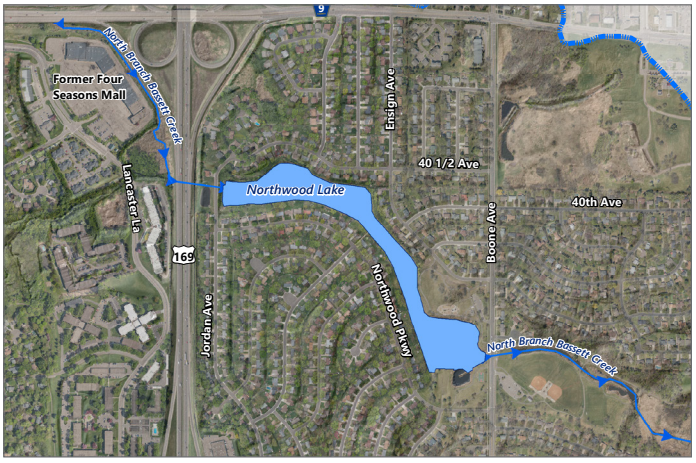
Item 5A.
BCWMC 7-20-23

Northwood Lake 2022 water quality monitoring



About Northwood Lake

BCWMC classification	Priority-1 shallow lake
Watershed area	1,294 acres
Lake size	15 acres
Average depth	2.7 feet
Maximum depth	5 feet
Ordinary high water level	885.5 feet
Normal water level	884.4 feet
Downstream receiving water body	North Branch Bassett Creek
Location (city)	New Hope
MPCA impairments	Nutrients
Aquatic invasive species	Curly-leaf pondweed, purple loosestrife, narrow-leaved cattail, reed canary grass, yellow iris
Public access	Yes

Monitoring water quality in Northwood Lake

The Bassett Creek Watershed Management Commission (BCWMC) has monitored water quality conditions in the watershed's 10 priority lakes since 1972. The BCWMC performs this monitoring to detect changes or trends in water quality and evaluate the effectiveness of efforts to preserve or improve water quality. A summary of 2022 monitoring efforts on Northwood Lake is provided below; more comprehensive information can be found on pages 2–8.

At a glance: 2022 monitoring results

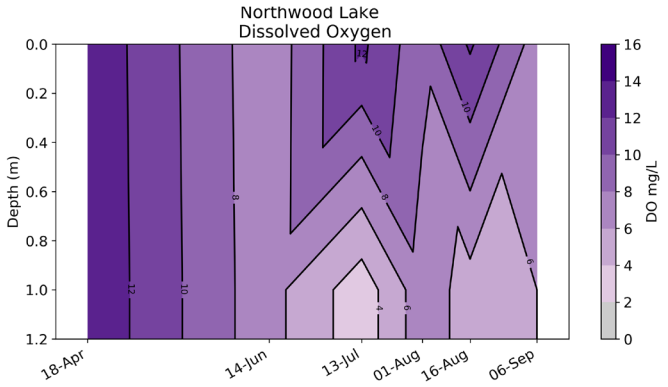
In 2022, the BCWMC monitored Northwood Lake for the following:

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

Results of 2022 monitoring show that Northwood Lake failed to meet the applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for chlorides, Secchi disc (a measure of clarity), total phosphorus, and chlorophyll *a*. Trend analyses show a significant decline in Secchi disc, a significant increase in chlorophyll *a*, but no significant change in total phosphorus over the past 10 years. More detailed results and recommendations are discussed on page 2.

At a glance: 2022 monitoring results (cont.)

- In 2022, the number of plant species in the lake in June failed to meet the Minnesota Department of Natural Resources (MNDNR) Plant Index of Biotic Integrity (IBI) threshold. In August, the number of plant species in the lake was better than the MNDNR Plant IBI threshold.
- Both the June and August Floristic Quality Index (FQI) values, a measure of plant species quality, were poorer than the MNDNR Plant IBI thresholds.
- The 2022 phytoplankton numbers were higher than all previous years except 1992.
- The 2022 zooplankton numbers were within the range of previous years, but the June 2022 value was higher than all but the May 2013 value.
- The results of an aquatic invasive species (AIS) suitability analysis indicate that Northwood Lake's water quality partially meets the suitability requirements for rusty crayfish, starry stonewort, spiny waterflea, zebra mussel, faucet snail, and Chinese mystery snail. Hence, these species would likely survive but may not thrive in Northwood Lake.
- Although lower oxygen levels were observed near the lake bottom in July, the lake was generally well oxygenated and had sufficient oxygen to support a fish community throughout the monitoring period.



