Item 5C.
BCWMC 7-21-22

Crane Lake 2021 water quality monitoring

The Bassett Creek Watershed Management Commission (BCWMC) has monitored water quality conditions in the watershed's 10 priority lakes since 1972. This monitoring is done to detect changes or trends in water quality and evaluate the effectiveness of efforts to preserve or improve water quality. A summary of 2021 monitoring efforts on Crane Lake is provided below; more comprehensive information can be found on pages 2–6.

At a glance: 2021 monitoring results

In 2021, the BCWMC monitored Crane Lake for:

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

Results of 2021 monitoring show that Crane Lake has very high chloride levels that do not meet Minnesota Pollution Control Agency (MPCA) water quality standards. Trend analyses show a statistically significant increase in chlorides over the past 50 years. The significant increases in chloride concentrations have reduced zooplankton diversity. The abundance of zooplankton in the lake also declined over the past 22 years, but a trend analysis indicates the decline is not significant.

Crane Lake does meet MPCA and Bassett Creek Watershed Management Commission (BCWMC) water quality standards for total phosphorus and chlorophyll a. Secchi depth did not meet the MPCA/BCWMC standard in 2021; however, the low value was due to the dense growth of aquatic plants, which limited the Secchi disc depth to the top of the plants. Trend analyses show a statistically significant decline in total phosphorus but no significant changes in Secchi disc and chlorophyll *a* over the past 25 years. Other results include:

- The lake plant community was of fair-to-good quality, based on the number of species in the lake and the FQI values compared to the Minnesota Department of Natural Resources (MNDNR) Plant IBI thresholds.
- 2021 phytoplankton and numbers were within the range observed since 1982.
- An aquatic invasive species (AIS) suitability analysis indicates that the water quality of Crane Lake meets the suitability requirements for rusty crayfish, zebra mussel, spiny waterflea, and starry stonewort. However, the sodium and specific conductance levels were too high to be suitable for faucet snail and Chinese mystery snail. Hence, these species would likely survive but may not thrive in Crane Lake.

About Crane Lake

BCWMC classification	Priority-2 shallow lake
Watershed area	591 acres
Lake size	30 acres
Average depth	3.3 feet
Maximum depth	5 feet
Ordinary high water level	920.5 feet (NGVD29)
Normal water level	917.1 feet (NAVD88)
Downstream receiving waterbody	Medicine Lake
Location (city)	Minnetonka
MPCA impairments	None
Aquatic invasive species	Curly-leaf pondweed, purple loosestrife, hybrid cattail
Public access	No

Recommendations

- Work with cities, businesses, Ridgedale Center property management, the Minnesota Department of Transportation, and Hennepin County to improve winter maintenance practices and reduce the chloride load conveyed to Crane Lake from streets and parking lots in its watershed.
- Continue water quality and biological monitoring at a 5-year frequency.

Water chemistry monitoring: 2021

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, excessive phosphorus leads to excessive algal growth, decreased water clarity, and water quality impairment.

- BCWMC/MPCA standard: 60 micrograms per liter (µg/L) or less
- Range: Low of 13 µg/L in early August to 38 µg/L in June
- Summer average: 23 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 with clear water generally have chlorophyll *a* levels less than 15 micrograms per liter (µg/L).

- BCWMC/MPCA standard: 20 µg/L or less
- Range: Low of 2.3 µg/L in early August to high of 6.6 µg/L in April
- Summer average: 4.0 µg/L (met BCWMC/MPCA standard)

