Medicine Lake

2024 Water Quality Monitoring

The Bassett Creek Watershed Management Commission

Stewardship of the Ȟaȟá Wakpádaŋ/Bassett Creek Watershed
to improve ecosystem health and reduce flood risk

Monitoring water quality in Medicine Lake

The Bassett Creek Watershed Management Commission (BCWMC) has monitored water quality conditions in the watershed's 10 priority lakes since 1972. This monitoring is performed to detect changes or observe trends in water quality, inform pollution modeling and studies, and target future projects and programs. Three Rivers Park District (TRPD) annually monitors the water quality of Medicine Lake, and BCWMC periodically partners with TRPD on additional monitoring in the lake.

At a glance: 2024 monitoring results

In 2024, TRPD monitored Medicine Lake for the following:

- Water chemistry (nutrients, chlorophyll *a*, chloride)
- Water clarity and dissolved oxygen, temperature, and specific conductance
- Macrophytes (aquatic plants)

In 2024, BCWMC partnered with TRPD to monitor the Southwest Bay of Medicine Lake and to add phytoplankton and zooplankton to the monitoring program. TRPD collected the samples. BCWMC funded the monitoring of the Southwest Bay and analyzed the phytoplankton and zooplankton samples.

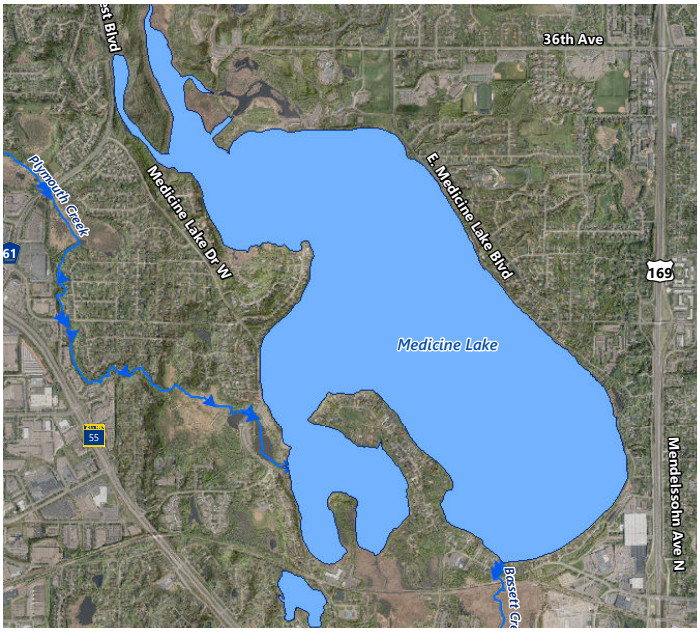
Results of 2024 monitoring show that the Main Basin and Southwest Bay of Medicine Lake met the applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for Secchi disc (a measure of clarity) and chlorophyll *a*, but did not meet the MPCA and BCWMC standard for total phosphorus. Trend analyses based on summer averages over the past 10 years show significant reductions in chlorophyll *a* and significant increases in Secchi disc at the 95th confidence level in the Main Basin and Southwest Bay. The significant changes are likely due to the increases in zebra mussels and the removal of algae by zebra mussel grazing. Declining summer average total phosphorus concentrations in the Main Basin and Southwest Bay over the past 10 years were not significant at the 95th percent confidence level.

Other results include the following:

- All measurements in the Main Basin and Southwest Bay during 2024 were well below the maximum chloride standard and, except for one bottom measurement from the Southwest Bay on April 1, were also below the chronic chloride standard.
- Both the number of species in the lake and Floristic Quality Index (FQI) values were better than the Minnesota Department of Natural Resources (MNDNR) Plant IBI thresholds.
- Four aquatic invasive species were observed in Medicine Lake in 2024: curly-leaf pondweed, Eurasian watermilfoil, starry stonewort, and zebra mussels.
- Following herbicide treatment of 113 acres of CLP in the spring of 2024, the plant's June frequency was 24 percent, which met the Lake Vegetation Management Plan (LVMP) goal of maintaining CLP at a frequency of less than 25 percent. However, this frequency

About Medicine Lake

BCWMC classification	Priority-1 deep lake
Watershed area	11,014 acres
Lake size	902 acres
Average depth	17.5 feet
Maximum depth	49 feet
MNDNR ordinary high water level	889.3 feet
Normal water level	887.9 feet
Downstream receiving waterbody	Ȟaȟá Wakpádaŋ/Bassett Creek
Location (city)	Medicine Lake, Plymouth
MPCA impairments	Mercury in fish tissue, nutrients
Aquatic invasive species	Eurasian watermilfoil, curly-leaf pondweed, zebra mussels (Nov. 2017), starry stonewort (Aug. 2018)
Public access	Yes (boat launch)



exceeded the CLP threshold frequency of 22 percent specified in the 2010 total maximum daily load (TMDL) implementation plan for Medicine Lake.

- Eurasian watermilfoil was not problematic in 2024, ranging in frequency from 13 to 19 percent of the sample locations.
- Starry stonewort occurred at a frequency of 1 to 3 percent from 2018 through June 2024, but increased to a frequency of 13 percent in August 2024.
- Zebra mussel surveys documented increases in number from about 1 per hour from 2017 to 2019 to 2,444 per hour in 2022 followed by a decline to 1,780 per hour in 2023. Zebra mussel veligers (planktonic larvae) were observed in zooplankton samples from the Main Basin in 2020 and 2024 and from the Southwest Bay in 2024.
- It appears zebra mussel grazing of algae has reduced phytoplankton numbers in the Main Basin and Southwest Bay of Medicine Lake by about 50 percent from 2016 to 2024.
- Zebra mussel grazing of green algae, a preferred food for zebra mussels, reduced early spring numbers in the Main Basin of Medicine Lake by more than an order of magnitude from 2016 to 2020 and kept numbers low in 2024. Zebra mussel grazing in the Southwest Bay reduced green algae numbers by more than 80 percent from 2016 to 2024.
- In 2024, cladocerans, the preferred food for fish, were found in lower numbers than copepods and rotifers in the Main Basin and Southwest Bay of Medicine Lake.
- In the Main Basin, average zooplankton numbers were lower in 2020 and 2024 than in 2016 due to fewer rotifers and copepods, and in the Southwest Bay due to fewer copepods. It appears the lower numbers of rotifers were due to zebra mussel predation. It is not known whether the lower numbers of copepods were due to fish predation or to food limitation caused by zebra mussels grazing on algae.
- An Aquatic Invasive Species (AIS) Suitability Analysis indicates that the water quality of the Main Basin and Southwest Bay of Medicine Lake meets the suitability requirements for rusty crayfish, faucet snail, and spiny waterflea, but only partially meets the suitability requirements for the Chinese mystery snail.

Recommendations

- An alum application split into three phases is recommended for Medicine Lake following a carp survey and development of a feasibility study, with monitoring done in between alum applications to help determine if future alum dose adjustments are warranted. A May treatment is recommended for each phase.
- Adaptive management to further address and control AIS is recommended, including:
    - Continued annual herbicide treatment of CLP to reduce total phosphorus loading during plant die-off in mid-summer. The current LVMP allows for the treatment of 25% to 30% of the littoral area. It is expected that a whole lake treatment may become an option at some point. We recommend that current CLP efforts should continue through the LVMP process with an adaptive management approach (considering the results of plant surveys) for both CLP and Eurasian watermilfoil after alum treatment based on future observed plant occurrence frequencies.
    - Current starry stonewort treatment efforts with copper/hydrothol/komeen may minimize the spread to other lake areas to prevent a surge in extent and biomass of starry stonewort with the improved water clarity expected after the alum treatment. In addition, an adaptive management approach should be taken with other controls as new research becomes available.
    - Current and potential zebra mussel treatments (molluscicides) have either been unsuccessful or cost-prohibitive. Until a cost-effective product becomes available for long-term control of zebra mussels on a whole lake, an adaptive management approach should be taken for alternative controls as new research becomes available.
- Street sweeping and/or enhanced treatment of stormwater runoff is recommended for the direct drainage area and a few small subwatersheds that drain directly to Medicine Lake.
- Continue working with cities, businesses, and Hennepin County to improve winter maintenance practices and reduce the chloride load conveyed to Medicine Lake from streets and parking lots in its watershed, including from Crane Lake and Parkers Lake, which ultimately drain to Medicine Lake.
- Continue to provide education and information to lake users to reduce the chance of AIS introduction and movement of AIS from Medicine Lake to other lakes.
- Continue water quality and biological monitoring at a 3-year frequency.

2024 water chemistry monitoring

2024 was a very wet year. According to data from the MNDNR, April through June was the wettest on record for Minnesota. During this period, the Twin Cities received 17.3 inches of precipitation, 5.9 inches above normal. March, July, and August were also wet, with 13.5 inches of precipitation in the Twin Cities—3.4 inches above normal. As shown in Figures 1–6, phosphorus and chlorophyll *a* concentrations in the Main Basin and Southwest Bay of Medicine Lake increased, and Secchi disc depth decreased from April through August, when above normal precipitation increased stormwater runoff to the lake.

