Nine Mile Creek Watershed District Summary of 2018 Water Quality Monitoring Program

Prepared for
Nine Mile Creek Watershed District

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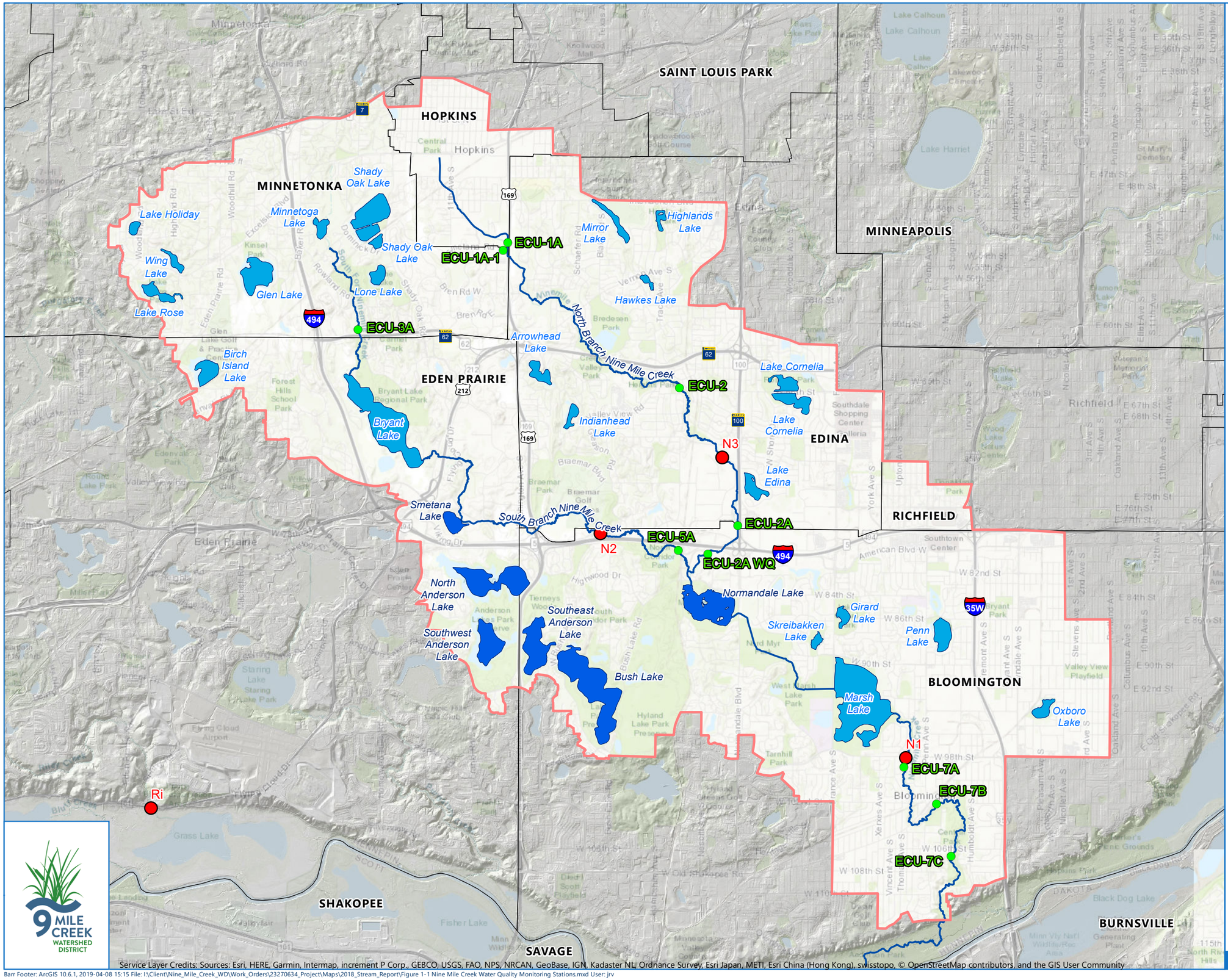
1 Introduction

A primary goal of the Nine Mile Creek Watershed District (District) is to protect and enhance the surface water quality of the lakes and streams of the District. To help accomplish this goal, the District operates an extensive lake and stream management program. Generally, the program includes:

- Data collection (monitoring)
- Assessment (e.g., studies)
- Implementation of projects and programs

Monitoring of District waterbodies is essential to developing an understanding of past and present conditions within the watershed and determining the need for action by the District or other entities. The District annually implements a lake and stream monitoring program designed to establish baseline conditions, track changes, and inform additional studies (e.g., feasibility studies, lake management plans) to identify BMPs for implementation to achieve water quality goals for both lakes and streams. The monitoring program also allows the District to measure the success of past and/or ongoing improvement projects.

The following report summarizes the lake and stream water quality data collected in 2018. The 2018 District water quality monitoring program included monitoring six lakes (Bush, Northwest Anderson, Southwest Anderson, Southeast Anderson, Smetana, and Normandale) and Nine Mile Creek (Figure 1-1).



NINE MILE CREEK WATER QUALITY MONITORING STATIONS
Nine Mile Creek Watershed District
Hennepin County, Minnesota

Figure 1-1

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

2 Lake Monitoring Conclusions and Recommendations

The Nine Mile Creek Watershed District (District) monitors the water quality of its lakes on a rotating basis. The 2018 lake water quality monitoring program included six lakes: Bush Lake, Northwest Anderson Lake, Southwest Anderson Lake, Southeast Anderson Lake, Smetana Lake, and Normandale Lake (Figure 1-1). Each lake was monitored on six occasions for selected parameters including: total phosphorus, soluble reactive phosphorus (ortho phosphorus), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, pH, chlorophyll *a*, chloride, dissolved oxygen, temperature, specific conductance, turbidity, oxidation reduction potential (ORP), phytoplankton, and zooplankton. Aquatic plant (macrophyte) surveys were performed during June and August. Results of the 2018 lake monitoring program are summarized in detail by lake in Sections 3 through Section 8. Overall conclusions and recommendations are described below. The 2019 District lake monitoring program is also described below.

2.1 Northwest Anderson Lake

Monitoring results indicate Northwest Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

Monitoring data from 2018 indicates that Northwest Anderson Lake water quality improvement projects have successfully controlled curly-leaf pondweed (CLP) and improved lake water quality. To protect the District's investment, it is recommended that the District annually complete a brief site visit or survey of the lake in spring to determine whether CLP is present. If present, spot treatment of the CLP should be considered. This approach would avoid the need for subsequent long-term annual treatments or a drawdown to reduce an established CLP population that can rebound once larger numbers of turions are present in the sediments.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

2.2 Southwest Anderson Lake

Monitoring results indicate that Southwest Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

The Southwest Anderson Lake water quality improvement projects successfully controlled CLP and improved lake water quality. To protect the District's investment, it is recommended that the District annually complete a brief site visit or survey of the lake in spring to determine whether CLP is present. If present, spot treatment of the CLP should be considered. This approach would avoid the need for

subsequent long-term annual treatments or a drawdown of the lake to reduce an established CLP population that can rebound once larger numbers of turions are present in the sediments.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

2.3 Southeast Anderson Lake

2018 results indicate that Southeast Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), and total phosphorus, but did not meet the State Standard for chlorophyll *a*. Review of monitoring data from recent years indicates internal phosphorus loading from lake sediment continues to adversely impact the lake's water quality. The Southeast Anderson Lake UAA recommended an alum treatment to reduce phosphorus loading from sediment. Completion of an alum treatment in Southeast Anderson Lake is identified as a capital improvement project in the *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018).

It is also recommended that herbicide treatment be considered to control both CLP and EWM. Additional CLP management is identified as a 2020 capital improvement project in the *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018). Control of CLP and EWM will protect the native plant community from being displaced due to expansion of these aggressive aquatic invasive species (AIS). Control of CLP will also minimize the likelihood of the invasive plant spreading to downstream Southwest and Northwest Anderson Lakes. CLP and EWM can be treated with a herbicide that combines endothall for control of CLP and 2,4-D for control of EWM. Hence, both species can be controlled simultaneously.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

2.4 Bush Lake

2018 results indicate that Bush Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

In 2018, two aquatic invasive species (AIS), CLP and EWM, were prevalent throughout the lake ranging in density from light to heavy.

As identified in the *Nine Mile Creek Watershed District Water Management Plan (*2017, amended 2018), the District plans to update the Use Attainability Analysis for Bush Lake in 2022. Additional water quality and biological monitoring data will be collected from Bush Lake in 2021 to support completion of the study.

2.5 Smetana Lake

2018 monitoring results indicate that Smetana Lake met MPCA water quality standards for Secchi disc (measure of clarity), and total phosphorus, and chlorophyll *a* concentrations in 2018.

2018 results indicate Smetana Lake did not meet the MPCA water quality standard for chlorides. Although Smetana Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. It is recommended that the District work with the City of Eden Prairie to identify and implement management measures to reduce chloride runoff from the lake's watershed.

