TWIN LAKE
2023 WATER QUALITY MONITORING

Bassett Creek Watershed Management Commission

Monitoring water quality in Twin Lake

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 feet
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

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. A summary of 2023 monitoring efforts on Twin Lake is provided below.

At a glance: 2023 monitoring results

In 2023, the BCWMC monitored Twin Lake for the following:

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

Results of 2023 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 2023 documented the continued effectiveness of the 2015 alum treatment. Trend analyses show no significant change in total phosphorus and chlorophyll *a* concentrations or Secchi disc depth over the last 10 years.

The lake's stable good water quality is in part due to the relatively high ratio of lake surface to drainage area and absence of highly impervious land nearby, limiting the quantity of stormwater runoff and pollutant loading to the lake. The southern half of the lake is located in the Theodore Wirth park preserve and 60 percent of the lake's watershed land use is park, recreational, or preserve.

- In 2023, Twin Lake chloride concentrations met the MPCA maximum and chronic standards.
- 2023 summer average phytoplankton numbers were lower than averages measured from 2008–2020.
- Twin Lake summer-average zooplankton numbers have been consistently higher since the 2015 alum treatment.

- In 2023, 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 Plant Index of Biotic Integrity (IBI) thresholds.
- Aquatic invasive species (AIS) observed in 2023 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 snails, zebra mussels, spiny waterfleas, and starry stonewort and partially meets the suitability requirements for the Chinese mystery snail.

More detailed results and recommendations are discussed on the following pages.

Recommendations

- Continue to provide education and information to residents and lake users to reduce the chance of AIS introduction.
- Continue water quality and biological monitoring at a 3-year frequency.

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 chemistry monitoring: 2023

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, too much phosphorus leads to excessive algae, decreased water clarity, and water quality 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 is absent or concentrations are very low.

- **BCWMC/MPCA standard:** 40 micrograms per liter (µg/L) or less
- **Range:** Low of 10 µg/L in July to a high of 25 µg/L in April
- **Summer average:** 13 µg/L (met BCWMC/MPCA standard)

Chlorophyll *a* levels

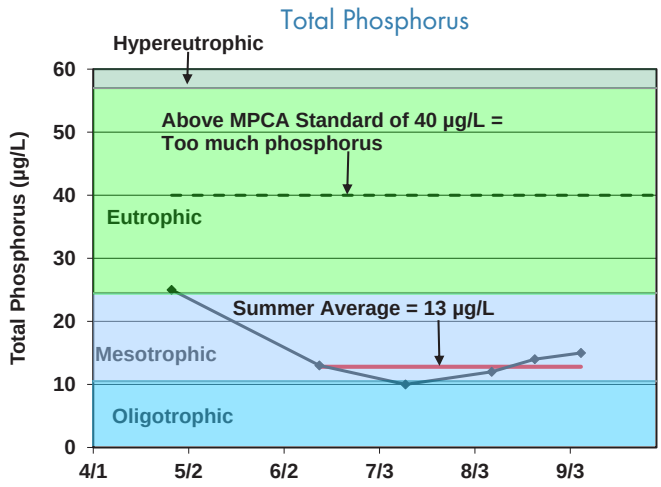
Chlorophyll *a* is a pigment in algae and generally reflects the amount of algae growth in a lake. Lakes which appear clear generally have chlorophyll *a* levels less than 15 micrograms per liter (µg/L). The graph to the right includes Citizen Assisted Monitoring Program (CAMP) data collected from Twin Lake.

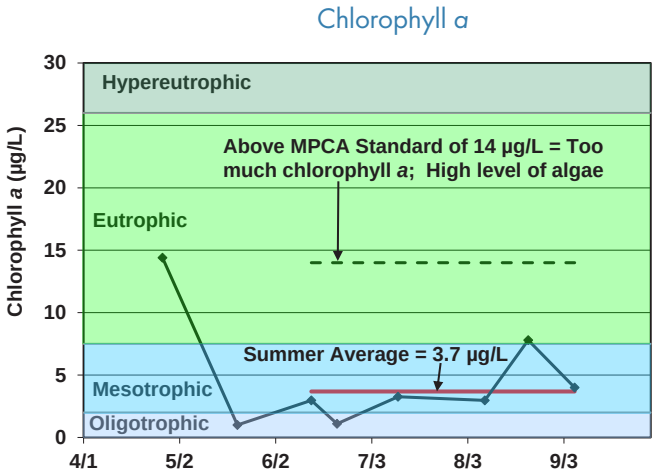
- **BCWMC/MPCA standard:** 14 micrograms per liter (µg/L) or less
- **Range:** Low of 1.0 µg/L in May to a high of 14.4 µg/L in late April
- **Summer average:** 3.7 µg/L (met BCWMC/MPCA standard)