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, too much phosphorus leads to excessive algae growth, 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.

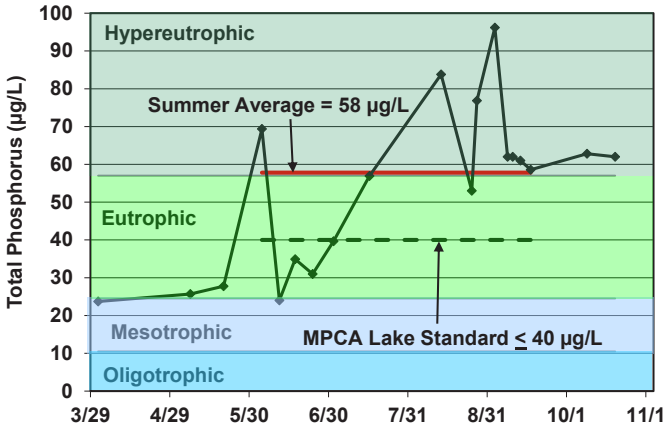
- **BCWMC/MPCA standard:** Summer average of 40 micrograms per liter (µg/L) or less.
- **Observed range:** 2024 total phosphorus concentrations in the Main Basin ranged from a low of 24 µg/L on April 1 to a high of 96 µg/L on September 3 (Figure 1). 2024 total phosphorus concentrations in the Southwest Bay ranged from a low of 23 µg/L on May 13 to a high of 84 µg/L on June 4 (Figure 2).
- **Summer average:** 2024 Main Basin and Southwest Bay summer averages were 58 µg/L and 52 µg/L, respectively, and did not meet the BCWMC/MPCA standard (Figures 1 and 2).

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 of less than 15 micrograms per liter (µg/L).

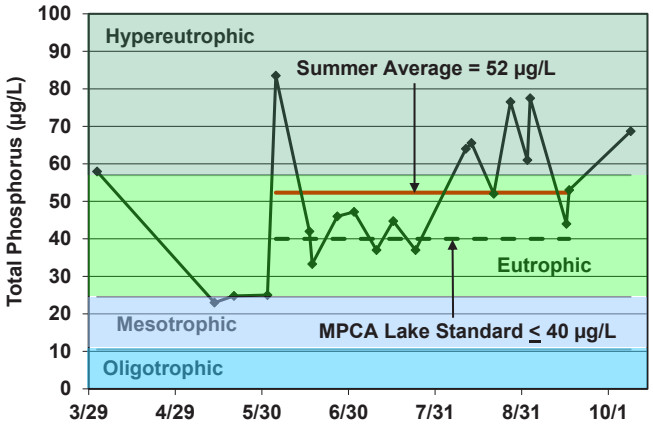
- **BCWMC/MPCA standard:** Summer average of 14 µg/L or less.
- **Observed range:** 2024 chlorophyll *a* concentrations in the Main Basin ranged from a low of 0.3 µg/L on June 4 to a high of 27.6 µg/L on September 3 (Figure 3). 2024 chlorophyll *a* concentrations in the Southwest Bay ranged from a low of 1.0 µg/L on May 13 to a high of 31.0 µg/L on August 11 (Figure 4).

Figure 1: 2024 Total Phosphorus–Main Basin



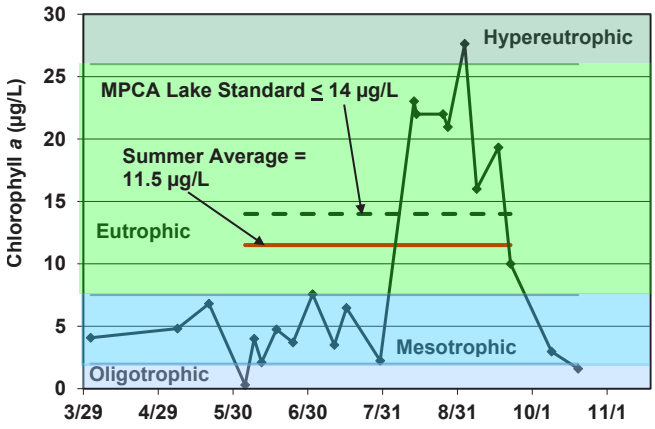
(Data collected by TRPD)

Figure 2: 2024 Total Phosphorus–Southwest Bay



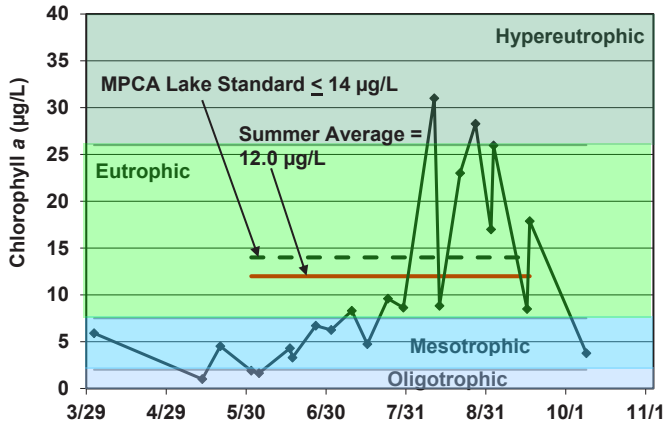
(Data collected by TRPD, funded by BCWMC)

Figure 3: 2024 Chlorophyll *a*–Main Basin



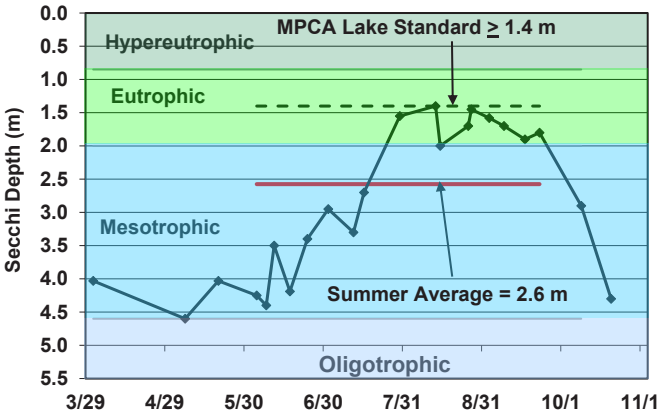
(Data collected by TRPD)

Figure 4: 2024 Chlorophyll *a*–Southwest Bay



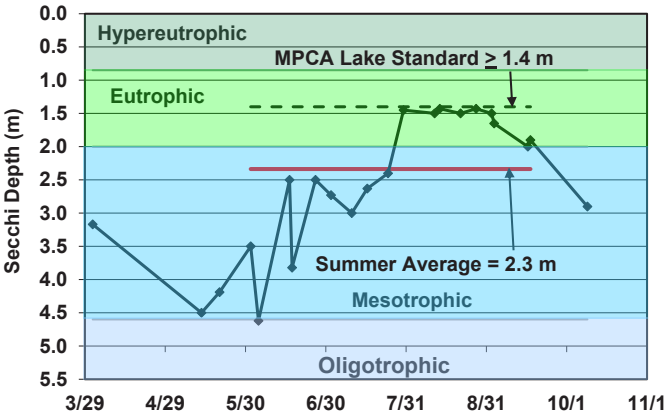
(Data collected by TRPD, funded by BCWMC)

Figure 5: 2024 Water Clarity (Secchi Depth) Main Basin



(Data collected by TRPD)

Figure 6: 2024 Water Clarity (Secchi Depth) Southwest Bay



(Data collected by TRPD, funded by BCWMC)

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

- **Summer average:** 2024 Main Basin and Southwest Bay summer averages were 11.5 µg/L and 12.0 µg/L, respectively, and met the BCWMC/MPCA standard (Figures 3 and 4).

Water clarity

Water clarity is often affected by sediment and the number 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 clarity.

- **BCWMC/MPCA standard:** Summer average of 1.4 meters or more.
- **Observed range:** 2024 Secchi disc depth in the Main Basin ranged from a low of 1.5 meters on August 27 to a high of 4.6 meters on May 7 (Figure 5). 2024 Secchi disc depth in the Southwest Bay ranged from a low of 1.4 meters on August 13 and August 27 to a high of 4.6 meters on June 4 (Figure 6).
- **Summer average:** 2024 Main Basin and Southwest Bay summer averages were 2.6 meters and 2.3 meters, respectively, and met the BCWMC/MPCA standard (Figures 5 and 6).

