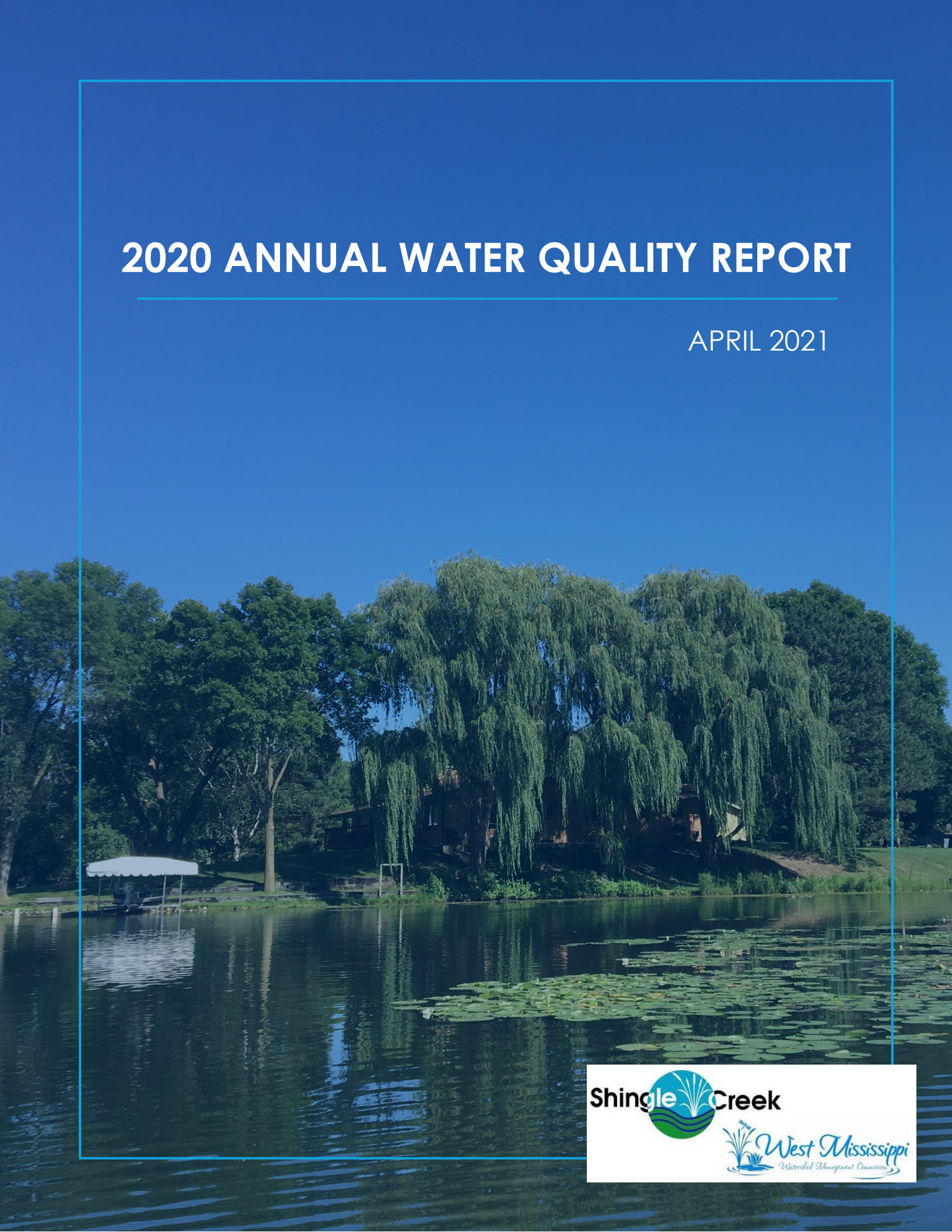
2020 ANNUAL WATER QUALITY REPORT

APRIL 2021



The Monitoring Program

The Shingle Creek and West Mississippi Watershed Management Commissions annually monitor water quality in the lakes, streams and outfalls of the watersheds. Data has been collected from Shingle Creek since 1996 and at West Mississippi river outfalls since 2010. In 2012 Shingle Creek expanded its volunteer-based lake monitoring program to start systematic detailed lake monitoring. The program has also expanded to incorporate fish, macroinvertebrate, and aquatic vegetation monitoring in the lakes and streams. Student and adult volunteers collect additional lake water quality and stream and wetland macroinvertebrate data. A Water Quality report summarizing current and historic conditions in the watersheds has been published annually since 1998.

Surface water quality in the watersheds is typical of urban lakes and streams in the Twin Cities metropolitan area. Agriculture followed by urban development have changed drainage patterns, increased pollutants to the waters, and reduced habitat for aquatic and terrestrial life. Both Shingle Creek and Bass Creek do not meet state water quality standards for chloride, bacteria, and dissolved oxygen, and have severely impacted fish and macroinvertebrate communities. Thirteen of the 16 lakes were listed as Impaired Waters of the State because of their high concentrations of phosphorus. Diagnostic and feasibility studies completed between 2007 and 2011 have identified actions that can be taken in the watersheds to help improve water quality.

In the more than ten years since the results have been heartening. Three of the impaired lakes **now meet state standards** and have been removed from the list of Impaired Waters. Long-term stream water quality monitoring shows a **clear improvement** in suspended sediment and nutrient concentrations in both Shingle Creek and Bass Creek, a result of ongoing efforts to stabilize streambanks, increase the frequency of street sweeping, enhance erosion control on construction sites, and install Best Management Practices to treat stormwater before it is discharged into the streams. However, chloride concentrations in the streams, mostly from road salt applied in the winter for snow and ice control, continue to be high.

Why Do We Monitor?

- To quantify the **current status** of streams and lakes throughout the watershed and compare to water quality standards.
- To quantify **changes over time**, or trends, in stream and lake water quality
- To **identify problem areas** for potential BMPs
- To quantify the **effectiveness** of implemented BMPs throughout the watershed

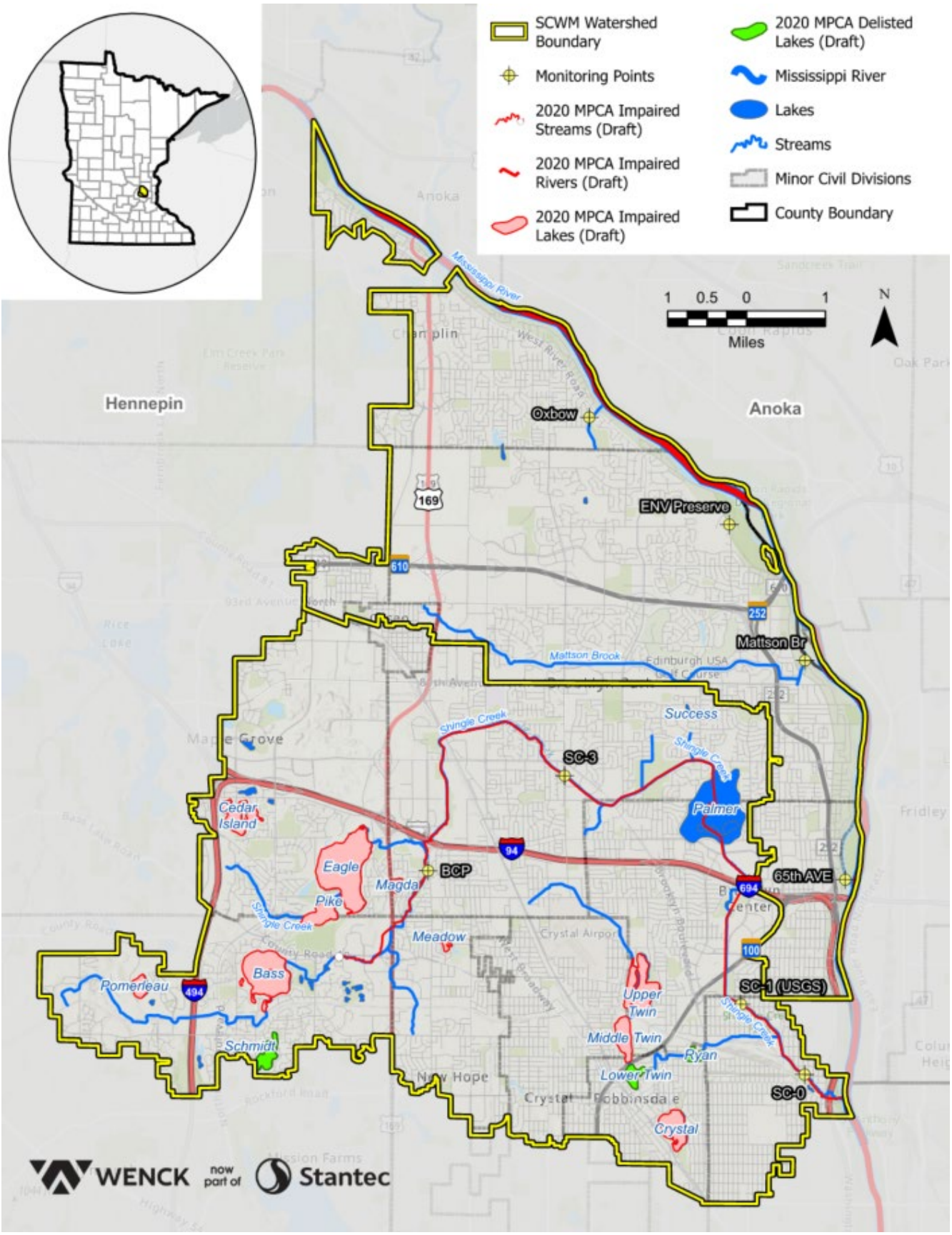


Figure 1. Impairments in the Shingle Creek and West Mississippi Watersheds.

What's in the watershed?

West Mississippi

- 25 square miles
- High impervious urban development (25%) and low-moderate impervious urban development (38%)
- 4 stream sites and 18.3 miles of streams
- No lakes, few wetlands

Middle Shingle Creek

- 15 square miles
- High impervious urban development (45%) and low-moderate impervious urban development (28%)
- 1 stream and 10.34 miles of streams
- 2 lakes: Success and Palmer

Upper Shingle Creek

- Headwaters of Shingle Creek
- 13 square miles
- High impervious urban development (28%) and low-moderate impervious urban development (26%)
- 3 streams and 16.2 miles of streams
- 8 lakes: Bass, Pomerleau, Schmidt, Cedar Island, Pike, Eagle, Magda, Meadow

Lower Shingle Creek

- Shingle Creek discharges to the Mississippi River
- 17 square miles
- High impervious urban development (71%) and low-moderate impervious urban development (8%)
- 2 streams and 18.9 miles of streams
- 5 lakes: Upper Twin, Middle Twin, Lower Twin, Crystal, and Ryan

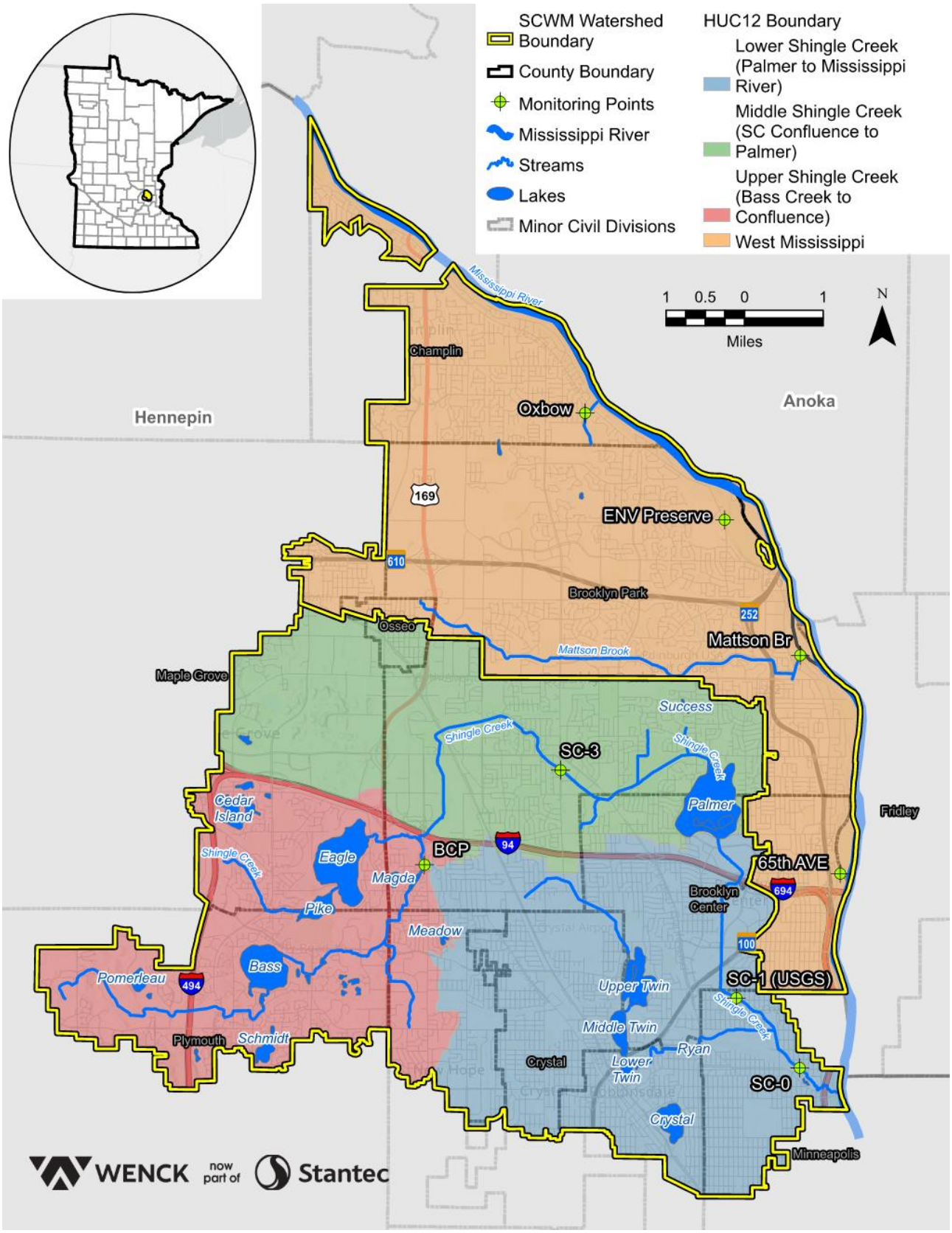


Figure 2. Overview and monitoring locations of the Shingle Creek and West Mississippi Watersheds.

