Cavanaugh Lake (Sunset Hill Pond) 2019 water quality monitoring

Monitoring water quality in Cavanaugh 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: 2019 monitoring results

In 2019, the BCWMC monitored Cavanaugh Lake for:

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

Results of 2019 monitoring show that Cavanaugh Lake met applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for shallow lakes. In addition, the plant community met the Minnesota Department of Natural Resources (MDNR) plant index of biotic integrity (IBI) standard for the number of species and Floristic Quality Index, which measures the quality of the plant community (see page 4). Both the lake's water quality and plant community have improved since 1998, when the lake failed to meet standards for water quality and plant community.

About Cavanaugh Lake

BCWMC classification	Priority-2 shallow lake
Watershed area	126 acres
Lake size	13 acres
Average depth	5.3 feet
Maximum depth	10.8 feet
Downstream receiving waterbody	Plymouth Creek (during large rain events)
Location (city)	Plymouth
MPCA impairments	None
Aquatic invasive species	Curly-leaf pondweed, purple loosestrife, narrow-leaved cattail, reed canary grass
Public access	No

Recommendations

- Continue efforts to improve the lake's water quality and plant community
- Continue water quality and biological monitoring

Water chemistry monitoring: 2019

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 in streets, atmospheric deposition, soil erosion, plant die-off (such as curly-leaf pondweed), and lake sediment which can release phosphorus when oxygen concentrations are absent or very low.

- **BCWMC/MPCA standard:** 60 micrograms per liter (µg/L) or less.
- **Range:** Total phosphorus concentrations ranged from a low of 30 µg/L in September to a high of 62 µg/L in April. The April concentration was in the hypereutrophic category (very high nutrient content) and all other concentrations were within the eutrophic category (high nutrient content).
- **Summer average:** 46 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:** 20 µg/L or less.
- **Range:** Chlorophyll *a* concentrations ranged from a low of 2.9 µg/L in September to a high of 16.2 µg/L in late August. Throughout 2019, chlorophyll *a* concentrations were generally in the eutrophic category, indicating poor water quality; however, during one September sample event the concentration was in the mesotrophic category, indicating good water quality.
- **Summer average:** 10.3 µg/L (met the BCWMC/MPCA standard).

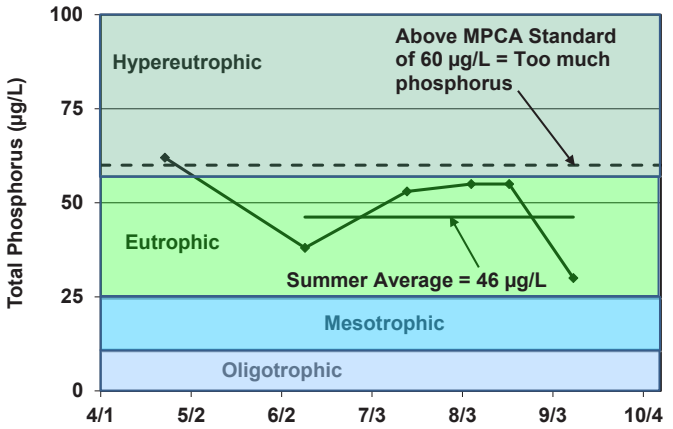
Water clarity

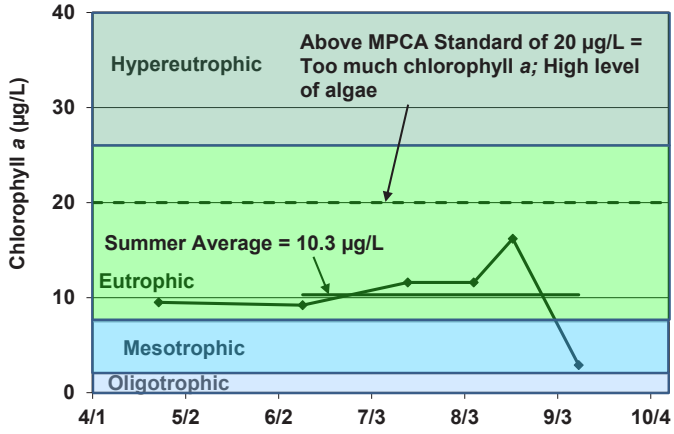
Water clarity is often affected by sediment and the amount of algae or other photosynthetic organisms in a lake. It is usually measured by lowering an 8-inch "Secchi" disc into the lake; the depth at which the disc's alternating black-and-white pattern is no longer visible is considered a measure of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