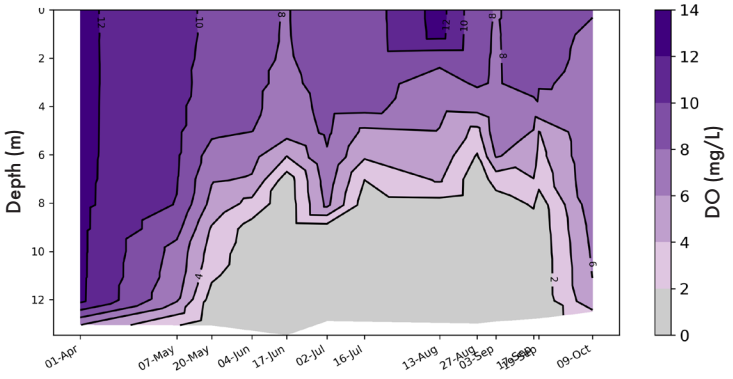
Phosphorus loading from sediment

When oxygen levels are low, phosphorus stored in sediment is released (internal loading), causing higher total phosphorus concentrations in near-bottom waters. The 2010 Medicine Lake TMDL study (LimnoTech) found internal phosphorus loading from sediment to be a significant source of lake phosphorus—about one-third of the lake's total annual phosphorus load. According to the study, phosphorus from Medicine Lake's sediment is conveyed to the surface either by diffusion or wind mixing. Wind-mixing events completely mix the water column several times each year, typically in July, August, and September.

The 2025 Medicine Lake TMDL Assessment (Barr) found that near-bottom oxygen levels in Medicine Lake are typically low in the Main Basin from June through August. Phosphorus release from sediments during this same period causes near-bottom phosphorus concentrations to consistently increase during the summer. Temperature and dissolved oxygen data indicate that the lake typically starts to mix between late August and early September, resulting in increased phosphorus concentrations at the surface and lower phosphorus concentrations near the bottom (in the hypolimnion).

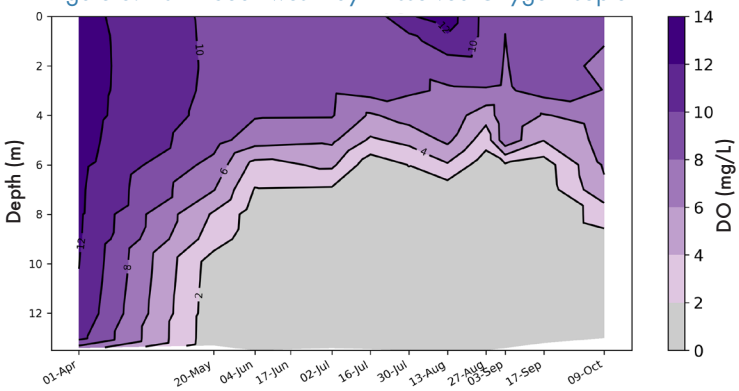
In 2024, near-bottom oxygen levels were low (<2 mg/L) in the Main Basin and Southwest Bay from May until September when the lake began to mix (Figures 7–8). Near-bottom total phosphorus concentrations in the Main Basin and Southwest Bay increased from May until September (Figures 9–10). When the lake began to mix in September, near-bottom total phosphorus concentrations decreased in the Main Basin but remained high in the Southwest Bay.

Figure 7: 2024 Main Basin–Dissolved Oxygen Isopleth



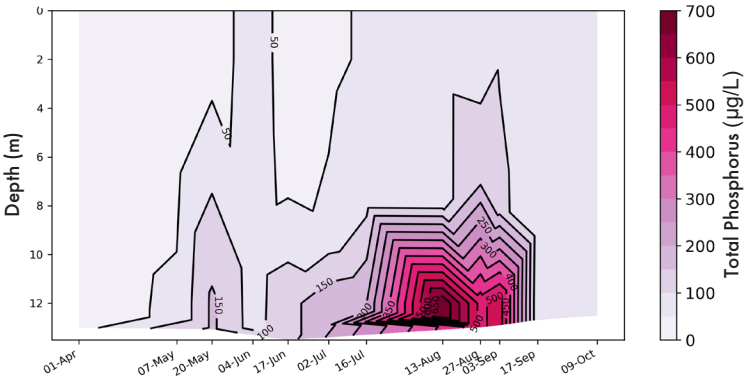
(Data collected by TRPD)

Figure 8: 2024 Southwest Bay–Dissolved Oxygen Isopleth



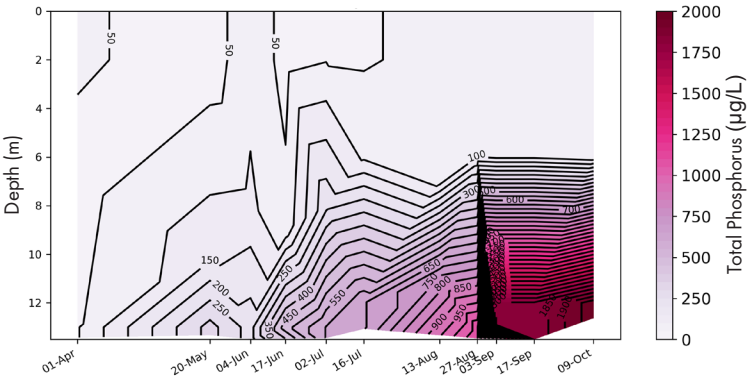
(Data collected by TRPD, funded by BCWMC)

Figure 9: 2024 Main Basin–Total Phosphorus Isopleth



(Data collected by TRPD)

Figure 10: 2024 Southwest Bay–Total Phosphorus Isopleth



(Data collected by TRPD, funded by BCWMC)

Water chemistry monitoring from 1972 to 2024: historical trends

Water quality in Medicine Lake has been monitored since 1972. Summer averages (June through September) of total phosphorus, chlorophyll *a*, and Secchi disc depth from the Main Basin and Southwest Bay from 1972–2024 are shown in Figures 11–16. During the period of record, the following percentage of 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):

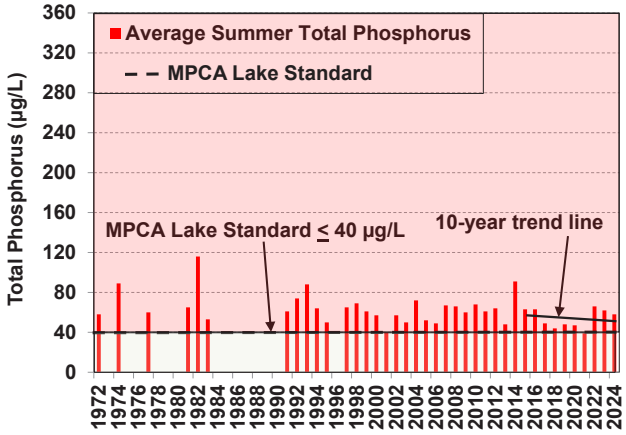
- 95 percent of Main Basin and 92 percent of Southwest Bay total phosphorus
- 95 percent of Main Basin and 88 percent of Southwest Bay chlorophyll *a*
- 26 percent of Main Basin and 17 percent of Southwest Bay Secchi disc

Trend analyses over the past 10 years show:

- Declining summer average total phosphorus concentrations in the Main Basin and Southwest Bay.
- Declining summer average chlorophyll *a* concentrations in the Main Basin and Southwest Bay.
- Increasing summer average Secchi disc transparency in the Main Basin and Southwest Bay.

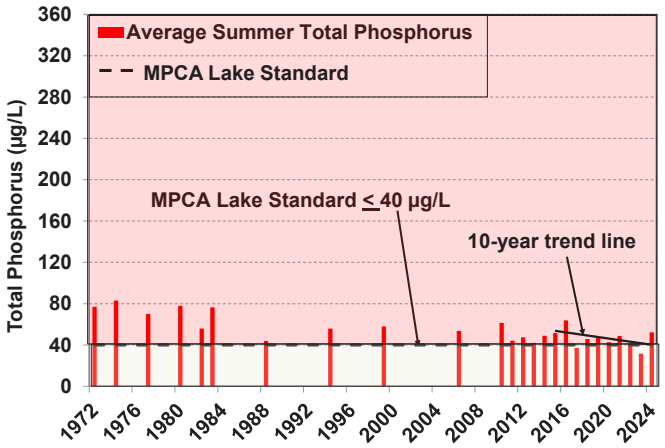
The changes in total phosphorus concentrations are not significant at the 95th percent confidence level, but the changes in chlorophyll *a* and Secchi disc are statistically significant at the 95th percent confidence level. Recent data collected by TRPD indicate that the statistically significant reductions in chlorophyll *a* and improvements in Secchi disc transparency are likely due to the increase in zebra mussels, which filter out certain types of algae.