Monitoring in 2020

Stream Monitoring

Routine Flow and Water Quality: Three sites along Bass and Shingle Creek were monitored biweekly from April through October: near the stream's outlet to the Mississippi River in Minneapolis (SC-0); mid-watershed in Brooklyn Park (SC-3); and in Bass Creek (BCP) in the upper watershed. Winter chloride was sampled monthly from November through March at the three locations mentioned and the USGS gage site (SC-1). In the West Mississippi Watershed, the Environmental Preserve (ENVP) and 65th Avenue were monitored monthly April through October.

River Watch: Stream macroinvertebrates are typically monitored by high school students at two sites on Shingle Creek through the Hennepin County River Watch program, however no monitoring occurred in 2020 due to the COVID-19 pandemic. Shingle Creek at Park Center High School has been monitored for 24 years by science students from the school. Shingle Creek at Webber Park was monitored by students from Patrick Henry High School between 2001 and 2012, then in 2018 and 2019 by students from the Avail Academy.

Lake Monitoring

Routine Water Quality: Water quality in Eagle and Pike Lakes in Maple Grove was monitored biweekly from May through September as part of Shingle Creek's routing monitoring program. Aquatic vegetation was surveyed once in late spring and once in late summer. The carp populations on both lakes were last surveyed in July 2018.

CAMP: Each year the Commission sponsors volunteer lake water quality monitoring through the Met Council's Citizen Assisted Monitoring Program (CAMP). Meadow, Success, Ryan, Upper Twin, Middle Twin and Lower Twin were monitored in 2020.

Grant Projects: Crystal, Bass, and Pomerleau Lakes were monitored biweekly from May through September for water quality as part of grant projects. These lakes have all been listed as impaired for nutrients and are undergoing active management. Bass and Pomerleau Lakes received a 2nd dose of alum in September 2020, following the first dose that occurred in May 2019. Crystal Lake will receive its first alum treatment in spring 2021. Water quality monitoring in the lakes has helped our understanding of changes in lake health following management activities.

Wetland Monitoring

Macroinvertebrate communities and vegetation are typically monitored, two in each watershed, by volunteers through the Wetland Health Evaluation Program (WHEP) administered by Hennepin County. That routine monitoring was not completed in 2020 due to the COVID-19 pandemic. Two wetlands in Shingle Creek watershed were monitored, both located within Webber Park.

2020 in Review

This summary provides an overview of findings and conditions in the two watersheds in 2020. A more detailed assessment and data are available in the technical appendices, which can be found at shinglecreek.org/water-quality.html.

Rainfall

Water quality in lakes, streams and wetlands is heavily influenced by precipitation and storm water runoff. Precipitation in 2020 in the Shingle Creek and West Mississippi watersheds rainfall was below the historic average (1992-2020) each month except March and August. Total rainfall in 2020 was 26.4 inches, 7.9 inches below the historic average of 34.3 inches.

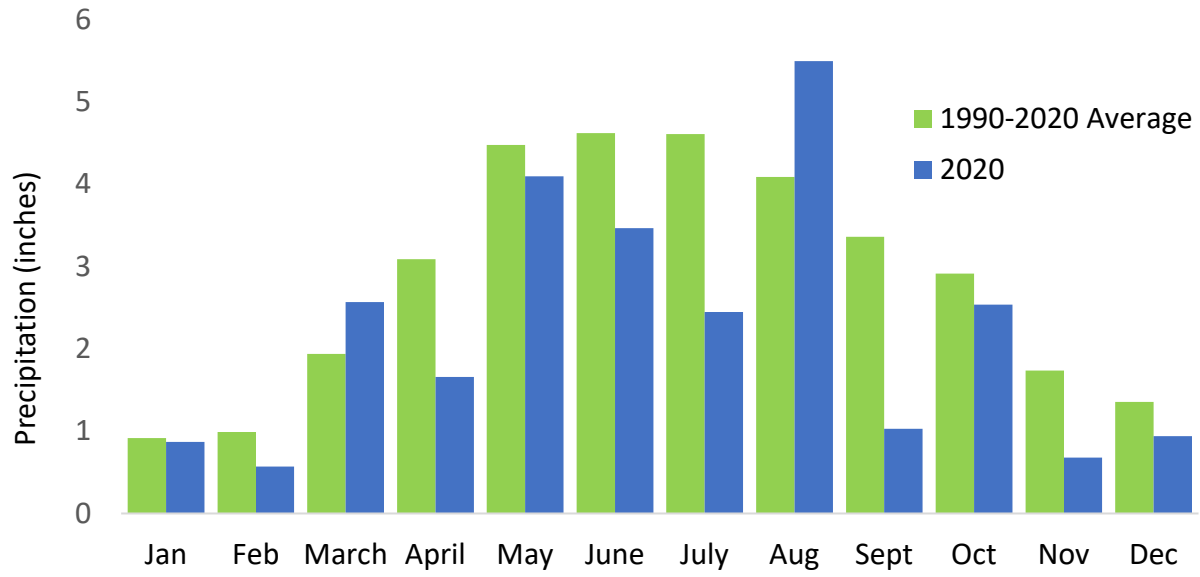


Figure 3. Monthly precipitation totals at the New Hope weather station for 1990-2020 and 2020.

Streams

Stream sites in Shingle Creek and West Mississippi Watersheds are monitored during normal, baseflow conditions (routine monitoring) and during rainfall events (storm monitoring). Runoff during storms carries pollutants into the stream and can contribute to downstream water body impairments. Stream water quality during storms is often worse than during routine monitoring.

Shingle Creek

Flow at all the monitored Shingle Creek sites (BCP, SC-3, SC-0) and at the USGS gage site were similar across sites and was largely driven by rainfall events in the watershed (Figure 4). The highest flows occur at the site closest to the watershed outlet (SC-0) and the lowest flows occur near the watershed headwaters (BCP). 2020 was a relatively dry year compared to historic precipitation averages (Figure 3), and total runoff from each monitoring site was the

lowest it has been since 2009 (Appendix C). The small amount of runoff resulted in historically low TP and TSS loading to the watershed.

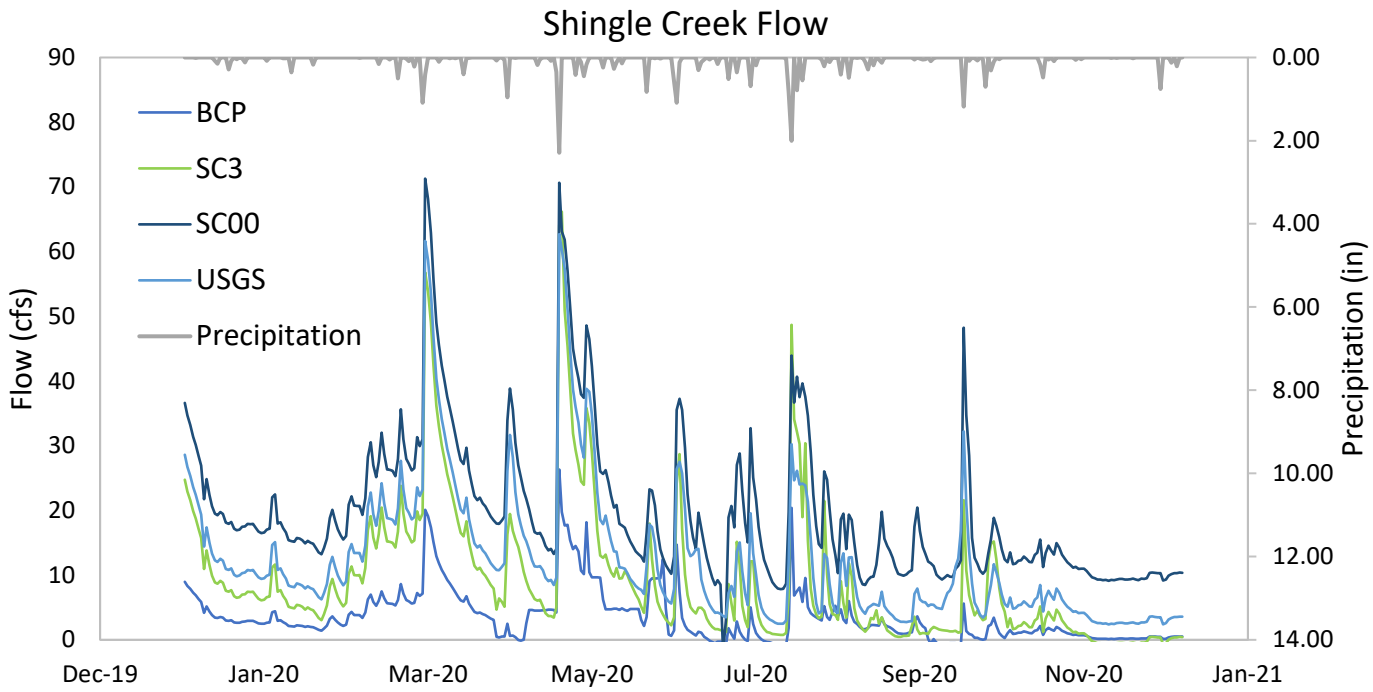


Figure 4. Flow at monitored stream sites and precipitation in the Shingle Creek Watershed during 2020.

Water quality at the Shingle Creek stream sites is generally worse during storm event monitoring (Figure 5). Average concentrations of chloride, *E. coli*, TP, and TSS during storm events were higher than during routine monitoring, with the exception of chloride. Chloride samples were collected year-round but were highest during winter routine monitoring when road salt application occurs.

Annual pollutant loads of TP, TSS, and chloride were estimated for each monitoring site by multiplying the mean pollutant concentration by the annual volume of runoff at each site. Loads are highest near the Shingle Creek watershed outlet at site SC-0.

Table 1. Annual pollutant loads at each Shingle Creek routine monitoring site.

Site	TP Load (lbs/acre/year)	TSS Load (lbs/acre/year)	Chloride Load (lbs/acre/year)
BCP	0.09	12.8	194
SC-3	0.11	17.1	218
SC-0	0.11	16.3	176

Trends: Water quality data has been collected in Shingle Creek since 1996, and trend analysis shows significant changes to stream water quality. TP concentrations are improving in both Shingle (SC-3) and Bass Creeks (BCP). Dissolved oxygen concentrations are declining at the

upper watershed site on Shingle Creek (SC-3), indicating a need to continue focusing on dissolved oxygen management. Trends were not detected for chloride, TSS, *E. coli*, or nitrogen.