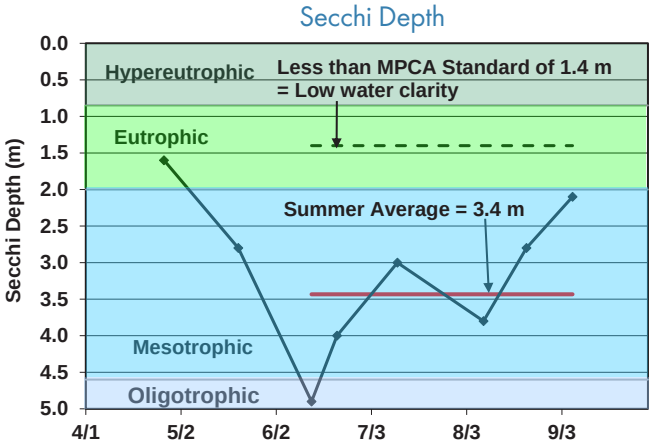
Water clarity

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. The graph to the right includes Citizen Assisted Monitoring Program (CAMP) data collected from Twin Lake

- **BCWMC/MPCA standard:** 1.4 meters or more
- **Range:** Low of 1.6 meters in April to a high of 4.9 meters in mid-June
- **Summer average:** 3.4 meters (met BCWMC/MPCA standard)





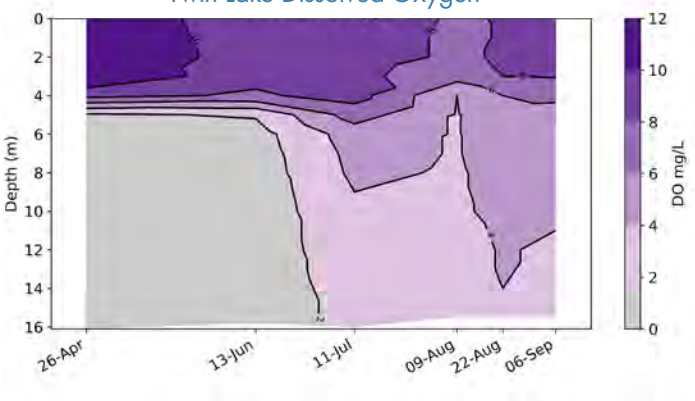


Phosphorus loading from sediment

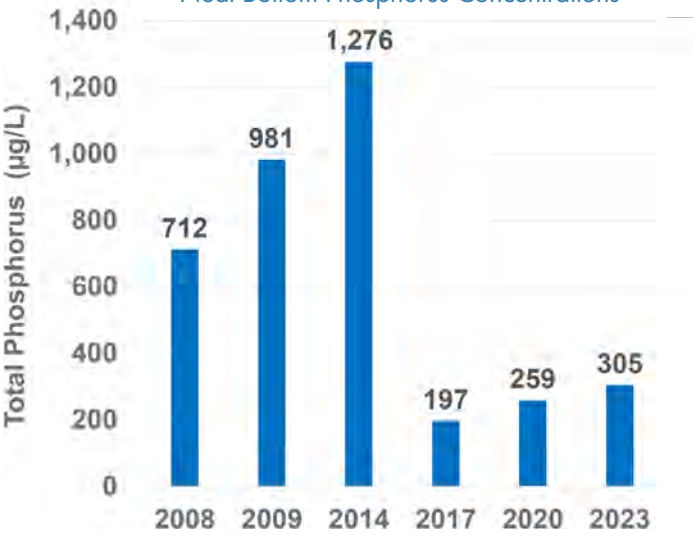
When oxygen levels are low, phosphorus stored in sediment is released (internal loading), causing higher total phosphorus concentrations in near-bottom waters. In 2008 and 2009, summer-average surface water concentrations of phosphorus in Twin Lake increased significantly. This increase prompted the BCWMC to conduct a study to evaluate 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 ordered and funded an alum treatment project on Twin Lake to reduce the internal loading. The City of Golden Valley performed the alum treatment in 2015.