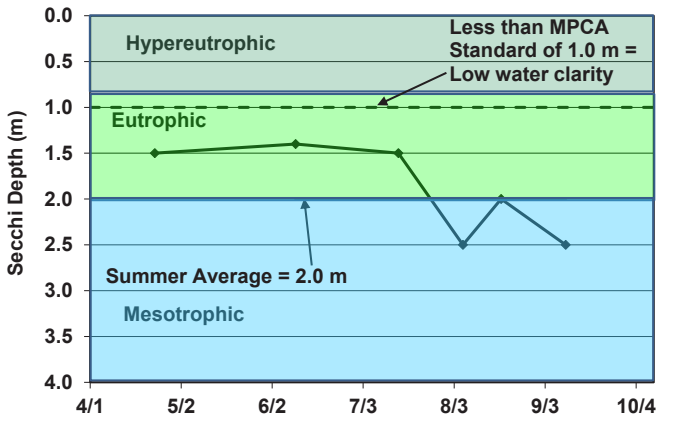
- **BCWMC/MPCA standard:** 1.0 meters or more.
- **Range:** Secchi disc depth ranged from 1.4 meters in June to 2.5 meters in early August and September. From April through July depths were in the eutrophic category, indicating poor water quality; during August and September they were in the mesotrophic category, indicating good water quality.
- **Summer average:** 2.0 meters (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