Figure 11: Historical Total Phosphorus–Main Basin



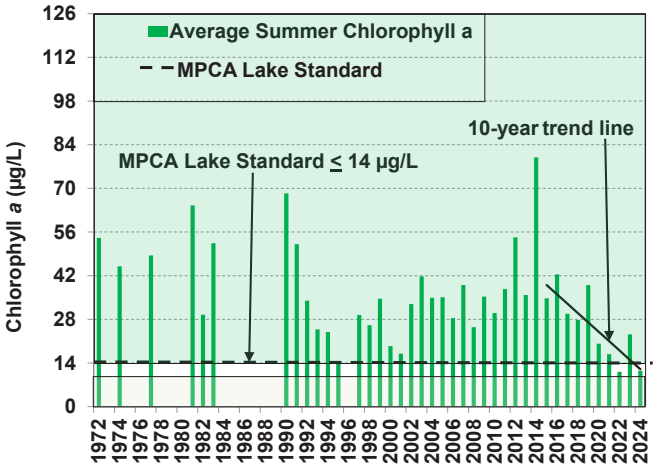
(Data collected by TRPD)

Figure 12: Historical Total Phosphorus–Southwest Bay



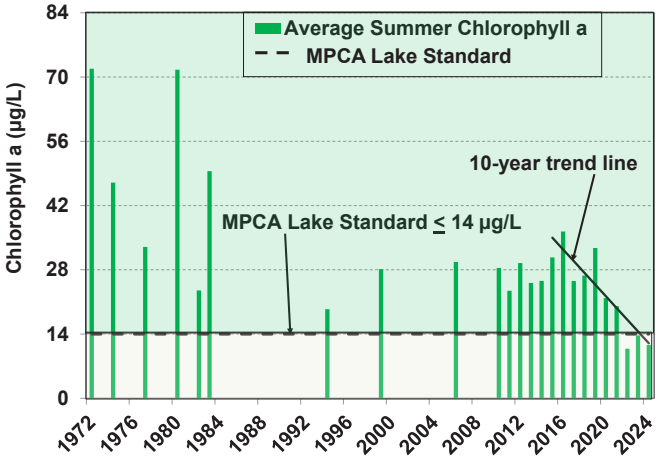
(Data collected by TRPD, funded by BCWMC)

Figure 13: Historical Total Chlorophyll *a*–Main Basin



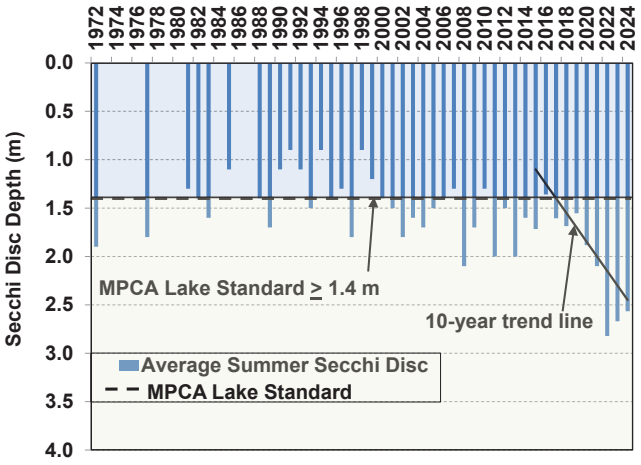
(Data collected by TRPD)

Figure 14: Historical Total Chlorophyll *a*–Southwest Bay



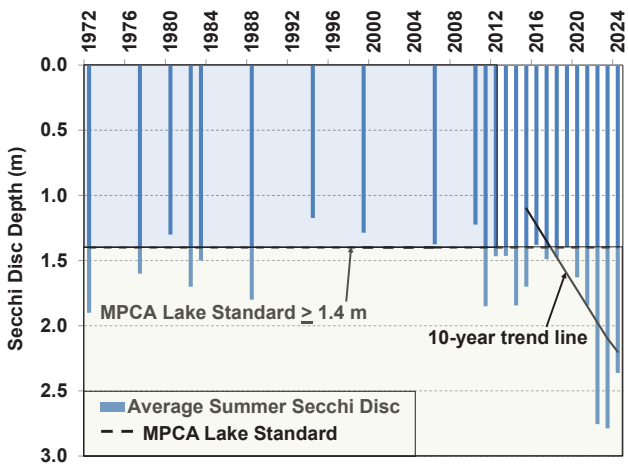
(Data collected by TRPD, funded by BCWMC)

Figure 15: Historical Water Clarity (Secchi Depth)—Main Basin



(Data collected by TRPD)

Figure 16: Historical Water Clarity (Secchi Depth)—Southwest Bay



(Data collected by TRPD, funded by BCWMC)

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 pollute 5 gallons of water, so 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 chloride concentrations can harm fish, zooplankton, and plant life, the MPCA 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 of the life span or more. Chronic effects 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).

Figures 17 and 18 show that all measurements in the Main Basin and Southwest Bay from 2016 through 2024 were well below the maximum chloride standard and were also below the chronic chloride standard, except for:

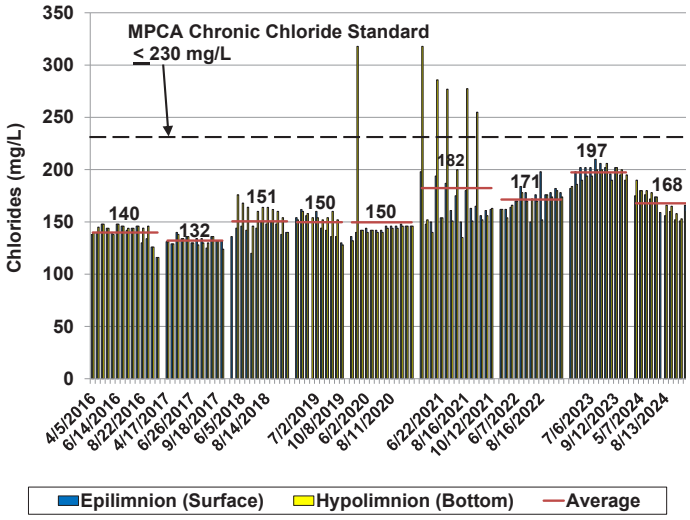
- Six measurements from the Main Basin hypolimnion (bottom) (one in 2020 and five in 2021).
- One measurement from the Southwest Bay in 2024.

Because six Medicine Lake chloride measurements exceeded the chronic criterion during 2020–2021, the lake met the MPCA impairment criterion of two or more measurements exceeding the chronic criterion within a 3-year period. The lake did not meet the MPCA impairment criterion in 2022–2023 since only one measurement exceeded the chronic criterion within the 3-year period.

Medicine Lake was recently classified by the State as a “high-risk water” for high chloride levels. While the lake has generally met MPCA standards since 2022, efforts should be made to reduce the chloride load to Medicine Lake, Parkers Lake, and Crane Lake. Both Parkers Lake and Crane Lake are chloride impaired and drain into Medicine Lake, along with the lake’s highly urbanized watershed.

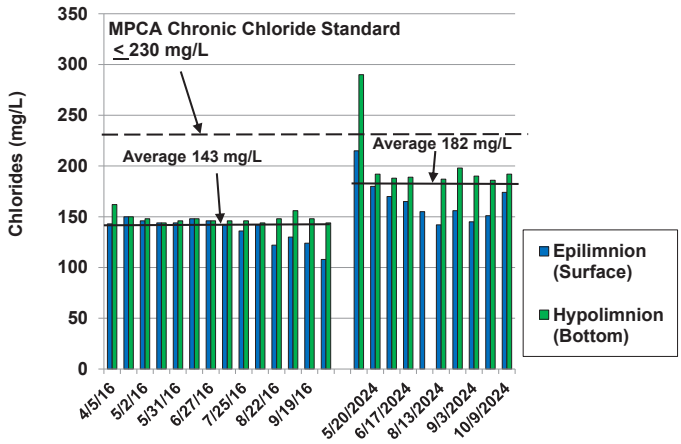
The 2024 average annual chloride concentration in the Main Basin of Medicine Lake (168 mg/L) was within the range of previous years (132 mg/L to 197 mg/L) and was lower than concentrations measured from 2021 through 2023 (171 mg/L to 197 mg/L). In the Southwest Bay, the 2024 average annual chloride concentration of 182 mg/L was higher than the 2016 average annual chloride concentration of 143 mg/L.

Figure 17: Historical Chloride–Main Basin



(Data collected by TRPD)

Figure 18: Historical Chloride–Southwest Bay



(Data collected by TRPD, funded by BCWMC)

Macrophytes

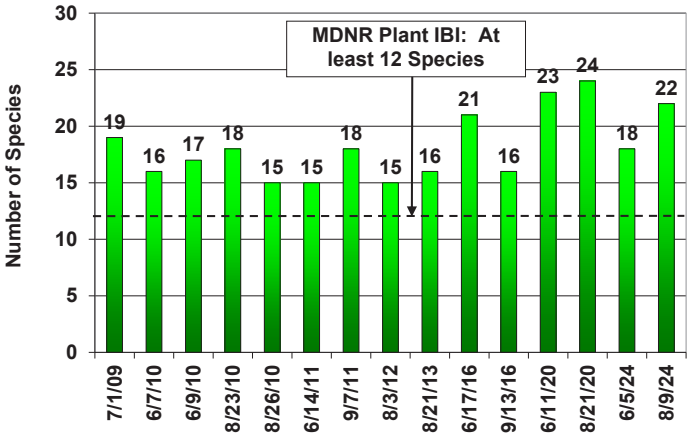
Lake Plant Eutrophication Index of Biological Integrity (IBI)

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 2009 to 2024 were assessed to determine plant IBI trends. Figures 19 and 20 show Medicine Lake FQI scores and the number of species for that period compared to the MNDNR Plant IBI threshold.