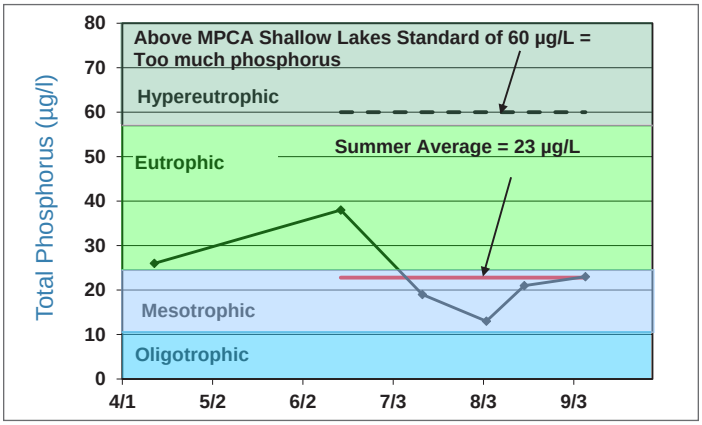
Water clarity

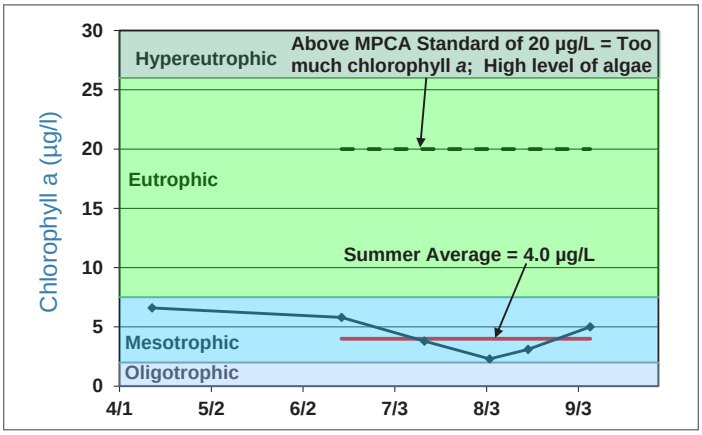
Water clarity is affected by the amount of algae and other suspended materials in a lake. It is usually measured by lowering an 8-inch "Secchi" disc into the lake (see bottom photo); the depth at which the disc's alternating black-and-white pattern is no longer visible is considered a measure of the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

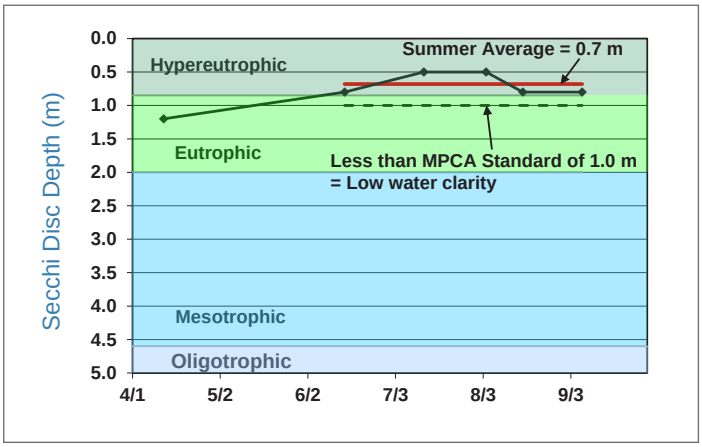
- BCWMC/MPCA standard: 1.0 meter or more.
- Range: From low of 0.5 meters (July and early August) to high of 1.2 meters (April)
- Summer average: 0.7 meters (did not meet BCWMC/MPCA standard, but the low value occurred because the dense growth of aquatic plants limited the Secchi disc depth to the top of the plants)

Definitions

- **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
- **Hypereutrophic:** Nutrient-rich lake conditions characterized by frequent and severe algal blooms and low transparency
- **Mesotrophic:** Lake condition characterized by medium levels of nutrients and clear water
- **Oligotrophic:** Lake condition characterized by a low level of dissolved nutrients, high oxygen content, and sparse algae growth