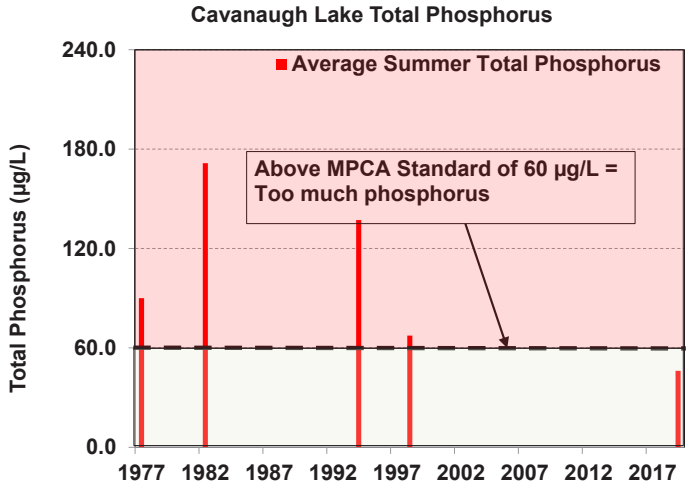


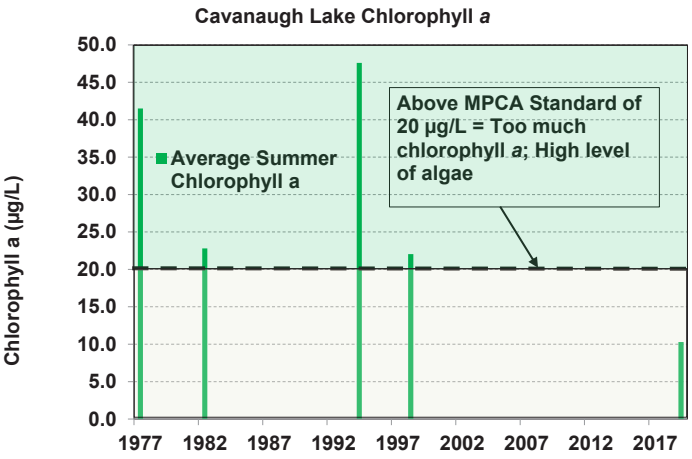


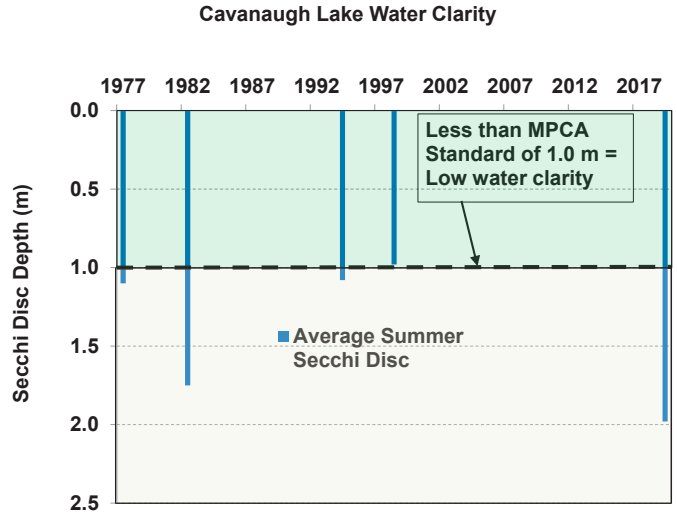


Water chemistry monitoring from 1977–2019: historical trends

Water quality in Cavanaugh Lake has been monitored since 1977. Summer averages (June through September) of total phosphorus, chlorophyll *a*, and Secchi disc depth from 1977–2019 are shown in the figures below. Summer averages for total phosphorus and chlorophyll *a* failed to meet the MPCA/BCWMC standard in 1977, 1982, 1994, and 1998, but met the standard in 2019. Secchi disc depth met the standard all years except 1998.







Chloride levels in 2019

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 melts, 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. 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 a chronic exposure chloride standard of 230 mg/l or less.

- **Range of chloride concentrations in Cavanaugh Lake:** From a high of 70 mg/L, measured in April, to a low of 50 mg/L, measured in September
- **Average concentration:** 59 mg/L (meets MPCA standard).

These low numbers are indicative of the small watershed area with little directly connected impervious area.

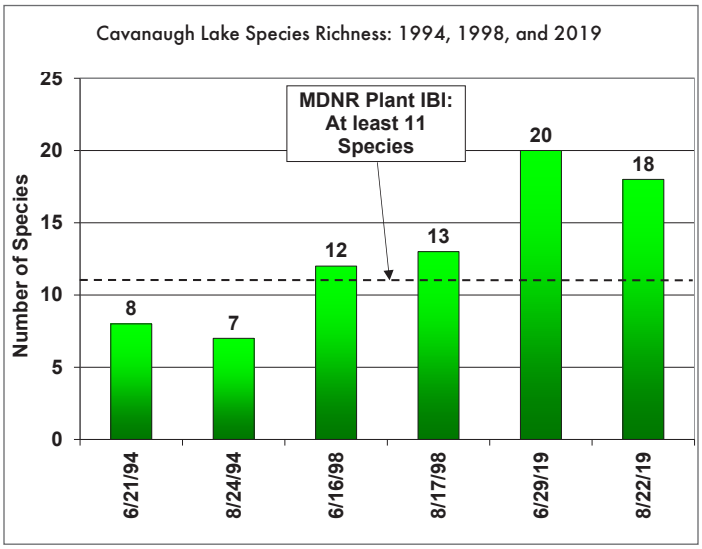
Macrophytes

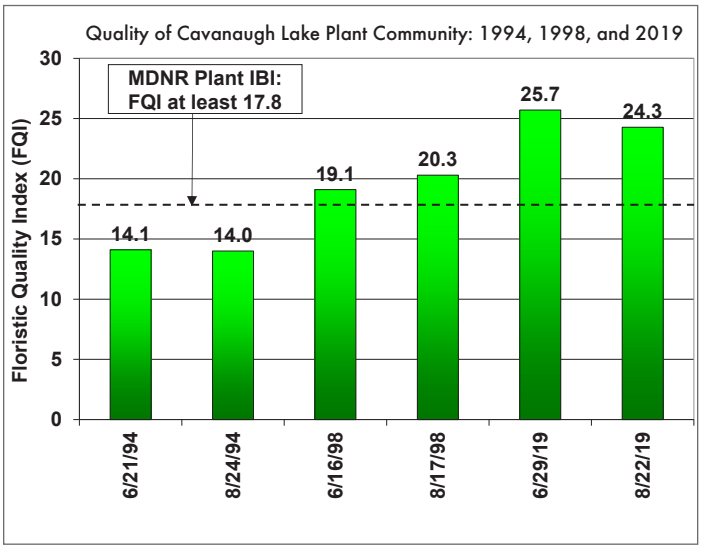
Lake Plant Eutrophication Index of Biological Integrity (IBI)

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

Plant survey data from 1994, 1998, and 2019 were assessed to determine plant IBI trends. The figures below show the Cavanaugh Lake FQI scores and number of species for that period compared to the MDNR plant IBI impairment threshold.