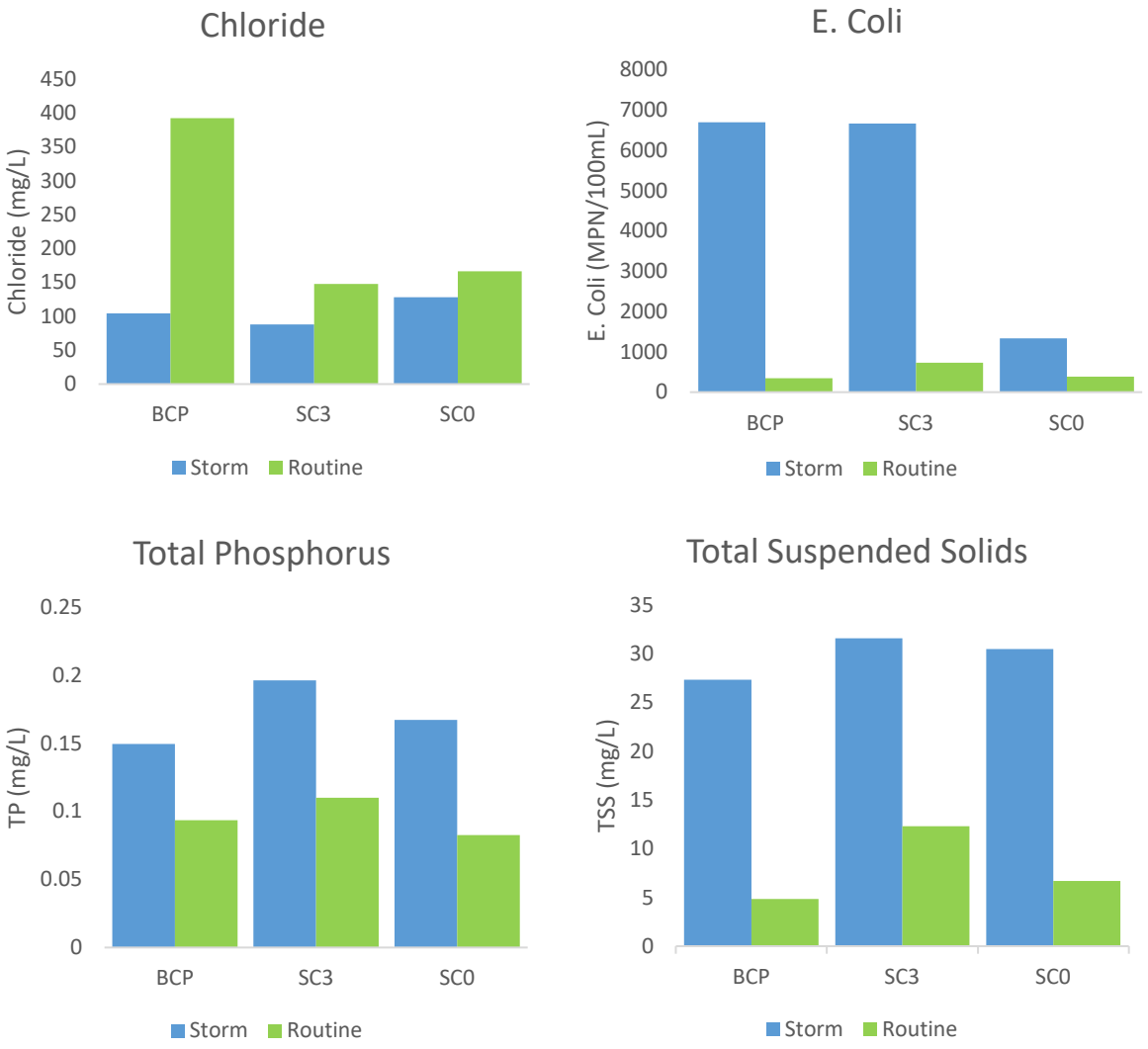


Figure 5. Average concentration of water quality parameters at Shingle Creek sites sampled during storm and routine monitoring in 2020.

West Mississippi

Flow at West Mississippi sites was monitored starting in April 2020. Flow at the 65th Ave site in West Mississippi was much higher than at the Environmental Preserve (Figure 6). Flow was highest during precipitation events.

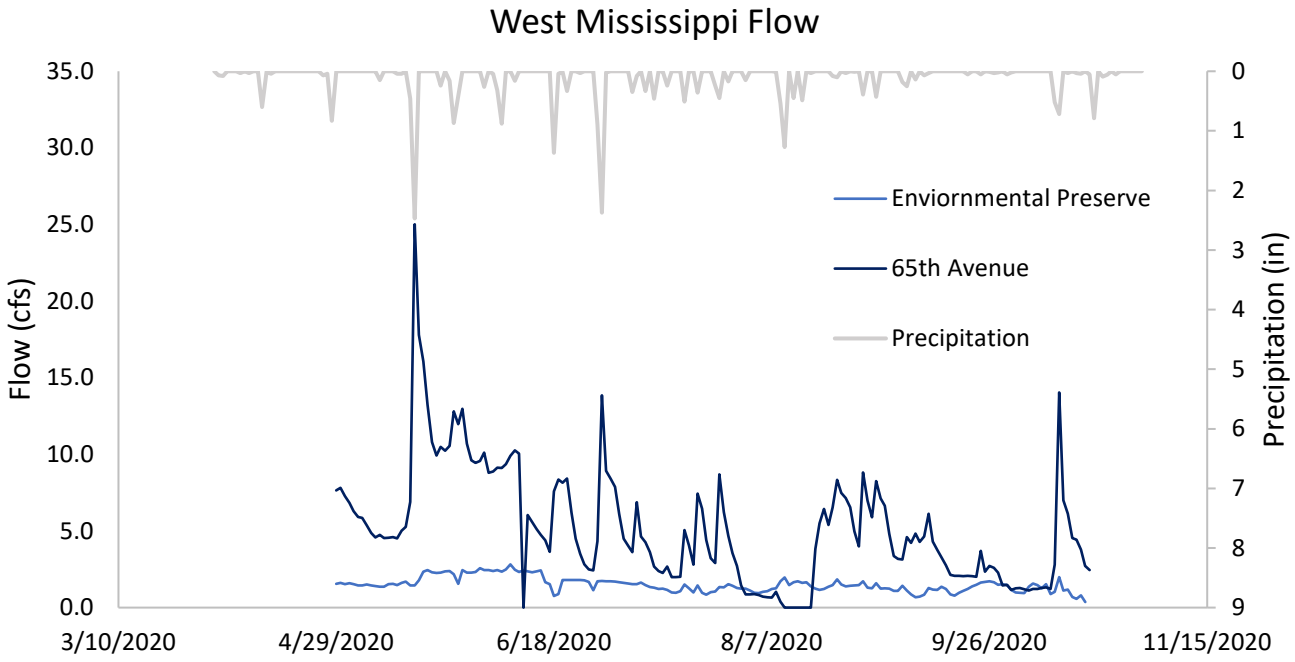


Figure 6. Flow at monitored stream sites and precipitation in the West Mississippi Watershed during 2020.

Similar to Shingle Creek stream sites, water quality (*E. coli*, TP, TSS) at West Mississippi sites was worse during storm events (Figure 7). No chloride samples were collected during storm events at ENVP and 65th Ave.

Monitoring season pollutant loads of TP, TSS, and chloride were estimated for each monitoring site by multiplying the mean pollutant concentration by the volume of runoff during the monitoring season at each site. Year-round flow data for West Mississippi sites were not available, preventing the calculation of annual pollutant loads.

Table 2. Monitoring season pollutant loads at West Mississippi routine monitoring sites.

Site	TP Load (lbs)	TSS Load (lbs)	Chloride Load (lbs)
ENVP*	120	22,760	13,166
65th Ave**	899	210,174	599,051

* ENVP Load was calculated from April 29th – October 19th, 2020.

** 65th Avenue Load was calculated from March 12th – December 31st, 2020.

Trends: Water quality data have been collected in the West Mississippi watershed since 2010. Trend analysis did not detect any trends in TP or TSS concentrations at ENVP. No other trends in chemical parameters at ENVP or 65th Ave could be detected due to lack of long-term data. Continued data collection at West Mississippi sites should be a focus of future monitoring activities.

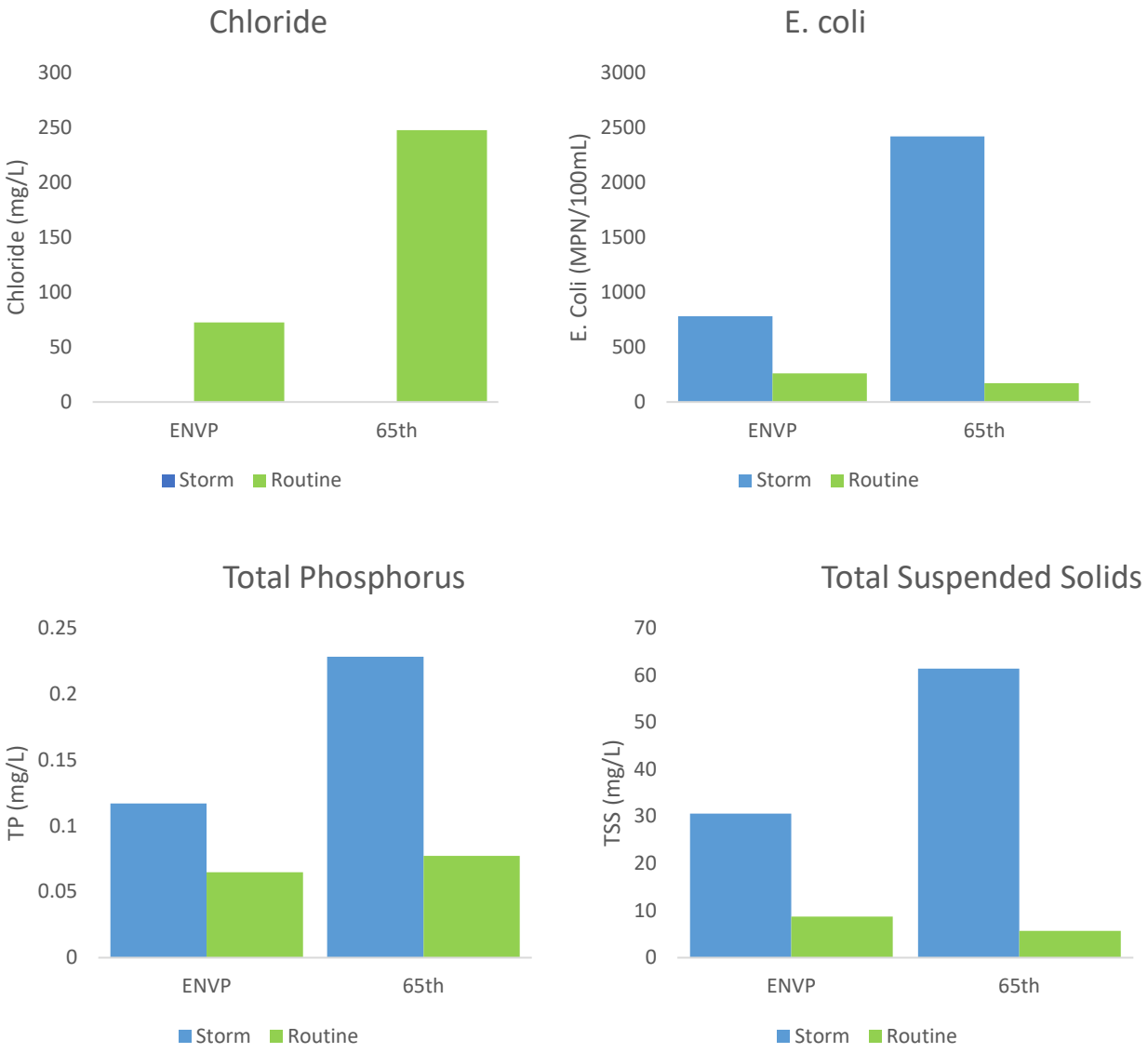
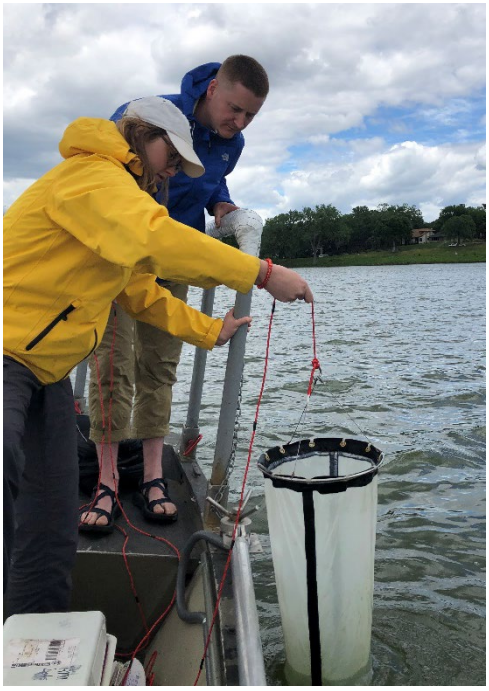


Figure 7. Average concentration of water quality parameters at West Mississippi sites sampled during storm and routine monitoring in 2020.

Lakes



Five lakes were monitored by the Commission in 2020 as part of the routine monitoring program or grant projects. Lakes were visited 11 times from early May through mid-September. Water quality in the lakes was measured as Secchi depth, TP concentration, and chlorophyll-*a* concentration. Submersed aquatic vegetation (SAV) communities were surveyed in three of the lakes (Eagle, Pike, Crystal). The health of the SAV community was measured as Floristic Quality Index (FQI) and species richness. The first routine zooplankton and phytoplankton samples were taken in all five lakes in mid and late Summer to assess the plankton community and how it changes over the monitoring season.

A brief overview of water quality, and the SAV, phytoplankton, and zooplankton communities for all five monitored lakes is provided below. For more detailed data and analysis including fisheries assessments, methods, and long-term water quality data and lake condition grades for all Shingle Creek lakes, see Appendix E.

