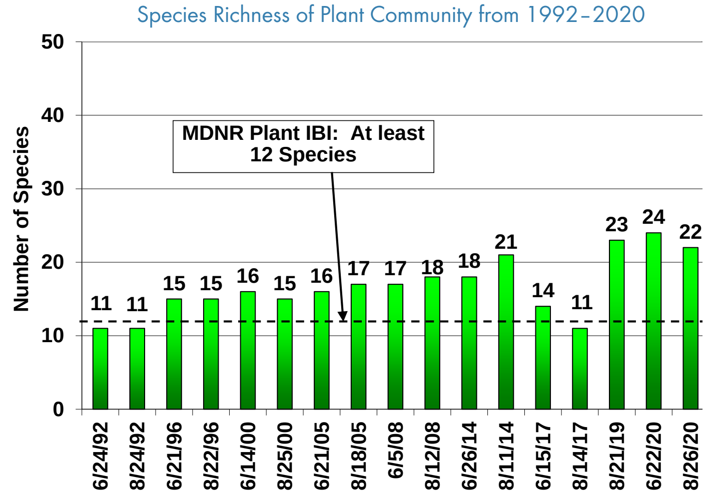
Plant survey data from 1992 to 2020 were assessed to determine plant IBI trends. The figures at right show Twin Lake FQI scores and the number of species for that period compared to the MNDNR Plant IBI thresholds.

- **Number of species:** A deeper water lake, such as Twin 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 Twin Lake ranged from 11 to 24, meeting or exceeding the MNDNR Plant IBI threshold from 1996 through June 2017 and 2019 through 2020. Twenty-two to 24 species were observed in the lake in 2019 and 2020, the highest number to date.

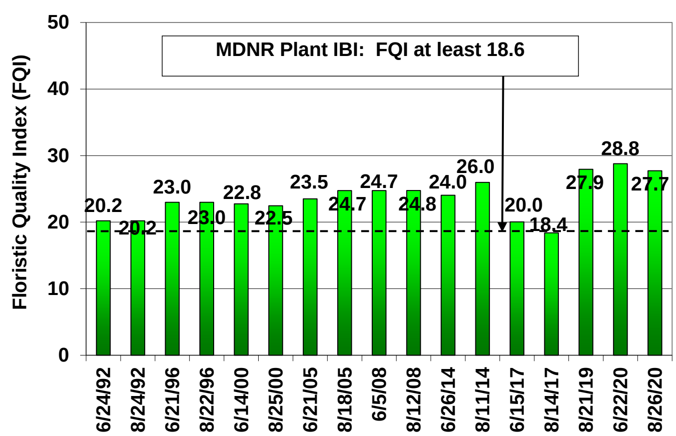
- **FQI values (quality of species):**): The MNDNR Plant IBI threshold for deeper water lakes, as measured by FQI, is a minimum value of 18.6. During the period examined, FQI values in Twin Lake ranged from 18.4 to 28.8, bettering the MNDNR Plant IBI threshold during all but August 2017. FQI scores from 27.7 to 28.8 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 and improved in 2019 and 2020.

Species Richness of Plant Community from 1992–2020



Quality of Twin Lake Plant Community from 1992–2020



Aquatic invasive species

In 2020, four invasive species were found in Twin Lake.

- **Curly-leaf pondweed (*Potamogeton crispus*):** Curly-leaf pondweed (CLP) has been sporadically observed in the lake at a low density since first appearing in June 2000 along the eastern side of the lake. It has been found at different locations in the lake without increasing in extent or density over the past 20 years. In 2020 the plant was observed on the western side of the lake in June and the north side in August.

- **Reed canary grass (*Phalaris arundinacea*):** Reed canary grass was first observed in Twin Lake in June 2014 at one location along the southeastern shoreline. It was found at this same location in August 2014, August 2019, and June 2020; it has not expanded its footprint.

- **Purple loosestrife (*Lythrum salicaria*):** Purple loosestrife was first observed along the southeastern shoreline of Twin Lake in 1992. In 2020, it was found at the southern end of the lake and along the western shoreline. Considerable damage to the plants from beetles was observed in 2020, suggesting the beetles were controlling the purple loosestrife.

- **Narrow-leaved cattail (*Typha angustifolia*):** Narrow-leaved cattail was first observed in June 2014. It was seen again in 2019 and 2020 at similar locations along all shorelines. In 2020, it was collected on the rake at five locations and observed at three other locations.