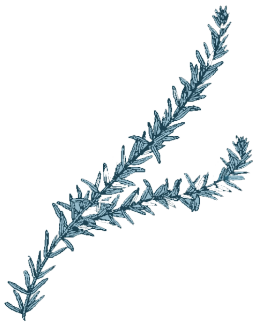
- **Number of species:** The number of species in Cavanaugh Lake has steadily improved over time, from a low of seven species observed in 1994, to 13 species in 1998, and 20 species in 2019—well exceeding the standard of at least 11 species. Some of the most common plants are shown below.
- **FQI values (quality of species):** The standard, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values for Cavanaugh Lake increased from 14.0 to 25.7, exceeding the standard of 17.8 in 1998 and 2019.
- **2019 results:** Both the number of species in the lake and FQI values were higher than the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants. In 2019, the Cavanaugh Lake plant community had higher numbers of species and higher FQI scores than in previous years.



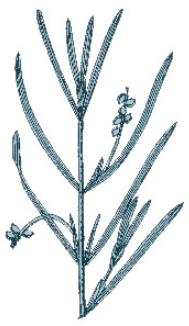


Commonly found aquatic species

Coontail
Ceratophyllum demersum
(native plant)

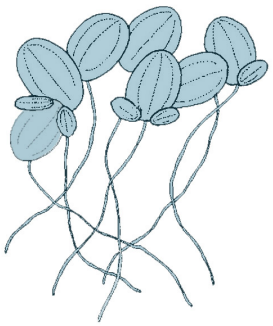


Canadian waterweed
Elodea canadensis
(native plant)



Flatstem pondweed
Potamogeton zosteriformis
(native plant)

Curly-leaf pondweed
Potamogeton crispus
(non-native invasive species)



Common duckweed
Lemna minor
(native plant)

Aquatic invasive species

In 2019, four invasive species were present in Cavanaugh Lake.

- **Curly-leaf pondweed (*Potamogeton crispus*):** The first sighting of curly-leaf pondweed occurred in June of 2019; low-density growth was observed at two southwest bay sample sites. All plants were isolated individuals under the canopy of white water lilies, which will likely limit the expansion of curly-leaf pondweed in the lake.
- **Purple loosestrife (*Lythrum salicaria*):** This emergent species was observed in a few scattered clumps along the shoreline in August.
- **Narrow-leaved cattail (*Typha glauca*):** Narrow-leaved cattail was observed at a single location along the north shoreline in June and August.
- **Reed canary grass (*Phalaris arundinacea*):** Reed canary grass was observed at a single location along the north shoreline in June and August.

Curly-leaf pondweed

Purple loosestrife

Narrow-leaved cattail

Reed canary grass

Curly-leaf pondweed in the lake's southwest bay

Phytoplankton and zooplankton

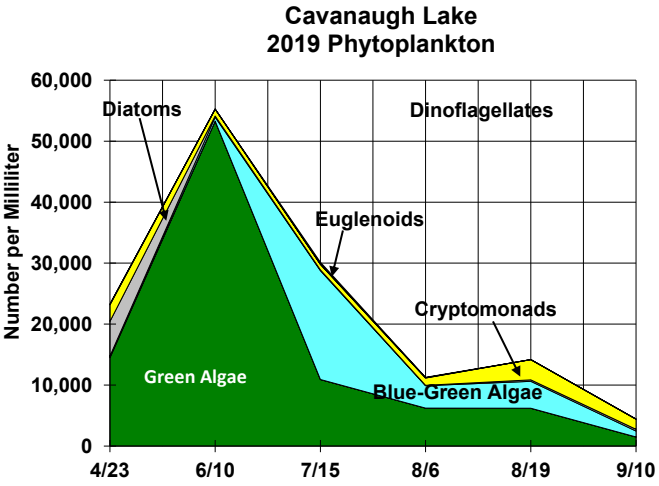
Samples of phytoplankton (microscopic aquatic plants) were collected from Cavanaugh Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). As shown in the figure below (right), phytoplankton numbers increased in June, then steadily decreased through September. In April and June, the community was dominated by green algae—considered a good source of food for the lake's zooplankton. In July, the community was co-dominated by green algae and small-celled blue-green algae. Blue-green algae are a poor quality food because they may be toxic and may not be assimilated if ingested. In August and September, the community comprised roughly equal numbers of green algae, blue-green algae, and cryptomonads. Cryptomonads are considered a good source of food for the lake's zooplankton.