Water chemistry monitoring from 1975–2021: historical trends

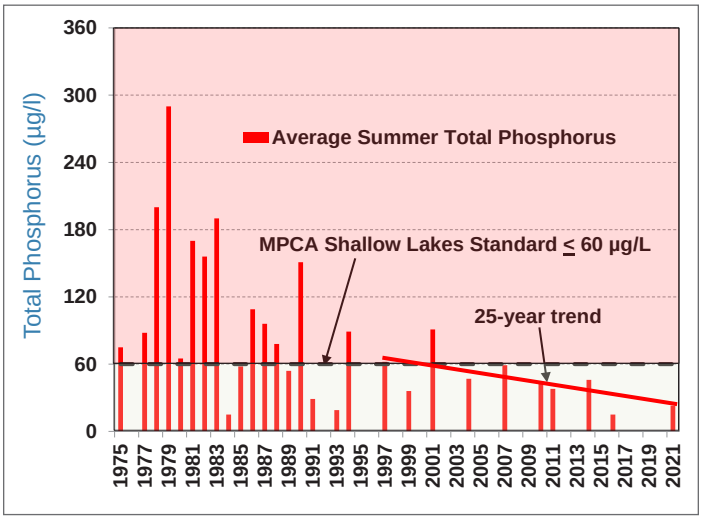
Summer water quality in Crane Lake has been monitored since 1975. Data have been collected by BCWMC (1977–2021), the City of Minnetonka (1993–2016), and Ridgedale Center (1975–1991).

Summer averages (June through September) of total phosphorus from 1975–2021 and chlorophyll *a* and Secchi disc depth from 1977–2021 are shown in the figures at right. During the monitored period, 46 percent of total phosphorus summer averages, 56 percent of chlorophyll *a* summer averages, and 57 percent of Secchi disc summer averages met Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion, as published in Minnesota Rules (Minn. R. Ch. 7050.0222 Subp. 4). All total phosphorus and chlorophyll *a* summer averages from 2004 through 2021 met BCWMC/MPCA standards. Secchi disc summer averages from 2004 through 2014 met BCWMC/MPCA standards. However, the lake's dense plant growth limited Secchi depth to the top of the plants in 2016 (0.9 meters) and 2021 (0.7 meters), and these depths failed to meet BCWMC/MPCA standards.

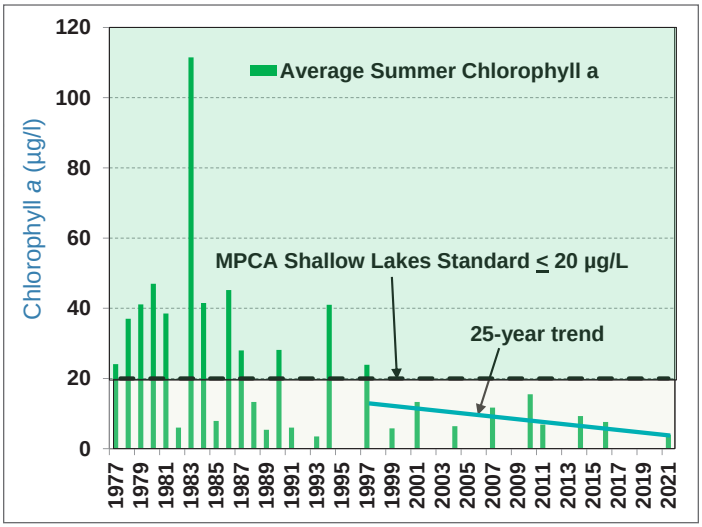
Trend analyses show a significant reduction (improvement) in summer average total phosphorus concentrations over the past 25 years (95-percent confidence level). Although summer average chlorophyll *a* concentrations and Secchi disc depths did not change significantly over the past 25 years, the data show:

- Declining (improving) summer average chlorophyll *a* concentrations.
- Declining (worsening) summer average Secchi disc depths.