Recommendations

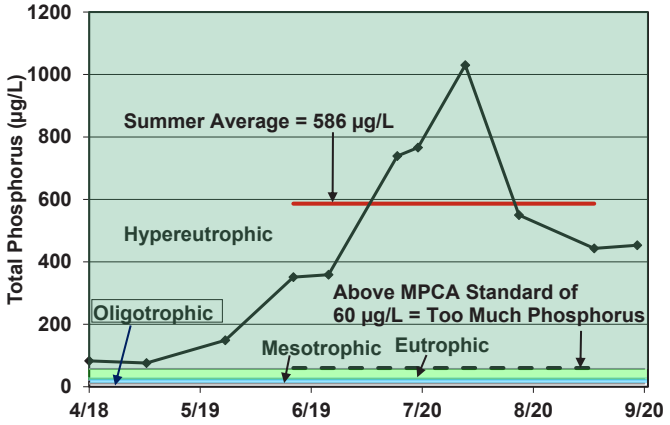
- Determine causes for the lake's significant decline in water quality over the past 10 years and feasible management measures to improve water quality
- Continue to provide education and information to lake users to reduce the chance of AIS introduction
- Continue water quality and biological monitoring at a 3-year frequency
- Work with cities, businesses, the Minnesota Department of Transportation, and Hennepin County to improve winter maintenance practices and reduce chloride load conveyed to Northwood Lake from streets and parking lots in its watershed.

Water chemistry monitoring: 2022

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.

- **BCWMC/MPCA standard:** 60 micrograms per liter (µg/L) or less
- **Range:** Low of 83 µg/L in April to a high of 1,030 µg/L in early August
- **Summer average:** 586 µg/L (failed to meet BCWMC/MPCA standard)



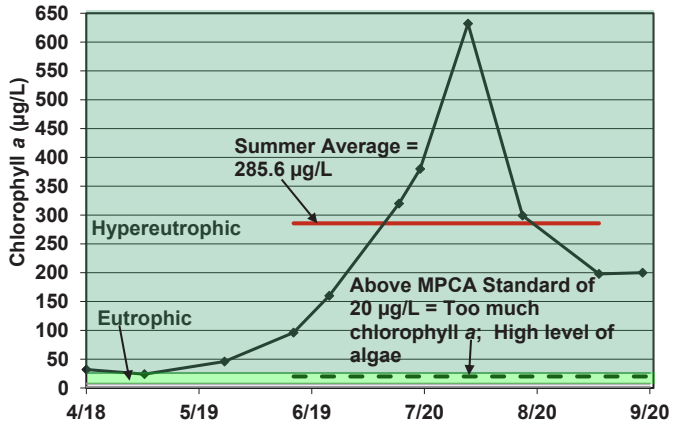
Definitions

- ***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

Chlorophyll *a* levels

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

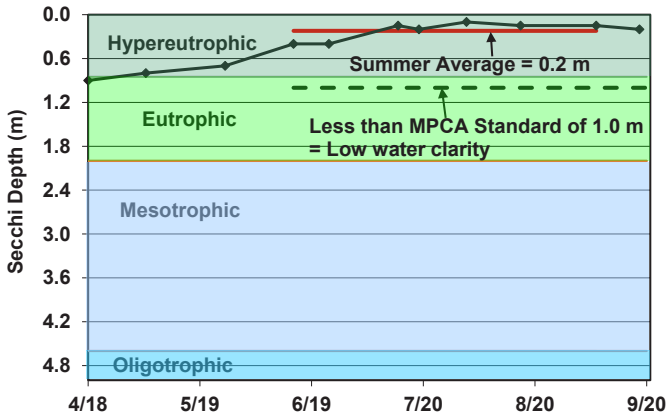
- **BCWMC/MPCA standard:** 20 µg/L or less
- **Range:** Low of 32 µg/L in April to a high of 632 µg/L in early August
- **Summer average:** 286 µg/L (failed to meet BCWMC/MPCA standard)