Monitoring since the alum treatment indicates good water quality and reduced phosphorus levels, documenting the continued effectiveness of the treatment. Even though the 2023 near-bottom oxygen levels were low (<2 mg/L) (figure top right) from April through June, the 2023 near-bottom total phosphorus concentrations remained lower than concentrations measured prior to the treatment, documenting the treatment's continued effectiveness (figure bottom right). Average near-bottom total phosphorus concentrations measured during the June through September period ranged from 712 µg/L to 1,276 prior to the alum treatment (2008 through 2014) and from 197 µg/L to 305 µg/L after the alum treatment (2017 through 2023).

Twin Lake Dissolved Oxygen



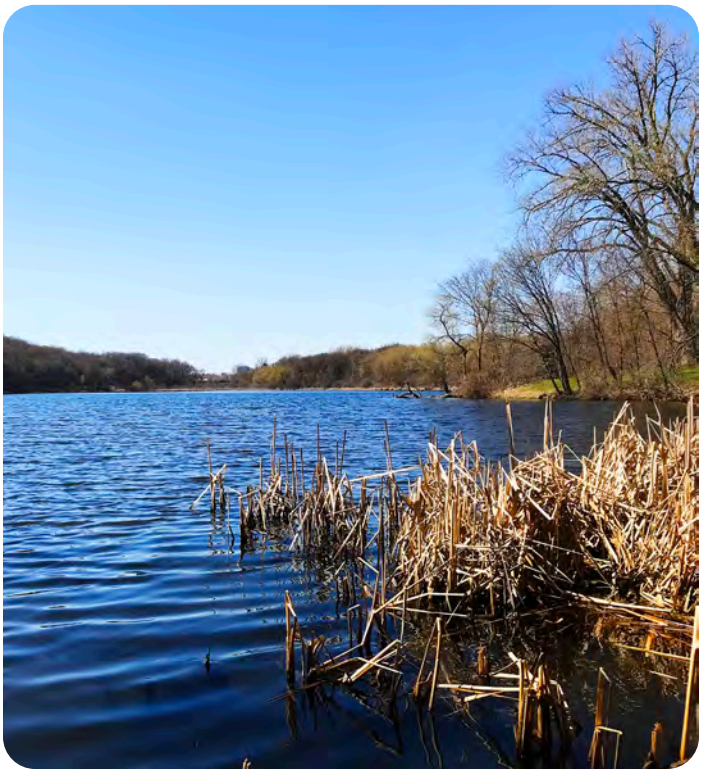
2008–2023 Twin Lake Summer Average Near-Bottom Phosphorus Concentrations



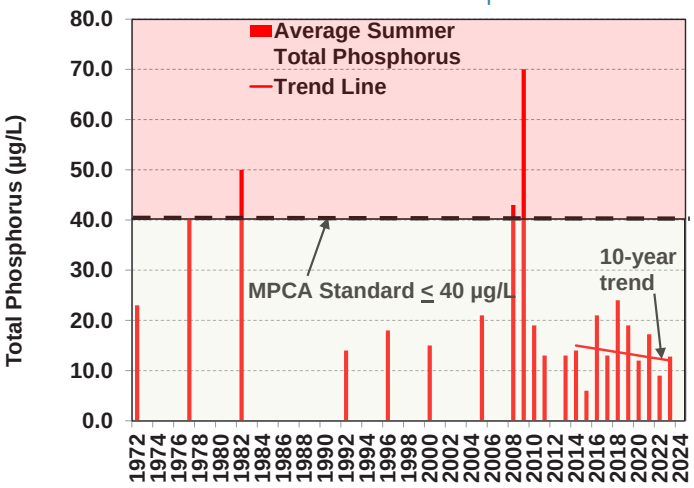
Water chemistry monitoring from 1972–2023: historical trends

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 1972–2023 are shown in the figures at right. During the period of record, 14 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.