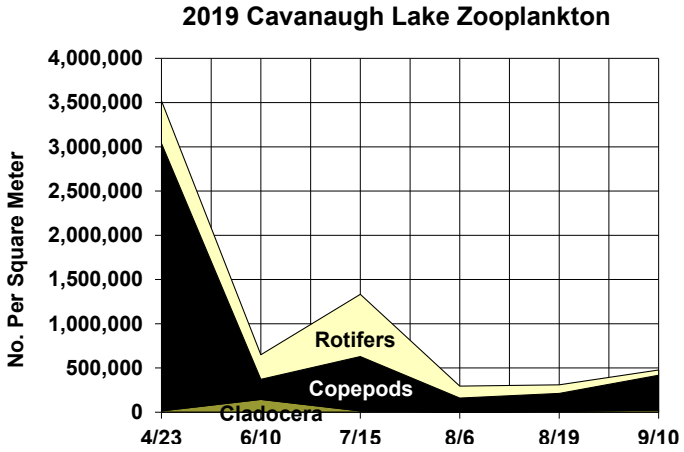
In 2019, blue-green algae numbers were lower than 1994 and, with the exception of July, were also lower than 1998. (See the graph on following page for historical Cavanaugh Lake pytoplankton information.) 2019 green algae numbers were higher in June, but were relatively similar to 1994 and 1998 numbers during July through September. The 2019 changes are favorable for lake water clarity and the health of the zooplankton community. By virtue of their smaller size, green algae take up less space in the water column than most blue-green algae—resulting in better water clarity. Water clarity was, on average, better in 2019 than 1994 and 1998. Green algae are a better quality food source than blue-green algae and contribute towards a healthier zooplankton community.

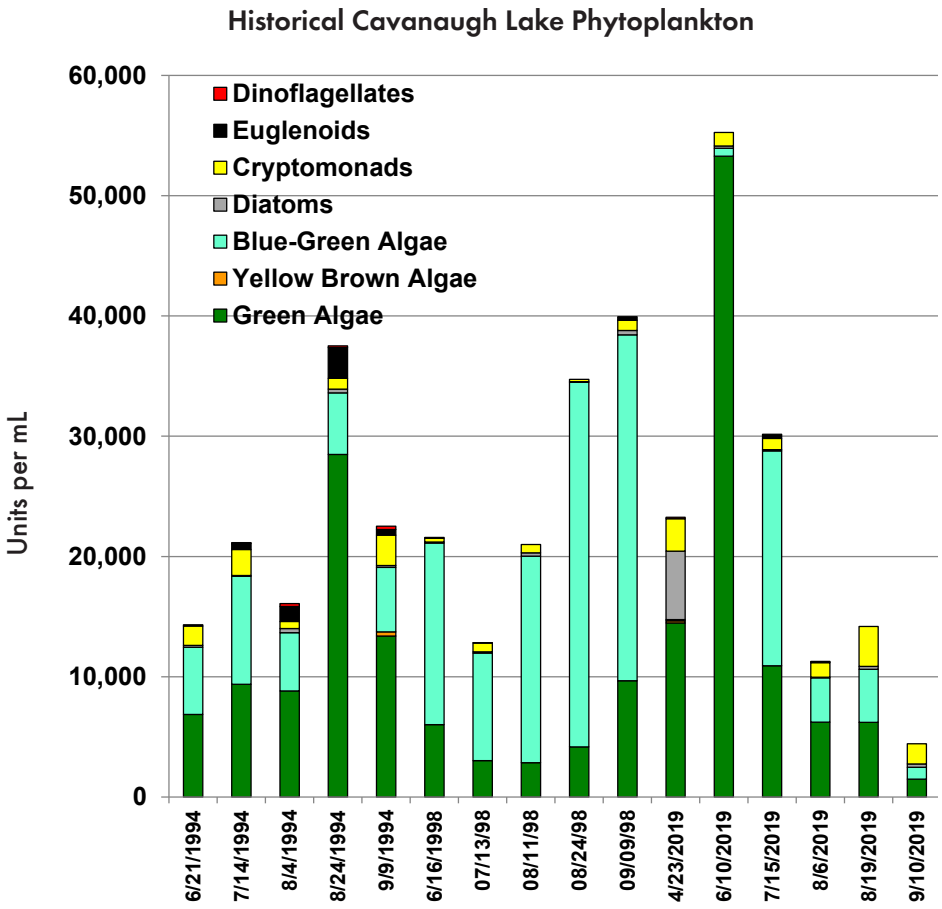
Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantities and species, they can filter the volume of an entire lake in a matter of days. They are also a valuable food source for planktivorous fish and other organisms.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