Eagle Lake

Eagle Lake is a deep lake in Maple Grove, MN. Water quality in the lake was sampled biweekly from May through September 2020. Two SAV surveys were completed, one in early summer and one in late summer to document the vegetation community and how it changes over the growing season. The phytoplankton and zooplankton communities were sampled in early summer and late summer.

Eagle Lake is impaired for nutrients; however, water quality was generally good in 2020 (Figure 8). Surface TP measurements remained below the State's deep lake standard of 40 ug/L for most of the monitoring season. Chlorophyll-*a* and Secchi depth measurements remained below the standard during the beginning of the monitoring season, but measurements exceeded the State standards late summer.

An analysis of the phytoplankton and zooplankton within the lake indicated a healthy, balanced community. The phytoplankton shifted slightly towards a cyanobacteria-dominated community in late summer (Figure 9), a typical composition shift in a healthy lake as water temperature warms and nutrients are high. The amount of cyanobacteria in the lake in late summer is not indicative of a cyanobacteria bloom. The zooplankton community shifted towards bosmina-dominated in late summer (Figure 10). Bosmina can survive on "poor" food sources like cyanobacteria, and thus were supported by the increase in cyanobacteria in late summer. The phytoplankton and zooplankton community changes were typical of a healthy lake ecosystem during the summer.

During both SAV surveys, biovolume, or the volume of water occupied by vegetation, was highest in shallow areas (Figure 9). The health of the SAV community was assessed using the Floristic Quality Index (FQI) and species richness. FQI during the early summer survey was 22.6 and FQI during the late summer survey was 27.0. Species richness was 18 and 23 during the early and late summer surveys, respectively. Eagle Lake FQI and species richness exceeded the suggested standards for deep lakes in this area and the lake is in good condition for aquatic plant life.

Eagle Lake water quality and plankton and SAV community data show the lake, though impaired, is in good condition. Routine monitoring of the lake should continue.

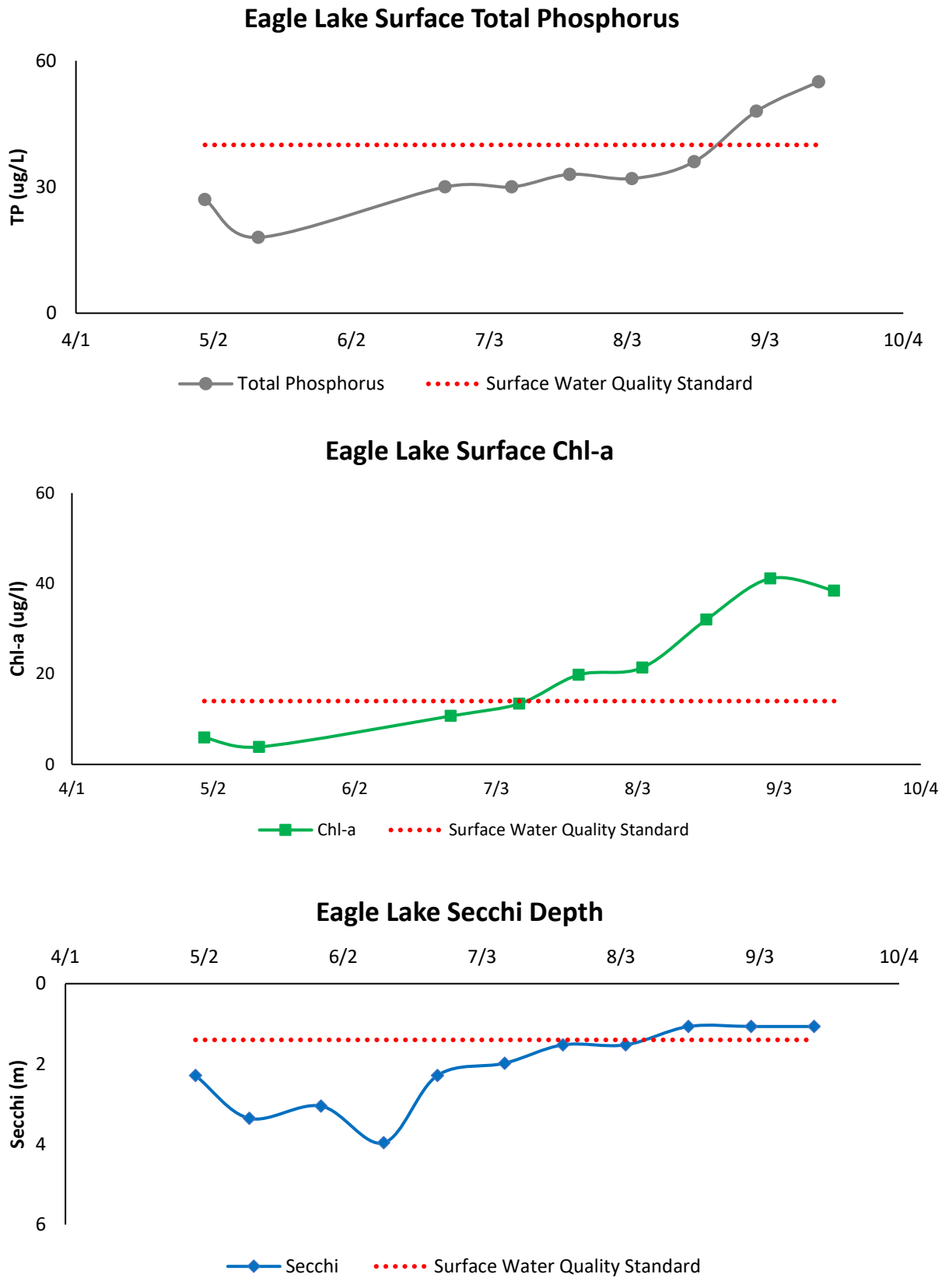


Figure 8. Water quality parameters in Eagle Lake during the 2020 monitoring season.

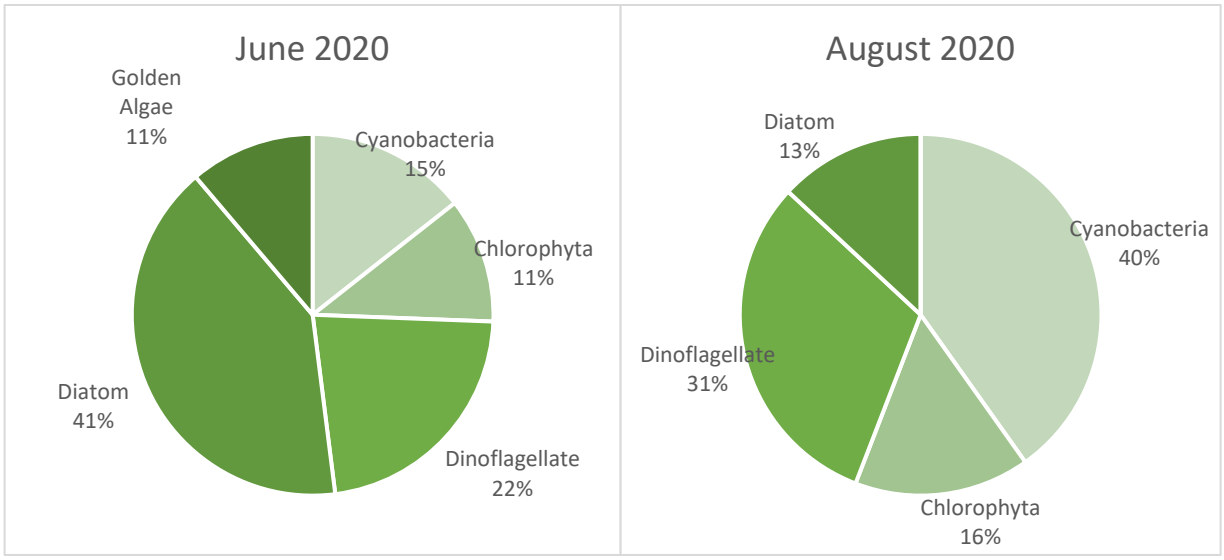


Figure 9. Phytoplankton community as relative percentage from June and August 2020 in Eagle Lake.

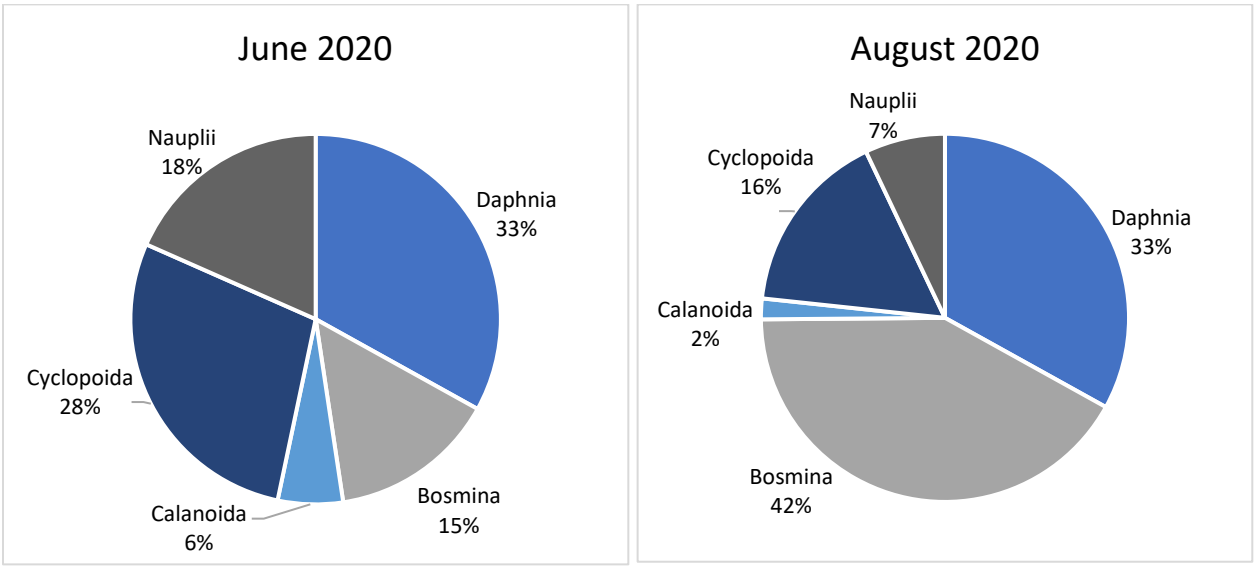


Figure 10. Zooplankton community as relative percentage from June and August 2020 in Eagle Lake.

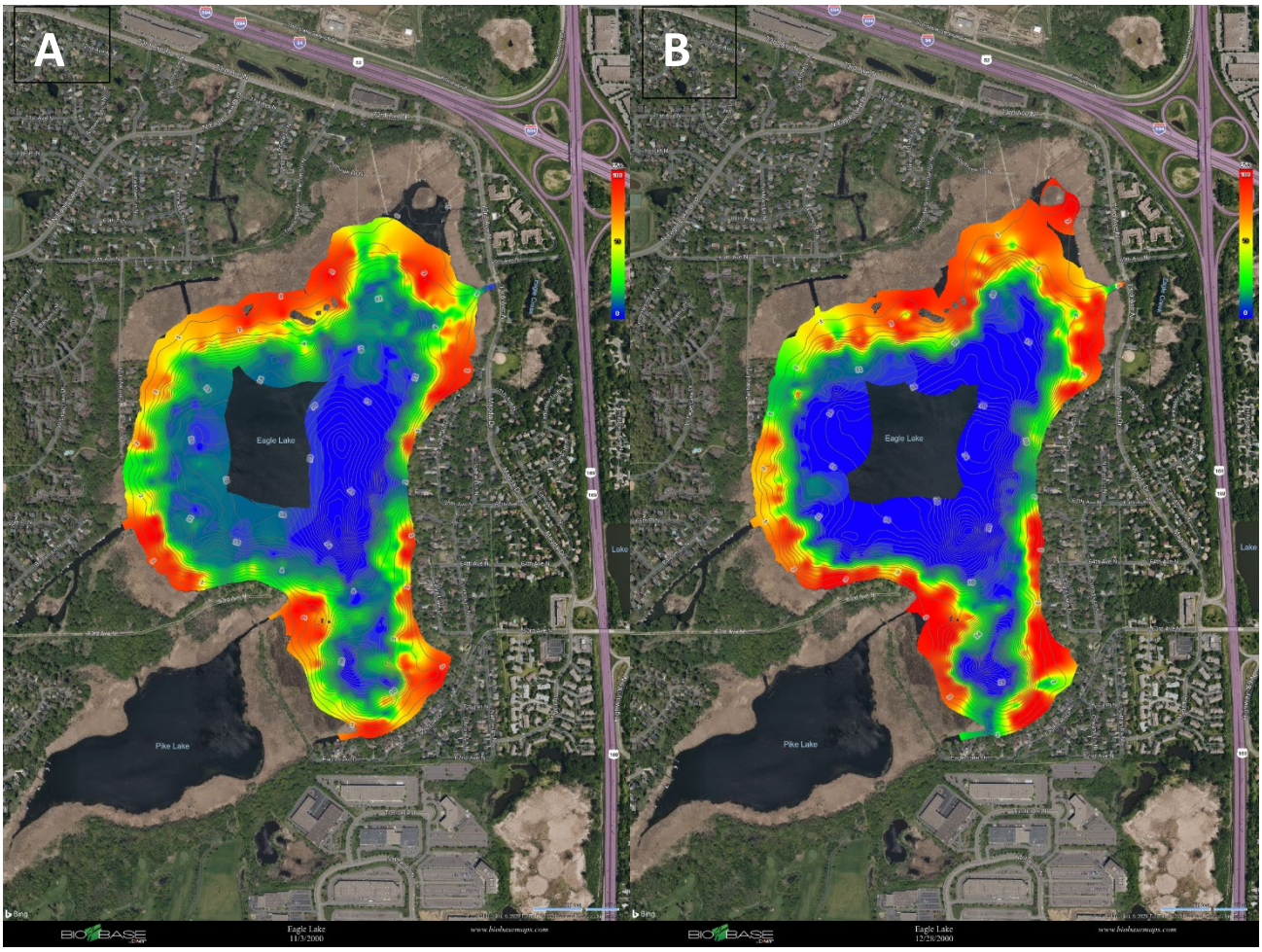


Figure 11. Submersed aquatic vegetation (SAV) shown as biovolume heat maps for Eagle Lake during the June (A) and July (B) 2020 surveys. In the heatmaps, red indicates 100% biovolume and blue indicates 0% biovolume. Biovolume refers to the percentage of the water column taken up by vegetation.