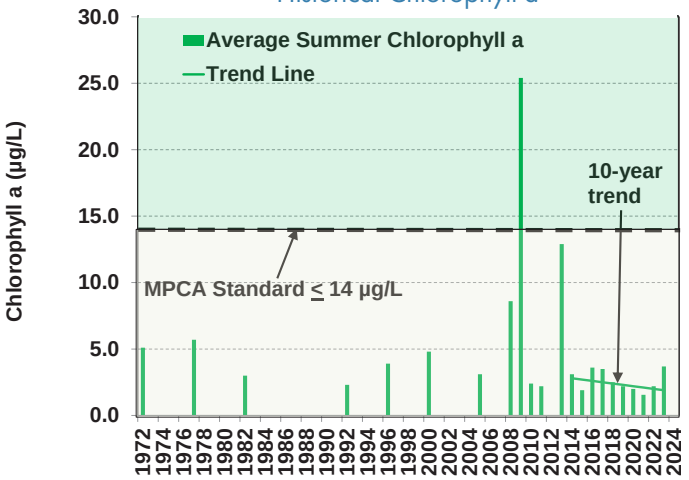
Trend analyses indicate that the lake's water quality has been stable over the past 10 years. Summer-average total phosphorus and chlorophyll *a* concentrations and Secchi disc depths slightly decreased, but none of the changes are statistically significant (95 percent confidence level). These results document the continued effectiveness of the 2015 alum treatment.



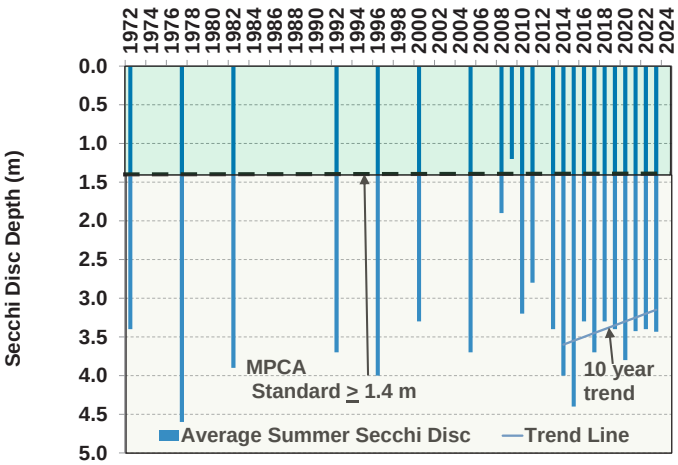
Historical Total Phosphorus



Historical Chlorophyll *a*



Historical Water Clarity



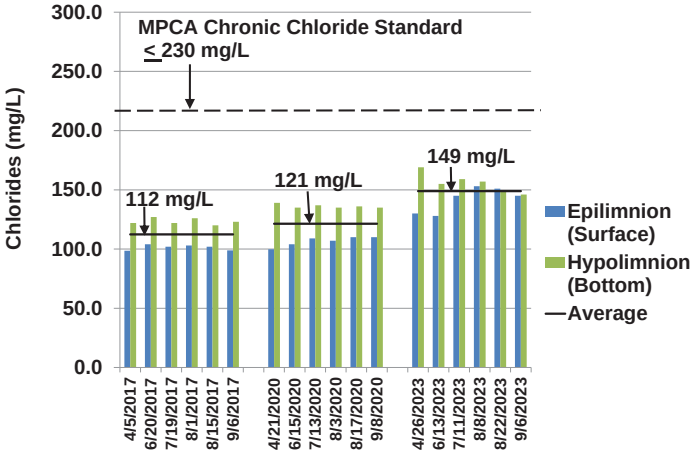
Chloride levels

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand and/or sand/salt mixtures to salt for winter road maintenance. When snow and ice melt, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes one teaspoon of salt to pollute 5 gallons of water such that it can no longer support freshwater life. That pollution is essentially permanent, as there is no easy or affordable way to remove chloride from water.

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 to indefinitely without causing chronic toxicity. Chronic toxicity means a stimulus that lingers or continues for an extended period, 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 the chronic criterion (230 mg/L or less) within a 3-year period or one measurement exceeds the maximum criterion (860 mg/L).

All measurements during 2017, 2020, and 2023 were well below both the maximum and chronic chloride standards. However, the 2023 average annual chloride concentration (149 mg/L) was higher than the 2020 (121 mg/L) and 2017 (112 mg/L) annual averages.

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 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.

Twin Lake plant survey data from 1992 to 2023 were assessed to determine plant IBI trends. The figures at right show the number of species and FQI scores for that period compared to the MNDNR Plant IBI thresholds.

