Item 5D.
BCWMC 7-15-21

Medicine Lake 2020 water quality monitoring

Bassett Creek Watershed Management Commission

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. 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. Three Rivers Park District (TRPD) annually monitors the water quality of Medicine Lake (Figure 1), and BCWMC periodically partners with TRPD on additional monitoring in the lake.

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	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)

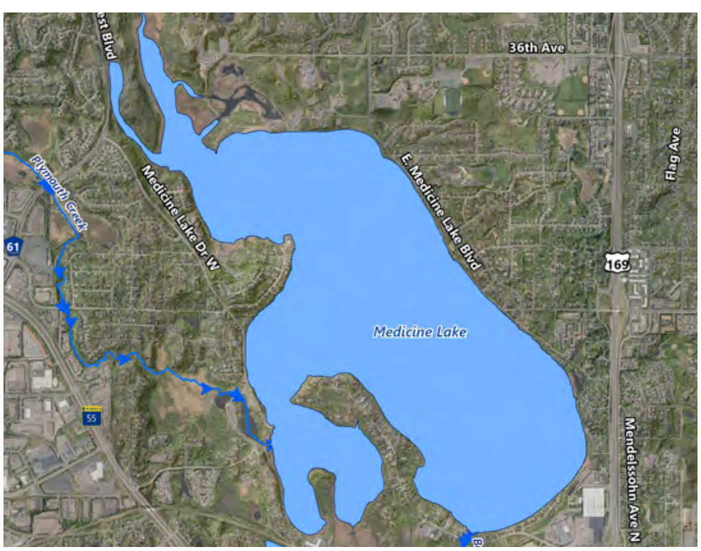


Figure 1

At a glance: 2020 monitoring results

In 2020, TRPD monitored Medicine Lake for:

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

In 2020, BCWMC partnered with TRPD to add phytoplankton and zooplankton to the monitoring program. TRPD collected the samples which were analyzed by BCWMC.

Results of 2020 monitoring show that Medicine Lake met the applicable Minnesota Pollution Control Agency (MPCA) and BCWMC water quality standards for Secchi disc (a measure of clarity) and total phosphorus, but did not meet the MPCA and BCWMC water quality standard for chlorophyll *a*. Trend analyses show no significant change in water quality over the last 10 years.

Other results include:

- All measurements during 2020 were well below the maximum chloride standard and all measurements except the May 5, 2020, measurement from the hypolimnion (bottom) were well below the chronic chloride standard.
- Both the number of species in the lake and Floristic Quality Index (FQI) values were better than the MNDNR Plant IBI thresholds and were the highest scores observed during the period of record.
- Four aquatic invasive species were observed in Medicine Lake in 2020: curly-leaf pondweed, Eurasian watermilfoil, starry stonewort, and zebra mussels.
- In spring of 2020, 49 acres of curly-leaf pondweed were treated with herbicide. In June, the plant's frequency was 65 percent, the second-highest frequency to date, exceeded only in 2004. The 2010 TMDL implementation plan for Medicine Lake specified that curly-leaf pondweed should continue to be managed annually.
- Eurasian watermilfoil was not problematic in 2020, ranging in frequency from 23 to 27 percent of the sample locations.
- A 2020 plant survey documented that starry stonewort has spread from its original infestation area

near the boat landing to areas along the western side of the lake.

- A 2020 zebra mussel survey documented that zebra mussels have spread from the southern end of the lake to the eastern and northern sides of the lake. The number of zebra mussels collected during surveys increased from three in 2019 to 278 in 2020. Zebra mussel veligers (planktonic larvae) were observed in zooplankton samples collected in April, May, June, August, and September 2020. On the dates when veligers were observed, numbers ranged from to 5,217 to 95,316 per square meter.
- 2020 numbers of phytoplankton were, on average, lower than 2010 and 2016, consistent with the lake's lower average summer chlorophyll *a* concentrations in 2020 compared with 2010 and 2016.
- Green algae numbers observed in Medicine Lake in April 2020 were more than an order of magnitude lower than numbers observed in April 2010 and 2016. Because green algae are a preferred food for zebra mussels, the lower numbers of green algae observed in Medicine Lake in April 2020 may be due to predation by zebra mussels.
- In 2020, cladocerans, the preferred food for fish, were found in lower numbers than copepods and rotifers.
- Fewer rotifers and copepods were observed in 2020 than 2010 and 2016, consistent with lower chlorophyll concentrations in 2020. Copepods and rotifers are less impacted by fish predation and changes in their numbers may indicate reductions in chlorophyll concentration in the lake.
- The Minnesota Department of Natural Resources (MNDNR) completed a standard fish survey of Medicine Lake in July 2020. Survey results indicated northern pike, walleye, bluegills, black crappie, and yellow bullhead were abundant. Other species caught in low abundance included brown bullhead, black bullhead, bowfin, common carp, hybrid sunfish, green sunfish, pumpkinseed, yellow perch, and white sucker.
- On September 1, 2020, the MNDNR Fisheries staff conducted a targeted survey of the nearshore fish community in Medicine Lake. Data from this survey were combined with data from the standard fish survey to compute a Fish Index of Biological Integrity (IBI) score of 30. This score is below the impairment threshold of 45, but better than the 2012 Fish IBI score of 25.

Recommendations

- Consider an alum treatment to reduce internal loading and improve water quality.
- Consider completing a Vegetation Management Plan for the lake.
- Assess feasibility of a partial lake drawdown to expose the littoral lake bed to a winter freeze, freezing out curly-leaf pondweed plants and turions (reproductive structures that act like seeds). If feasible and implemented, we recommend working with MNDNR and the Minnesota Aquatic Invasive Species Research Center to monitor impacts of the winter freeze on zebra mussels and starry stonewort.
- Complete an annual herbicide treatment of CLP to reduce total phosphorus loading during plant die off in mid-summer.
- Complete an annual herbicide treatment of starry stonewort to reduce abundance near the boat launch and help minimize its spread.
- Continue water quality and biological monitoring at a 3-year frequency.