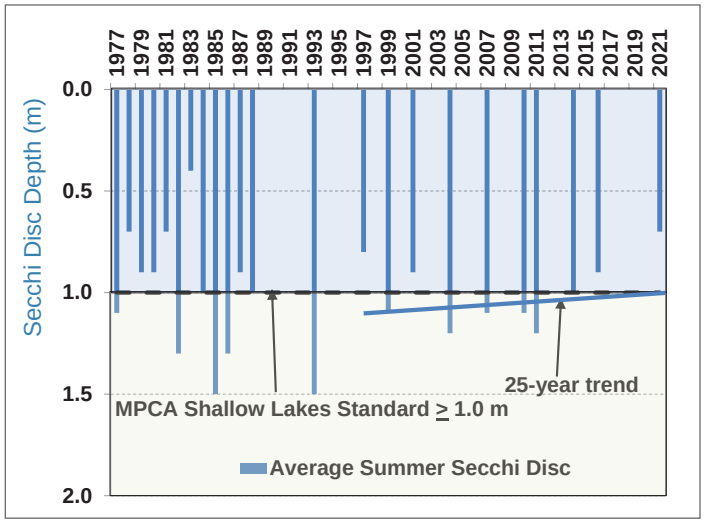
Total phosphorus trends



Chlorophyll *a* trends



Water clarity trends



Chloride levels from 1972 through 2021

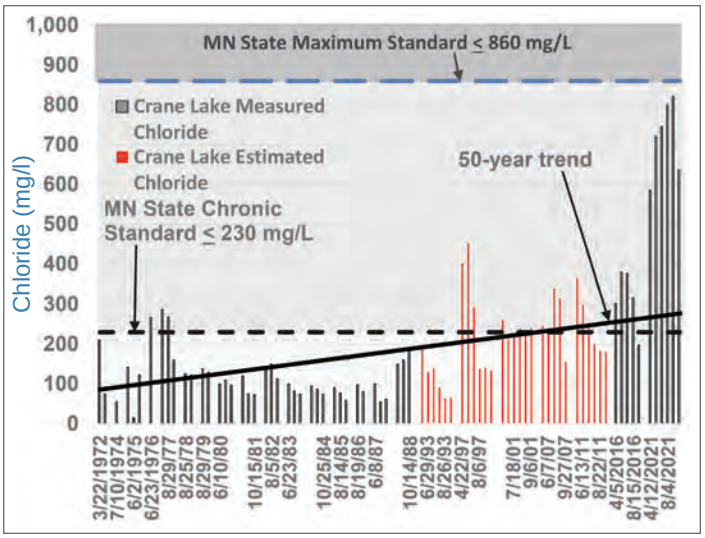
Chloride concentrations in area lakes have increased since the early 1990s, when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melt, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes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

Because high chloride concentrations 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 (zooplankton [see page 7], bugs, fish, frogs, etc.) 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 one measurement exceeds the maximum criterion (860 mg/L).

2021 chloride measurements ranged from 585 mg/L in April to 820 mg/L in late August. All measurements were well above the chronic chloride standard and below the maximum, although the late August measurement was close to the maximum. Although Crane Lake is not on the MPCA's impaired waters list, the data indicate the lake is impaired for chlorides. (The lake is slated to be included on the 2024 list of impaired waters.) Crane Lake is in the Medicine Lake watershed. The BCWMC lake -level data show that Crane Lake frequently discharges, which means that chlorides from Crane Lake could eventually reach Medicine Lake. This is a concern because Medicine Lake is close to being added to the impaired waters list for chlorides.

Trend analyses show a significant increase in chloride concentrations over the past 50 years (95-percent confidence level). Chloride measurements from 1972 through 1988 met the MPCA chronic chloride standard except for concentrations of 267 mg/L in June 1976, 287 mg/L in June 1977, and 268 mg/L in late August 1977 (see figure below). More than half of the chloride concentrations estimated from specific conductance measurements from 1997 through 2011 failed to meet the MPCA chronic chloride standard. 2016 chloride measurements failed to meet the MPCA chronic standard from April through August but met the standard in September. Chloride concentrations in the lake more than doubled between 2016 and 2021, and all 2021 concentrations failed to meet the MPCA chronic chloride standard.

Much of the area draining to Crane Lake comprises roads and parking lots, including the Ridgedale Mall area which is directly adjacent to the lake. Winter maintenance practices on these properties should be analyzed for potential improvements to reduce salt use. A 2026 BCWMC Capital Improvement Project also aims to reduce chlorides in the lake.



Increased use of chloride for road maintenance has had an impact on chloride levels in Twin Cities metro area lakes.