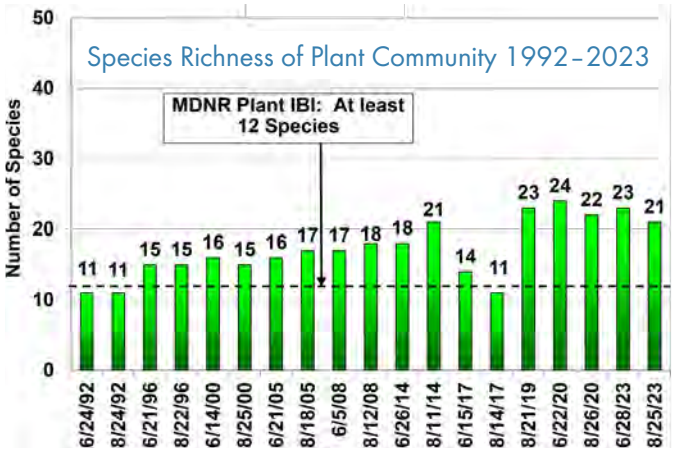
- Number of species: A deep water lake, such as Twin Lake, meets the MNDNR Plant IBI threshold when it has 12 or more species. During the period examined, the number of species in Twin Lake ranged from 11 to 24, meeting or exceeding the MNDNR Plant IBI threshold from 1996 through June 2017 and 2019 through 2023. Twenty-one to 24 species were observed in the lake in August 2014, August 2019, June and August 2020, and June and August 2023, the highest numbers to date.
- FQI values (quality of species): The MNDNR Plant IBI threshold for deep 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 ranged from 25.1 to 28.8 in August 2014, August 2019, June and August 2020, and June and August 2023, the highest scores to date.

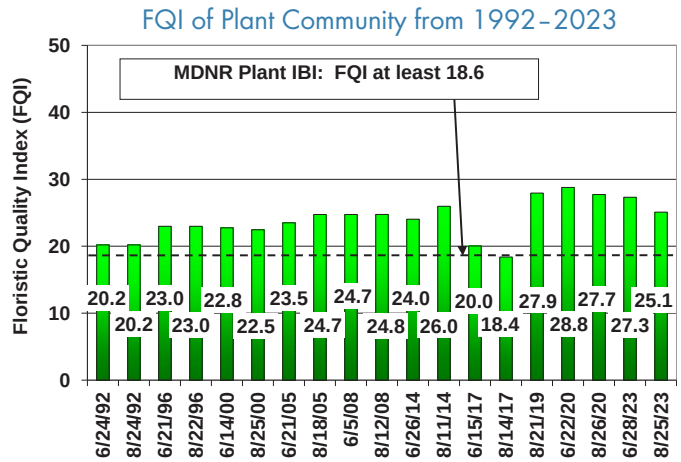
High quality plants observed in Twin Lake in 2023 included southern naiad (*Najas guadalupensis*), Fries' pondweed (*Potamogeton friesii*), muskgrass (*Chara sp.*), northern watermilfoil (*Myriophyllum sibericum*), small pondweed (*Potamogeton pusillus*), long-leaf pondweed (*Potamogeton nodosus*), common bladderwort (*Utricularia vulgaris*), and horned pondweed (*Zannichellia palustris*).

Aquatic invasive species

Although four invasive species were found in Twin Lake in 2023, they do not appear to be expanding and don't appear to have a negative impact on the native plant community. Invasive species observed in Twin Lake in 2023 include:

- Curly-leaf pondweed (CLP, *Potamogeton crispus*): CLP has been sporadically observed at a low density since first appearing in June 2000 along the eastern side of the lake. It has not increased in extent or density over the past 20 years. In 2023, the plant was observed on the western side of the lake in June but was not observed in August.
- Reed canary grass: Reed canary grass has been sporadically observed at a single location in Twin Lake since 2014. In 2023, it was at a single location along the northwestern shoreline in June and a single location along the southeastern shoreline in August.
- Purple loosestrife: Purple loosestrife was first observed along the southeastern shoreline of Twin Lake in 1992. In 2023, it was at a single location along the western shoreline during June and August.
- Narrow-leaved cattail: Narrow-leaved cattail was first observed in June 2014. It was seen again in 2019, 2020, and 2023 at similar locations along all shorelines. In 2023, it was collected on the rake at eight locations and observed at five other locations.