Water chemistry monitoring: 2020

Total phosphorus levels

While phosphorus is necessary for plant and algae growth, too much phosphorus leads to excessive algae, 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:** 40 micrograms per liter (µg/L) or less.
- **Range:** Total phosphorus concentrations in Medicine Lake ranged from a low of 10 µg/L on June 2 to a high of 78 µg/L on September 9 (Figure 2). Eight percent of total phosphorus concentrations were in the oligotrophic category, indicating low levels of nutrients; 15 percent were in the mesotrophic category, indicating medium levels of nutrients; 62 percent were in the eutrophic category, indicating high levels of nutrients; and 15 percent were in the hypereutrophic category, indicating very high levels of nutrients.
- **Summer average:** 39 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:** 14 µg/L or less.
- **Range:** Chlorophyll *a* concentrations ranged from a low of 3.4 µg/L on June 2 to a high of 44.0 µg/L on September 9 (Figure 3). Thirty-eight percent of chlorophyll *a* concentrations were in the mesotrophic category, indicating clear water; 23 percent were in the eutrophic category, indicating poor water quality; and 38 percent were in the hypereutrophic category, indicating very poor water quality. .
- **Summer average:** 25.1 µg/L (did not 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

Total Phosphorus

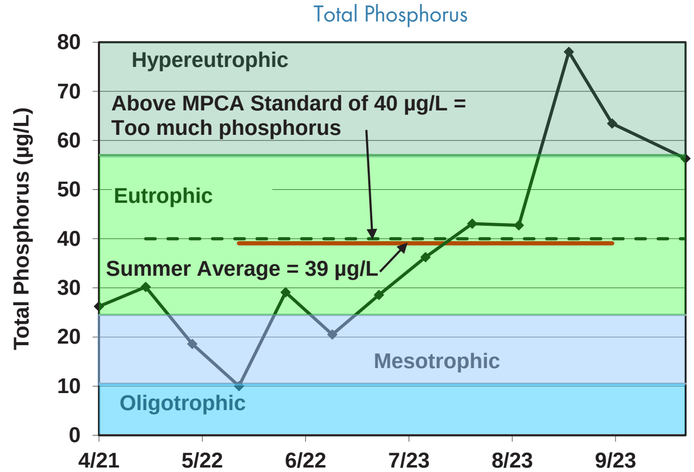


Figure 2 (Data collected by TRPD)

Chlorophyll *a*

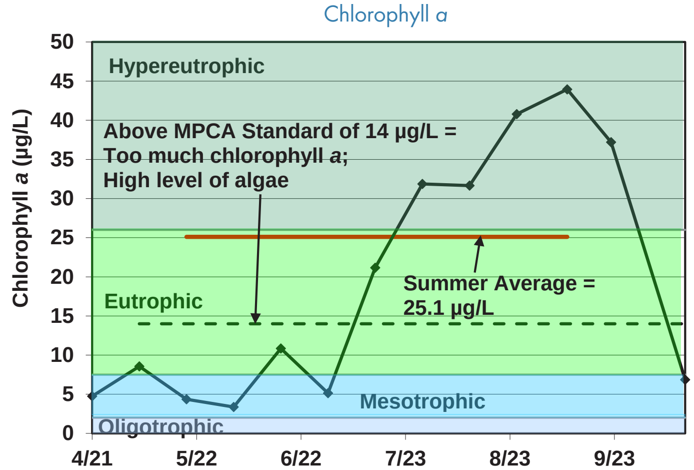


Figure 3 (Data collected by TRPD)

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 transparency.

- **BCWMC/MPCA standard:** 1.4 meters or more.
- **Range:** Secchi disc depth ranged from a low of 1.0 meter on August 25 to a high of 5.6 meters on May 19 (Figure 4). Eight percent of Secchi disc depths were in the oligotrophic category, indicating very good water quality; 46 percent were in the mesotrophic category, indicating good water quality; and 46 percent were in the eutrophic category, indicating poor water quality.
- **Summer average:** 1.9 meters (met BCWMC/MPCA standard).

Phosphorus loading from sediment

When oxygen levels are low, phosphorus stored in sediment is released (internal loading), causing higher total phosphorus concentrations in near-bottom waters. The Medicine Lake total maximum daily load (TMDL) study (LimnoTech, 2010) 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. BCWMC's capital improvement program includes a project to perform an alum treatment in Medicine Lake in the future.

The 2020 data are consistent with the TMDL findings. Near-bottom oxygen levels in Medicine Lake were low in the Main Basin from June through August (Figure 5). Internal phosphorus loading from sediment during this period caused near-bottom phosphorus concentrations to consistently increase (Figure 6). Temperature and dissolved oxygen data indicate that the lake mixed between late August and early September, resulting in increased surface water phosphorus concentrations and lower near-bottom phosphorus concentrations.

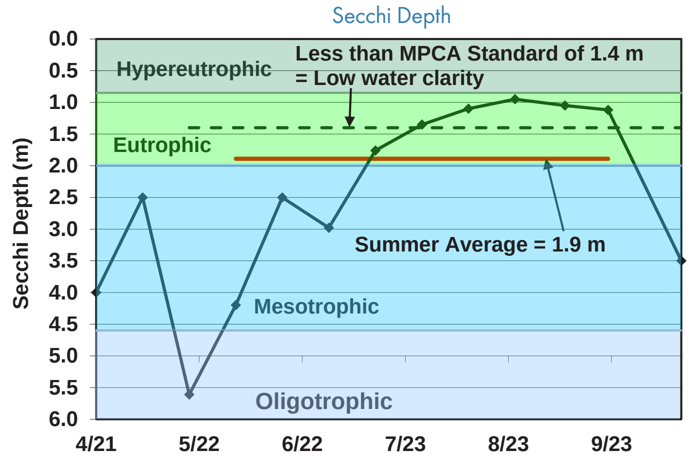


Figure 4 (Data collected by TRPD)

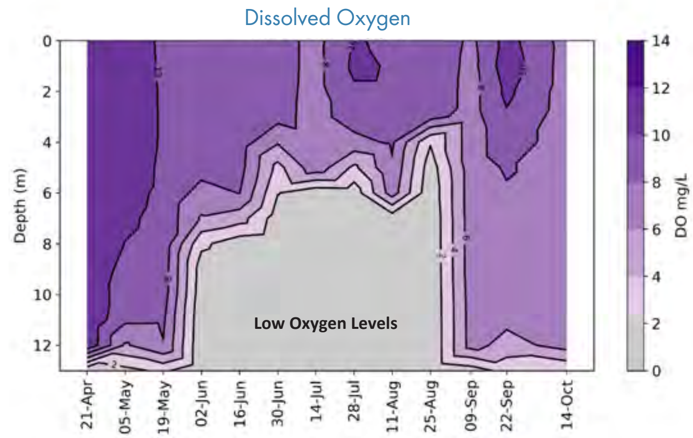


Figure 5 (Data collected by TRPD)

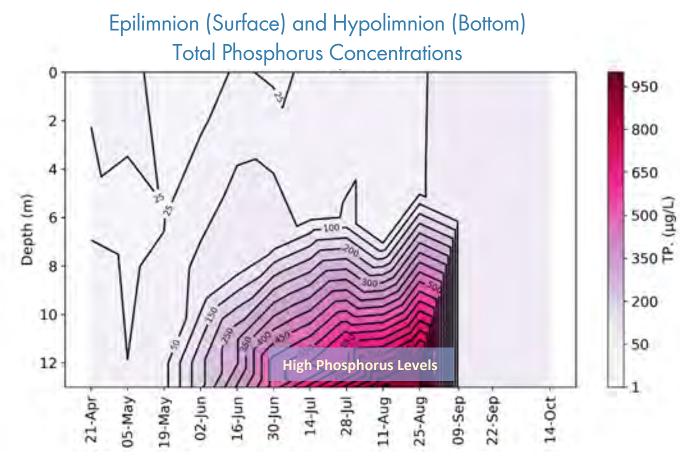


Figure 6 (Data collected by TRPD)

Water chemistry monitoring from 1972–2020: 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 1972–2020 are shown in the Figures 7–9. During the period of record, 94 percent of total phosphorus, 100 percent of chlorophyll a, and 31 percent of Secchi disc summer averages failed to meet Minnesota State Water Quality Standards for lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). The 2020 summer average total phosphorus concentration was the lowest concentration observed during the period of record, a favorable change for the lake.