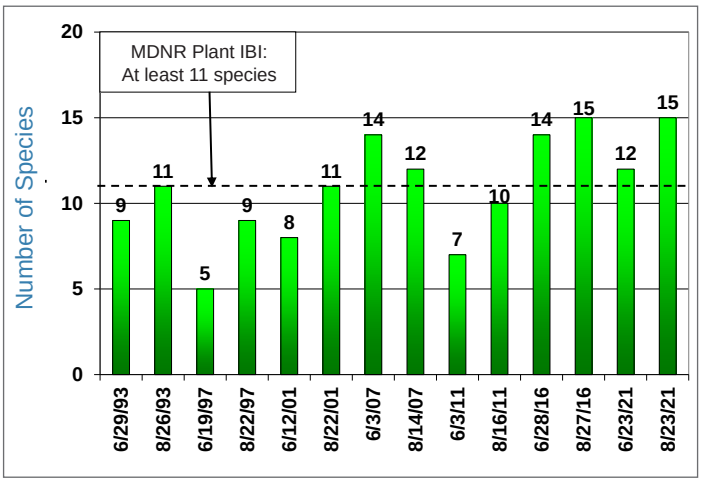
Macrophytes (aquatic plants)

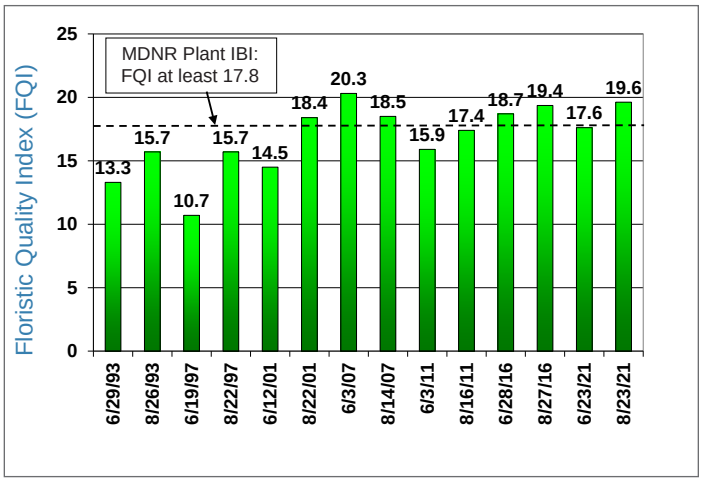
Lake Plant Eutrophication Index of Biological Integrity (IBI)