Phytoplankton

Samples of phytoplankton (microscopic aquatic plants, such as algae) were collected from Twin Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). As shown in the figure at right, 2023 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 September, by green algae from June through July, and co-dominated by green algae and blue-green algae in August. 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.

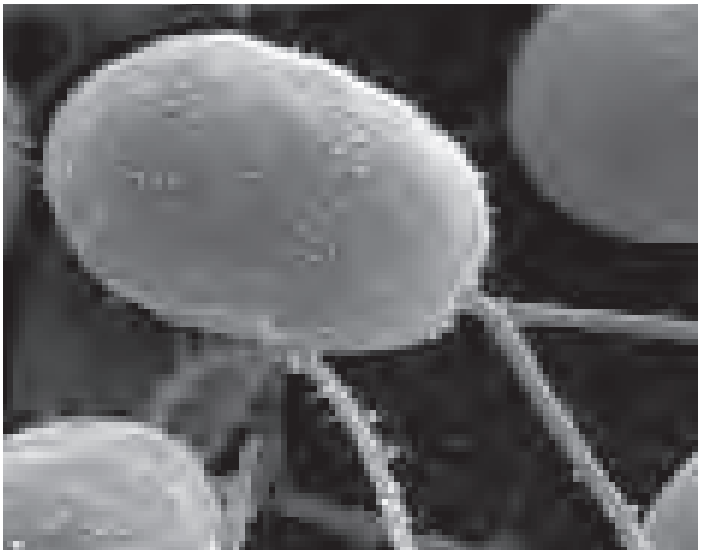
As shown in the figure on page 10, 2023 summer-average phytoplankton numbers were lower than averages measured from 2008 through 2020. The lower phytoplankton numbers in 2023 indicate the lake had good water quality due to water quality improvements from the 2015 alum treatment and reduced nutrient loading from the dry climatic conditions in 2023.

Zooplankton

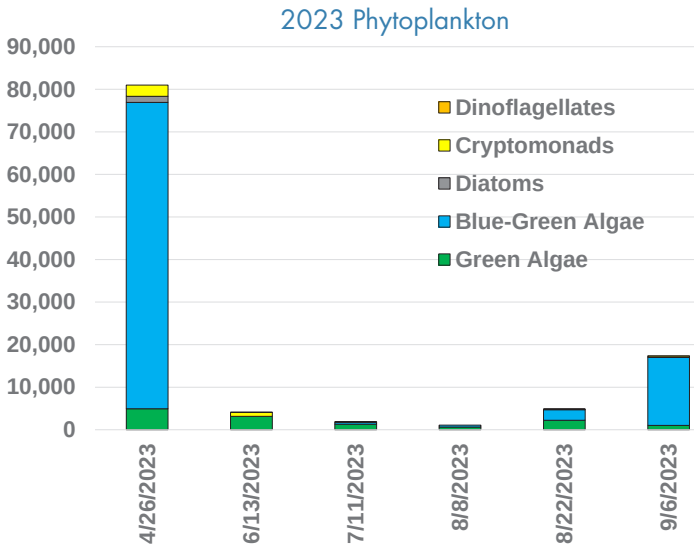
Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantities and species, they can filter the volume of an entire lake in a matter of days. They are also valuable food for planktivorous fish and other organisms.

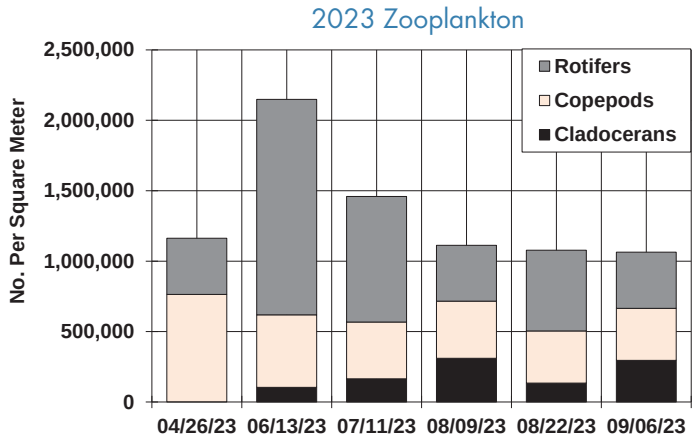
The 2023 community composition indicates the zooplankton community is healthy and has provided food for the lake's fish. Fish generally select the largest zooplankters they see and prefer cladocerans to copepods because they swim slowly and lack the copepods' ability to escape predation by jerking or jumping out of the way. Rotifers are the least preferred food for fish because of their small size. In 2023, rotifers and copepods consistently occurred in higher numbers than cladocerans (see figure below, right), an indication fish predation had the greatest impact on cladocerans