Water clarity

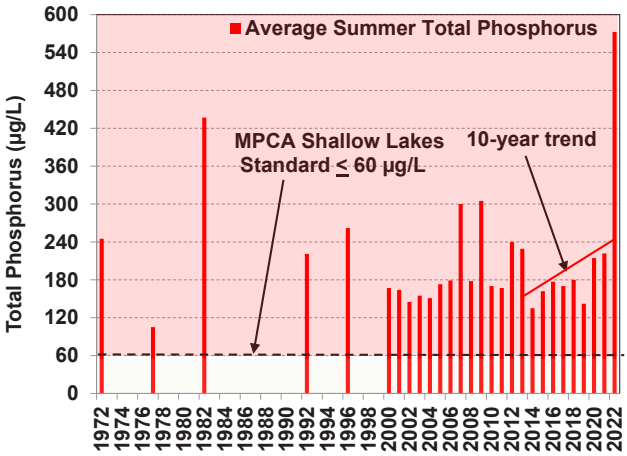
The number of algae or other photosynthetic organisms in a lake often affects water clarity. It is usually measured by lowering an 8-inch "Secchi" disc into the lake; the depth at which the disc is no longer visible is considered a measure of the water's transparency.

- **BCWMC/MPCA standard:** 1.0 meter or more
- **Range:** Low of 0.1 meters in early August to a high of 0.9 meters in April
- **Summer average:** 0.2 meters (failed to meet BCWMC/MPCA standard).

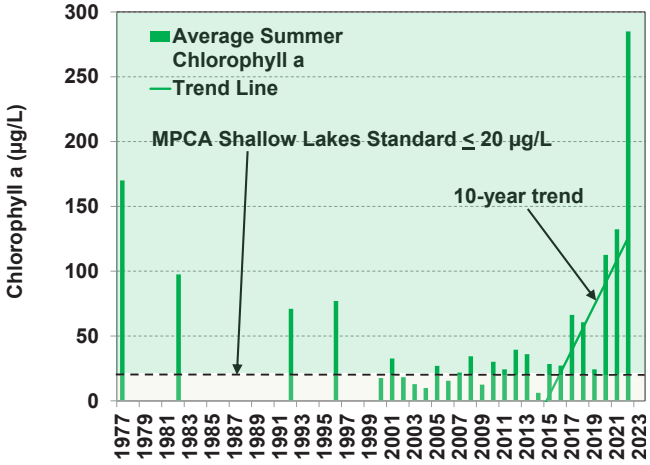


Historical water quality trends

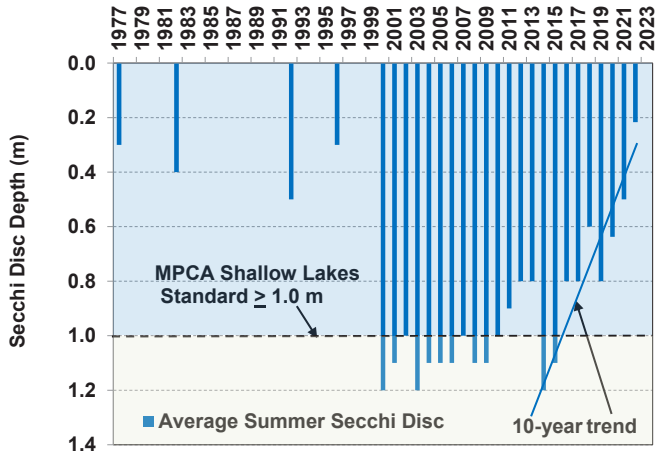
1972–2022 phosphorus levels (no significant trend)



1972–2022 chlorophyll a levels (significant increase)



1972–2022 secchi disc depths (significant decrease)