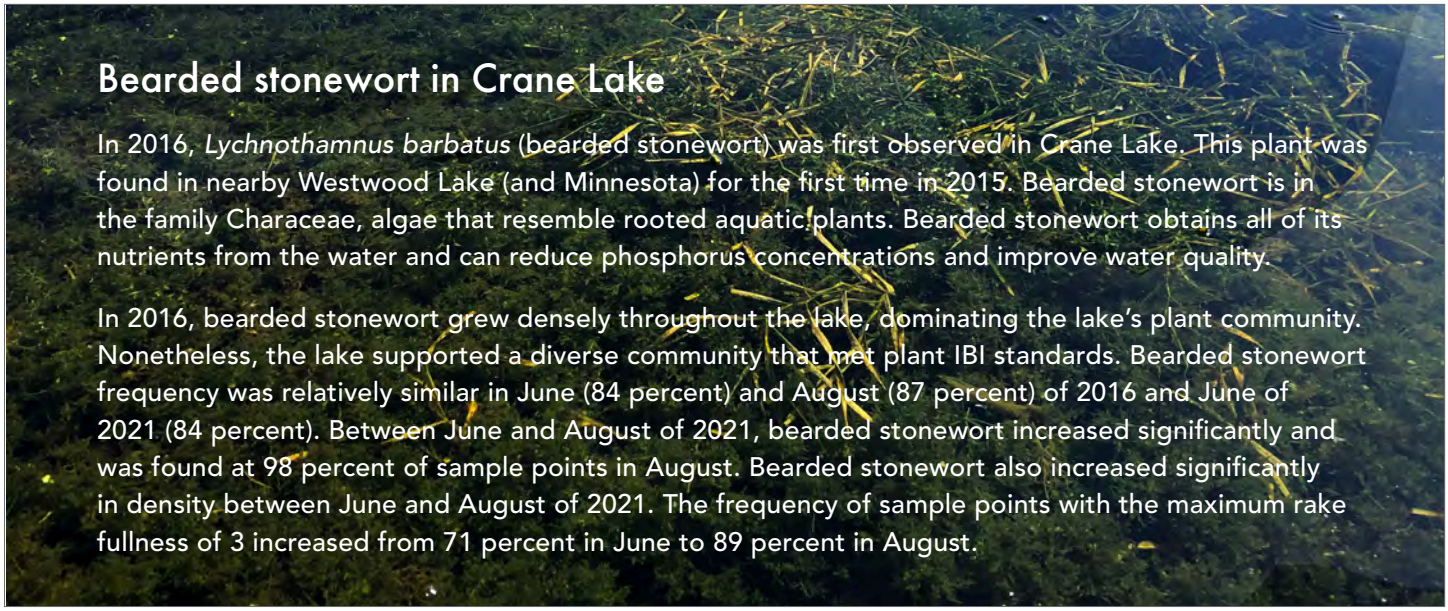
Eutrophication (excessive nutrients) may have detrimental effects on a lake, including reducing the quantity and diversity of plants. The MNDNR developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Lake Plant 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 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 1993 to 2021 were assessed to determine Plant IBI trends. The figures at right show Crane 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 Crane Lake meets the MNDNR Plant IBI threshold when at least 11 species exist. During the period examined, the number of species in Crane Lake ranged from 5 to 15, meeting or exceeding the MNDNR Plant IBI threshold 57 percent of the time. Fifteen species were observed in the lake in August 2016 and 2021, the highest number to date.
- **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 Crane Lake ranged from 10.7 to 20.3, bettering the MNDNR Plant IBI threshold 43 percent of the time. The FQI value of 19.6 in August of 2021 was the second-highest to date.
- **2021 results:** The number of species in the lake was better than the MNDNR Plant IBI threshold in June and August. The FQI value was better than the MNDNR Plant IBI threshold in August but poorer than the MNDNR Plant IBI threshold in June.







Bearded stonewort in Crane Lake

In 2016, *Lychnothamnus barbatus* (bearded stonewort) was first observed in Crane Lake. This plant was found in nearby Westwood Lake (and Minnesota) for the first time in 2015. Bearded stonewort is in the family Characeae, algae that resemble rooted aquatic plants. Bearded stonewort obtains all of its nutrients from the water and can reduce phosphorus concentrations and improve water quality.

In 2016, bearded stonewort grew densely throughout the lake, dominating the lake's plant community. Nonetheless, the lake supported a diverse community that met plant IBI standards. Bearded stonewort frequency was relatively similar in June (84 percent) and August (87 percent) of 2016 and June of 2021 (84 percent). Between June and August of 2021, bearded stonewort increased significantly and was found at 98 percent of sample points in August. Bearded stonewort also increased significantly in density between June and August of 2021. The frequency of sample points with the maximum rake fullness of 3 increased from 71 percent in June to 89 percent in August.

Aquatic invasive species

In 2021, three aquatic invasive species (AIS) were present in Crane Lake; no species was considered problematic.

- **Curly-leaf pondweed *(Potamogeton crispus):*** Curly-leaf pondweed was first observed in 1993 and has since been found in 25 percent of the plant surveys. It was observed at one location in August 2021 but not in June.
- **Purple loosestrife (*Lythrum salicaria*):** This emergent species has consistently been found at one or two locations along the lake's shoreline since 1993. In June and August of 2021, it was observed at one location along the southern shoreline.
- **Hybrid cattail (*Typha glauca*):** Hybrid cattail was first observed at one location along the northern shoreline in 2016. In 2021, it was found at one location along the southern shoreline.

Suitability of Crane Lake for AIS

Many AIS currently residing in Minnesota have not been observed in Crane Lake but could be introduced. For example, both zebra mussels and starry stonewort are present in nearby Medicine Lake but have not yet been found in Crane Lake. To evaluate whether Crane 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 2021 water quality in Crane 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 Crane Lake meets the suitability requirements for rusty crayfish, zebra mussel, spiny waterflea, and starry stonewort. However, the sodium and specific conductance levels were too high to be suitable for faucet snail and Chinese mystery snail. Hence, these species would likely survive but may not thrive in Crane Lake.