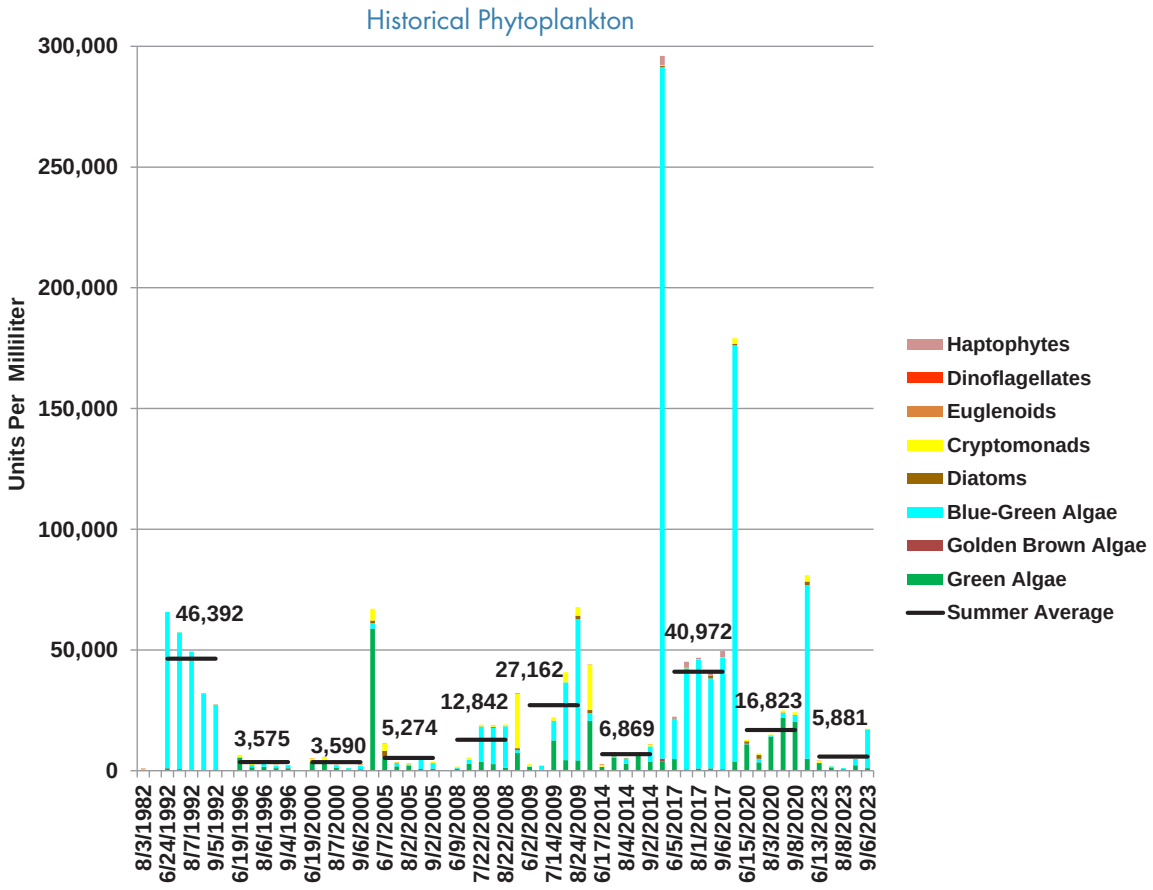
1982 through 2023 zooplankton data indicate the zooplankton community has consistently been healthy and diverse, consisting of all three major groups: rotifers, copepods, and cladocerans (see figure on page 10). Twin Lake summer-average zooplankton numbers have been consistently higher since the 2015 alum treatment (see figure on page 10), an indication that the lake's improved water quality positively impacted the its zooplankton community.