Trend analyses over the past 10 years show:

- Declining summer average total phosphorus concentrations.
- Declining summer average chlorophyll a concentrations.
- Declining summer average Secchi disc depths.

However, none of the changes are at statistically significant levels.

Sampling with a Secchi disc

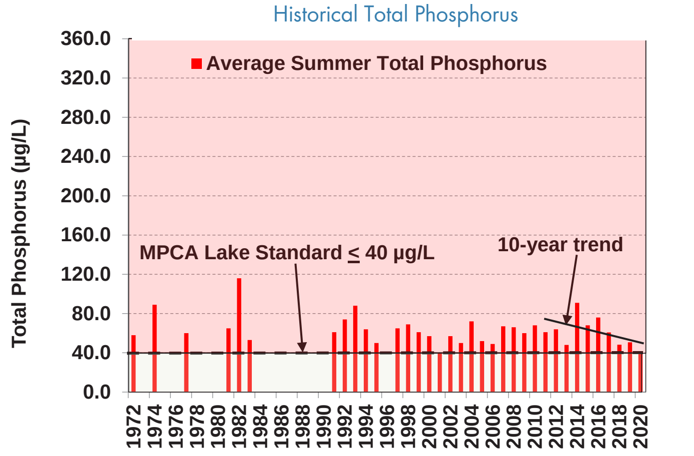


Figure 7 (Data collected by TRPD)

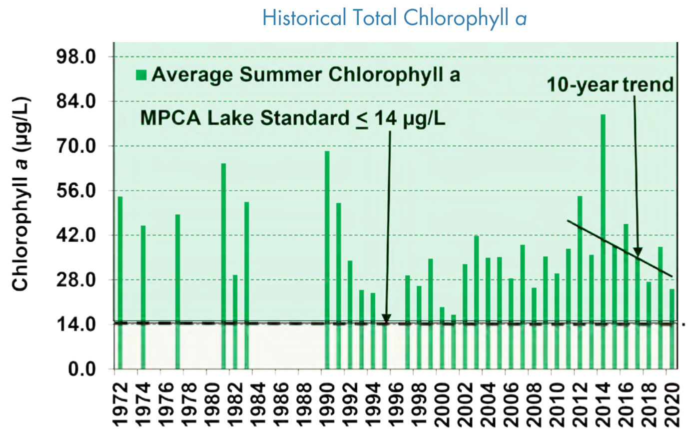


Figure 8 (Data collected by TRPD)

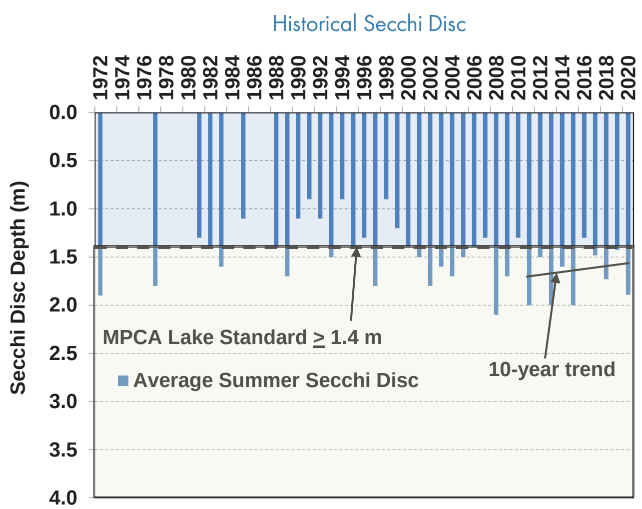


Figure 9 (Data collected by TRPD)

Chloride levels

Chloride concentrations in lakes and streams have increased since the early 1990s when winter maintenance practices largely switched from using sand and/or sand/salt mixtures to salt for roads and parking lots. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of 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 maximum and chronic chloride standards. The maximum standard is the highest concentration of chloride that aquatic organisms can be exposed to for a brief time with zero to slight mortality. The chronic standard is the highest chloride concentration that aquatic life can be exposed to indefinitely without causing chronic toxicity. Chronic toxicity means a condition that lingers or continues for a long period of time, 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 chronic criterion (230 mg/L or less) within a 3-year period or one measurement exceeds maximum criterion (860 mg/L).

All measurements from 2016 through 2020 were well below the maximum chloride standard. And, all measurements from 2016 through 2020, except the May 5, 2020, measurement from the hypolimnion (bottom), were well below the chronic chloride standard (Figure 10). The 2020 average annual chloride concentration (150 mg/L) was the same as the 2019 average annual chloride concentration, and well below the maximum and chronic chloride standards.

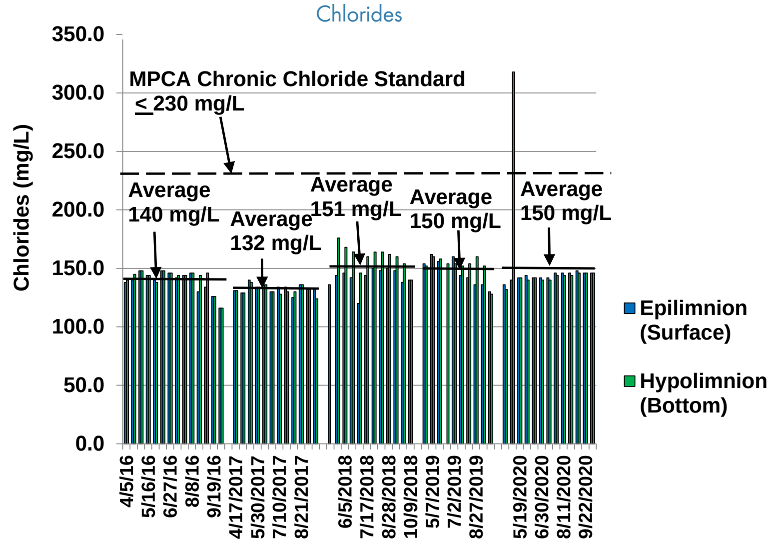


Figure 10 (Data collected by TRPD)

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 2020 were assessed to determine plant IBI trends. The figures at right show Medicine Lake FQI scores and the number of species for that period compared to the MNDNR Plant IBI thresholds.