According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired. However, the expansion of CLP in the lake during the past two years is unfavorable for the Smetana Lake native plant community and could increase the number of CLP turions conveyed downstream to Normandale Lake by the creek. As identified in their *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018), the District plans to update the Use Attainability Analysis for Smetana Lake in 2019. Recommendations for future aquatic plant management activities will be considered as part of that study.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

2.6 Normandale Lake

2018 results indicate that Normandale Lake met MPCA water quality standards for Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a*. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

In 2018, Normandale Lake did not meet the MPCA water quality standard for chlorides. Although Normandale Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. It is recommended that the District work with entities in the watershed to identify and implement measures to reduce chloride runoff from the lake's watershed.

In 2018, two aquatic invasive species (AIS), CLP and EWM, were present in the lake. CLP was observed at about half of the sample locations in June. EWM occurred at low levels in June and August, but was beginning to form EWM beds along the north shoreline in August.

In 2018, the District began implementation of a water quality improvement project for Normandale Lake. A drawdown of the lake was completed in fall of 2018 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed (CLP). An alum treatment is planned for spring of 2019. In the summer of 2019, plant and turion surveys are planned to determine whether CLP and/or turions survived the drawdown. If so, herbicide treatments would begin in 2020 to control the remaining CLP.

Continuation of water quality and biological monitoring is recommended in upcoming years to assess the impacts of the improvement project(s) on the condition of the lake's water quality and biological community.

2.7 2019 Lake Monitoring

The District's 2019 lake monitoring program will include the following lakes:

- **Normandale Lake, Bloomington-**- water quality and biological monitoring
- **Mirror Lake, Edina**—water quality and biological monitoring
- **Indianhead Lake, Edina**—water quality and biological monitoring
- **Arrowhead Lake, Edina**—water quality and biological monitoring
- **Rose Lake, Minnetonka**—biological monitoring (water quality monitoring being conducted by City of Minnetonka)
- **Wing Lake, Minnetonka**—biological monitoring (water quality monitoring being conducted by City of Minnetonka)
- **Lake Holiday, Minnetonka**-- biological monitoring (water quality monitoring being conducted by City of Minnetonka)

3 Northwest Anderson Lake

Northwest Anderson Lake is located in Eden Prairie. The lake is quite shallow, especially in comparison with its large surface area of approximately 185 acres. It has a maximum depth of approximately 10 feet and a mean depth of approximately 4 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

Water quality improvement projects were completed on Northwest Anderson Lake during 2008 through 2013 to reduce internal phosphorus loading. The project focus was reduction of curly-leaf pondweed (CLP), an aquatic invasive species, which dies off in late June, senesces, and adds phosphorus to the lake which fuels algal growth and reduces lake water quality. A partial drawdown of the lake was completed during the fall of 2008 to expose the lake bed to a winter freeze and freeze out CLP. The drawdown successfully controlled CLP throughout the lake, with exception of the lake's eastern bay which was not drained. Herbicide treatments during 2010 through 2013 controlled CLP in the lake's eastern bay.

In 2018, the Nine Mile Creek Watershed District monitored Northwest Anderson Lake for:

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

Monitoring results are discussed in the following paragraphs.

3.1 Chlorides

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of road salt to permanently pollute 5 gallons of water. And, once in the water, it is very difficult and expensive to remove.

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. All 2018 chloride measurements met the MPCA standard. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations observed in Northwest Anderson Lake:** From a high of 86 mg/L, measured in August, to a low of 73 mg/L, measured in May.
- **Average 2018 concentration:** 81 mg/L.

All 2018 chloride measurements met the MPCA standard.

3.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2018, the lake's water quality was excellent. The lake's average summer total phosphorus and chlorophyll *a* concentrations were 26 and 10 µg/L, respectively. The lake's average summer Secchi disc transparency was 1.8 meters. All three parameters met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

The District water quality improvement projects have substantially improved the lake's water quality. For the monitored period prior to the start of the lake's water quality improvement projects (1988-2007), the average summer total phosphorus and chlorophyll *a* concentrations were 101 and 53 µg/L and the average summer Secchi disc transparency was 0.8 meters. For the period after the completion of the water quality improvement project (2014-2018), the average summer total phosphorus and chlorophyll *a* concentrations were 27 and 7 µg/L and the average Secchi disc transparency was 1.8 meters (Figure 3-1). All water quality measurements after the completion of the water quality improvement project have met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4).

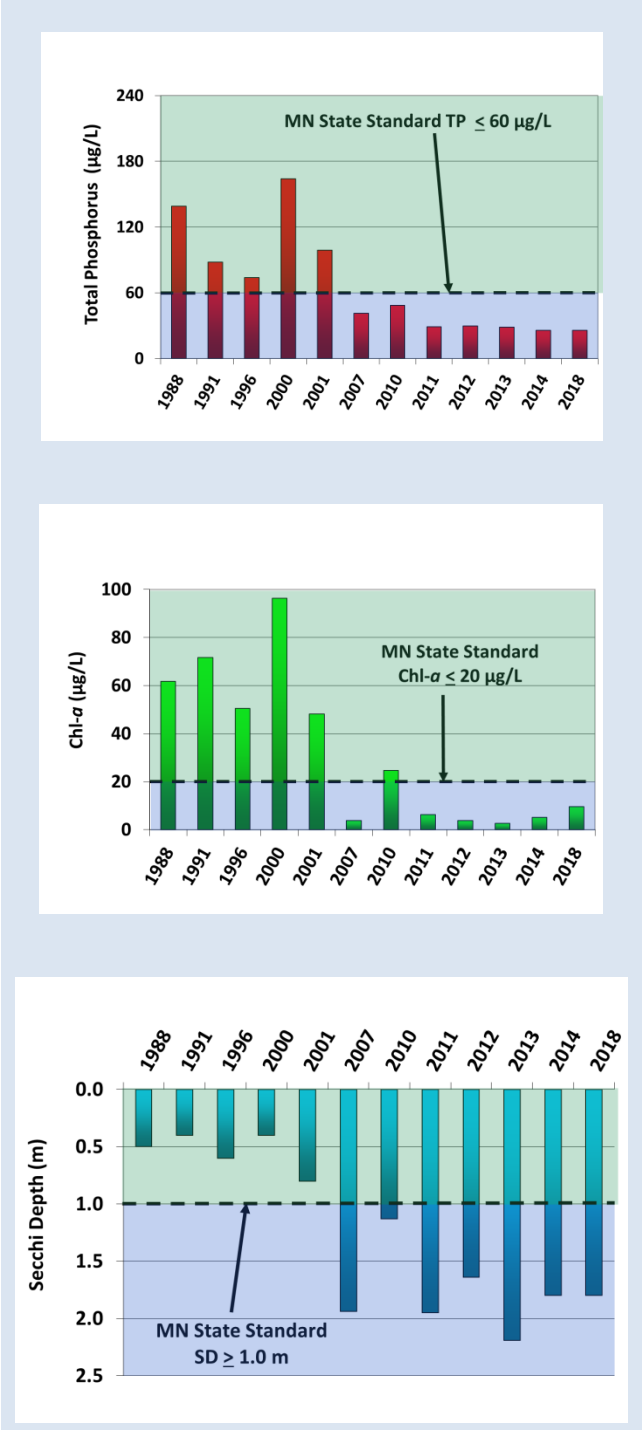


Figure 3-1 **Northwest Anderson Lake summer average total phosphorus (top) , chlorophyll *a* (middle), and Secchi disc (bottom) values during 1988-2018**

The improved water quality is due to: (1) reduced phosphorus loading because of reduced presence of curly-leaf pondweed; and (2) increased phosphorus absorption by *Chara,* which increased in abundance after the drawdown.

3.3 Phytoplankton and Zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Northwest Anderson Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). Phytoplankton numbers during the monitored period 1988 through 2018 followed a pattern similar to chlorophyll, both reflecting the substantial improvement in water quality resulting from the Northwest Anderson Lake water quality improvement project. For the period prior to the start of the lake's water quality improvement projects (1988-2007), the average summer phytoplankton number was 76,363 per milliliter (Figure 3-2) and the average summer chlorophyll concentration was 53 µg/L (Figure 3-1). For the period after the completion of the water quality improvement project (2014-2018), the average summer phytoplankton number was 9,011 per milliliter (Figure 3-2) and the average summer chlorophyll concentration was 7 µg/L (Figure 3-1). Blue-green algae numbers were much lower after the completion of the water quality improvement projects – pre-project average blue-green numbers were 68,937 units per milliliter compared with post-project average blue-green numbers of 1,660 units per milliliter (Figure 3-2).