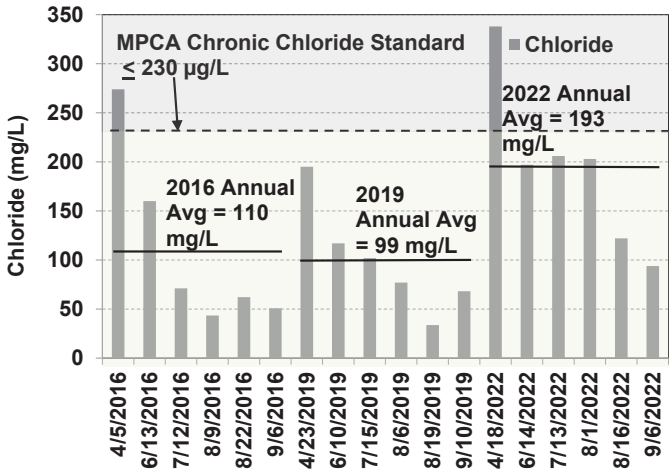


2016, 2019, 2022 chloride levels

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand 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 1 teaspoon of road salt to permanently pollute 5 gallons of water. Once in the water, chloride is very difficult and expensive to remove.

Because high chloride concentrations 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 is defined as a stimulus that lingers or continues for a long 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) within a 3-year period or if one measurement exceeds the maximum criterion (860 mg/L).

All 2016, 2019, and 2022 chloride measurements were well below the maximum standard. The April 2016 and 2022 measurements exceeded the chronic chloride standard, but all other 2016, 2019, and 2022 measurements met the standard. There was an increase in chloride between 2019 and 2022. The 2022 average annual chloride concentration (193 mg/L) was nearly double the 2019 average (99 mg/L), but both were well below the maximum and chronic chloride standards.



Macrophytes (aquatic plants)

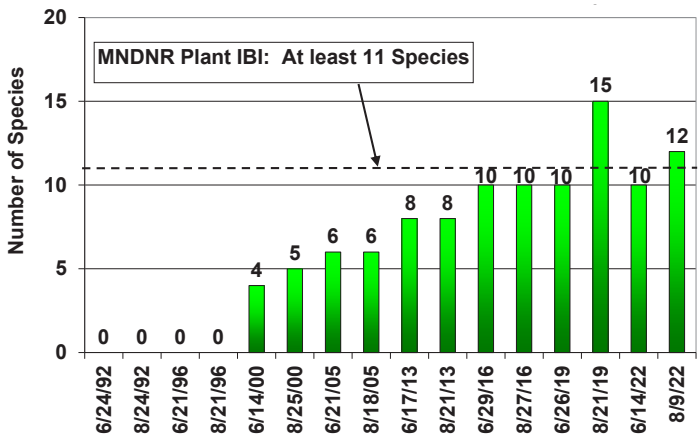
Lake Plant Eutrophication Index of Biological Integrity (IBI)

Eutrophication (excessive nutrients) may harm a lake, including reducing the quantity and diversity of 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.

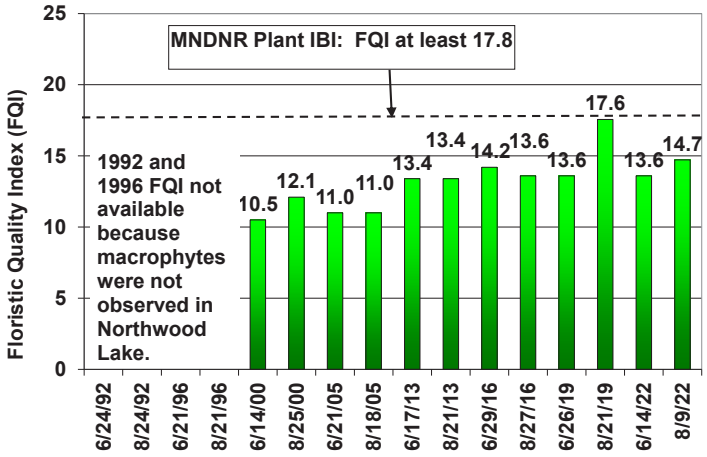
Plant survey data from 1992 to 2022 were assessed to determine Plant IBI trends. The figures on page 5 show Northwood Lake FQI scores and the number of species for that period compared to the MNDNR Plant IBI thresholds.