- **Number of species:** A deeper water lake, such as Medicine Lake, fails to meet the MNDNR Plant IBI threshold when it has fewer than 12 species. During the period examined, the number of species in Medicine Lake ranged from 15 to 24 (Figure 11), meeting or exceeding the MNDNR Plant IBI threshold during the entire period of record. Twenty-three to 24 species were observed in the lake in 2020, the highest number to date.

- **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, bettering the MNDNR Plant IBI threshold during the entire period of record (Figure 12). An FQI score of 28 was observed during June and August 2020, the highest score to date.

- **2020 results:** Both the number of species in the lake and FQI values were better than the MNDNR Plant IBI thresholds and were the highest scores observed during the period of record.

Species Richness of Plant Community from 2009–2020

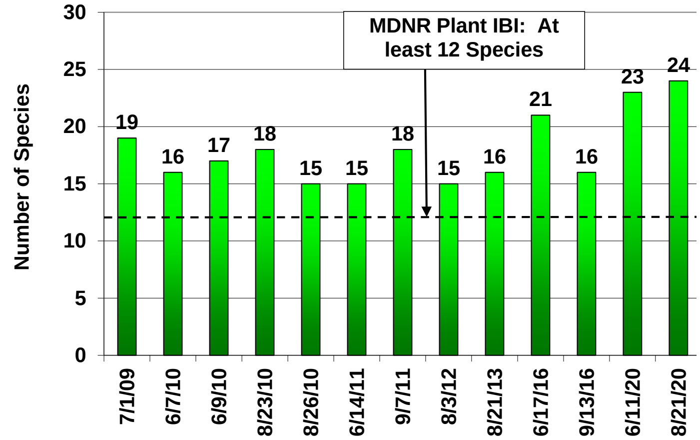


Figure 11 (Data collected by TRPD)

FQI of Plant Community from 1992–2020

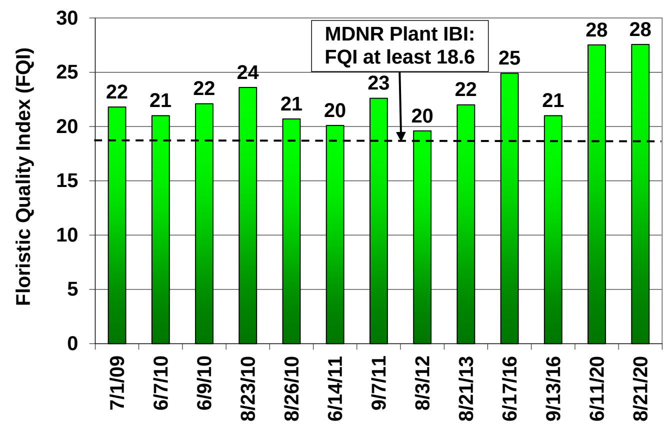


Figure 12 (Data collected by TRPD)

Coontail, one of the species found in Medicine Lake

Aquatic invasive species

In 2020, four invasive species were found in Medicine Lake.

Curly-leaf pondweed *(Potamogeton crispus)*

Curly-leaf pondweed has been a consistent problem in Medicine Lake. As shown in Figure 13, 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 2020. The 2010 TMDL implementation plan for Medicine Lake specified that curly-leaf pondweed should continue to be managed annually to prevent it from exceeding 2006 levels (22 percent of sample locations).

As shown in Figure 13, in spring of 2020, 49 acres of curly-leaf pondweed were treated with herbicide. Figure 14 shows the treatment area and pre-treatment density. In June, the plant's frequency was 65 percent, the second-highest frequency to date (Figure 15). The plant's frequency exceeded the TMDL threshold in 2010, 2011, 2012, 2017, 2019, and 2020. Because die-off of curly-leaf pondweed is an internal source of nutrients for Medicine Lake, control of the plant helps reduce the lake's internal loading.

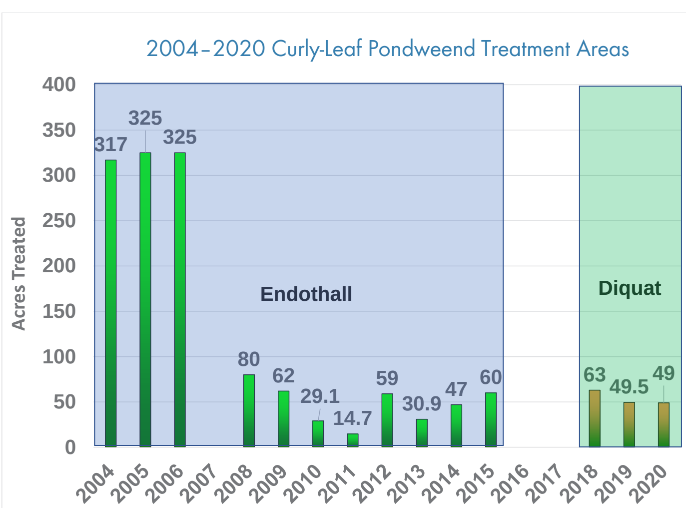


Figure 13 (Data Collected by TRPD)

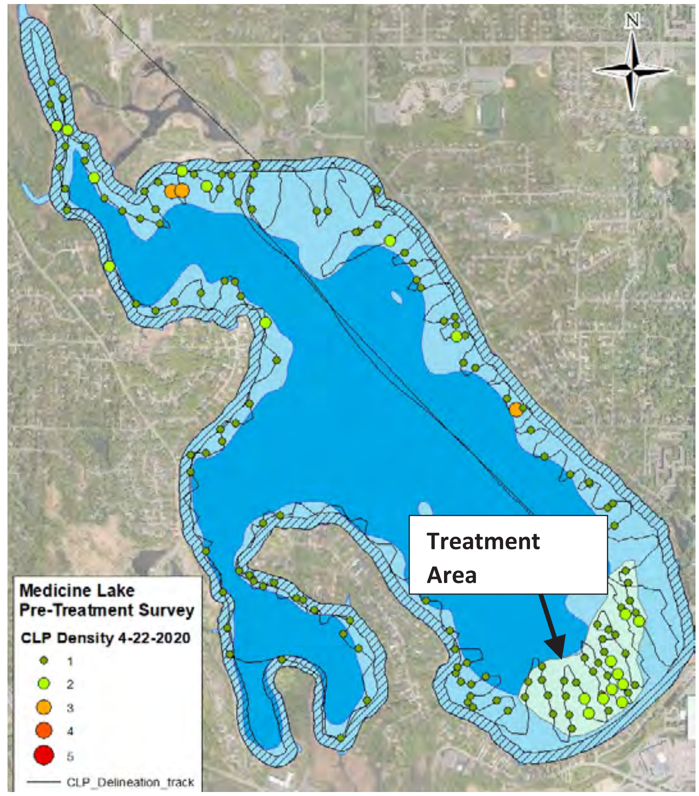


Figure 14: 2020 CLP Delineation and Treatment Area (TRPD)