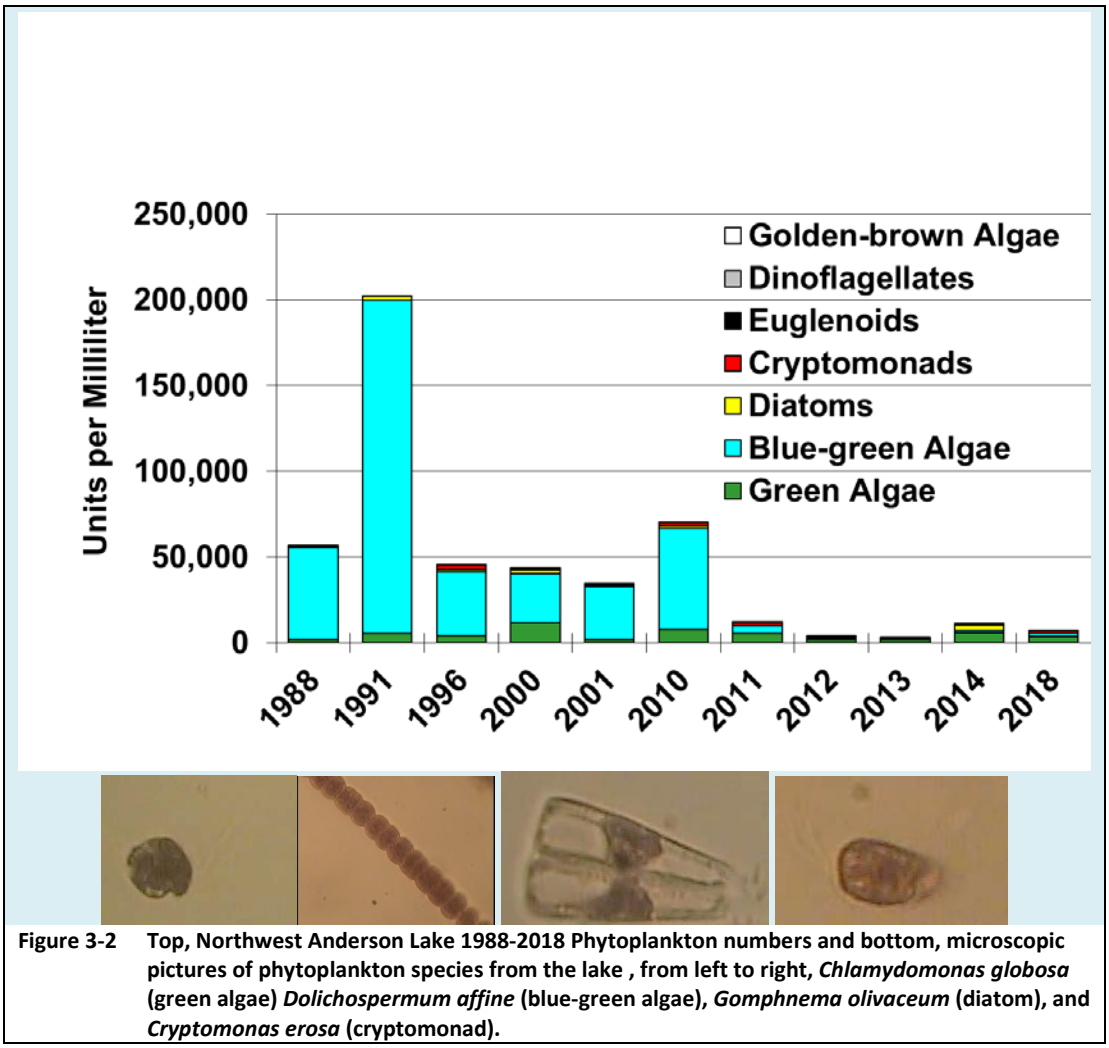


Figure 3-2 **Top, Northwest Anderson Lake 1988-2018 Phytoplankton numbers and bottom, microscopic pictures of phytoplankton species from the lake , from left to right, *Chlamydomonas globosa* (green algae) *Dolichospermum affine* (blue-green algae), *Gomphnema olivaceum* (diatom), and *Cryptomonas erosa* (cryptomonad).**

The composition of the 2018 zooplankton community was consistent with recent years, with all three groups of zooplankton (rotifers, copepods, and cladocerans) represented (Figure 3-3). Higher numbers of rotifers were observed in 2018 than previous years, primarily due to higher numbers of *Poyarthra vulgaris* (Figure 3-3). Although the reason for the increase in numbers is unknown, because *Polyarthra vulgaris* is a favorite food for yellow perch and bluegills, both present in the lake, the increased numbers in 2018 are considered a favorable change. During the period of record, small rotifers and copepods have generally dominated the community. The low numbers of cladocerans are an indication of fish predation which is typical of shallow lakes. Because small rotifers and copepods do not graze as heavily on algae as the larger cladocerans, they generally have limited impact on the lake's water quality. This suggests that future Northwest Anderson Lake water quality management efforts should focus on management of phosphorus, a nutrient that contributes to algae growth.

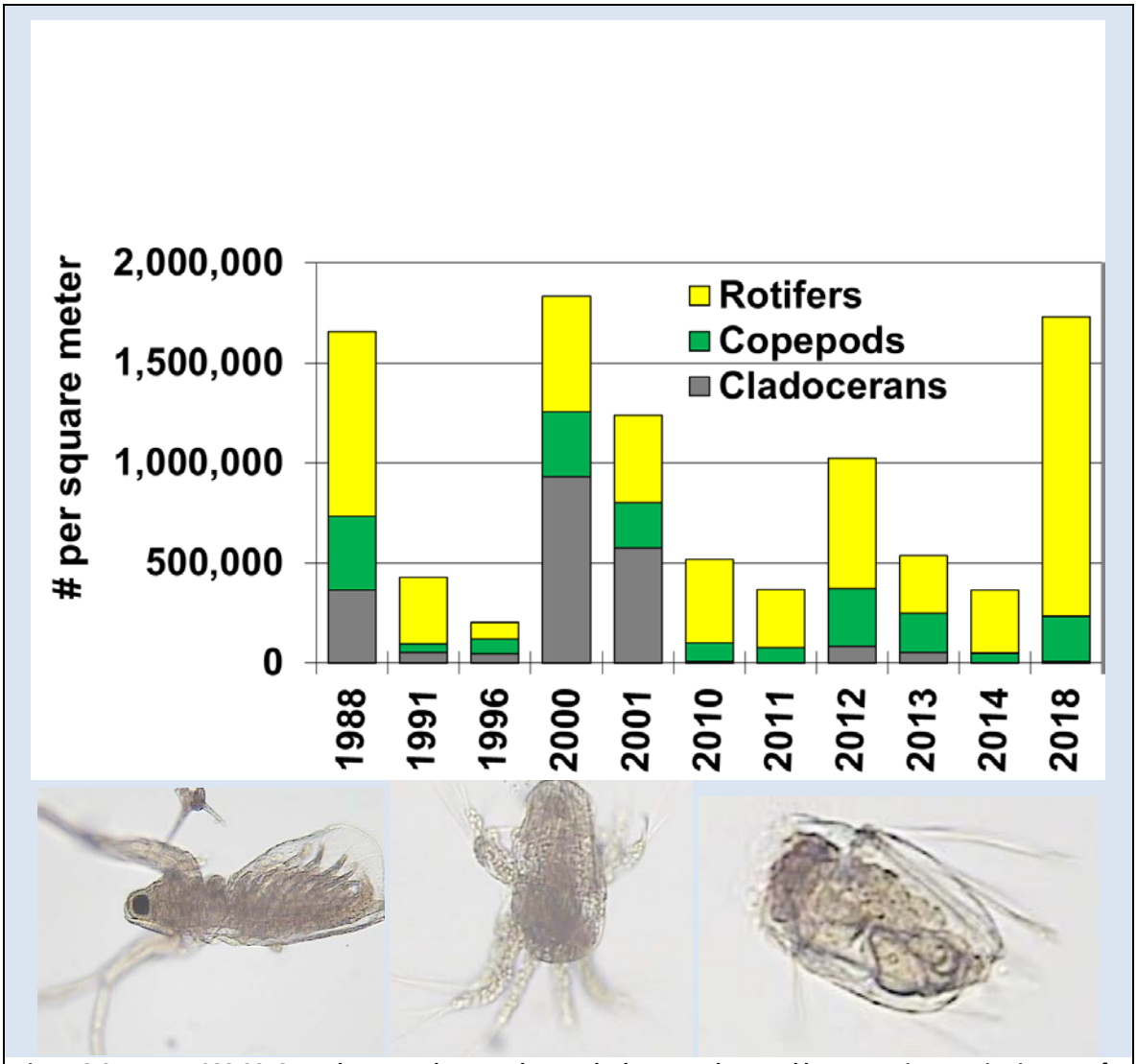


Figure 3-3 **Top, 1988-2018 Northwest Anderson Lake zooplankton numbers and bottom, microscopic pictures of zooplankton species from the lake, from left to right, *Diaphanosoma leuchtenbergianum* (cladoceran), nauplii (baby copepod), and *Polyarthra vulgaris* (rotifer).**