- **Number of species:** A shallow lake such as Northwood Lake fails to meet the MNDNR Plant IBI threshold when fewer than 11 species are found. During the period examined, the number of species in Northwood Lake ranged from 0 to 15, exceeding the MNDNR Plant IBI threshold in August 2019 and August 2022. Aquatic plants were first observed in the lake in 2000, and the number of species consistently increased from four in 2000 to 15 in 2019. In 2022, the number of species ranged from 10 to 12. The number of species in June 2022 was the same as the June 2019 value, but the August 2022 value was lower than the August 2019 value.
- **FQI values (quality of species):** The MNDNR Plant IBI threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values in Northwood Lake ranged from 10.5 to 17.6. All values were below the MNDNR Plant IBI threshold. FQI could not be computed in 1992 and 1996 because plants were not observed in the lake. The FQI value in June 2022 was the same as the June 2019 value, but the August 2022 value was lower than the August 2019 value.
- **Summary of 2022 results:** The number of species in the lake was better than the MNDNR Plant IBI threshold in August, but below the threshold in June. The FQI values in both June and August were below the MNDNR Plant IBI thresholds.

Northwood Lake Number of Species from 1992–2022



Quality of Northwood Lake Plant Community from 1992–2022



Aquatic invasive species (AIS)

In 2022, five aquatic invasive species were present in Northwood Lake.

- Curly-leaf pondweed (*Potamogeton crispus*): Curly-leaf pondweed has been observed in Northwood Lake since 2000. The plant increased in extent and density from 2016 (50 percent of sample locations) through 2019 (92 percent of sample locations) and was again observed at 92 percent of sample locations in June 2022. It was considered problematic in both June of 2019 and 2022, with an average rake density of 2.5 on a 1 to 3 scale. The surge and subsequent die-off of curly-leaf pondweed added phosphorus to the lake, resulting in increased algal growth and decreased clarity.
- Purple loosestrife (*Lythrum salicaria*): This emergent species has been observed along the shoreline since 2000. It has decreased in extent since 2016, when it was scattered around the lake. In 2019, it was observed at one location in June and two in August. In 2022, it was observed at one location in both June and August. Purple loosestrife observed in 2016, 2019, and 2022 had suffered damage from beetles introduced to control the population, suggesting that the beetles had the desired effect.
- Reed canary grass (*Phalaris arundinacea*): Reed canary grass has been observed along the shoreline since 2016. It was seen at one location in 2016 and two in 2019. In 2022, it was observed at two locations in June and six in August.
- Narrow-leaved cattail (*Typha angustifolia*): This emergent species was first observed in 2022 at five locations.
- Yellow iris (*Iris pseudacorus*): The first observation of yellow iris occurred in 2019 at one location on the south end of the lake. In 2022, it was observed at one location on the south end of the lake in June and one on the northeast side in August.

Curly-leaf pondweed

Purple loosestrife

Reed canary grass

Narrow-leaved cattail

Yellow Iris

Suitability of Northwood Lake for aquatic invasive species

Many aquatic invasive species (AIS) in Minnesota have not yet been observed in Northwood Lake but could be introduced. For example, both zebra mussels and starry stonewort are present in nearby Medicine Lake. A suitability analysis was performed to evaluate whether Northwood Lake water quality would support the introduction of six AIS: starry stonewort, zebra mussels, spiny waterflea, faucet snail, Chinese mystery snail, and rusty crayfish.

The analysis compared 2022 water quality in Northwood Lake with the water quality conditions required for each species, specifically evaluating total phosphorus, chlorophyll *a*, Secchi disc depth, trophic state index (TSI), water temperature, dissolved oxygen, specific conductance, calcium, magnesium, sodium, alkalinity, hardness, and calcium carbonate. The results indicate that the water quality of Northwood Lake only partially meets the suitability requirements for rusty crayfish, starry stonewort, spiny waterflea, zebra mussels, the faucet snail, and the Chinese mystery snail. Hence, these species would likely survive but may not thrive in Northwood Lake.