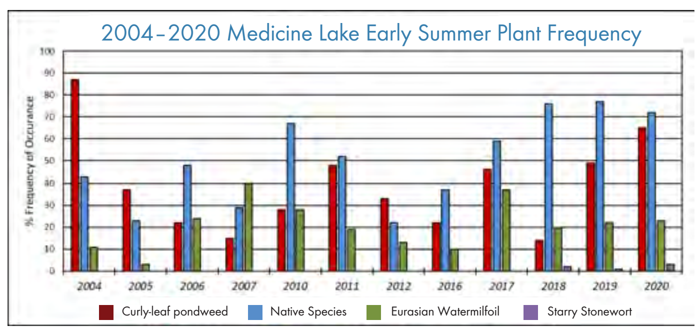


Figure 15 (Data Collected byTRPD)

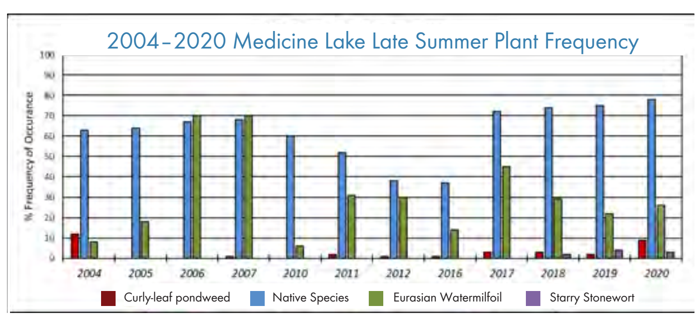


Figure 16 (Data Collected byTRPD)

Eurasian watermilfoil *(Myriophyllum spicatum)*

Eurasian watermilfoil was not problematic in 2020, ranging in frequency from 23 to 27 percent of the sample locations. From 2004 through 2020, Eurasian watermilfoil frequency has ranged from 3 to 70 percent (Figures 15 and 16, page 9).

Starry stonewort *(Nitellopsis obtusa)*

Starry stonewort was first observed in Medicine Lake in 2018 after a boat inspector recognized the plant on a boat leaving the lake. 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 (Figure 17). The MNDNR funded treatment of the plant with herbicide (copper sulfate and endothall) from 2018 through 2020. Despite the treatments, a 2020 plant survey documented the plant has spread to areas along the western side of the lake (Figure 18).

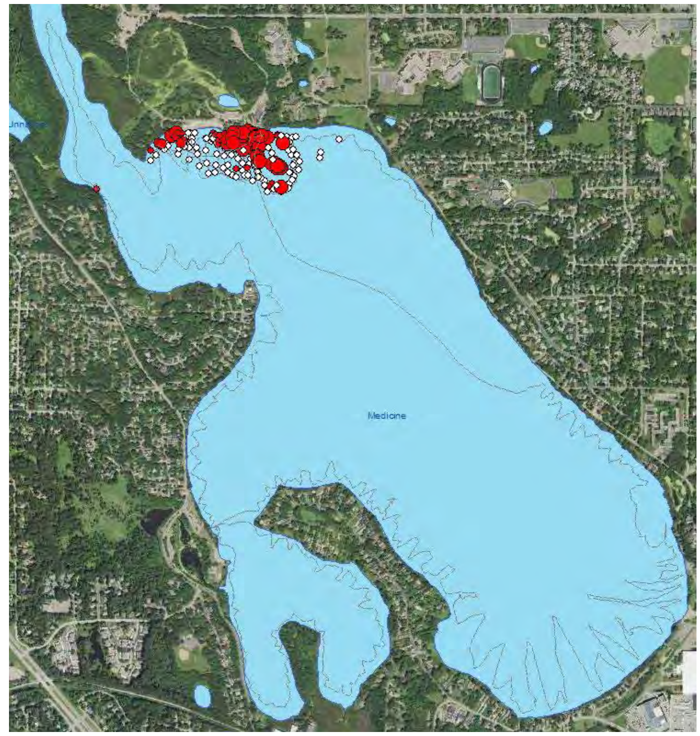


Figure 17: Starry Stonewort Delineation in August 2018 (MNDNR)

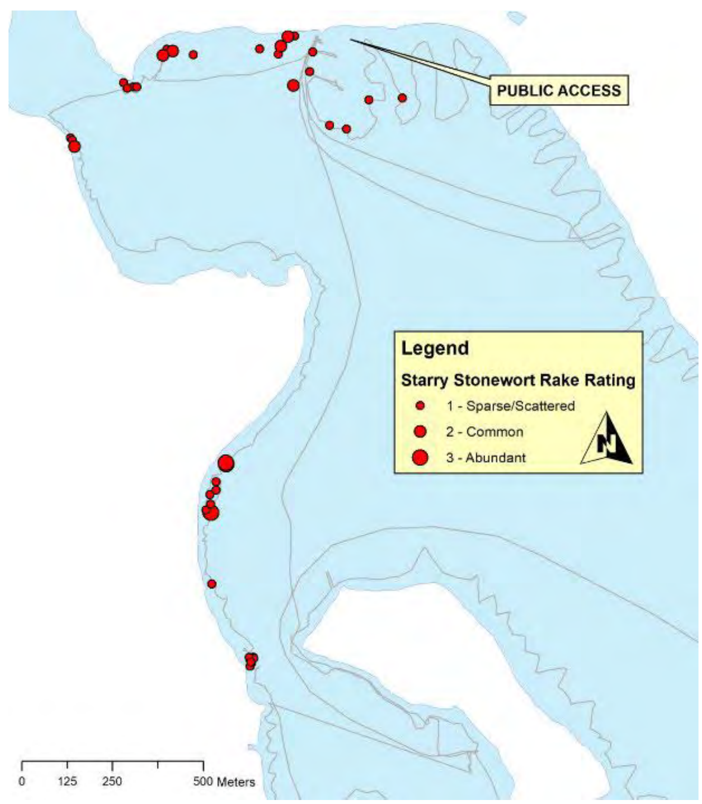


Figure 18: Starry Stonewort Delineation in October 2020 (MNDNR)

Zebra mussels *(Dreissina polymorpha)*

Zebra mussels were first observed in Medicine Lake when a resident living on the south end of the lake found a zebra mussel on a dock. On November 2, 2017, MNDNR staff examined docks removed from the southern end of the lake and found zebra mussels on two additional docks (Figure 19). Surveys from 2018 through 2020 found that zebra mussels remained at low numbers through 2019 and then increased by nearly an order of magnitude. Five zebra mussels were observed in 2018, three in 2019, and 278 in 2020. During this period, zebra mussels spread from the southern end of the lake to the eastern and northern sides). Zebra mussel veligers (planktonic larvae) were observed in the zooplankton samples collected from Medicine Lake in April, May, June, August, and September 2020. On the dates when veligers were observed, numbers ranged from to 5,217 to 95,316 per square meter (Figure 20).