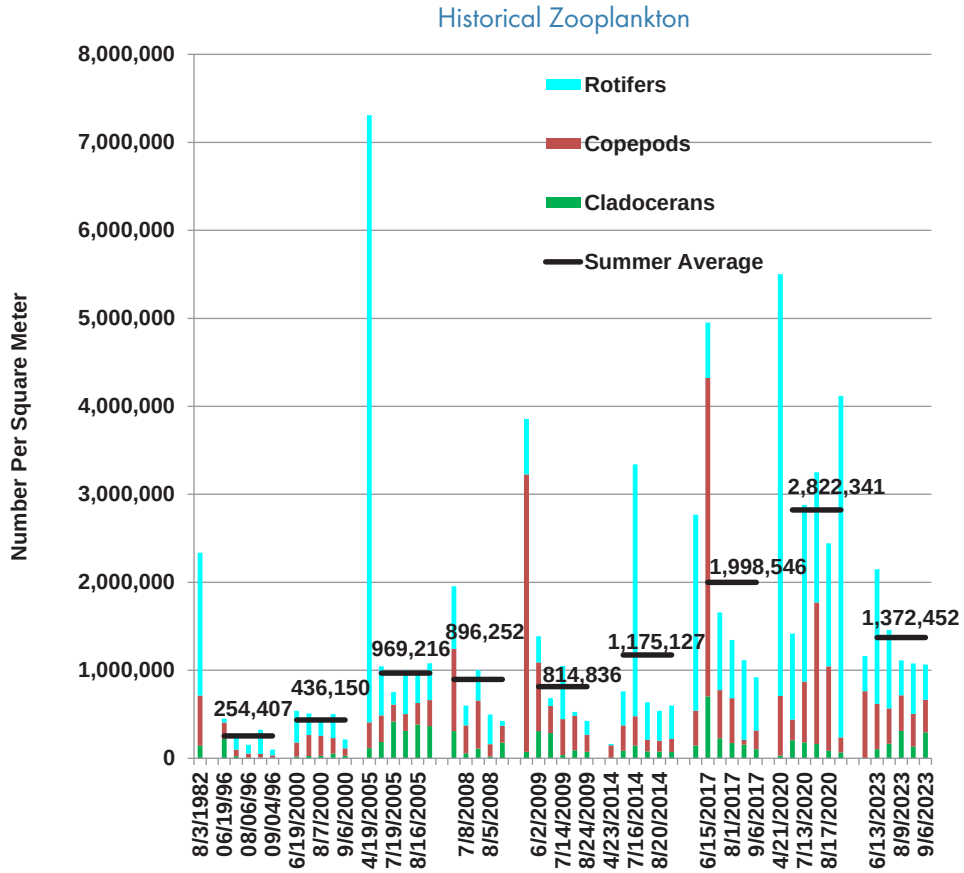


Chlamydomonas, a green algae found in Twin Lake in 2023.






Historical Phytoplankton
Units Per Milliliter
300,000
250,000
200,000
150,000
100,000
50,000
0
46,392
3,575
3,590
5,274
12,842
27,162
6,869
40,972
16,823
5,881
8/3/1982
6/24/1992
8/7/1992
9/5/1992
6/19/1996
8/6/1996
9/4/1996
6/19/2000
8/7/2000
9/6/2000
6/7/2005
8/2/2005
9/2/2005
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
6/13/2023
8/8/2023
9/6/2023
Haptophytes
Dinoflagellates
Euglenoids
Cryptomonads
Diatoms
Blue-Green Algae
Golden Brown Algae
Green Algae
Summer Average


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
254,407
436,150
969,216
896,252
814,836
1,175,127
1,998,546
2,822,341
1,372,452
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
6/13/2023
8/9/2023
9/6/2023
Rotifers
Copepods
Cladocerans
Summer Average

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. A suitability analysis for each species was performed to determine whether Twin Lake water quality would support the introduction of six AIS (starry stonewort, zebra mussels, spiny waterfleas, faucet snails, Chinese mystery snails, and rusty crayfish).

The analysis compared water quality data collected in 2023 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 that the water quality of Twin Lake meets the suitability requirements for rusty crayfish, faucet snails, spiny waterfleas, zebra mussels, 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.

Bassett Creek Watershed Management Commission
bassettcreekwmo.org

Stewardship of water resources to protect and enhance our communities