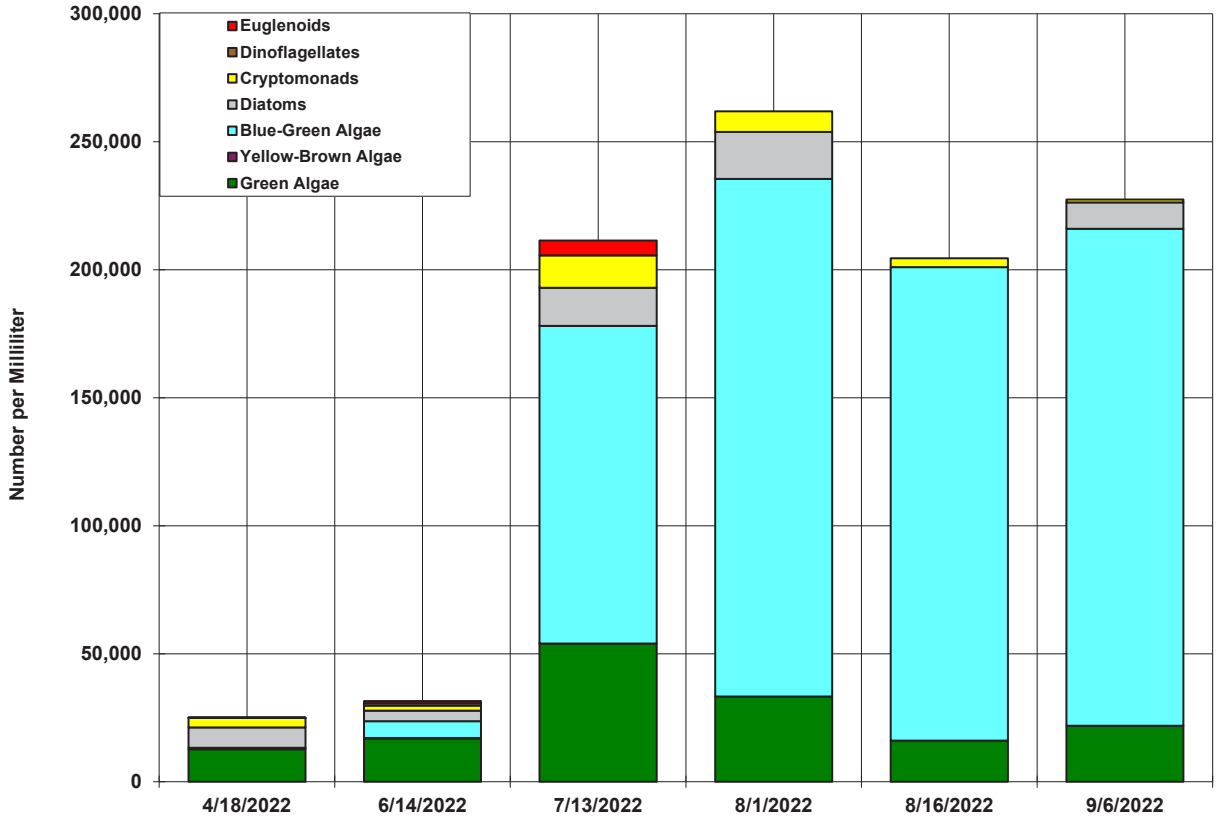
Phytoplankton (algae)

Phytoplankton, or algae, are small aquatic plants naturally present in lakes. Phytoplankton derive energy from the sun through photosynthesis and provide food for several types of aquatic organisms, including zooplankton (microscopic animals), which are, in turn, eaten by fish. An inadequate phytoplankton population limits a lake's zooplankton population and indirectly limits fish production in a lake. Excess phytoplankton can reduce water clarity.

Phytoplankton samples were collected from Northwood Lake to evaluate water quality and the quality of food available to zooplankton. The phytoplankton monitoring also included blue-green algae, a type of bacteria called cyanobacteria. This type of bacteria thrives in warm, nutrient-rich water and can grow rapidly under certain conditions, causing "blooms." Blue-green algae can produce algal toxins, which can harm humans or other animals. Blue-green algae are also a poor-quality food for zooplankton; they can be toxic and may not be assimilated if ingested.