3.4 Aquatic Plants

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

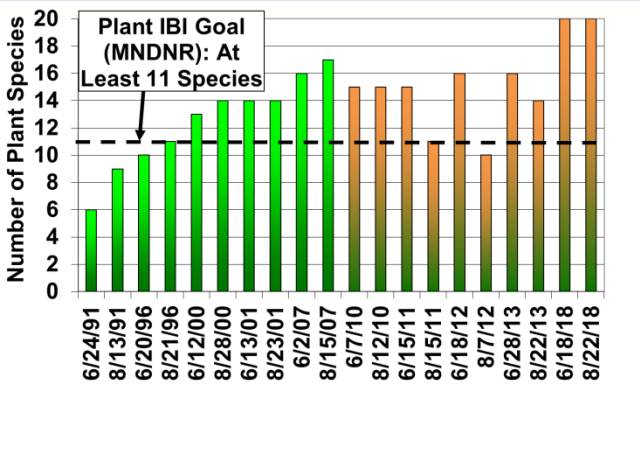


Figure 3-4A

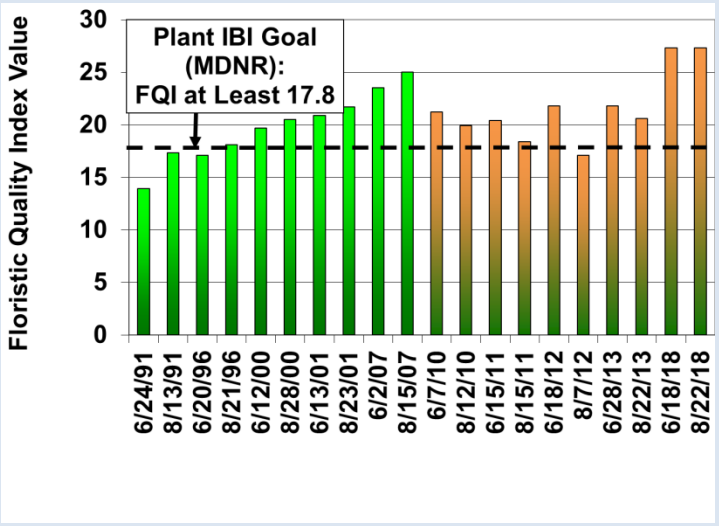


Figure 3-4B

Figure 3-4 1991-2018 Northwest Anderson Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

The District conducted qualitative aquatic plant surveys of Northwest Anderson Lake in June and August of 2018. Maps showing survey results are included in Appendix B. Plant survey data from 1991 through 2018 were assessed to determine plant IBI trends. Figure 3-4 shows the Northwest Anderson Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold. The green bars depict data collected before completion of the water quality improvement projects while the orange bars depict data collected during and after completion of the water quality improvement projects.

- **Number of species:** A shallow lake (maximum depth less than 15 feet) is considered impaired when it has fewer than 11 species. During the period examined, the number of species in Northwest Anderson Lake ranged from 6 to 20, bettering the impairment threshold during all years except 1991 (June and August), 1996 (June), and 2012 (August). (Figure 3-4A).

- **FQI values (quality of species):** The impairment threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values in Northwestern Anderson Lake

ranged from 13.9 to 27.3, bettering the threshold during all years except 1991 (June and August), 1996 (June), and 2012 (August) (Figure 3-4B).

- **2018 results:** Both the number of species in the lake and FQI values were higher than the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants. In 2018, the Northwest Anderson Lake plant community had higher numbers of species and higher FQI scores than were observed in previous years.

The only CLP observed in Northwest Anderson Lake in 2018 was one CLP fragment on the west side of the lake in June. No rooted CLP plants were observed in the lake. These data verify the success of the District's CLP control projects.

3.5 Conclusions and Recommendations

Monitoring results indicate Northwest Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

Monitoring data from 2018 indicates that Northwest Anderson Lake water quality improvement projects have successfully controlled curly-leaf pondweed (CLP) and improved lake water quality. To protect the District's investment, it is recommended that the District annually complete a brief site visit or survey of the lake in spring to determine whether CLP is present. If present, spot treatment of the CLP should be considered. This approach would avoid the need for subsequent long-term annual treatments or a drawdown to reduce an established CLP population that can rebound once larger numbers of turions are present in the sediments.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

4 Southwest Anderson Lake

Southwest Anderson Lake is located in Eden Prairie. The lake is quite shallow, especially in comparison with its large surface area of approximately 110 acres (the open water area is variable, depending upon the seasonally-varying coverage of the lake's cattail fringe). It has a maximum depth of approximately 8 feet and a mean depth of approximately 4 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

Water quality improvement projects were completed on Southwest Anderson Lake during 2008 through 2012 to reduce internal phosphorus loading. A partial drawdown of the lake was completed during the fall of 2008 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed (CLP), an invasive plant species, which dies off in late June, senesces, and adds phosphorus to the lake. This summer addition of phosphorus fuels algal growth and reduces lake water quality. The drawdown successfully controlled CLP except for the lake's center that was not drained. Herbicide treatments during 2010 through 2011 controlled CLP in the lake's center. An alum treatment was completed in fall of 2012 to reduce the release of phosphorus from lake bottom sediments into the water column.

In 2018, the Nine Mile Creek Watershed District monitored Southwest Anderson Lake for:

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

Monitoring results are discussed in the following paragraphs.

4.1 Chlorides

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of road salt to permanently pollute 5 gallons of water. And, once in the water, it is very difficult and expensive to remove.

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. All 2018 measurements met the MPCA standard. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations in Southwest Anderson Lake:** From a high of 40 mg/L, measured in August, to a low of 37 mg/L, measured in May.
- **Average 2018 concentration:** 39 mg/L.

4.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2018, the lake's water quality was excellent. The lake's average summer total phosphorus and chlorophyll *a* concentrations were 24 and 6 µg/L, respectively. The lake's average summer Secchi disc transparency was 1.4 meters. All three parameters met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

The District water quality improvement projects have substantially improved the lake's water quality. For the period prior to the start of the lake's water quality improvement projects (1988-2007), the average summer total phosphorus and chlorophyll *a* concentrations were 100 and 24 µg/L and the average summer Secchi disc transparency was 1.0 meters. However, during completion of the District's lake improvement projects, the lake's water quality deteriorated. For the period after the completion of the water quality improvement projects (2013-2018), the average summer total phosphorus and chlorophyll *a* concentrations were 21 and 6 µg/L and the average Secchi disc transparency was 1.2 meters (Figure 4-1). All water quality measurements after the completion of the water quality improvement projects have met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4).

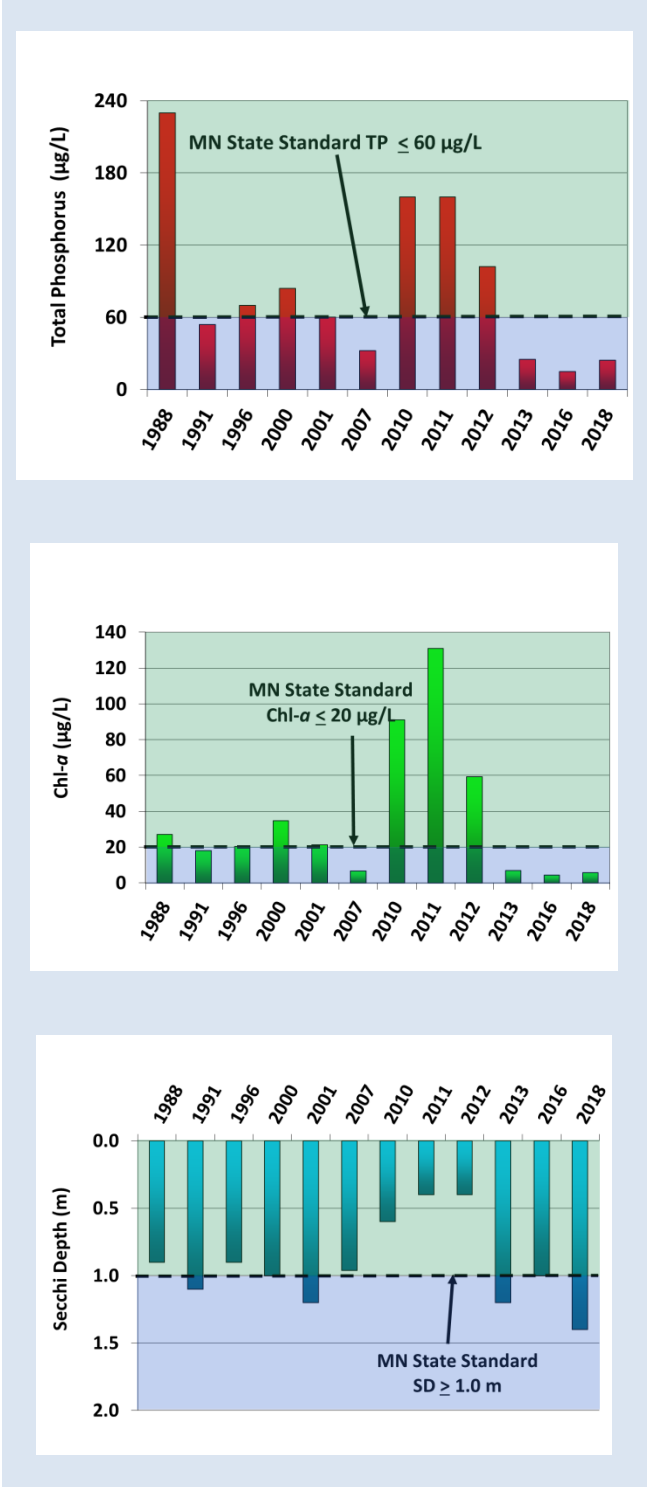


Figure 4-1 **Southwest Anderson Lake summer average total phosphorus (top) , chlorophyll *a* (middle), and Secchi disc (bottom) values during 1988-2018.**

The improved water quality is due to: (1) reduced phosphorus loading because of reduced presence of curly-leaf pondweed; and (2) reduced phosphorus loading from sediment because the aluminum applied during the alum treatment bound phosphorus, locking it in the sediment.