Curly-leaf pondweed

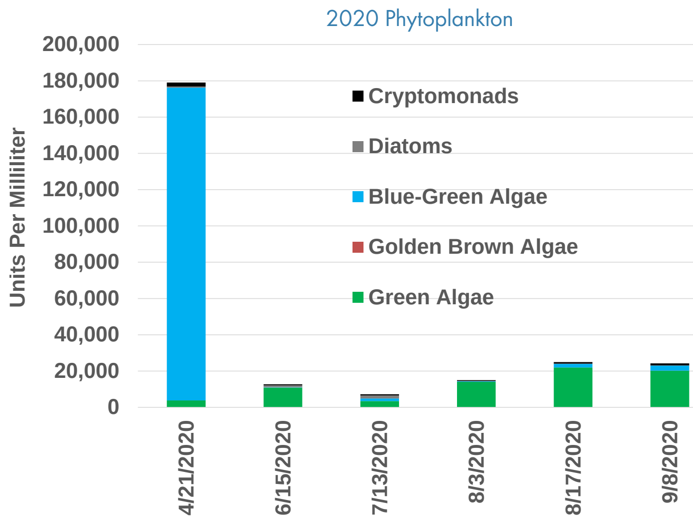
Purple loosestrife

Reed canary grass

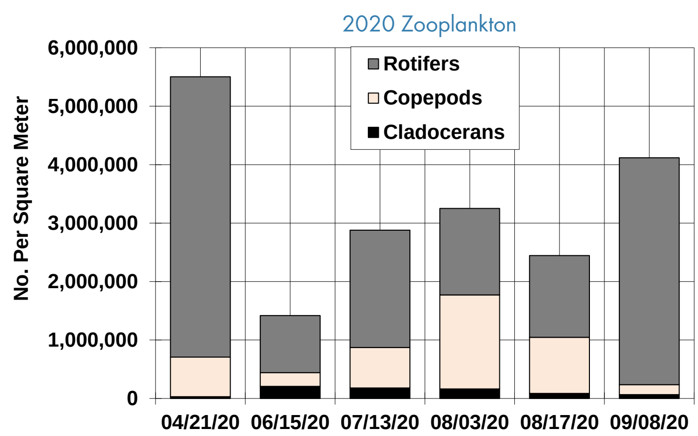
Narrow-leaved cattail

Phytoplankton and zooplankton

Samples of phytoplankton (microscopic aquatic plants) were collected from Twin Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). As shown in the figure (top right), phytoplankton numbers declined from April to June and then remained low through September, an indication of good water quality throughout the summer. The community was dominated by blue-green algae in April and by green algae from June through September. 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.



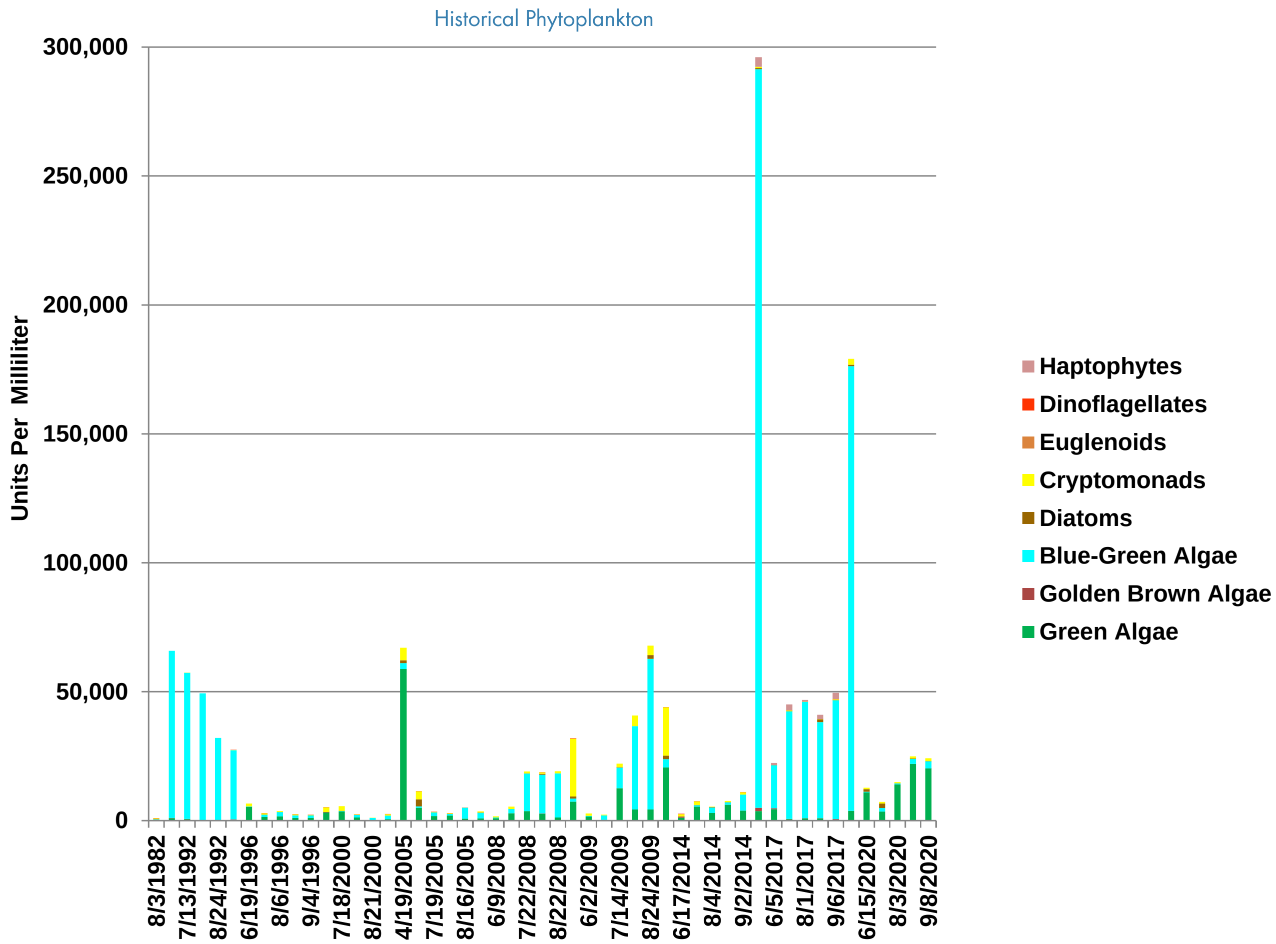
2020 phytoplankton numbers were within the range observed since 1982. Numbers in 2020 were lower than in 2017 (see figure on page 10). The lower phytoplankton numbers in 2020 are consistent with the lower average summer chlorophyll a concentration in 2020 (see figure on page 3).