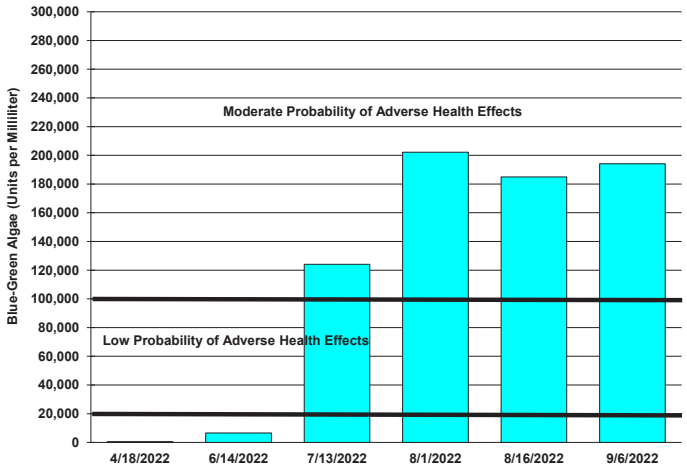
The figure below summarizes the number and major groups of phytoplankton in Northwood Lake in 2022. Green algae, diatoms, and cryptomonads provided a good quality food source for the zooplankton community. The figure on page 5 shows historical Northwood Lake phytoplankton.