4.3 Phytoplankton and Zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Southwest Anderson Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals).

The District water quality improvement projects have reduced phytoplankton numbers in the lake. For the period prior to the start of the lake water quality improvement projects (1988-2007), the average summer phytoplankton number was 10,548 per milliliter (Figure 4-2) and the average summer chlorophyll *a* concentration was 24 µg/L (Figure 4-1). During completion of the District's lake improvement projects, the lake's phytoplankton numbers increased. However, for the period after the completion of the water quality improvement projects (2013-2018), the average summer phytoplankton number was 9,005 per milliliter (Figure 4-2) and the average summer chlorophyll *a* concentration was 6 µg/L(Figure 4-1), both lower than pre-project numbers. Blue-green algae numbers were much lower after the completion of the water quality improvement projects – pre-project average blue-green numbers were 4,141 units per milliliter compared with post-project average blue-green numbers of 923 units per milliliter (Figure 4-2).

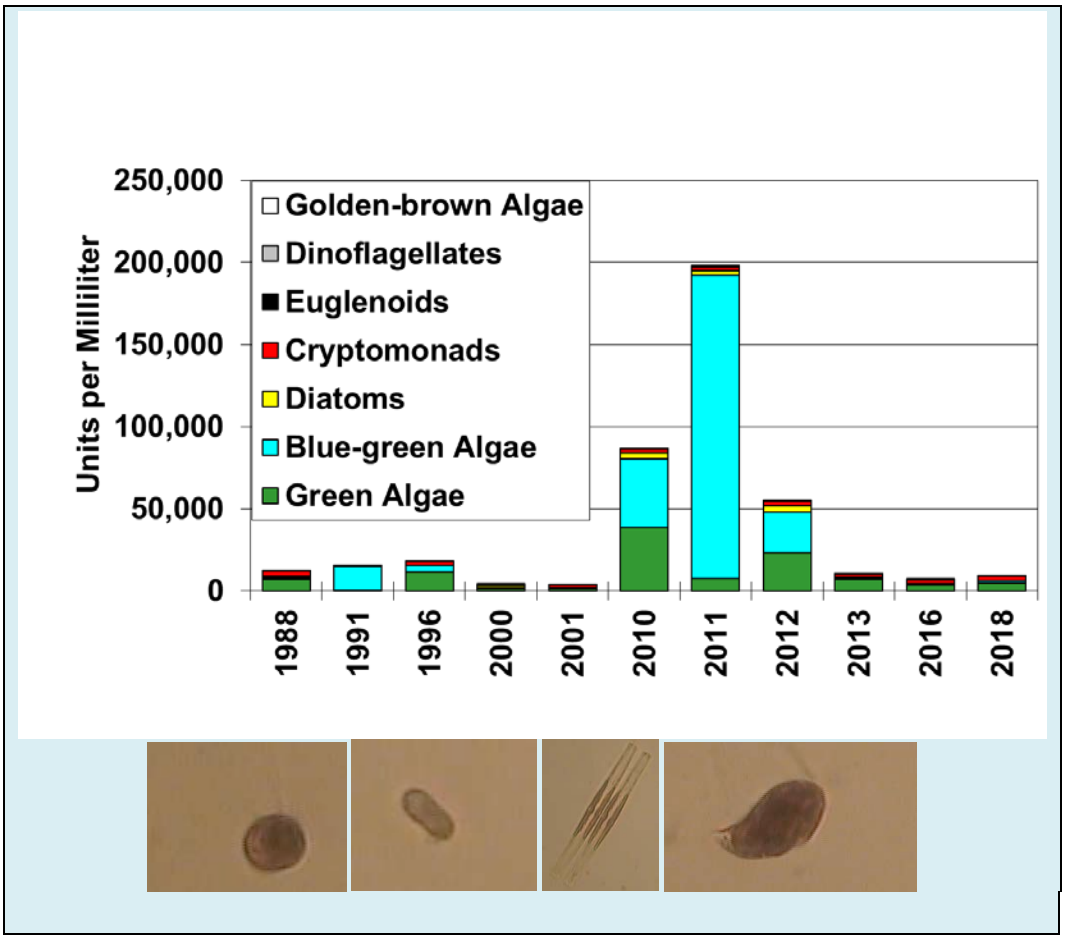


Figure 4-2 **Top, Southwest Anderson Lake 1988-2018 summer average phytoplankton numbers and bottom, microscopic pictures of phytoplankton species from the lake , from left to right, *Chlamydomonas globosa* (green algae) *Pseudanabaena mucicola* (blue-green algae), *Fragilaria crotonensis* (diatom), and *Cryptomonas erosa* (cryptomonad).**

The composition of the 2018 zooplankton community was consistent with recent years, with all three groups of zooplankton (rotifers, copepods, and cladocerans) represented (Figure 4-3). During the period of record, small rotifers and copepods have generally dominated the community. The low numbers of cladocerans are an indication of fish predation which is typical of shallow lakes. Because small rotifers and copepods do not graze as heavily on algae as the larger cladocerans, they generally have limited impact on the lake's water quality. This suggests that future Southwest Anderson Lake water quality management efforts should focus on management of phosphorus, a nutrient that contributes to algae growth.

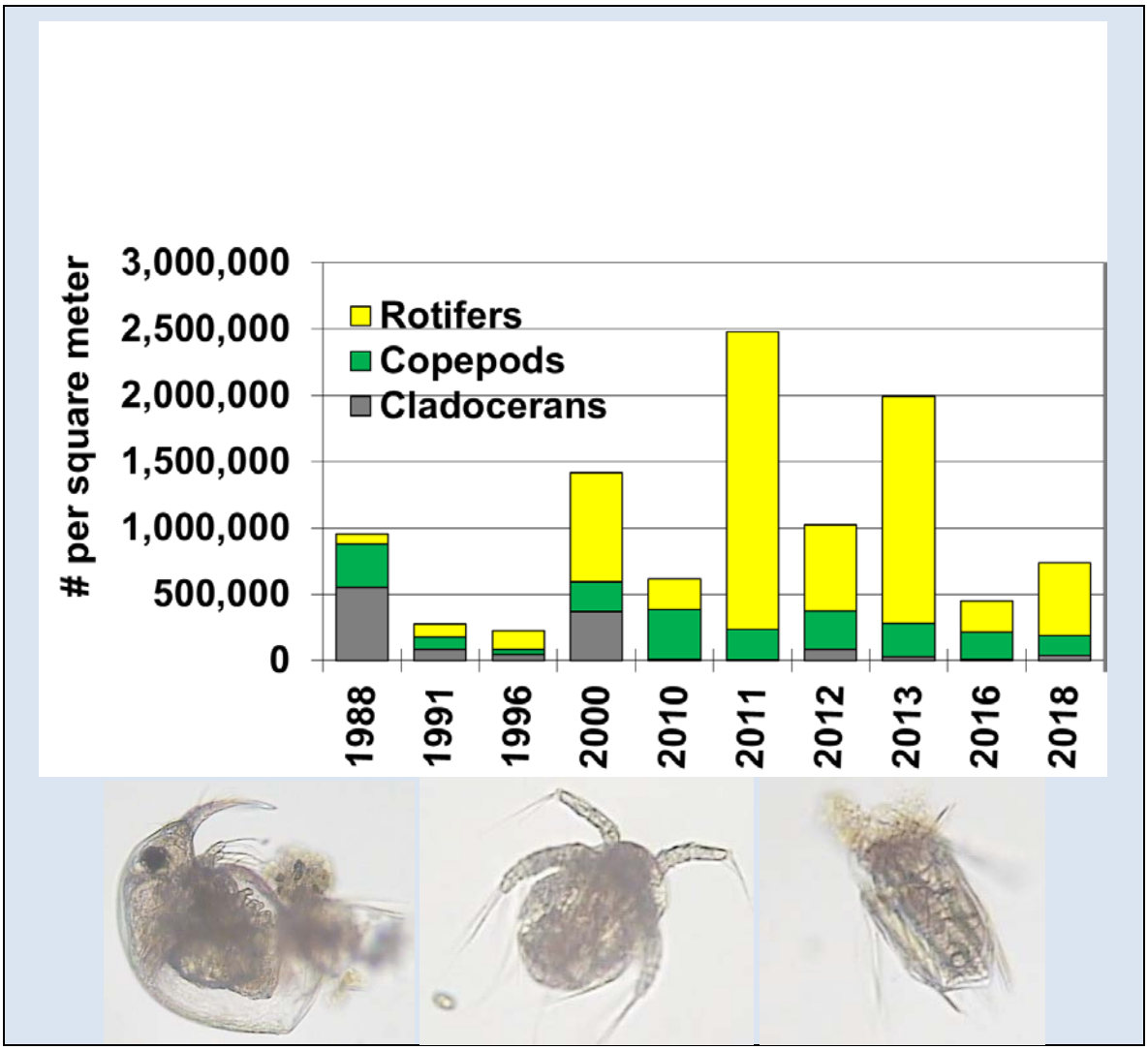


Figure 4-3 **Top, 1988-2018 Southwest Anderson Lake zooplankton numbers and bottom, microscopic pictures of zooplankton species from the lake, from left to right, *Bosmina longirostris* (cladoceran), nauplii (baby copepod), and *Polyarthra vulgaris* (rotifer)..**