Pike Lake

Pike Lake is a shallow lake in Maple Grove, MN. Water quality in the lake was sampled biweekly from May through September 2020. Two SAV surveys were completed, one in early summer and one in late summer, to document the vegetation community and how it changes over the growing season. The phytoplankton and zooplankton communities were sampled in early summer and late summer.

Pike Lake is impaired for nutrients. Surface TP and chlorophyll-a concentrations in Pike Lake were in good condition early in the season but declined in later summer and exceeded the eutrophication standards (Figure 12). Water clarity was consistently high throughout the entire monitoring season. Both surface TP and chlorophyll-a peaked during the last sampling of the season in mid-September, indicating an algae bloom related to phosphorus availability. TP samples taken from the hypolimnion were high throughout the monitoring season and indicate the potential of internal phosphorus loading from lake sediments.

An analysis of the phytoplankton and zooplankton within the lake indicated a healthy, balanced community. The phytoplankton shifted from a dinoflagellate-dominated community in June to an equal distribution of dinoflagellates and cyanobacteria in August (Figure 13). The dinoflagellate-dominated community in early summer is indicative of lower nutrients and cooler water temperature. The late summer sample had very low concentrations of both dinoflagellates and cyanobacteria, indicating a collapse in the community most likely due to warmer water temperatures. The early summer zooplankton community was dominated by bosmina and daphnia (Figure 14). In late summer, the community shifted to an even distribution among bosmina, daphnia, nauplii, and cyclopoida, indicating less competition among groups.

During both SAV surveys, biovolume, or the volume of water occupied by vegetation, was high throughout the lake (Figure 15). The health of the SAV community was assessed using the Floristic Quality Index (FQI) and species richness. FQI during the early summer survey was 16.5 and FQI during the late summer survey was 18.8. Species richness was 12 during both surveys. The aquatic invasive species (AIS) curly-leaf pondweed was observed in Pike Lake in the early summer survey with high occurrence. Pike Lake species richness exceeded the suggested standards for shallow lakes in this area during both surveys. FQI fell short of the suggested standard during the early summer survey, suggesting that curly-leaf pondweed growth in Spring may have an impact on the health of the aquatic plant community.

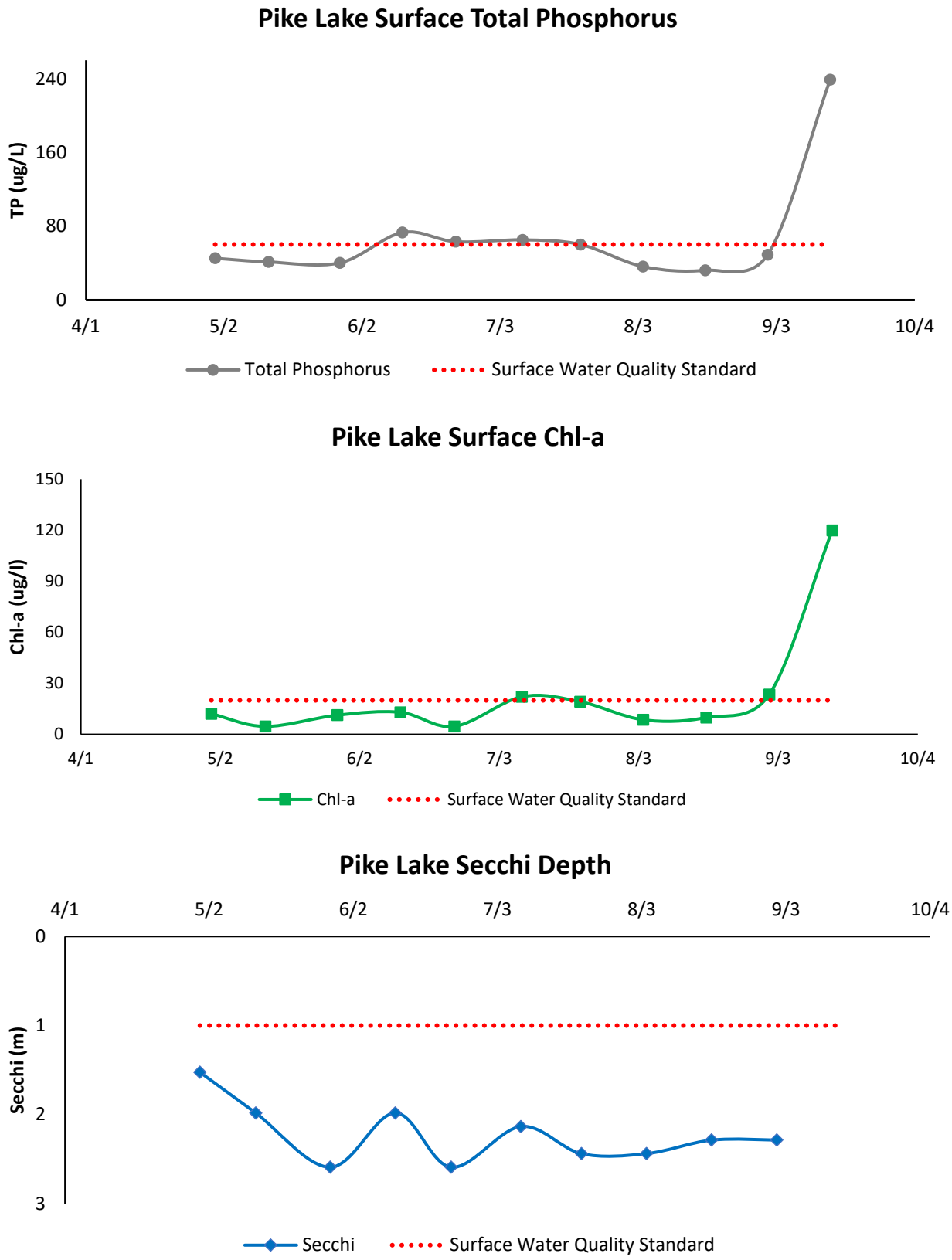


Figure 12. Water quality parameters in Pike Lake during the 2020 monitoring season.

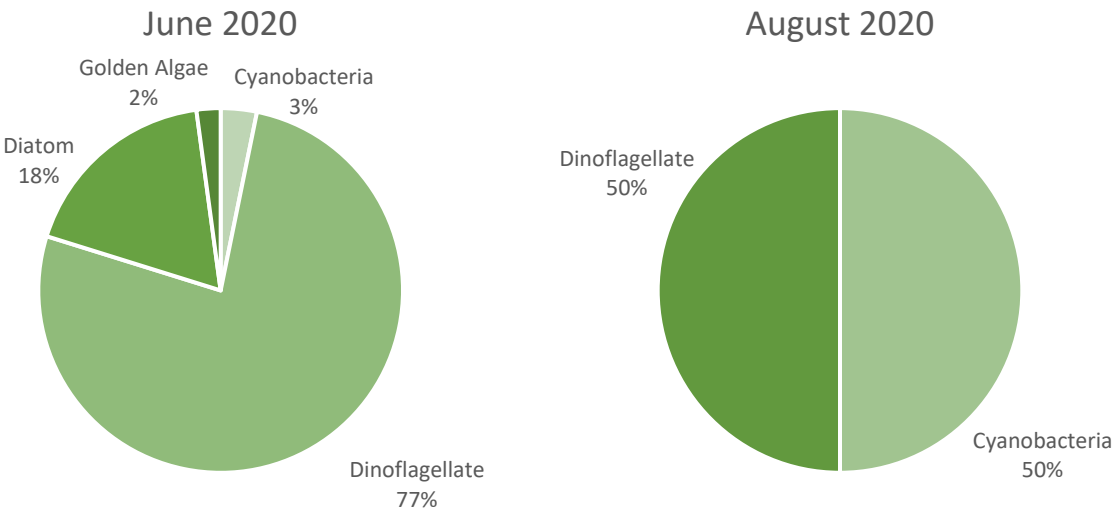


Figure 13. Phytoplankton community as relative percentage from June and August 2020 in Pike Lake.

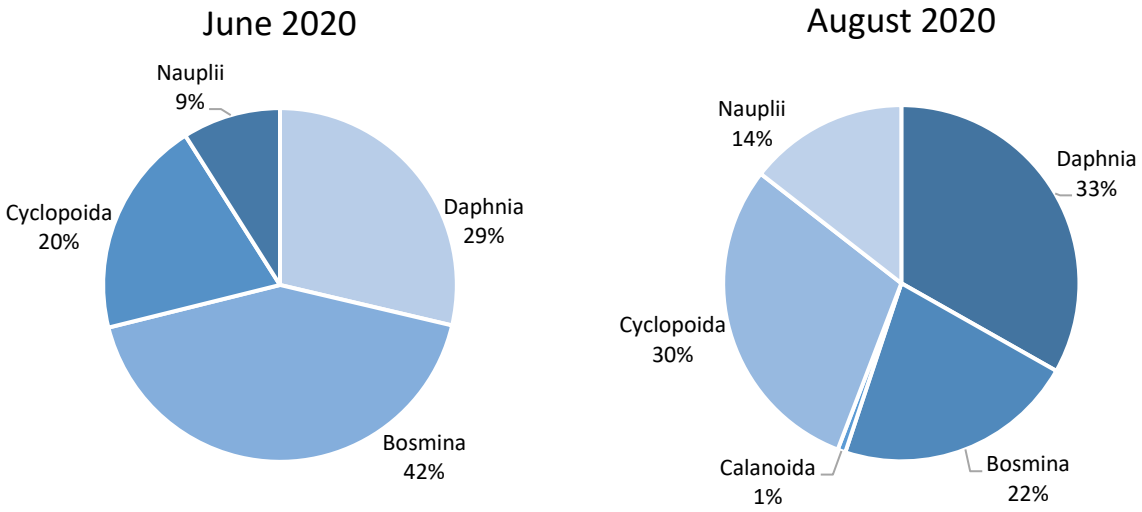


Figure 14. Zooplankton community as relative percentage from June and August 2020 in Pike Lake.