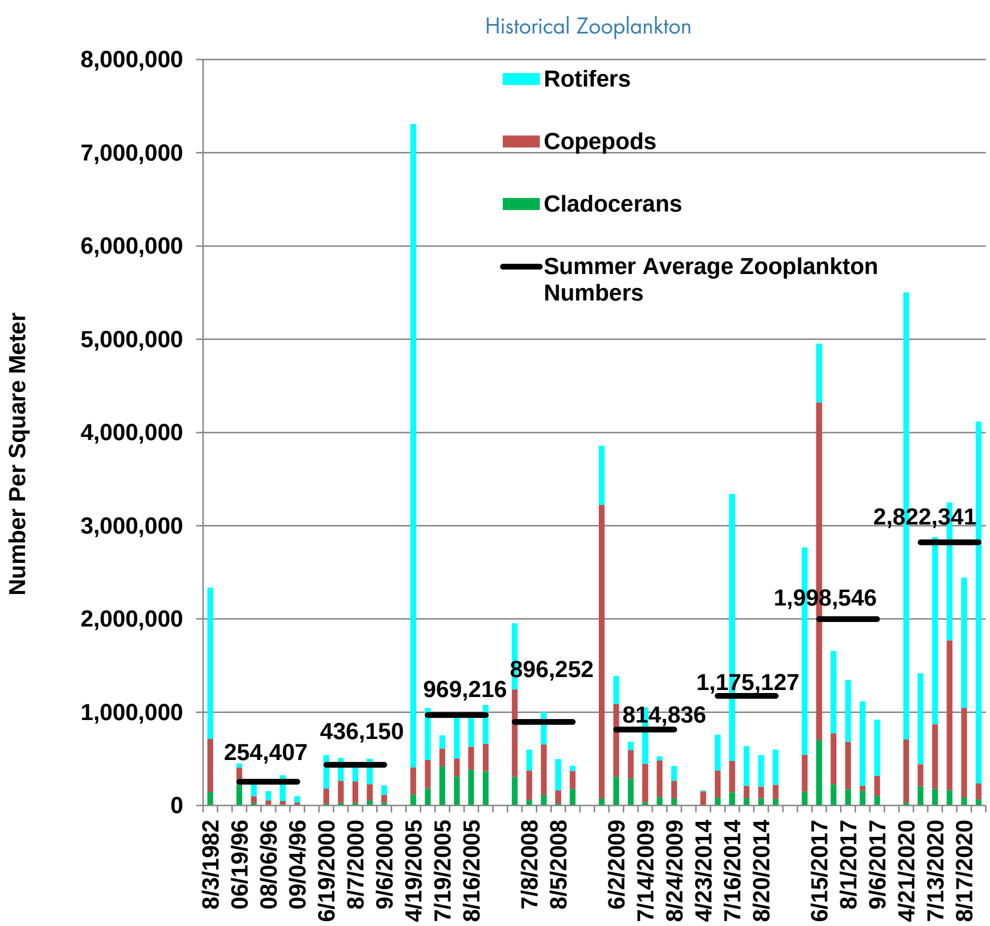


Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantities and species, they can filter the volume of an entire lake in a matter of days. They are also valuable food for planktivorous fish and other organisms.