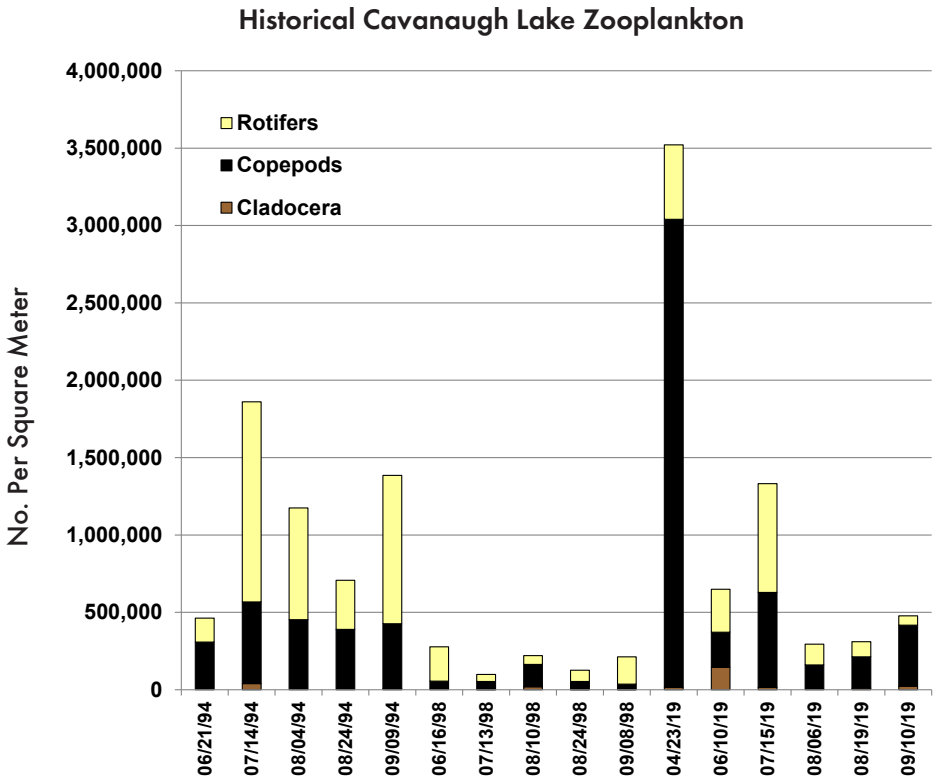
The 2019 numbers and community composition of zooplankton in Cavanaugh Lake reflect the impact of fish predation on the community. Zooplankton numbers were highest in spring, prior to the spring hatch of fish, and declined quickly when the newly hatched fish began feeding on zooplankton. Small rotifers and copepods were prevalent throughout the summer, while cladocerans were observed in low numbers; their numbers were so low they are not generally visible on the figure at right. The low numbers of cladocerans are likely due to fish predation. Low numbers of cladocerans in shallow lakes are common because they have no refuge to escape predation. Deeper waters have sufficient oxygen for zooplankton survival, but insufficient oxygen for fish survival. Consequently, deeper lakes often have higher numbers of cladocerans than shallow lakes.

Numbers of zooplankton during the summer were higher in 2019 than 1998 and relatively similar to 1994 numbers. (See the graph on the following page for historical Cavanaugh Lake zooplankton information.) Reductions in the amount of good quality food (green algae) available to zooplankton in 1998 appear to have reduced zooplankton numbers. In 2019, increased numbers of green algae and reduced numbers of blue-green algae (poor quality food) are correlated with increased numbers of zooplankton. Community composition in summer was relatively similar during all three years. Rotifers and copepods were prevalent throughout the summer and cladoceran numbers were consistently low due to fish predation.









Suitability of Cavanaugh Lake for Aquatic Invasive Species (AIS)

A large number of AIS residing in Minnesota have not yet been observed in Cavanaugh Lake, but could be introduced. For example, both zebra mussels and starry stonewort were recently found in nearby Medicine Lake. To determine whether Cavanaugh 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 analyses compared 2019 lake water quality 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 Cavanaugh Lake meets the suitability requirements for rusty crayfish, faucet snail, and spiny waterflea. The lake's water quality only partially meets the suitability requirements for Chinese mystery snail, zebra mussel, and starry stonewort. Hence, these species would likely survive, but may not thrive in Cavanaugh Lake if introduced.

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