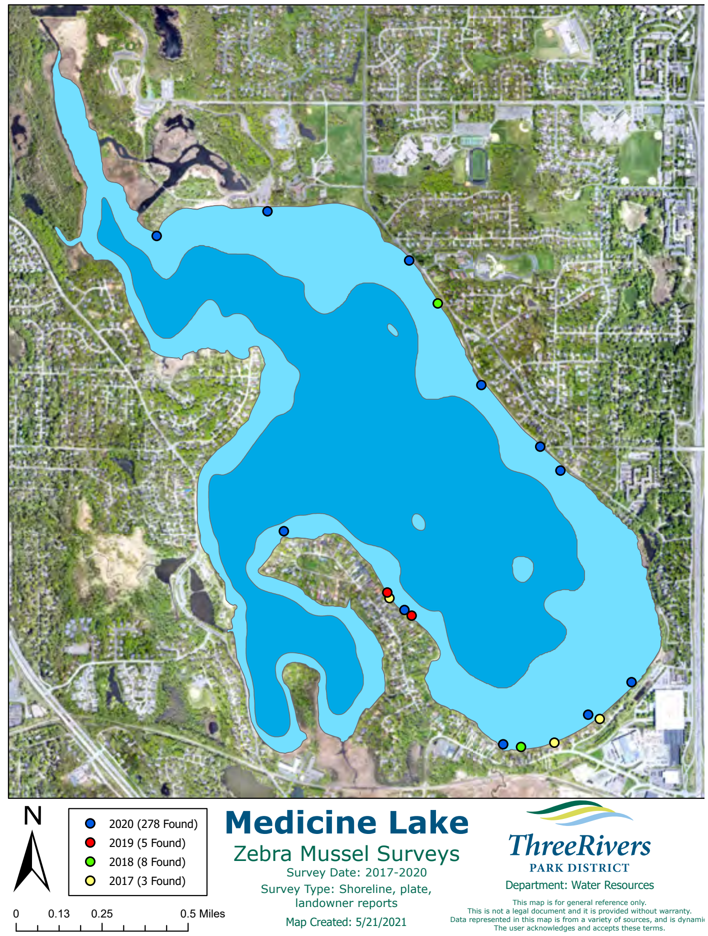


Figure 19 (Data Collected by TRPD)

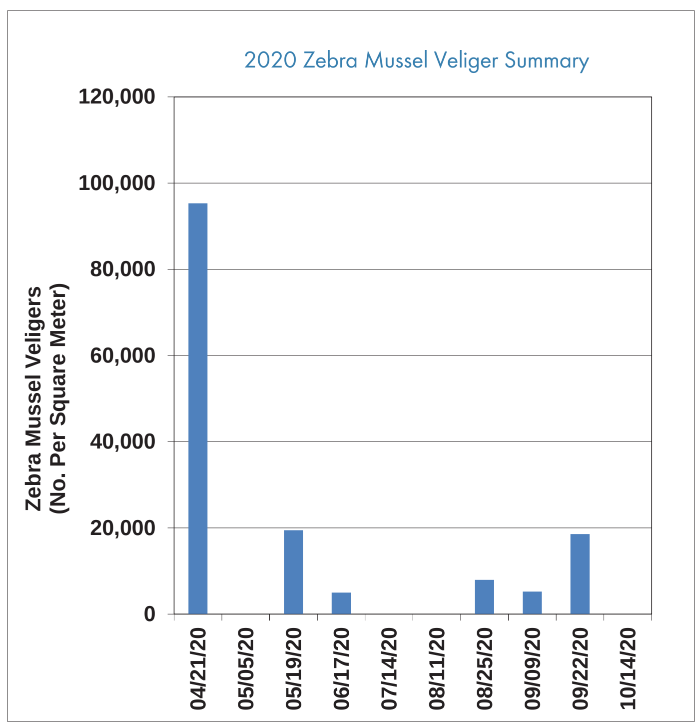


Figure 20

Phytoplankton and zooplankton

Reductions in numbers of phytoplankton (microscopic aquatic plants) and rotifers (a type of zooplankton—microscopic animal) between 2016 and 2020 are likely due to predation by zebra mussels. Zebra mussels primarily feed on algae, but also consume rotifers, which are small. From 2016 to 2020, algae and rotifer numbers both declined. Reductions in algae limit the quantity of food available to the larger zooplankters (cladocerans and copepods). Copepod numbers declined between 2016 and 2020, but it is not known whether their decline was due to fish predation or food limitation from reduced numbers of phytoplankton. Cladoceran numbers increased from 2016 to 2020, indicating they were not impacted by the reductions in algae.

Samples of phytoplankton were collected from Medicine Lake to evaluate water quality and the quality of food available to zooplankton and zebra mussels. As shown in Figure 21, phytoplankton numbers were low from April through June and October and increased from July through September due to increasing numbers of blue-green algae. While blue-green numbers increased with higher concentrations of phosphorus during this period other types of algae did not. This is because:

- Blue-green algae can move up and down the water column while other types of algae cannot.
- Blue-green algae can grow in a wider variety of light conditions than other algae.
- Blue-green algae can capture atmospheric nitrogen while other types of algae cannot.

Lower phytoplankton numbers in 2020 compared with 2016 and 2010 are likely due to zebra mussel consumption of algae. A comparison of 2020 phytoplankton numbers with 2010 and 2016 indicates that 2020 numbers were, on average, 34 to 38 percent lower than 2010 and 2016 numbers—with an April through September average of 13,536 units per milliliter in 2020 compared with 21,826 in 2016 and 20,394 in 2010 (Figure 21). As noted previously, zebra mussels were first observed in the lake in 2017. Zebra mussels consume all types of algae, although they prefer the more palatable types such as diatoms, green algae, and cryptomonads.