The 2020 community composition reflects the impact of fish predation on the community. 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. Rotifers, the least preferred food for fish, dominated the community throughout 2020 (except for August 3) and copepods consistently occurred in higher numbers than cladocerans (see figure at right).

Summer-average zooplankton numbers increased from 1996 to 2005, declined in 2008 and 2009, and then increased from 2014 through 2020. The decline in summer average zooplankton numbers in 2008 and 2009 coincided with a decline in lake water quality. The 2020 summer average zooplankton number was the highest to date, a favorable change for the lake (see figure on page 10).


Historical Phytoplankton
Units Per Milliliter
300,000
250,000
200,000
150,000
100,000
50,000
0
8/3/1982
7/13/1992
8/24/1992
6/19/1996
8/6/1996
9/4/1996
7/18/2000
8/21/2000
4/19/2005
7/19/2005
8/16/2005
6/9/2008
7/22/2008
8/22/2008
6/2/2009
7/14/2009
8/24/2009
6/17/2014
8/4/2014
9/2/2014
6/5/2017
8/1/2017
9/6/2017
6/15/2020
8/3/2020
9/8/2020
Haptophytes
Dinoflagellates
Euglenoids
Cryptomonads
Diatoms
Blue-Green Algae
Golden Brown Algae
Green Algae


Historical Zooplankton
Number Per Square Meter
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Rotifers
Copepods
Cladocerans
Summer Average Zooplankton Numbers
254,407
436,150
969,216
896,252
814,836
1,175,127
1,998,546
2,822,341
8/3/1982
06/19/96
08/06/96
09/04/96
6/19/2000
8/7/2000
9/6/2000
4/19/2005
7/19/2005
8/16/2005
7/8/2008
8/5/2008
6/2/2009
7/14/2009
8/24/2009
4/23/2014
7/16/2014
8/20/2014
6/15/2017
8/1/2017
9/6/2017
4/21/2020
7/13/2020
8/17/2020

Suitability of Twin Lake for Aquatic Invasive Species (AIS)

A large number of AIS residing in Minnesota have not yet been observed in Twin 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 Twin Lake. To evaluate whether Twin 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 in 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 Twin Lake meets the suitability requirements for rusty crayfish, faucet snail, spiny waterflea, zebra mussel, and starry stonewort. However, the water quality of Twin Lake only partially meets the suitability requirements for the Chinese mystery snail. Hence, this species would likely survive, but may not thrive in Twin Lake.

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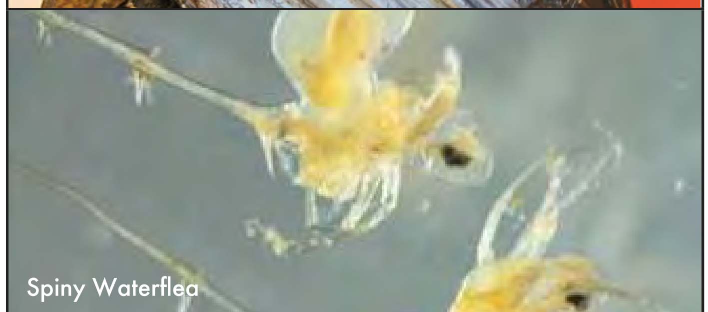
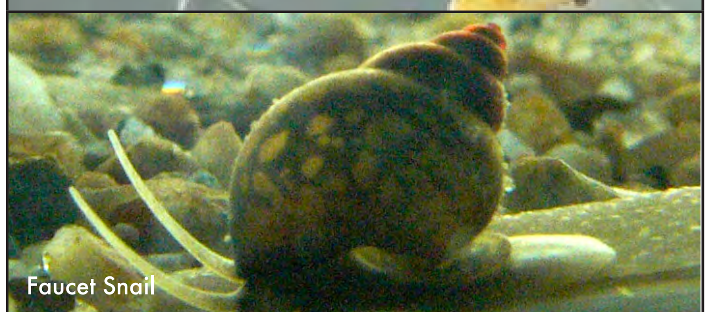
Starry Stonewort

Zebra Mussels



Spiny Waterflea



Faucet Snail

Chinese Mystery Snail

Rusty Crayfish

Bassett Creek Watershed Management Commission
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Cleaner, healthier water for a growing community