2022 Northwood Lake phytoplankton summary by division

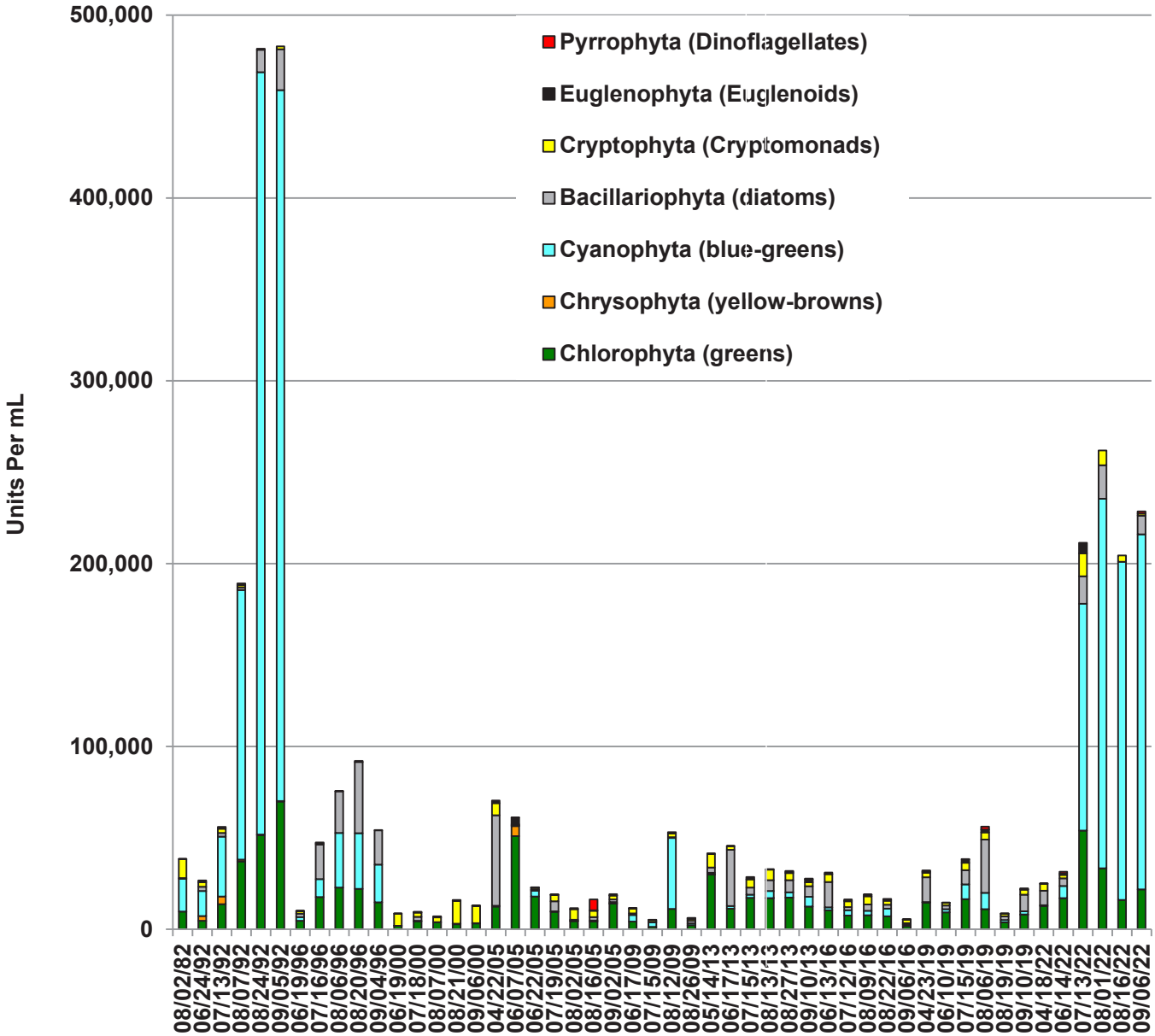


In 2022, a severe blue-green algal bloom was observed in the lake from the July through September sample events. Blue-green algae numbers during this period ranged from approximately 124,000 units per milliliter in July to 202,000 units per milliliter in August (see figure at right), well above the WHO threshold (100,000 per milliliter) for a moderate probability of adverse health effects. Blue-greens comprised a higher percentage (90 percent) of the phytoplankton in mid-August of 2022 than in previous years (0 to 87 percent). Although there can be many causes of blue-green algal blooms, the high total phosphorus concentrations, hot, dry summer conditions, and very little flow through the lake contributed to the growth and persistence of the blue-green algal population throughout the summer months.

2022 Northwood Lake blue-green algae compared with World Health Organization (WHO) thresholds for health impacts



Historical Northwood Lake phytoplankton



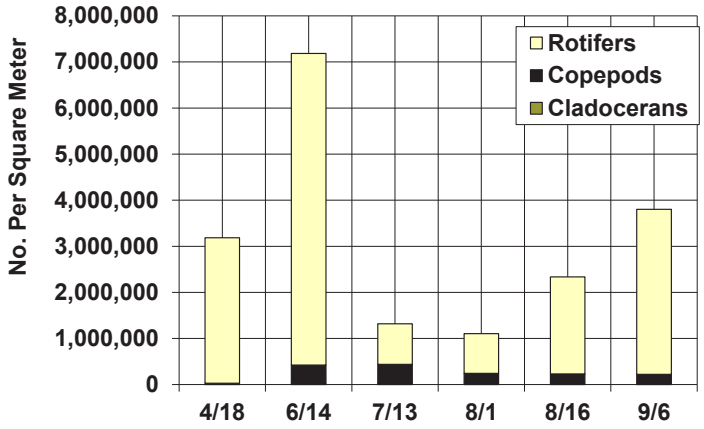
Zooplankton

Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantity 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. Cladocerans swim slowly and lack the copepods' ability to escape predation by jerking or jumping out of the way.

Small rotifers, the least preferred food for fish, dominated the zooplankton community throughout 2022 (figure at right). Copepods were also prevalent throughout the summer, while the number of cladocerans was so low that they are not generally visible in the figure at right. The low number of cladocerans is likely due to fish predation. Low numbers of cladocerans in shallow lakes are common because they have no deep water refuge to escape fish. Deeper waters have sufficient oxygen for zooplankton but insufficient oxygen for fish. Consequently, deeper lakes often have higher numbers of cladocerans than shallow lakes.

The 2022 numbers and community composition of zooplankton in Northwood Lake were within the range observed since 2013; however, the June 2022 value was higher than all but the May 2013 value (see figure below). There were more zooplankton from 2013 through 2022 than before 2013. The higher zooplankton numbers since 2013 are likely due to the increased extent and density of aquatic plants within the lake. Aquatic plants provide hiding places for zooplankton to avoid predation by fish. Aquatic plants were not observed in Northwood Lake before 2000, and zooplankton numbers were very low. The use of barley straw in 2000 through 2003 to inhibit algal growth and improve water clarity has increased the aquatic plant community's extent and density, and zooplankton numbers have also increased.

2022 Northwood Lake Zooplankton



Historical Northwood Lake Zooplankton