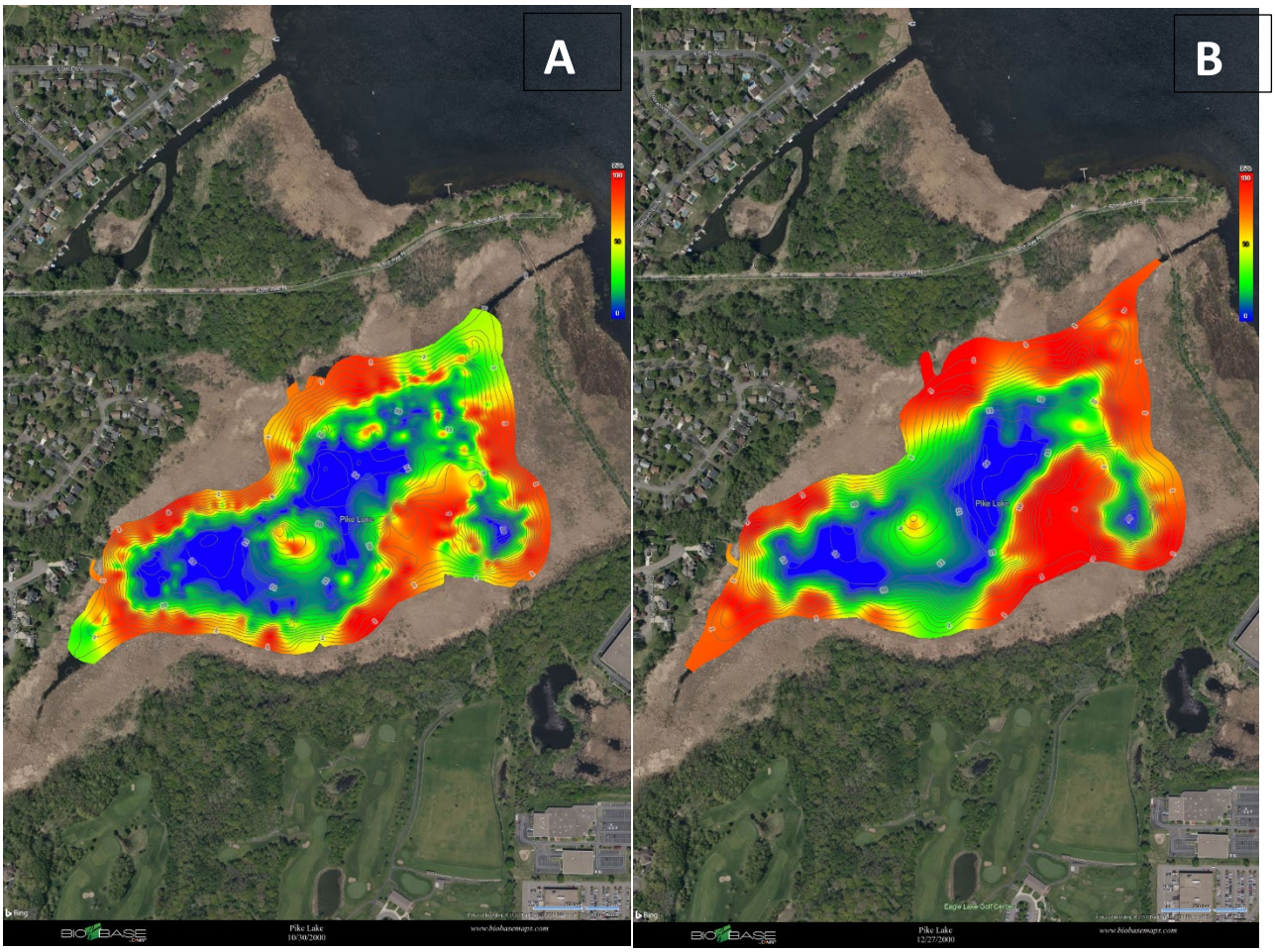


Figure 15. Biovolume heat maps for Pike Lake during the June (A) and July (B) 2020 surveys. In the heatmaps, red indicates 100% biovolume and blue indicates 0% biovolume. Biovolume refers to the percentage of the water column taken up by vegetation.

Bass Lake

Bass Lake is a shallow lake in Plymouth, MN. Water quality in the lake was sampled biweekly from May through September 2020. No SAV surveys were completed on the lake in 2020; however, a delineation of curly-leaf pondweed was performed on April 16, 2020. Delineated curly-leaf pondweed areas were treated with an herbicide in May 2020. The phytoplankton and zooplankton communities were sampled in early summer and late summer.

Bass Lake is impaired for nutrients and is undergoing active management by the Commission. Bass Lake received its first alum treatment in May 2019. The second treatment was applied in September 2020 at the end of the monitoring season. Surface TP remained below the shallow lake standard during the entire monitoring season in 2020 (Figure 16). Chlorophyll-a concentrations and Secchi depth declined in mid-summer and exceeded the eutrophication standards, indicating an algae bloom. Chlorophyll-a and Secchi depth were beginning to improve during the last lake sampling in mid-September. TP samples taken from the hypolimnion remained low throughout the monitoring season, similar to 2019 monitoring data, indicating the efficacy of the 2019 alum treatment (Appendix E).

An analysis of the phytoplankton and zooplankton within the lake indicated a healthy, balanced community. The phytoplankton community was well-balanced throughout the summer, with similar distribution of diatoms, dinoflagellates, chlorophyta, and cyanobacteria in June and August (Figure 17). Cyanobacteria became slightly more dominant in late summer, a normal shift as water temperature is warmer, but their abundance was not indicative of a cyanobacteria bloom. The zooplankton community shifted from calanoida-dominated in early Summer to nauplii-dominated in late summer (Figure 18). Nauplii are the early stage of many zooplankton species. Their abundance indicates a healthy zooplankton community with a plentiful food source.

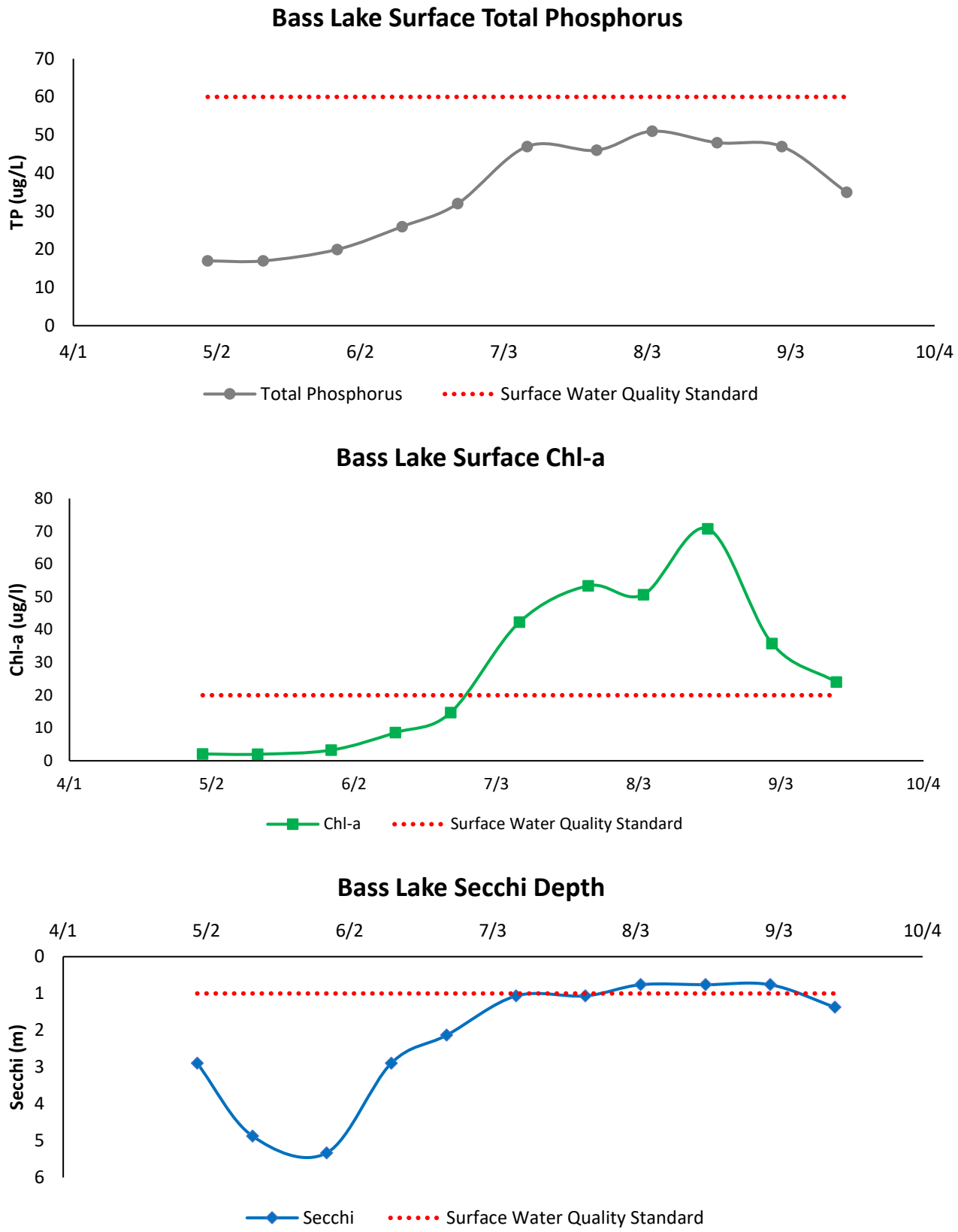
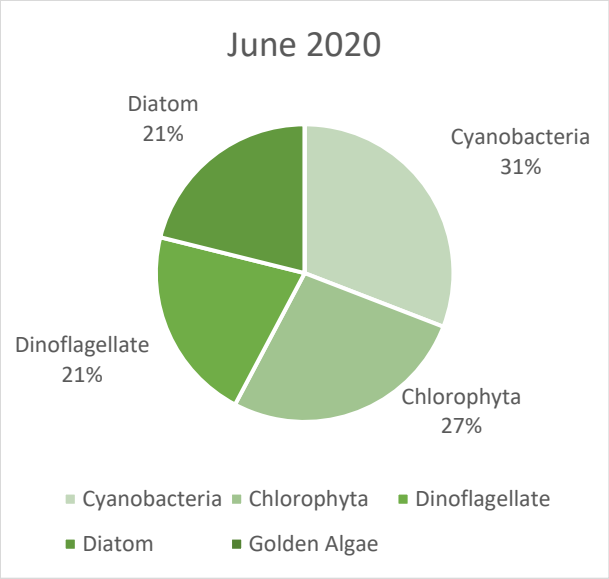


Figure 16. Water quality parameters in Bass Lake during the 2020 monitoring season.



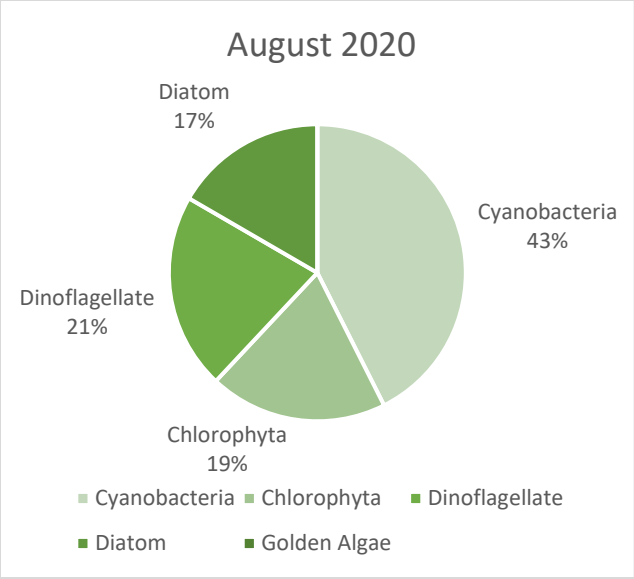
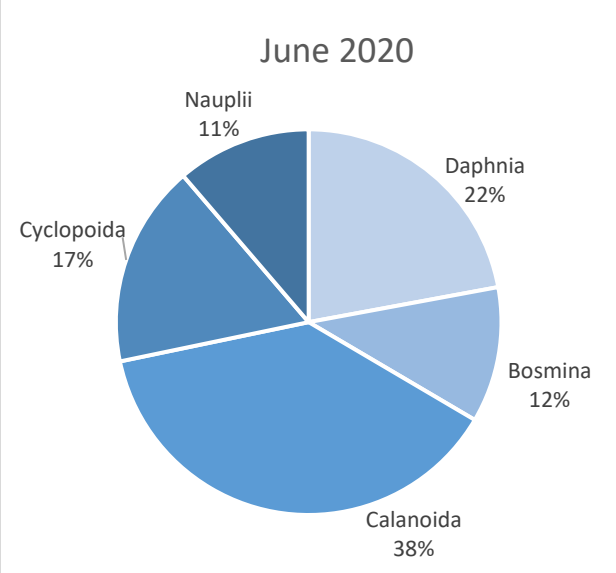


Figure 17. Phytoplankton community as relative percentage from June and August 2020 in Bass Lake.



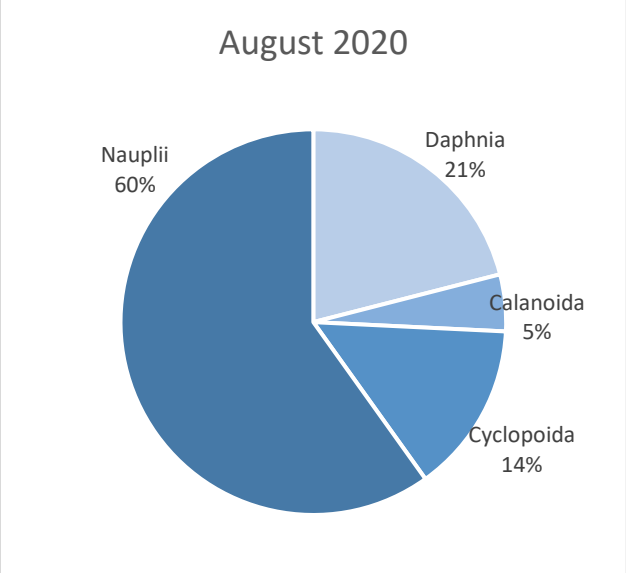


Figure 18. Zooplankton community as relative percentage from June and August 2020 in Bass Lake.