4.4 Aquatic Plants

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

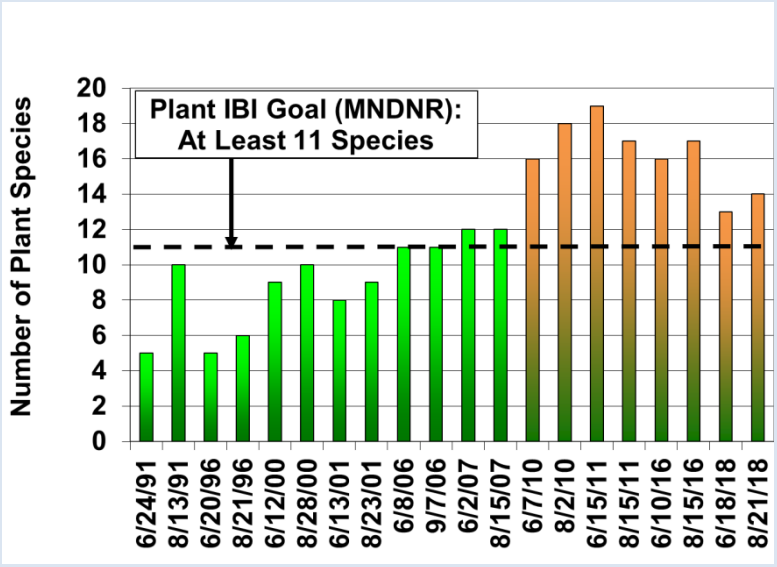


Figure 4-4A

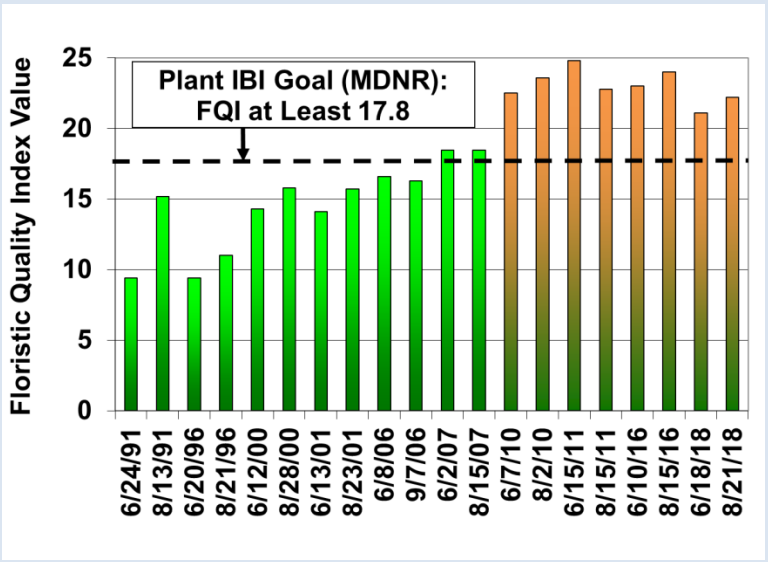


Figure 4-4B

Figure 4-4 1991-2018 Southwest Anderson Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

The District conducted qualitative aquatic plant surveys of Southwest Anderson Lake in June and August of 2018. Maps showing survey results are included in Appendix B. Plant survey data from 1991 through 2018 were assessed to determine plant IBI trends. Figure 4-4 shows the Southwest Anderson Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold. The green bars depict data collected before completion of the water quality improvement projects while the orange bars depict data collected during and after completion of the water quality improvement projects.

- **Number of species:** A shallow lake (maximum depth less than 15 feet) is considered impaired when it has fewer than 11 species. During the period examined, the number of species in Southwest Anderson Lake ranged from 5 to 19 and has been better than the impairment threshold since 2006 Higher

numbers of species were observed from 2010 through 2018 than 1991 through 2007 (Figure 4-4A). The increase in species numbers is a positive result of the lake's water quality improvement projects.

- **FQI values (quality of species):** The impairment threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values ranged from 9.4 to 27.8 bettering the threshold since 2007 (Figure 4-4B). Higher FQI values were observed from 2010 through 2018 than 1991 through 2007 (Figure 4-4A). The increase in FQI values is a positive result of the lake's water quality improvement projects.
- **2018 results:** Both the number of species in the lake and FQI values were better than the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants.

CLP was not observed in Southwest Anderson Lake during 2018. Its absence verifies the success of the District's CLP control projects.

4.5 Conclusions and Recommendations

Monitoring results indicate that Southwest Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

The Southwest Anderson Lake water quality improvement projects successfully controlled CLP and improved lake water quality. To protect the District's investment, it is recommended that the District annually complete a brief site visit or survey of the lake in spring to determine whether CLP is present. If present, spot treatment of the CLP should be considered. This approach would avoid the need for subsequent long-term annual treatments or a drawdown of the lake to reduce an established CLP population that can rebound once larger numbers of turions are present in the sediments.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

5 Southeast Anderson Lake

Southeast Anderson Lake is located in Bloomington. The lake is quite shallow, especially in comparison with its large surface area of approximately 81 acres. It has a maximum depth of approximately 9 feet and a mean depth of approximately 5 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

Southeast Anderson Lake was annually treated with herbicide during 2009 through 2014 to control curly-leaf pondweed (CLP) and reduce internal phosphorus loading. Curly-leaf pondweed (CLP), an aquatic invasive species, dies off in late June, senesces, and adds phosphorus to the lake which fuels algal growth and reduces lake water quality.

In 2018, the Nine Mile Creek Watershed District monitored Southeast Anderson Lake for:

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

Monitoring results are discussed in the following paragraphs.

5.1 Chlorides

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of road salt to permanently pollute 5 gallons of water. And, once in the water, it is very difficult and expensive to remove.

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. All 2018 measurements met the MPCA standard. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations in Southeast Anderson Lake:** From a low of 74 mg/L, measured in May, to a high of 87 mg/L, measured in August.
- **Average 2018 concentration:** 82 mg/L.

All 2018 measurements met the MPCA standard.

5.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

2018 data indicate excess algae were in the lake. The lake's summer average chlorophyll *a* concentration failed to meet Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Chlorophyll *a* concentrations were relatively low during spring and early summer, but increased rapidly in late summer due to a blue-green algae bloom. The high late summer chlorophyll *a* concentrations heavily influenced the summer average, resulting in a summer average that failed to meet the State Standard. During the past 20 years, excess algae in the lake have caused 75 percent of average summer chlorophyll *a* concentrations to fail to meet the State Standard (Figure 5-1). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

In 2018, the lake's summer average total phosphorus concentration and summer average Secchi disc transparency both met the State Standard. During the past 20 years, average summer total phosphorus concentrations and Secchi disc transparency measurements have failed to meet the State Standard 33 percent and 42 percent of the time, respectively(Figure 5-1).

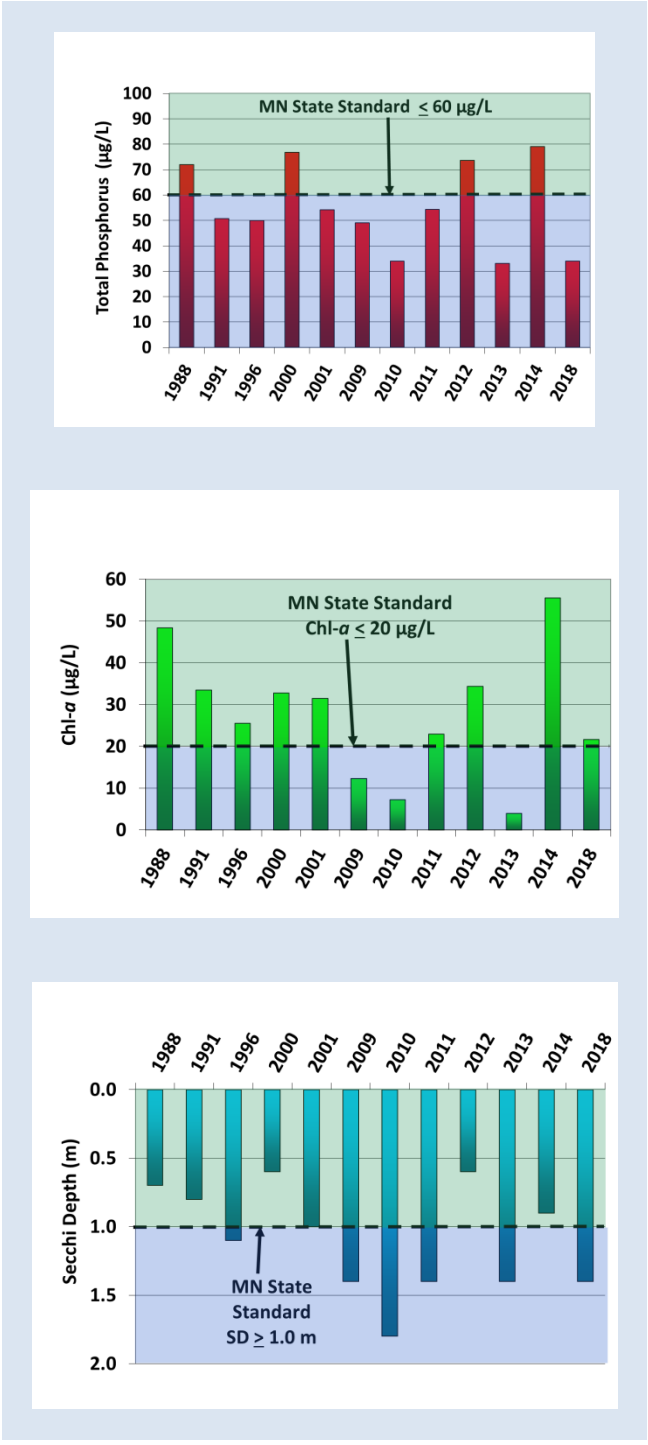


Figure 5-1 Southeast Anderson Lake summer average total phosphorus (top) , chlorophyll *a* (middle), and Secchi disc (bottom) values during 1988-2018.