Phytoplankton and zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Crane Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). 2021 phytoplankton numbers followed a pattern similar to chlorophyll *a*, both reflecting good water quality. As shown in the figure on page 7, these numbers declined from April through early August and then increased through early September. Cryptomonads and green algae, good food sources for the lake's zooplankton, were dominant throughout the 2021 monitoring period, except during June, when blue-green algae were dominant. Blue-green algae, which are associated with water quality problems and can be a health concern, were present in low numbers in 2021. As shown in the figure on page 7, numbers of phytoplankton in 2021 were within the range observed since 1980. However, the 2021 average number of phytoplankton (4,181 units per mL) was the second-lowest summer average since 1980.

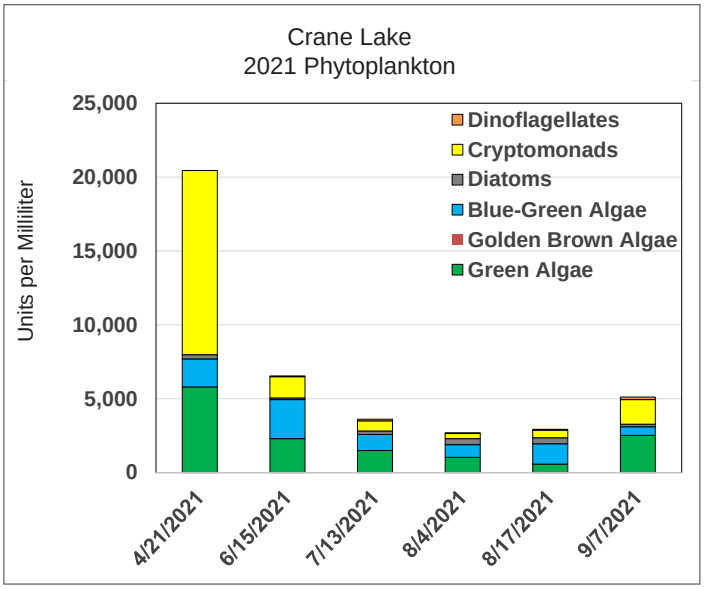
Unlike phytoplankton, zooplankton do not produce their own food. As "filter feeders," they eat millions of small algae; given the right quantity and species, they can filter the

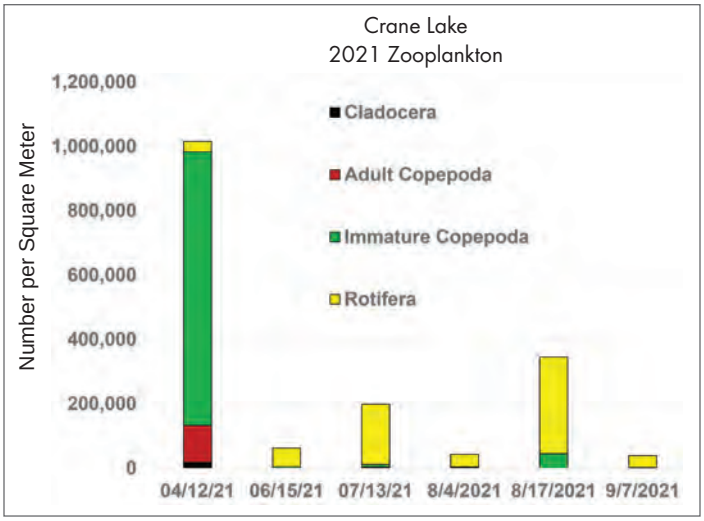
volume of an entire lake in a matter of days. They are also valuable food for planktivorous fish and other organisms.