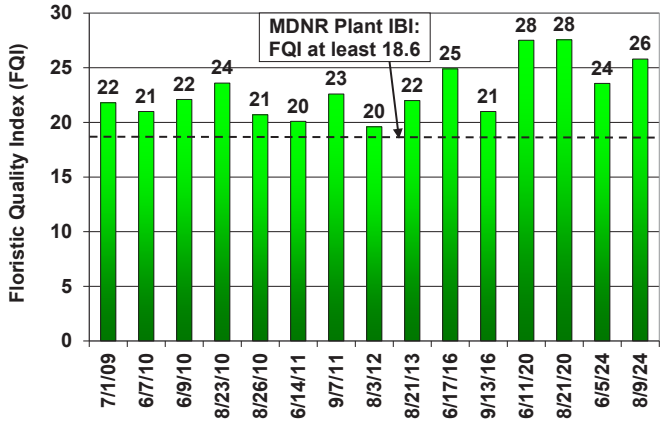
- **Number of species:** A deeper water lake, such as Medicine Lake, meets the MNDNR Plant IBI threshold when it has 12 or more species. During the period examined, the number of species in Medicine Lake ranged from 15 to 24 (Figure 19), meeting or exceeding the MNDNR Plant IBI threshold during the entire period of record. Eighteen to 22 species were observed in the lake in 2024.
- **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 Medicine Lake ranged from 20 to 28, exceeding the MNDNR Plant IBI threshold during the entire period of record (Figure 20). FQI scores ranged from 24 to 26 in 2024.

Figure 19: Species Richness from 2009–2024



(Data collected by TRPD)

Figure 20: FQI of Plant Community from 2009–2024



(Data collected by TRPD)

Aquatic invasive species

In 2024, four invasive species were found in Medicine Lake.

Curly-leaf pondweed *(Potamogeton crispus)*

Curly-leaf pondweed (CLP) has been a consistent problem in Medicine Lake and continued to be a problem in 2024. With the exception of 2007, the herbicide endothall was used to control the plant each year from 2004 through 2015, and the herbicide diquat was used to control the plant annually from 2018 through 2021 (Figure 21). An LVMP to manage CLP in Medicine Lake was created by the TRPD and approved by the MNDNR in April of 2022. The management goals of the LVMP were to maintain CLP below 25 percent frequency of occurrence, maintain a diverse native species population, and reduce CLP turion density. From 2022 through 2024, CLP was treated with two herbicides, diquat and galleon, and treatment areas approximately doubled compared with areas treated from 2019 through 2021 (Figure 21).

The 2022 through 2024 treatments reduced June CLP frequency of occurrence from 40 percent in 2022 to 24 percent in 2024 (Figure 22) and average turion density from 966 turions per square meter in 2022 to 262 turions per square meter in 2024. The reduction of CLP frequency below 25 percent and the reduction of turion density met the management goals of the LVMP. However, the 2024 CLP frequency of 24 percent still exceeded the goal of 22 percent frequency, set in the 2010 TMDL implementation plan for Medicine Lake.

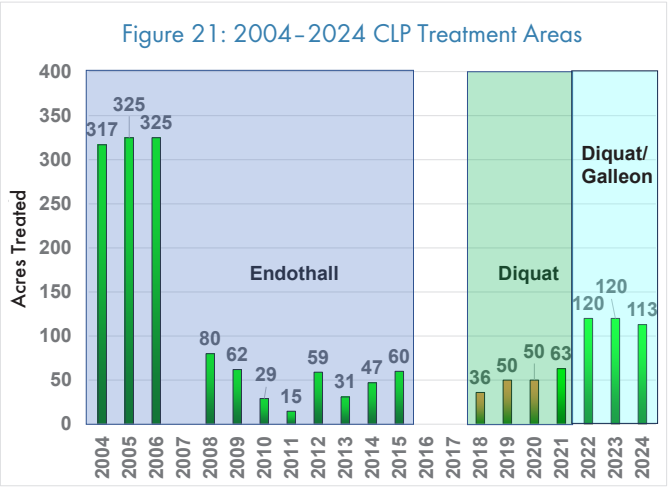
Eurasian watermilfoil *(Myriophyllum spicatum)*

Eurasian watermilfoil (EWM) was not problematic in 2024, ranging in frequency from 13 to 19 percent of the sample locations. From 2004 through 2024, EWM frequency has ranged from 0 to 70 percent (Figure 23). Although EWM has not been targeted for herbicide treatment, the lower frequencies since 2018 indicate the diquat treatments of CLP have also been effective in controlling EWM.

Curly-leaf pondweed

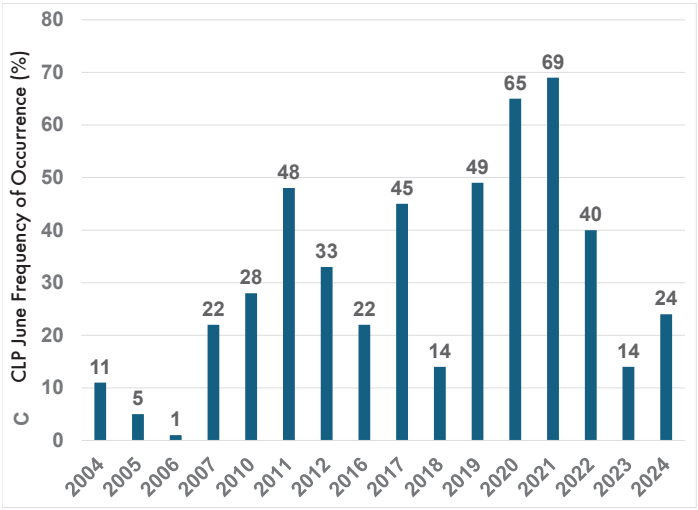
Eurasian watermilfoil

Figure 21: 2004–2024 CLP Treatment Areas



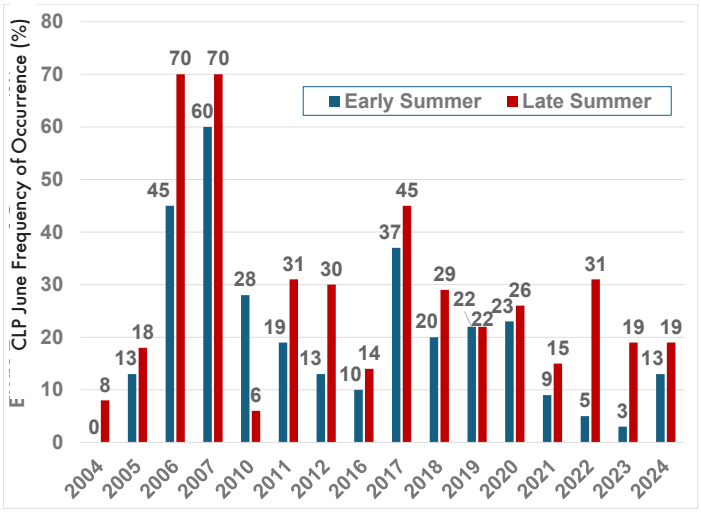
(Data provided by TRPD)

Figure 22: CLP Frequency of Occurrence (%)



(Data collected by TRPD)

Figure 23: EWM Frequency of Occurrence (%)



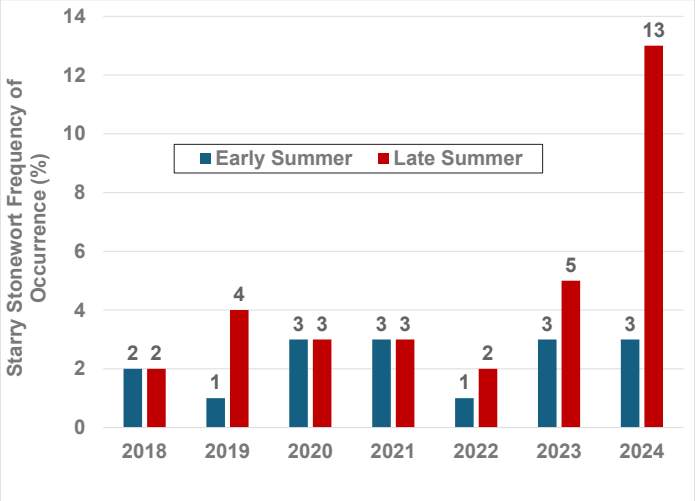
(Data collected by TRPD)

Starry stonewort *(Nitellopsis obtusa)*

Although starry stonewort frequency remained at low levels from when it was first observed in the lake in 2018 until June 2024, its frequency increased between June and August 2024. The MNDNR completed a plant survey on August 1, 2018, and confirmed that a 14-acre area of starry stonewort was present on the northern side of the lake near the boat landing and swimming beach. The MNDNR funded herbicide treatment of the plant (copper sulfate and endothall) from 2018 through 2020. Despite the treatments, a 2020 plant survey documented that the plant had spread to areas along the western and eastern sides of the lake, but the frequency of occurrence remained low through 2023, ranging from 1 to 3 percent. However, starry stonewort frequency of occurrence increased in 2024, from 3 percent in June to 13 percent in August (Figure 24).