Zebra mussel grazing of green algae reduced early spring numbers in Medicine Lake by more than an order of magnitude in 2020 and seasonal average numbers by more than half compared with 2010 and 2016. In spring, zebra mussel filtration rates rise dramatically as waters warm from 41° F to 50° F and then stabilize. Green algae numbers observed in Medicine Lake during April 2020 were more than an order of magnitude lower than

Phytoplankton (Chlamydomonas)

Zooplankton (copepod)

numbers observed in April 2010 and April 2016—with 1,493 units per milliliter in 2020 compared with 15,335 in 2016 and 19,413 in 2010 (Figure 22). The 2020 April through September average number of green algae was less than half the average observed in 2010 and 2016: 1,774 per milliliter in 2020 compared with 4,290 in 2010 and 4,643 in 2016 (Figure 22).

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. Zebra mussels prey upon small zooplankton (rotifers), but do not consume the larger cladocerans and copepods.

Lower numbers of rotifers in Medicine Lake during 2020 were likely due to zebra mussel predation. The April through September 2020 average number of rotifers was less than half the 2010 and 2016 averages—with 558,898 per square meter in 2020 compared with 1,651,848 in 2010 and 1,410,935 in 2016 (Figure 23 and Figure 24).

Although zebra mussels do not prey upon larger zooplankton, they can impact numbers and sizes by limiting their food supply. Cladocerans and copepods consume algae and may be impacted by food limitation caused by zebra mussels grazing on algae. The April through September 2020 average number of copepods was 30 percent lower than the 2010 average and 20 percent lower than the 2016 average. However, it is not known whether the reduced numbers of copepods in 2020 was due to food limitation or fish predation (Figure 23 and Figure 25). 2020 cladoceran numbers were within the range of 2010 and 2016 numbers (Figure 23 and Figure 26), indicating cladocerans were not impacted by food limitation from zebra mussels grazing on algae.