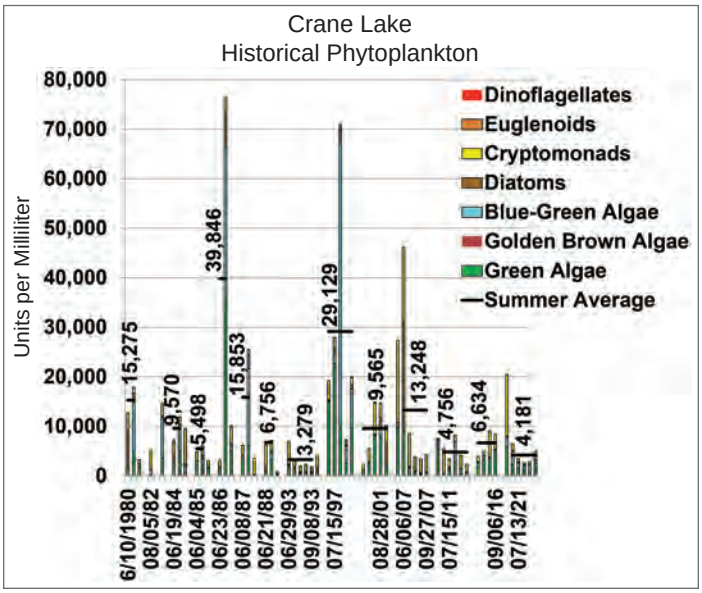
It's likely that fish predation impacted the 2021 zooplankton community, but the lake's high chloride concentrations likely caused a greater impact. Studies have documented reductions in adult cladocerans and copepods when chloride concentrations were within the range measured in Crane Lake in 2021; immature copepods (nauplii) and rotifers were less impacted by chlorides within this range. Consistent with these findings, zooplankton capable of surviving the high chloride concentrations in the lake dominated the 2021 zooplankton community. As shown in the figure below, immature copepods and rotifers comprised 87 percent of the April zooplankton community and from 90 to 100 percent of the June through September zooplankton community. Zooplankton most vulnerable to harm from the high chloride concentrations in the lake were either not observed or seen in low numbers.

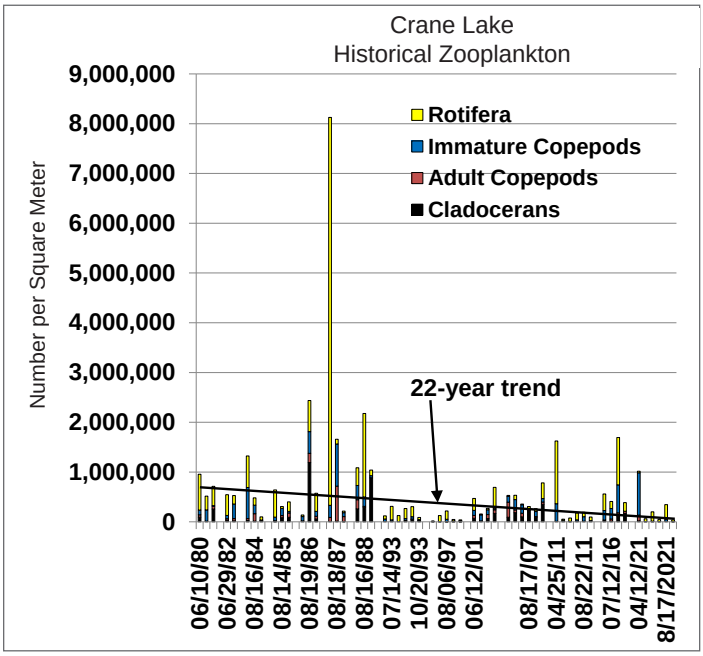
Adult copepods were not observed from June through September. Cladocerans were not observed in June, mid-August, and September and were seen in low numbers during April, July, and early August.

Significant increases in chloride concentrations over the past 50 years (95-percent confidence level) have reduced zooplankton species diversity in Crane Lake. Declines in number of species and abundance reduce the food supply for planktivorous fish and other organisms in the lake. Studies have documented reductions in zooplankton diversity with increasing chloride concentrations. Consistent with these studies, the number of zooplankton species in Crane Lake during the past 22 years has declined, and a trend analysis indicates the decline is significant (at the 95-percent confidence level). The abundance of zooplankton in Crane Lake also declined during the past 22 years, but a trend analysis indicates the decline is not significant (see figure below).









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