The increased frequency is concerning because starry stonewort can produce dense mats at the water's surface that interfere with boating, fishing, swimming, and other recreation and may choke out native plant communities.

Figure 24: Starry Stonewort Frequency of Occurrence (%)



(Data collected by TRPD)


Starry stonewort

Zebra mussels *(Dreissina polymorpha)*

Zebra mussels have increased in extent and number since they were first observed in Medicine Lake in 2017, when a resident living on the south end of the lake found a zebra mussel on a dock. According to surveys performed by TRPD, the number of zebra mussels:

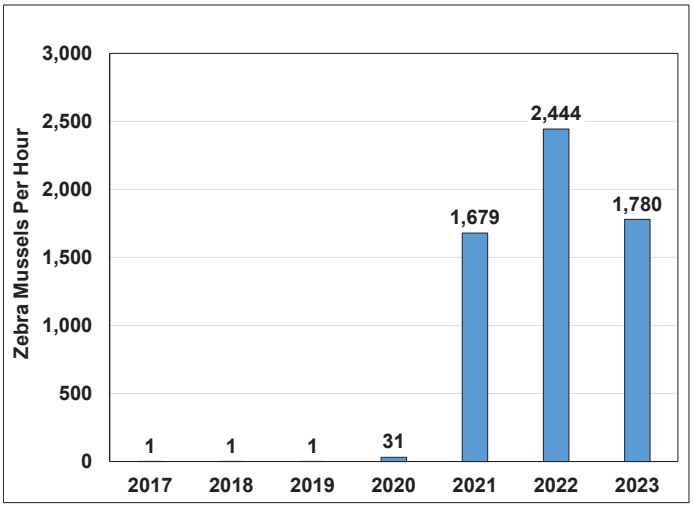
- Remained low through 2019 (about 1 per hour found in survey).
- Greatly increased in 2020 (31 per hour).
- Greatly increased in 2021 (1,679 per hour).
- Increased in 2022 (2,444 per hour).
- Declined in 2023 (1,780 per hour, Figure 25).

A 2024 zebra mussel survey was not conducted.

The 2020 zebra mussel survey documented that zebra mussels had spread from the southern end of the lake to the eastern and northern sides of the lake. As shown in Figures 26 and 27, zebra mussel veligers (planktonic larvae) have been observed in zooplankton samples collected from the lake in 2020 (Main Basin) and 2024 (Main Basin and Southwest Bay).

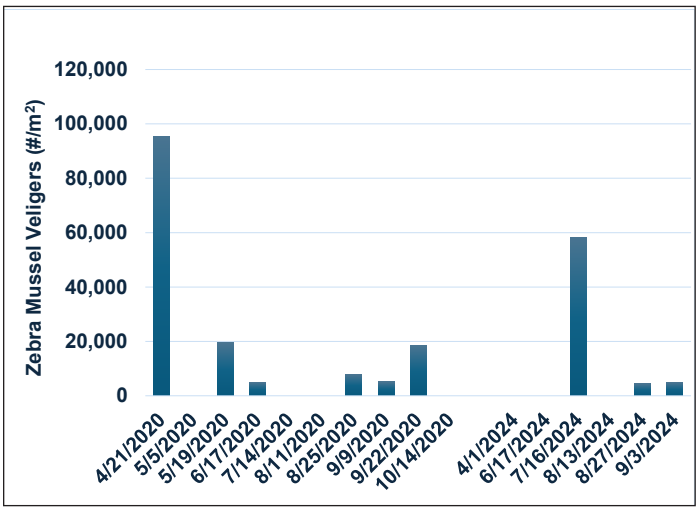
Zebra mussels

Figure 25: Zebra Mussel Surveys



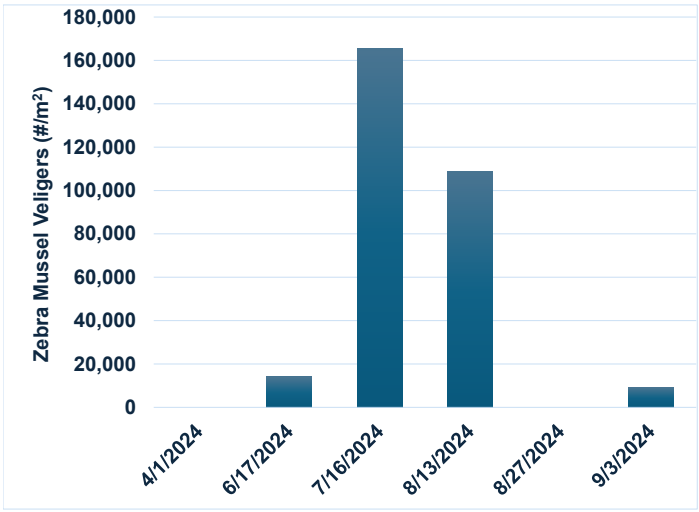
(Samples collected by TRPD)

Figure 26: 2020 and 2024 Zebra Mussel Veligers—Main Basin



(Samples collected by TRPD, analyzed by BCWMC)

Figure 27: 2024 Zebra Mussel Veligers—Southwest Bay



(Samples collected by TRPD, funded and analyzed by BCWMC)

Phytoplankton and Zooplankton

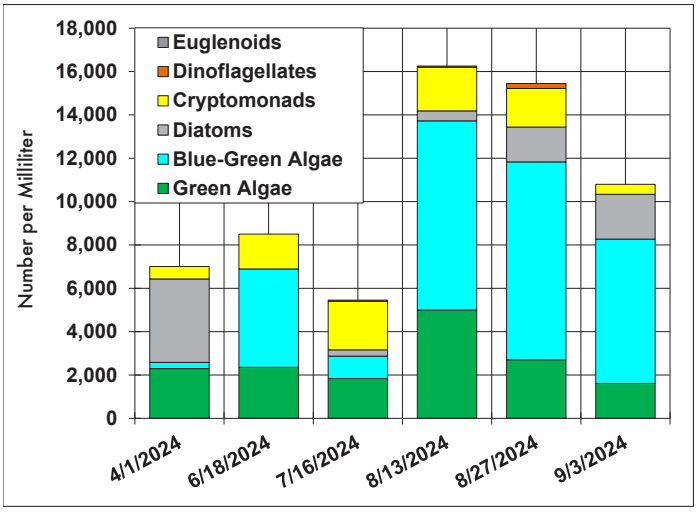
Phytoplankton, or algae, are small aquatic plants naturally present in lakes. Phytoplankton derive energy from the sun through photosynthesis and provide food for several types of aquatic organisms, including zooplankton (microscopic animals), which are, in turn, eaten by fish. An inadequate phytoplankton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

Samples of phytoplankton were collected from Medicine Lake to evaluate water quality and the quality of food available to zooplankton. In 2024, diatoms, cryptomonads, and green algae, good food sources for the lake's zooplankton, were present in the Main Basin and the Southwest Bay throughout the monitored period. Phytoplankton numbers in the Main Basin and Southwest Bay declined from June through July, increased in August, and remained at higher numbers in September due to increased blue-green algae. While blue-green numbers increased with higher concentrations of phosphorus during August and September, other types of algae did not (Figures 28 and 29).

It appears that zebra mussel grazing of algae has reduced phytoplankton numbers in Medicine Lake by about 50 percent from 2016 to 2024. As shown in Figure 30 and Figure 31, average phytoplankton numbers declined from 21,826 units per milliliter in 2016 to 10,578 units per milliliter in 2024 in the Main Basin and from 20,332 units per milliliter in 2016 to 10,970 units per milliliter in 2024 in the Southwest Bay. In spring, zebra mussel filtration rates rise dramatically as waters warm from 41°F to 50°F and then stabilize. The declining phytoplankton numbers are consistent with declining chlorophyll *a* concentrations during this period.