The data indicate phosphorus added to the lake from its sediments may be causing excess algae in the lake. As identified in previous analyses, an alum treatment is recommended to reduce the phosphorus loading from the lake's sediments.

Overall, the District water quality improvement project appears to have improved the lake's water quality. For the period prior to the start of the lake's water quality improvement projects (1988-2001), the average summer total phosphorus and chlorophyll *a* concentrations were 61 and 34 µg/L and the average summer Secchi disc transparency was 0.8 meters (Figure 5-1). During the 5 year period of project completion (2009-2014), the average summer total phosphorus and chlorophyll *a* concentrations were 34 and 25 µg/L and the summer average Secchi disc transparency was 1.2 meters (Figure 5-1). After the completion of the water quality improvement project (2018), the average summer total phosphorus and chlorophyll *a* concentrations were 34 and 22 µg/L and the average Secchi disc transparency was 1.4 meters (Figure 5-1). Despite the improved water quality resulting from the District's water quality improvement project, chlorophyll *a* failed to meet the MPCA standard in 2018 due to excess algae.

5.3 Phytoplankton and Zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Southeast Anderson Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals).

During the period of record, changes in phytoplankton numbers have reflected precipitation conditions and the associated changes in phosphorus loading to the lake. In 2018, a relatively normal precipitation year, the lake's phytoplankton numbers were lower than either dry (2012) or wet (2011 and 2014) climatic years. During dry years, such as 2012, higher internal phosphorus loading from sediment increased phytoplankton numbers in the lake. Similarly, during wet years, such as 2011 and 2014, higher watershed phosphorus loading increased phytoplankton numbers in the lake (Figure 5-2).

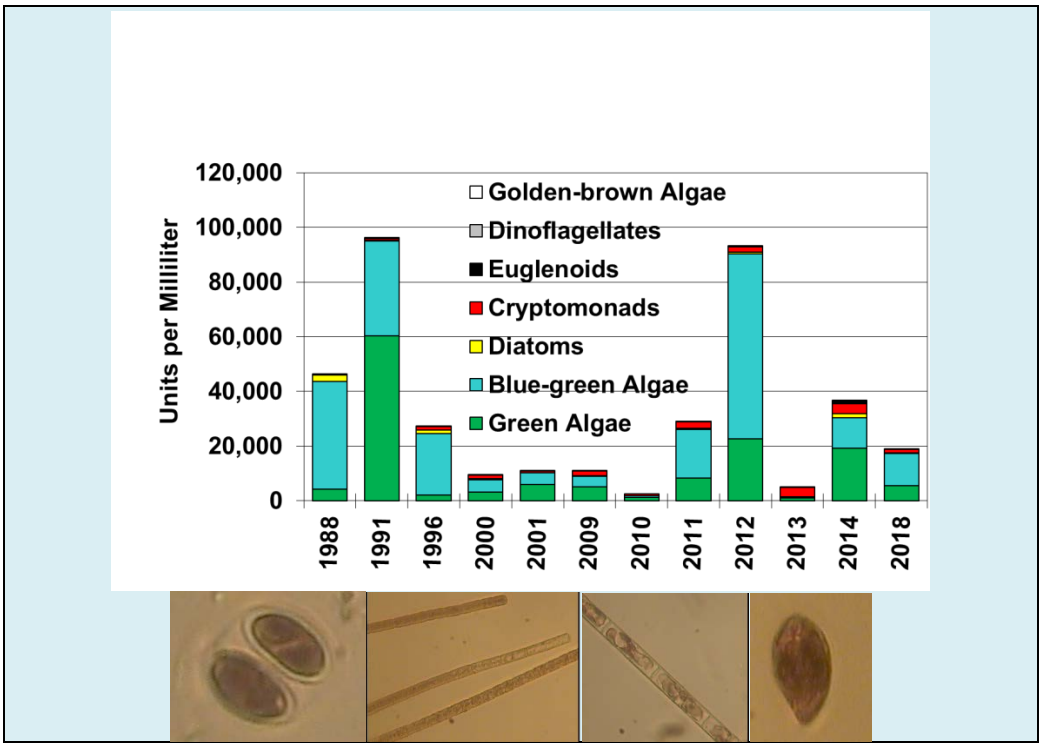


Figure 5-2 **Top, Southeast Anderson Lake 1988-2018 summer average phytoplankton numbers and bottom, microscopic pictures of phytoplankton species from the lake , from left to right, *Oocystis parva* (green algae) *Aphanizomenon flos-aquae* (blue-green algae), *Aulacoseira granulata* (diatom), and *Cryptomonas erosa* (cryptomonad).**

The composition of the 2018 zooplankton community was consistent with recent years, with all three groups of zooplankton (rotifers, copepods, and cladocerans) represented (Figure 5-3). During the period of record, small rotifers and copepods have generally dominated the community. Because small rotifers and copepods do not graze as heavily on algae as the larger cladocerans, they generally have limited impact on the lake's water quality. This suggests that future Southeast Anderson Lake water quality management efforts should focus on management of phosphorus, a nutrient that contributes to algae growth.