Pomerleau Lake

Pomerleau Lake is a deep lake in Plymouth, MN. Water quality in the lake was sampled biweekly from May through September 2020. No SAV surveys were completed on the lake in 2020; however, a delineation of curly-leaf pondweed was performed on April 16, 2020. Delineated curly-leaf pondweed areas were not treated because they were too small in extent. The phytoplankton and zooplankton communities were sampled in early summer and late summer.

Pomerleau Lake is impaired for nutrients and is undergoing active management by the Commission. Pomerleau Lake received its first alum treatment in May 2019. The second treatment was applied in September 2020 at the end of the monitoring season. Water quality in 2020 was excellent. Surface TP, chlorophyll-a, and Secchi depth met deep lake eutrophication standards throughout the entire monitoring season (Figure 19). TP samples taken from the hypolimnion remained low throughout the monitoring season, similar to 2019 monitoring data, indicating the efficacy of the 2019 alum treatment (Appendix E).

The phytoplankton community shifted from dinoflagellate-dominated in early summer to cyanobacteria-dominated in late summer (Figure 20). The shift from dinoflagellates to cyanobacteria is normal for Minnesota lakes during the monitoring season. The abundance of cyanobacteria at 67% in late summer indicates a potentially harmful algal bloom (HAB). Phytoplankton will be monitored again in 2021 to better understand the community changes throughout the season. The zooplankton community was dominated by daphnia in early summer, indicating abundant food sources and low predation (Figure 21). The late summer zooplankton community shifted to an even distribution between nauplii and daphnia, indicating zooplankton reproduction.

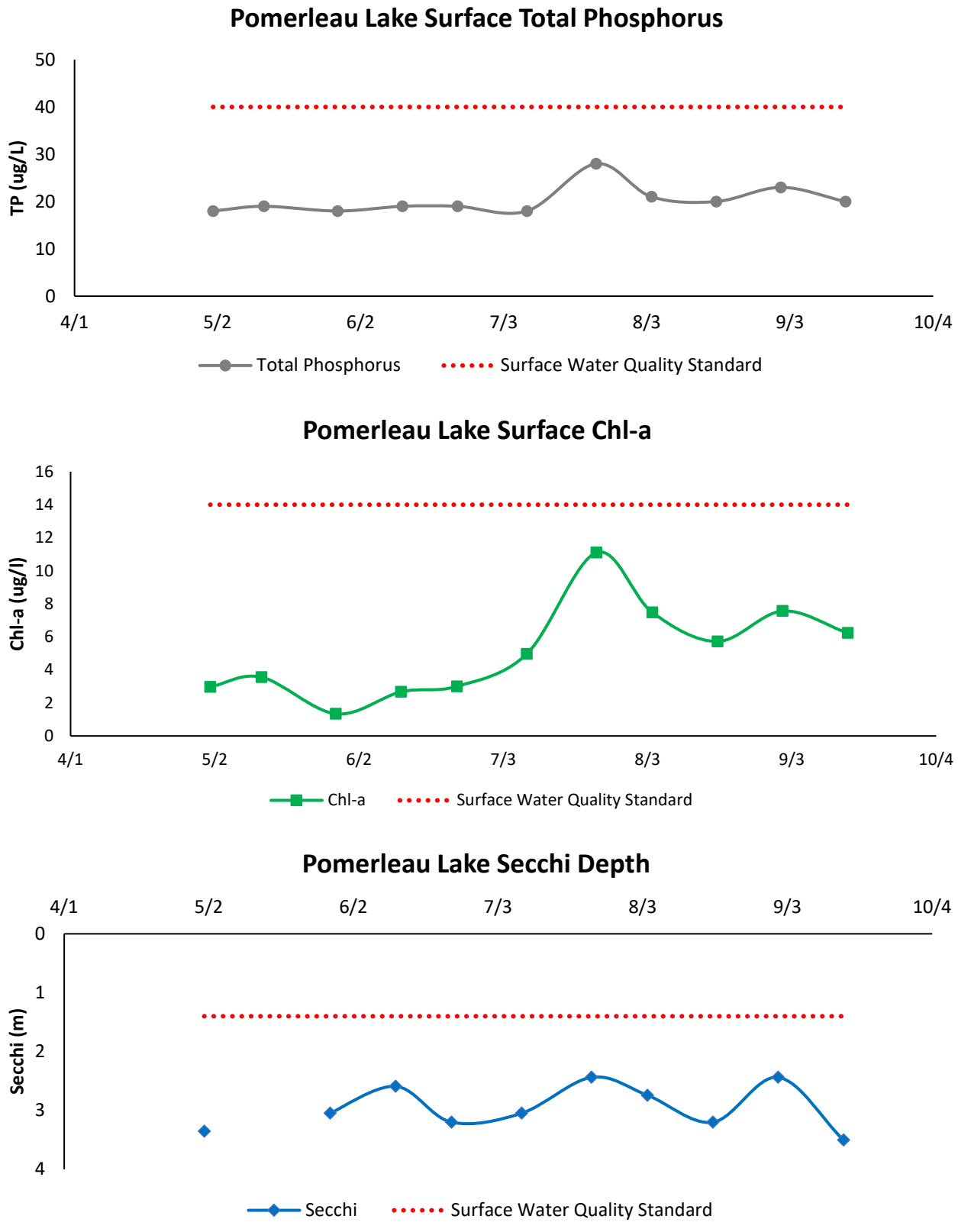


Figure 19. Water quality parameters in Pomerleau Lake during the 2020 monitoring season.

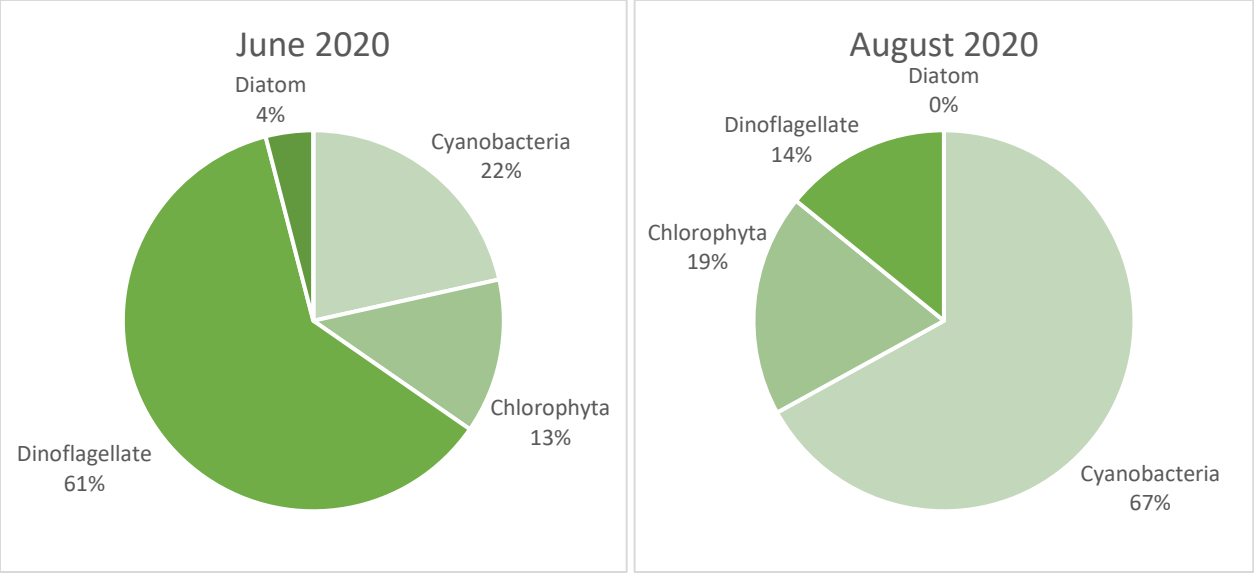


Figure 20. Phytoplankton community as relative percentage from June and August 2020 in Pomerleau Lake.

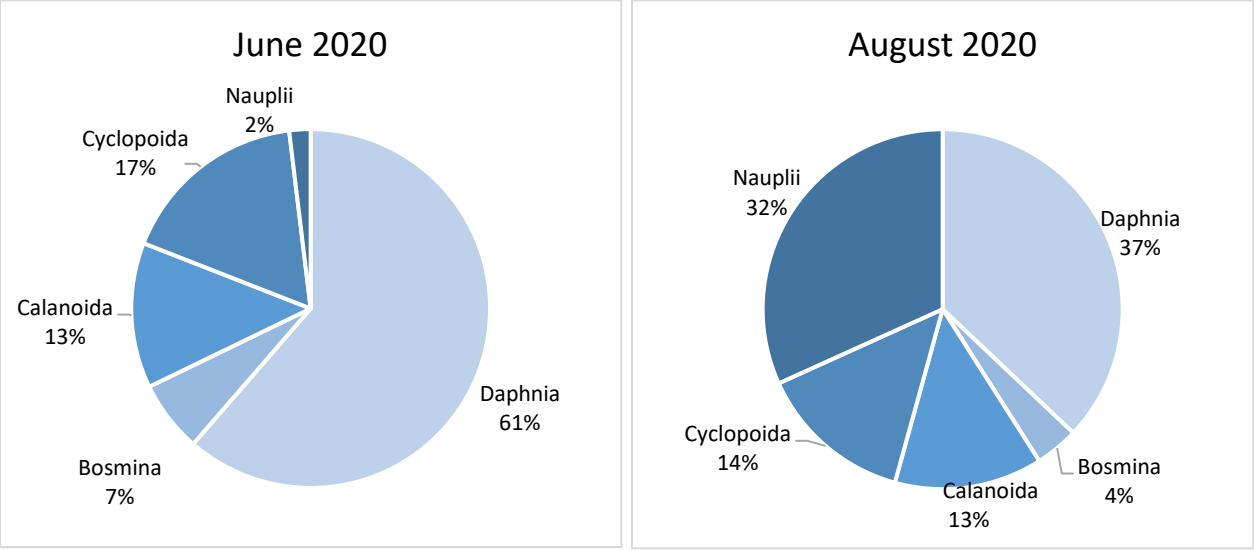


Figure 21. Zooplankton community as relative percentage from June and August 2020 in Pomerleau Lake.

Crystal Lake

Crystal Lake is a deep lake in Robbinsdale, MN. Water quality in the lake was sampled biweekly from May through September 2020. A mid-summer SAV survey was completed on the lake in 2020. The phytoplankton and zooplankton communities were sampled in early summer and late summer.

Crystal Lake is impaired for nutrients and is undergoing active management in 2021 by the Commission. The lake will receive its first alum treatment in Spring 2021 to reduce internal phosphorus loading. Monitoring in 2020 provided baseline lake condition data to help understand the impacts of active management lake health. Surface TP exceeded the deep lake standard for many of the sampling dates in 2020 and reached peak values in September (Figure 22). Chlorophyll-a concentrations and Secchi depth declined in early summer and exceeded the eutrophication standards from early June through September. TP samples taken from the hypolimnion show a high concentration, indicating internal loading from lake sediments during anoxic conditions. The Spring 2021 alum treatment will address phosphorus loading from Crystal Lake sediments.

An analysis of the phytoplankton in Crystal Lake showed an early summer community dominated by cyanobacteria and a late summer community made up completely of cyanobacteria (Figure 23). Concentrations of cyanobacteria in late summer were very high and indicate the likelihood of a HAB. The zooplankton community shifted from calanoida-dominated in early summer to daphnia-dominated in late summer (Figure 24). Daphnia can graze on poor-quality food like cyanobacteria and likely increased in abundance with the cyanobacteria bloom.

A mid-summer aquatic vegetation survey was performed on Crystal Lake in June 2020. Only two species were observed during the survey: curly-leaf pondweed and white waterlily. Both species were found in low abundance (Figure 25). FQI was 6.4. Neither species richness nor FQI met the proposed standards for a deep lake in this ecoregion (12 and 18.6, respectively). The Crystal Lake vegetation community is in poor condition. Increased water clarity from the 2021 alum treatment will increase light availability to aquatic vegetation in the lake.

The carp population was also assessed in 2020. Carp are present in Crystal Lake at an estimated abundance that is harmful to lake health and water quality. Active carp management on the lake begins in 2021.