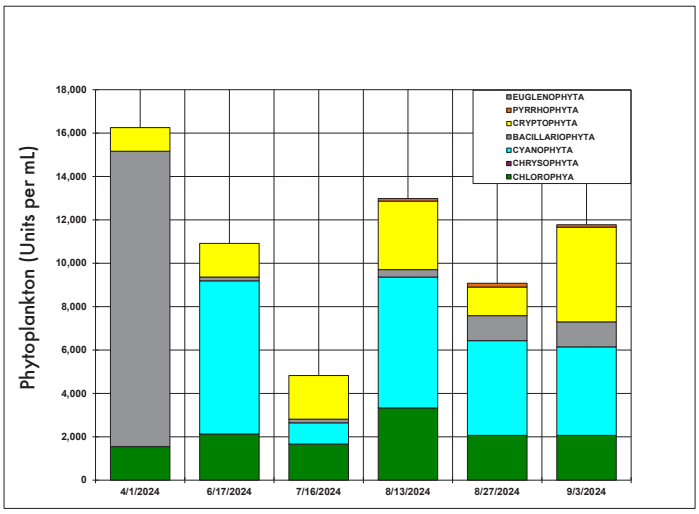
As shown in Figure 32, it appears that zebra mussel grazing of green algae, a preferred food for zebra mussels, reduced early spring numbers in the Main Basin of Medicine Lake by more than an order of magnitude from 2016 (15,335 units per mL) to 2020 (1,493 units per mL) and kept numbers low in 2024 (2,135 units per mL). In the Southwest Bay, early spring numbers were reduced by more than 80 percent from 2016 (9,477 units per mL) to 2024 (1,551 units per mL) (Figure 33).

Figure 28: 2024 Phytoplankton per Milliliter–Main Basin



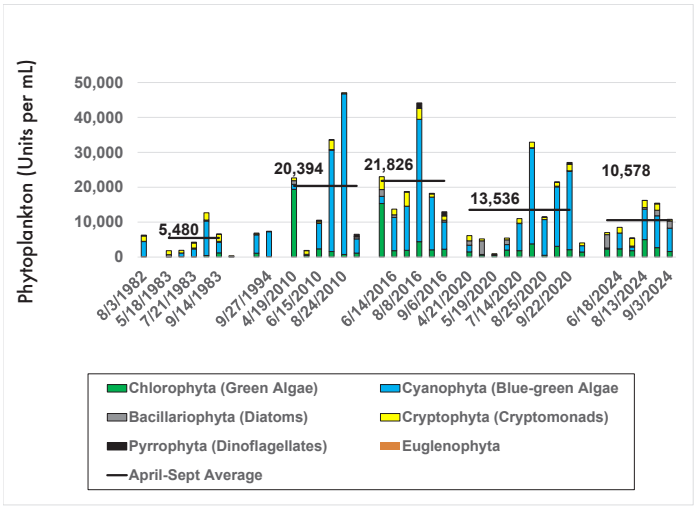
(Samples collected by TRPD, analyzed by BCWMC)

Figure 29: 2024 Phytoplankton per Milliliter–Southwest Bay



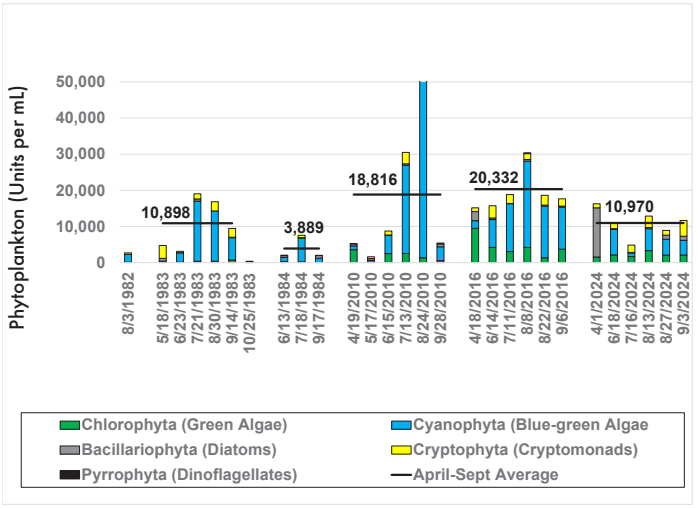
(Samples collected by TRPD, funded and analyzed by BCWMC)

Figure 30: 1982–2024 Phytoplankton–Main Basin



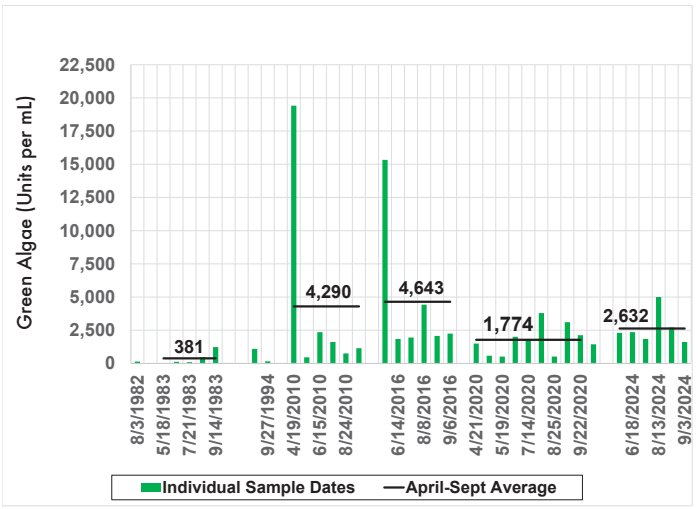
(Samples collected by TRPD, analyzed by BCWMC)

Figure 31: 1982–2024 Phytoplankton–Southwest Bay



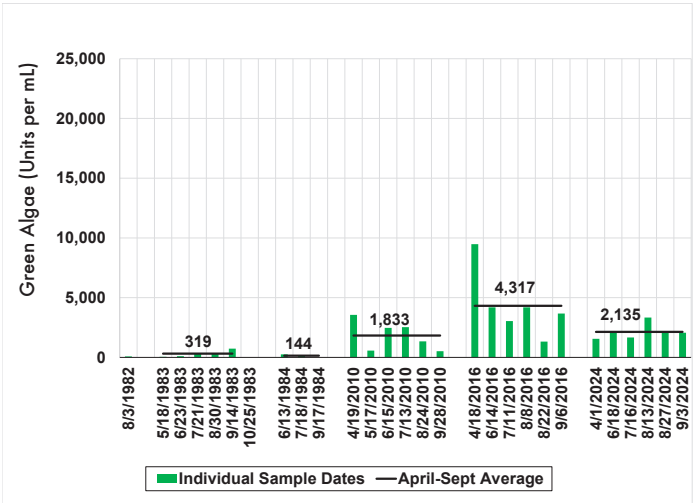
(Samples collected by TRPD, funded and analyzed by BCWMC)

Figure 32: 1982–2024 Green Algae–Main Basin



(Samples collected by TRPD, analyzed by BCWMC)

Figure 33: 1982–2024 Green Algae–Southwest Bay

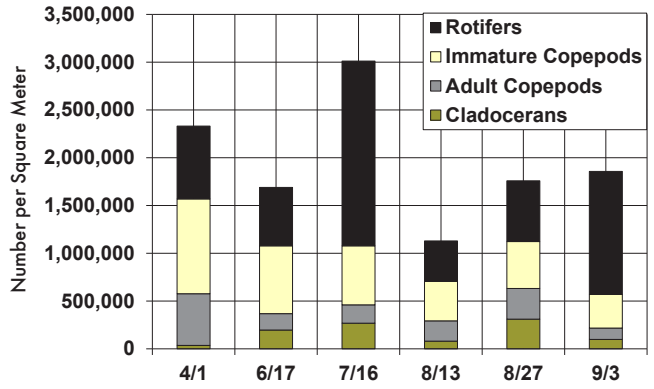


(Samples collected by TRPD, funded and analyzed by BCWMC)

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.

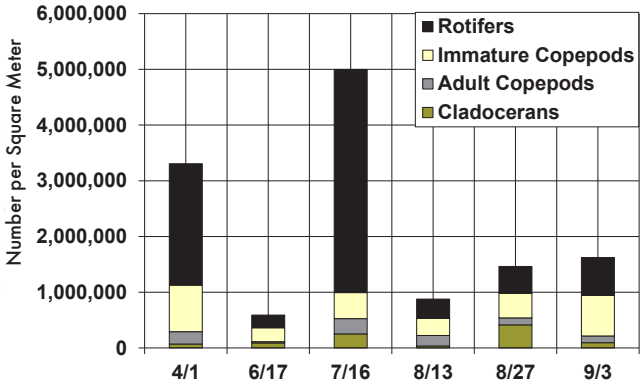
In 2024, cladocerans, the preferred food for fish, were found in lower numbers than copepods and rotifers in the Main Basin and Southwest Bay (Figures 34 and 35). Average zooplankton numbers were lower in 2020 and 2024 than 2016 in the Main Basin (Figure 36) due to fewer rotifers (Figure 38) and copepods (Figure 40). Average zooplankton numbers were lower in 2024 than 2016 in the Southwest Bay (Figure 37) primarily due to fewer copepods (Figure 41). The lower numbers of rotifers in the Main Basin were likely due to zebra mussel predation. Zebra mussels primarily feed on algae, but also consume rotifers, which are small. It is not known whether the lower numbers of copepods in the Main Basin and Southwest Bay were due to fish predation or to food limitation caused by zebra mussels grazing on algae.