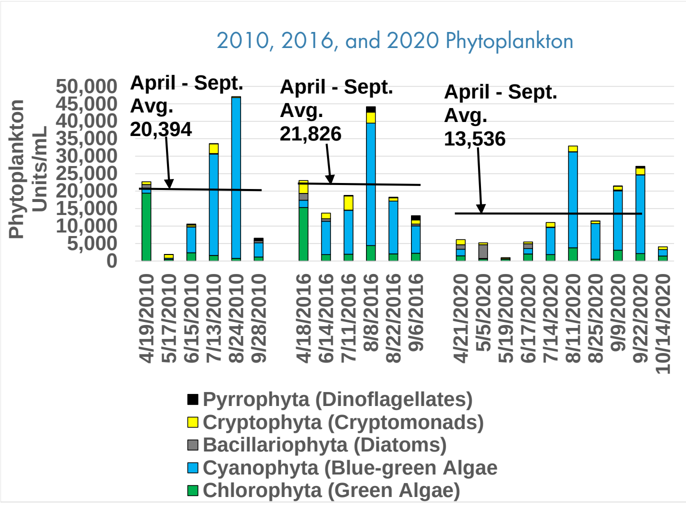


Figure 21

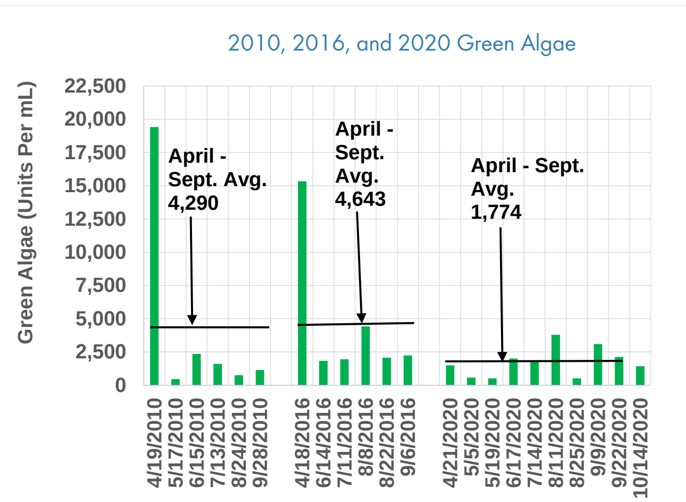


Figure 22

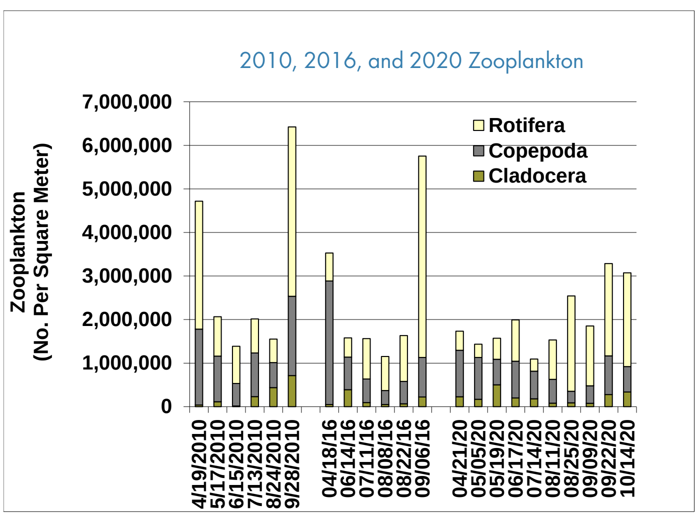


Figure 23

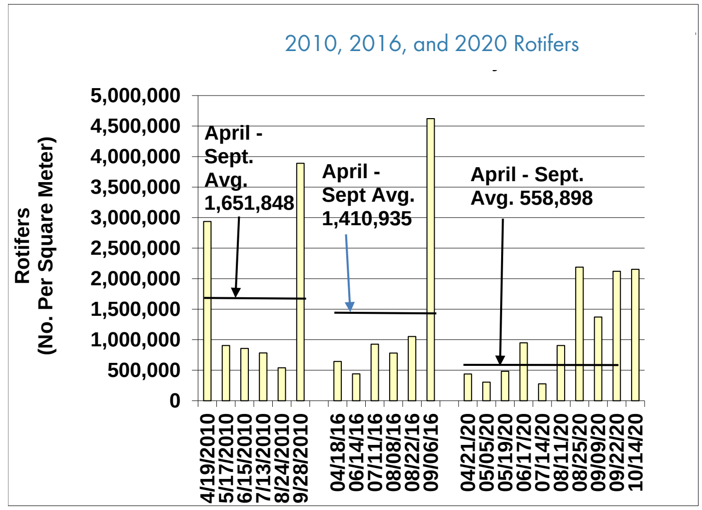


Figure 24

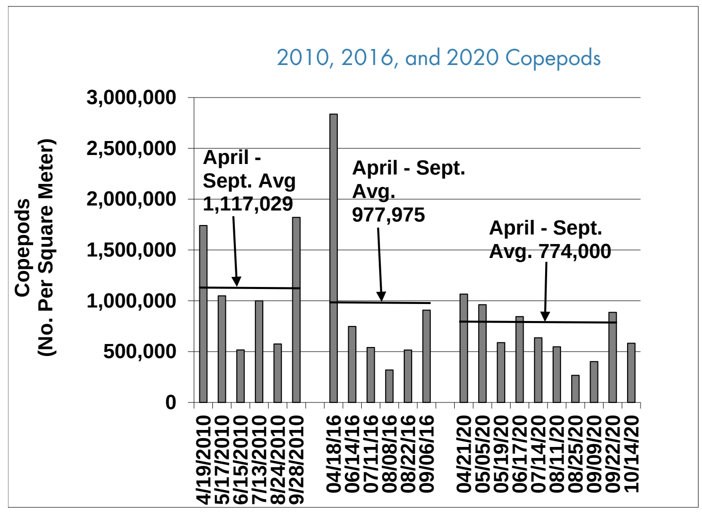


Figure 25

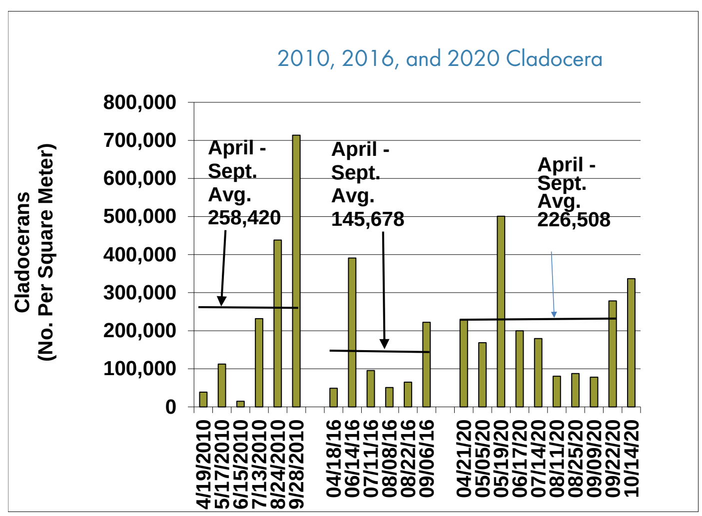
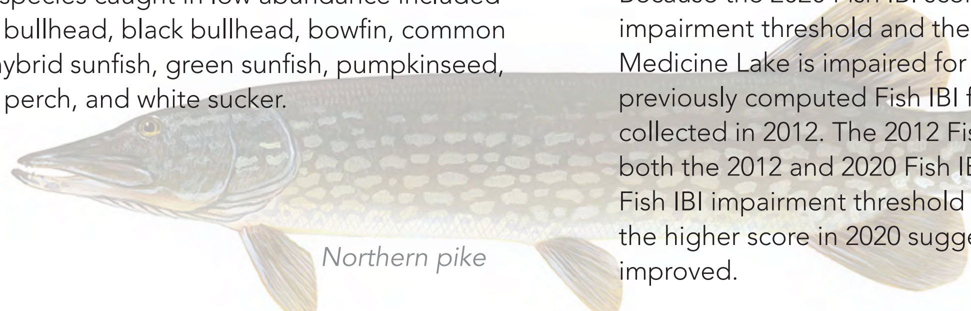


Figure 26

Fish

In July 2020, the MNDNR conducted a standard fish survey of Medicine Lake using trap and gill nets. Survey results indicate:

- Northern pike were highly abundant. Forty-four percent of the 255 pike sampled were less than 22 inches and 22 percent exceeded 26 inches. The MNDNR survey report stated "with lots of smaller fish, and a good chance of catching a few larger fish, Medicine Lake would be the place for a harvest-oriented angler."
- Good numbers of walleye were present and fish size ranged from 10 to 28 inches. The average size of walleye in Medicine Lake was 17.8 inches and 2.35 pounds.
- Medicine Lake supports a strong population of bluegill. In 2020, the largest bluegill in the lake was 9.2 inches and a good proportion of the fish were larger than 7 inches. Because the lake supports large bluegill, a special regulation will be implemented in 2021 to reduce the limit on harvesting bluegill from 20 per day to five per day. The regulation will keep bluegills in the lake longer and hopefully allow a greater proportion of bluegills to attain a large size.
- Black crappie are abundant in the lake and of modest size. A special regulation will be implemented in 2021 to reduce the limit on harvesting of black crappie to five per day. The regulation will keep black crappie in the lake longer and hopefully improve the size of these fish.
- Yellow bullhead in Medicine Lake are both abundant and of quality size. The average-size yellow bullhead was 11.8 inches and 0.9 pound. More than half of the sample exceeded 12 inches.
- Other species caught in low abundance included brown bullhead, black bullhead, bowfin, common carp, hybrid sunfish, green sunfish, pumpkinseed, yellow perch, and white sucker.



Northern pike

Fish IBI

Recent fish surveys and metrics indicate Medicine Lake has a fishery impairment, meaning it does not meet the State thresholds for a thriving and healthy fish community. However, it appears the fish community improved since the last survey in 2012.

An index of biological integrity (IBI) is a group of metrics that, combined, depict the overall biological integrity or condition of a system. The MNDNR has developed four fish-based Index of Biotic Integrity (IBI) tools to assess Minnesota lakes from 100 to 10,000 acres in size. The Fish IBI tools have been used by the MNDNR since 2015 to assess whether lake waters are impaired for fish (i.e., do not support a lake's fish population).

On September 1, 2020, the MNDNR Fisheries Index of Biological Integrity (FIBI) staff conducted a targeted survey of the nearshore fish community in Medicine Lake. Fifteen native species were captured in the nearshore survey including three species that are intolerant of disturbance (banded killifish, Iowa darter, and least darter). Data from the targeted nearshore fish survey were combined with data from the standard fish survey completed in July 2020 to compute a Fish IBI score, assesing the aquatic life use in Medicine Lake.

Tool 2 was used to compute Fish IBI in Medicine Lake, resulting in a score of 30 which was below both the impairment threshold of 45 and the lower confidence limit of 36. The relatively low species diversity in general and the trap net community metrics were the main negative influences on the Fish IBI score. Positive influences on the Fish IBI score were the number of small benthic-dwelling species (Iowa darter, Johnny darter, least darter, and tadpole madtom) and the somewhat high proportional biomass of top carnivores in the gill net catch (78 percent). Because the 2020 Fish IBI score was below both the impairment threshold and the lower confidence limit, Medicine Lake is impaired for fish. The MNDNR had previously computed Fish IBI from Medicine Lake fish data collected in 2012. The 2012 Fish IBI score was 25. Although both the 2012 and 2020 Fish IBI scores were below the Fish IBI impairment threshold and lower confidence limit, the higher score in 2020 suggests the fish community has improved.