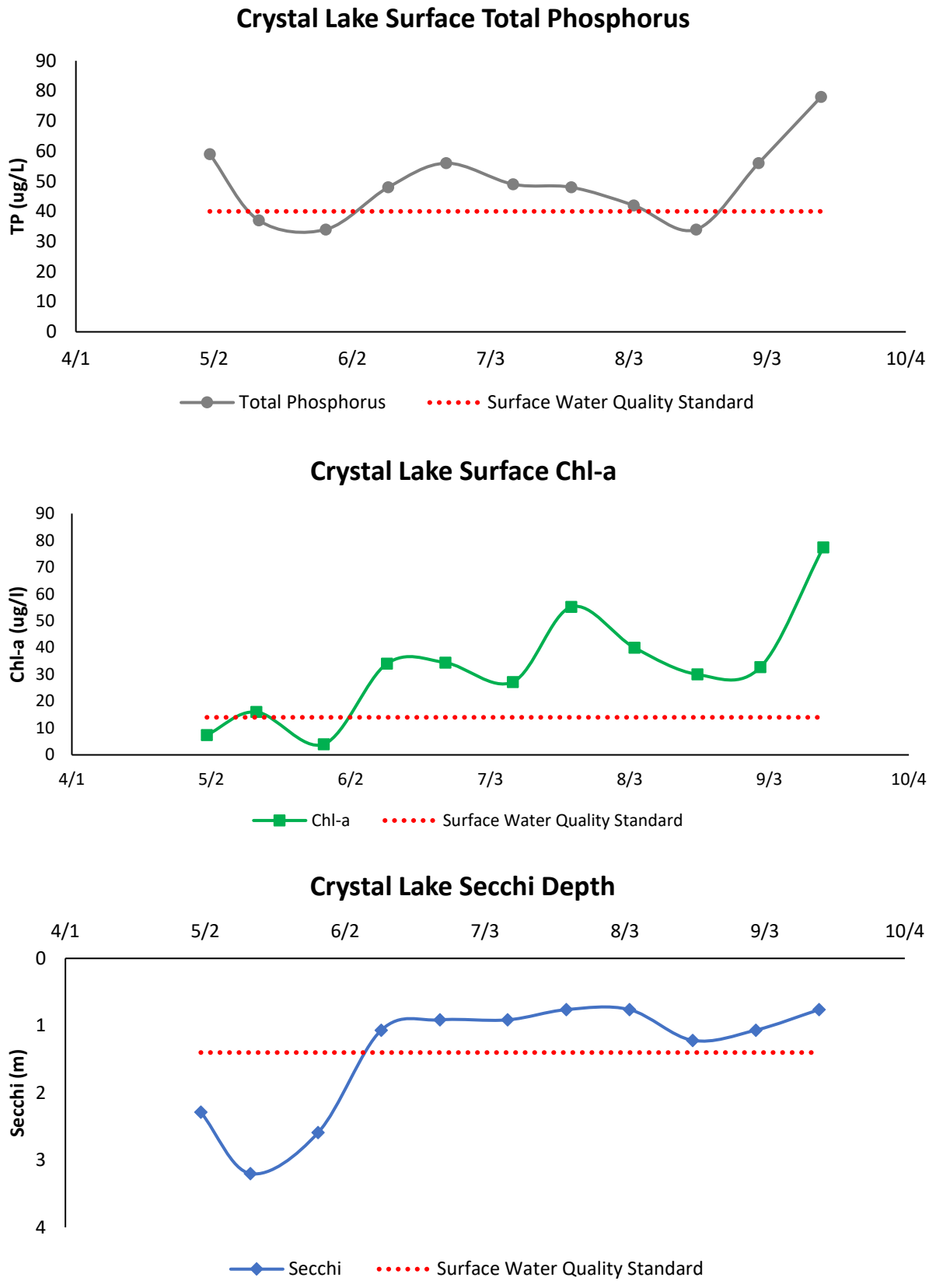


Figure 22. Water quality parameters in Crystal Lake during the 2020 monitoring season.

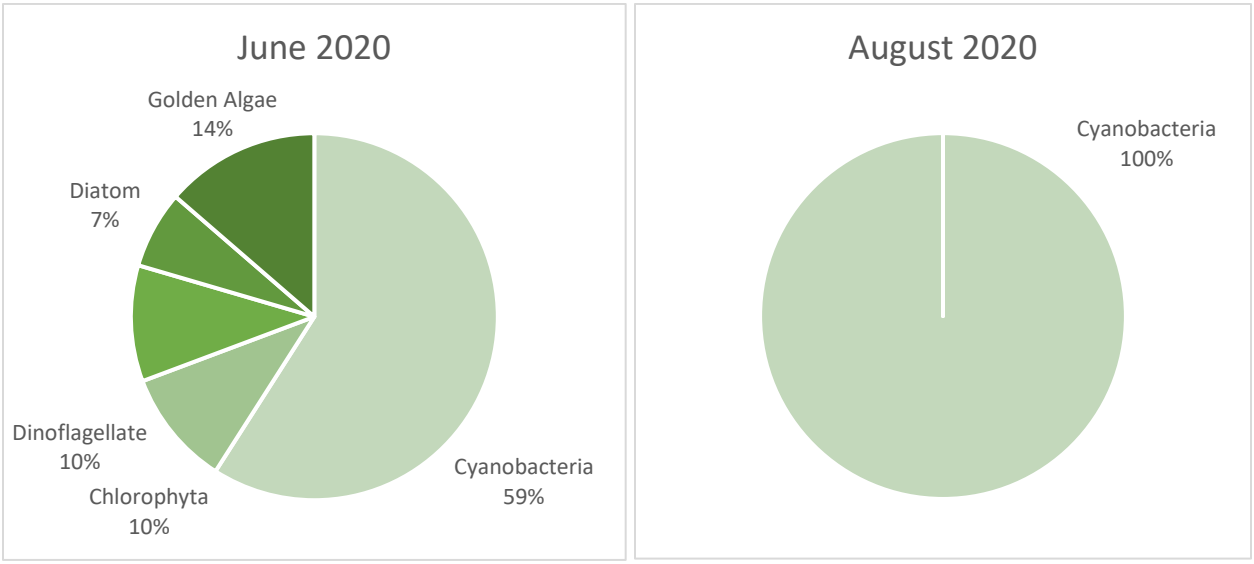


Figure 23. Phytoplankton community as relative percentage from June and August 2020 in Crystal Lake.

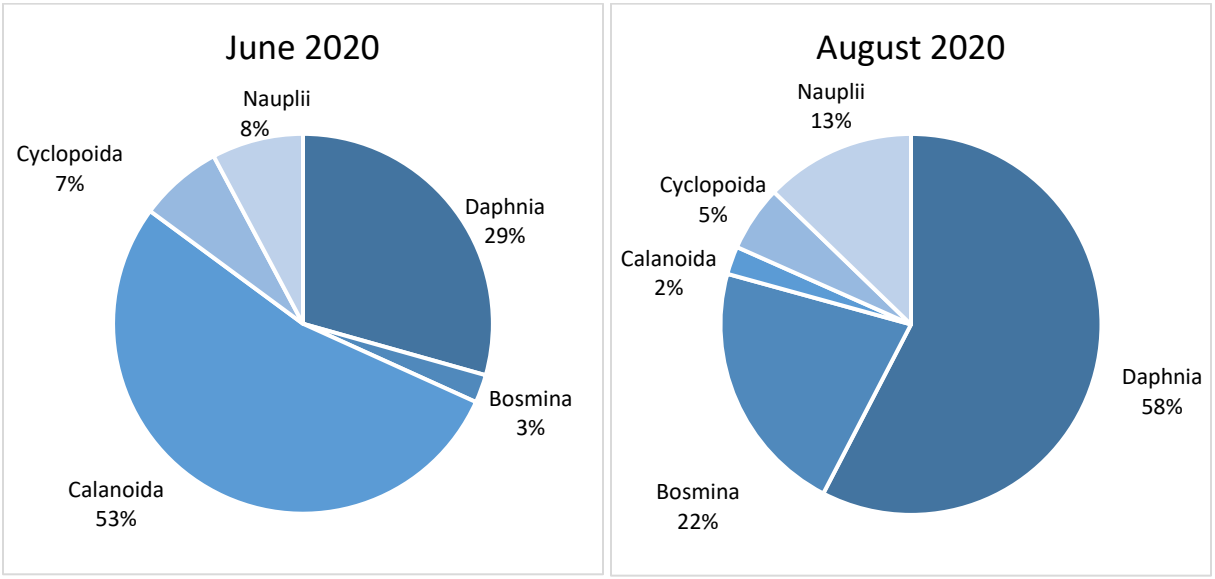


Figure 24. Zooplankton community as relative percentage from June and August 2020 in Crystal Lake.

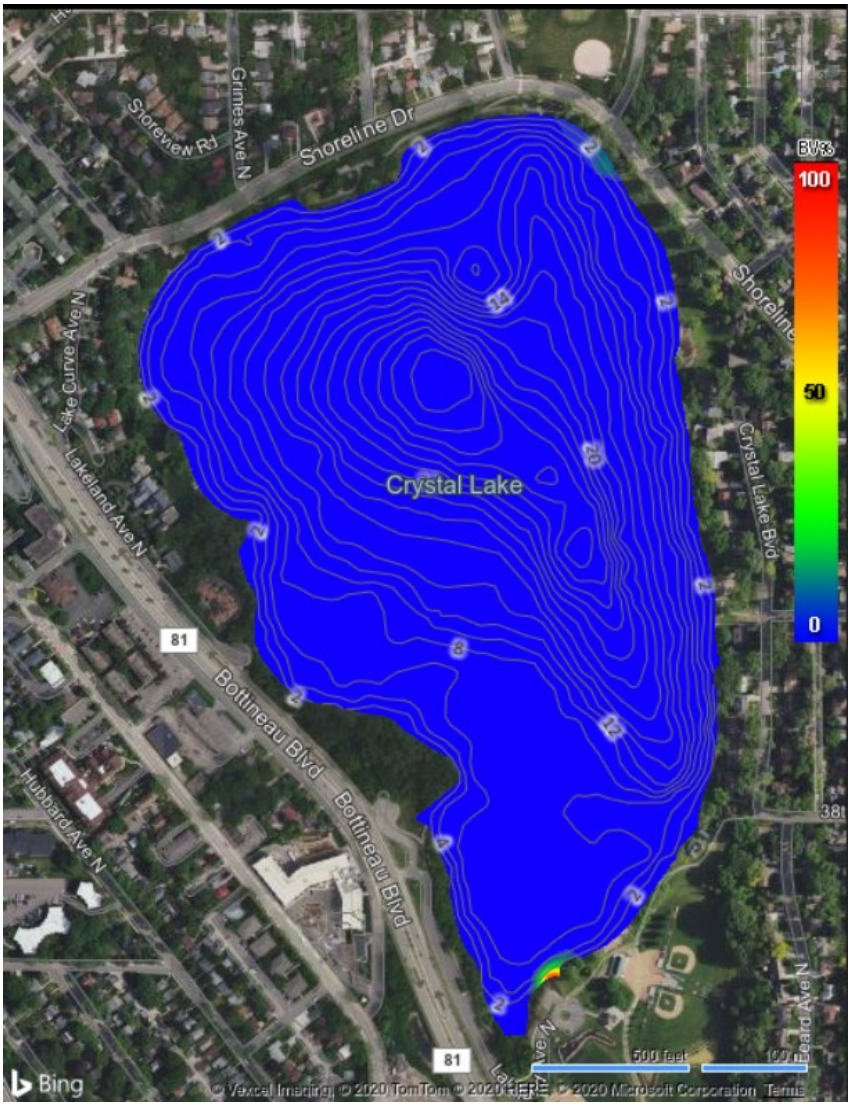


Figure 25. Biovolume heat map of Crystal Lake. In the heatmap, red indicates 100% biovolume and blue indicates 0% biovolume. Biovolume refers to the percentage of the water column taken up by vegetation.

Volunteer Stream and Wetland Monitoring

Through the RiverWatch program, high school students collect macroinvertebrates (small aquatic organisms such as insects, worms, and snails) from streams, and identify and classify them. Because these organisms are directly impacted by conditions in the stream, the type and abundance of different organisms can be an indicator of general stream health. Unfortunately, the RiverWatch program did not happen in 2020 due to the COVID-19 pandemic.

Through the WHEP program, adult volunteers monitored macroinvertebrates and vegetation in one wetland in Shingle Creek in 2020, MP-19 Webber Stormwater. The site scored Excellent for macroinvertebrates and Moderate for vegetation. See Appendix D for 2020 and historic wetland data.

Moving Forward

Routine and storm monitoring will continue on Bass and Shingle Creeks in 2021. The 65th Ave and Mattson Brook Outfalls in West Mississippi will also be monitored by the Commission.

Cedar Island Lake and Lake Success will undergo routine lake monitoring in 2021. Early and late summer SAV surveys will be done on both lakes, and a fish survey and carp population assessment are planned for Cedar Island. Phytoplankton and zooplankton community monitoring will continue. As part of the ongoing active management projects, Bass, Pomerleau, and Crystal Lakes will be monitored for water quality, SAV, and phytoplankton and zooplankton. Curly-leaf pondweed management is planned for Bass and Pomerleau. Crystal Lake will receive the first of two planned alum applications in late Spring and active carp management will commence. Volunteer monitoring through the CAMP program will continue on Schmidt, Magda, Meadow, Eagle, and Pike lakes.

Active management is expected to begin in Fall 2021 on Meadow Lake with a planned water level drawdown to consolidate the sediments and significantly reduce or eliminate invasive vegetation and fathead minnows that degrade water quality and clarity.