Figure 34: 2024 Zooplankton–Main Basin



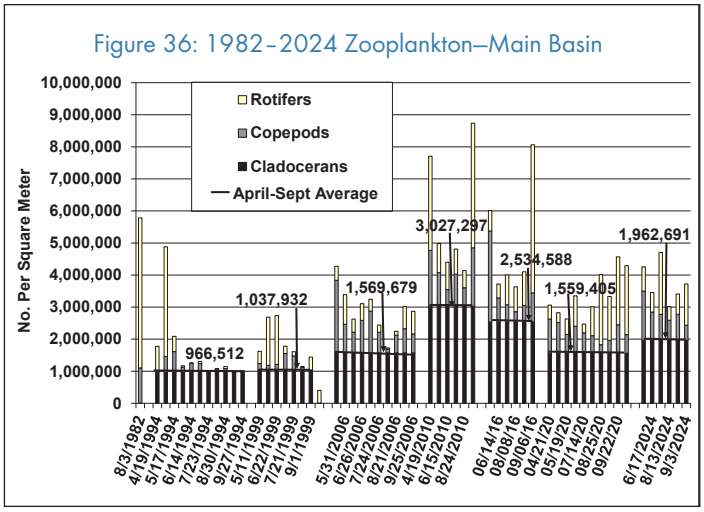
(Samples collected by TRPD, analyzed by BCWMC)

Figure 35: 1982–2024 Zooplankton–Southwest Bay



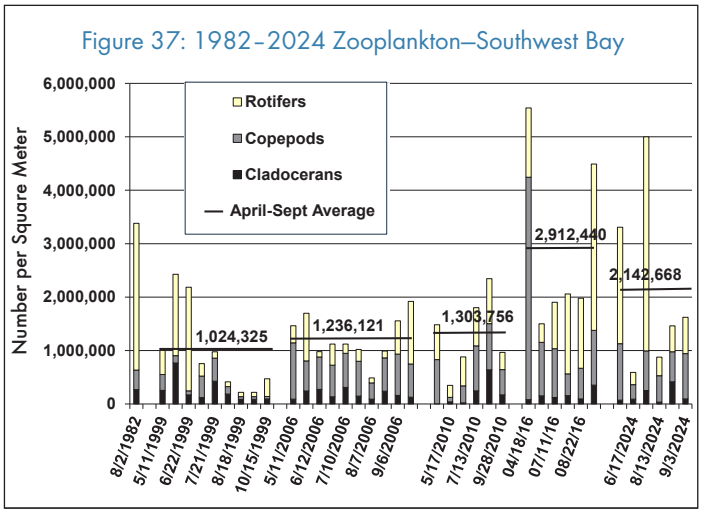
(Samples collected by TRPD, funded and analyzed by BCWMC)

Figure 36: 1982–2024 Zooplankton–Main Basin

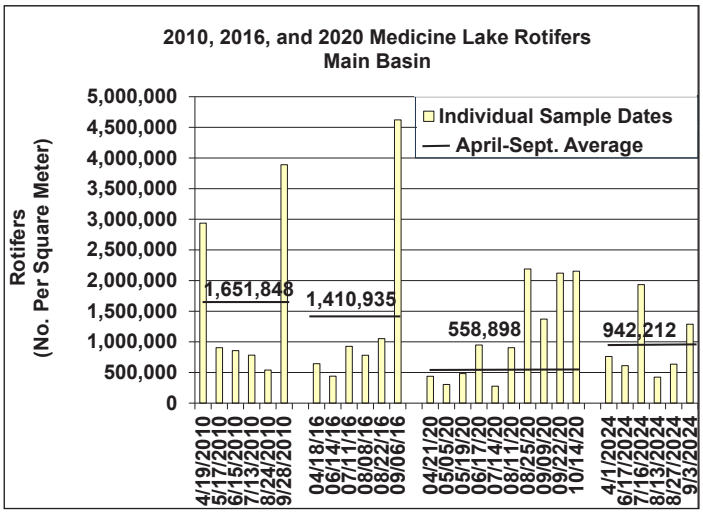


(Samples collected by TRPD, analyzed by BCWMC)

Figure 37: 1982–2024 Zooplankton–Southwest Bay

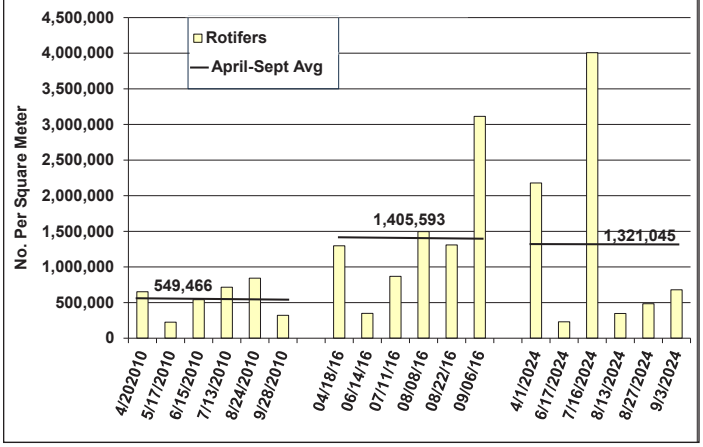


(Samples collected by TRPD, funded and analyzed by BCWMC)



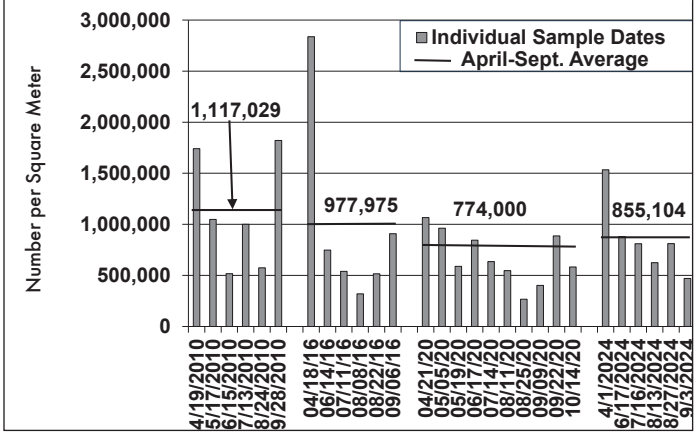
(Samples collected by TRPD, analyzed by BCWMC)

Figure 39: 2010, 2016, and 2024 Rotifers–Southwest Bay



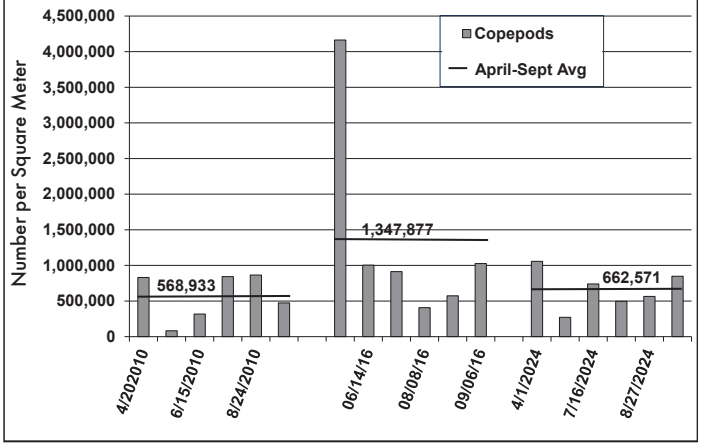
(Samples collected by TRPD, funded and analyzed by BCWMC)

Figure 40: 2010, 2016, 2020, and 2024 Copepods–Main Basin



(Samples collected by TRPD, analyzed by BCWMC)

Figure 41: 2010, 2016, and 2024 Copepods–Southwest Bay



(Samples collected by TRPD, funded and analyzed by BCWMC)

Suitability of Medicine Lake for Aquatic Invasive Species (AIS)

Many aquatic invasive species (AIS) residing in Minnesota have not yet been observed in Medicine Lake, but could be introduced. A suitability analysis was performed to evaluate whether Medicine Lake water quality would support the introduction of four AIS (spiny waterflea, faucet snail, Chinese mystery snail, and rusty crayfish).

The analysis compared 2024 water quality in the Main Basin and Southwest Bay with the water quality conditions required for each species, specifically evaluating water temperature, pH, dissolved oxygen, specific conductance, calcium, magnesium, and sodium. The results indicate that the water quality of the Main Basin and Southwest Bay of Medicine Lake meets the suitability requirements for rusty crayfish, faucet snail, and spiny waterflea, but only partially meets the suitability requirements for the Chinese mystery snail. Hence, the Chinese Mystery Snail would likely survive but may not thrive in Medicine Lake.