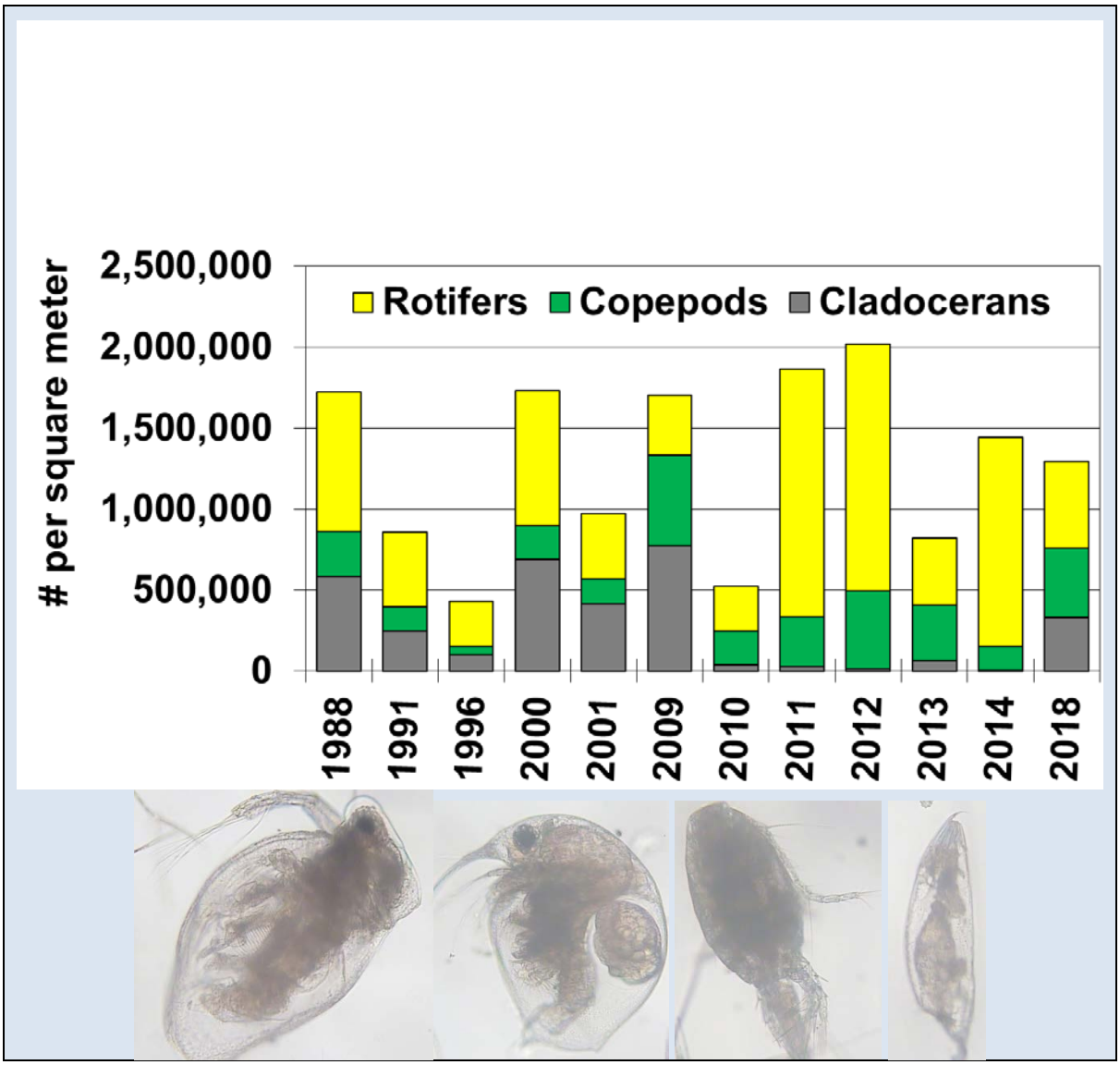


Figure 5-3 **Top, 1988-2018 Southeast Anderson Lake zooplankton numbers and bottom, microscopic pictures of zooplankton species from the lake, from left to right, *Ceriodaphnia sp*. (cladoceran), *Bosmina longirostris* (cladoceran), *Cyclops sp*. (copepod), and *Trichocerca cylindrica* (rotifer)..**

5.4 Aquatic Plants

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

The District conducted qualitative aquatic plant surveys of Southeast Anderson Lake in June and August of 2018. Maps showing survey results are included in Appendix B. Plant survey data from 1991 through 2018 were assessed to determine plant IBI trends. Figure 5-4 shows the Southeast Anderson Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold. The green bars depict data collected before completion of the water quality improvement project while the orange bars depict data collected during and after completion of the water quality improvement project.

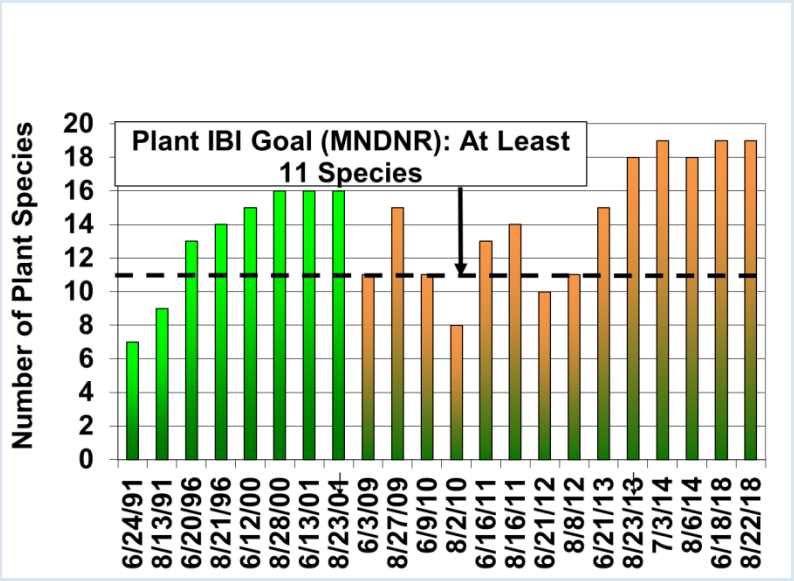


Figure 5-4A

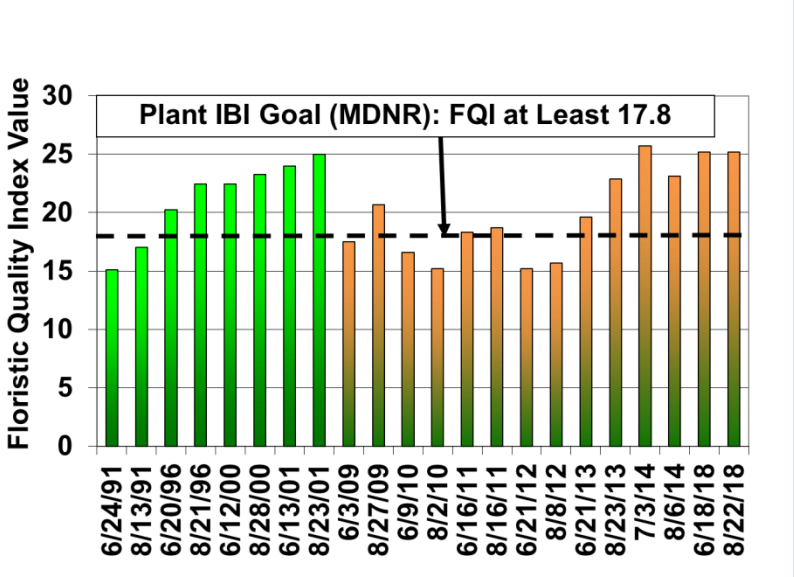


Figure 5-4B

Figure 5-4 1991-2018 Southeast Anderson Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

- **Number of species:** A shallow lake (maximum depth less than 15 feet) is considered impaired when it has fewer than 11 species. During the period examined, the number of species in Southeast Anderson

Lake ranged from 7 to 19 and has been better than the impairment threshold since August 2012. Higher numbers of species were observed from August 2013 through 2018 than in previous years (Figure 5-4A). The increase in species numbers is a positive result of the lake's water quality improvement project.

- **FQI values (quality of species):** The impairment threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values in Southeast Anderson Lake ranged from 15.1 to 25.7, better than the threshold since 2013 (Figure 5-4B).

- **2018 results:** Both the number of species in the lake and FQI values exceeded the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants (Figure 5-4).

The annual herbicide treatments in Southeast Anderson Lake successfully reduced CLP and improved lake water quality. At the conclusion of the project in 2014, CLP was not observed in the lake. The density of CLP turions, which act like seeds, was reduced by the project, but turions were still present when the project concluded. Since 2014, these turions appear to have replenished the CLP in the lake. In 2018, CLP was prevalent with densities ranging from light to heavy.

In 2017, Eurasian watermilfoil (EWM) was first observed in the lake near the boat launch on the southeast side of the lake. In 2018, EWM was observed throughout the lake with densities ranging from light to heavy.

5.5 Conclusions and Recommendations

2018 results indicate that Southeast Anderson Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), and total phosphorus, but did not meet the State Standard for chlorophyll *a*. Review of monitoring data from recent years indicates internal phosphorus loading from lake sediment continues to adversely impact the lake's water quality. The Southeast Anderson Lake UAA recommended an alum treatment to reduce phosphorus loading from sediment. Completion of an alum treatment in Southeast Anderson Lake is identified as a capital improvement project in the *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018).

It is also recommended that herbicide treatment be considered to control both CLP and EWM. Additional CLP management is identified as a 2020 capital improvement project in the *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018). Control of CLP and EWM will protect the native plant community from being displaced due to expansion of these aggressive aquatic invasive species (AIS). Control of CLP will also minimize the likelihood of the invasive plant spreading to downstream Southwest and Northwest Anderson Lakes. CLP and EWM can be treated with a herbicide that combines endothall for control of CLP and 2,4-D for control of EWM. Hence, both species can be controlled simultaneously.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

6 Bush Lake

Bush Lake is a deep mesotrophic lake (good water quality) with a surface area of 188 acres, a maximum depth of 35 feet, and an estimated mean depth of 9.8 feet. The lake has a littoral zone (shallow area where plants grow) of 114 acres which is about 66 percent of the lake's surface area.

Bush Lake was a landlocked lake until a pumped outlet to the Anderson Lakes was constructed in 2000 to manage water levels. The pump is programmed to turn on when the lake reaches a level of 833.5 M.S.L and continue pumping until the lake reaches a level of 833 M.S.L.

Aquatic Invasive Species (AIS) management projects were completed by the United States Army Corps of Engineers (USACOE) Engineer Research and Development Center (ERDC) during 2004 through 2007. During this period, the lake was annually treated with two herbicides, 2,4-D to control Eurasian watermilfoil (EWM) and endothall, to control curly-leaf pondweed (CLP).

In 2018, the Nine Mile Creek Watershed District monitored Bush Lake for:

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

Monitoring results are discussed in the following paragraphs.

6.1 Chlorides

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes 1 teaspoon of road salt to permanently pollute 5 gallons of water. And, once in the water, it is very difficult and expensive to remove chloride.

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. All 2018 Bush Lake chloride measurements met the MPCA standard. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations in Bush Lake:** From a low of 50 mg/L, measured in May, to a high of 53.5 mg/L, measured in August.
- **Average 2018 concentration:** 51 mg/L.

All 2018 Bush Lake chloride measurements met the MPCA standard.

6.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2018, the lake's water quality was excellent. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 10 µg/L and 2 µg/L respectively. The lake's summer average Secchi disc transparency was 3.9 meters (Figure 6-1). All three parameters met the 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). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

Review of the monitoring data suggests that the water quality of Bush Lake consistently improved during 2006 through 2018. The lake's summer average total phosphorus concentration declined from 20 µg/L in 2006 to 10 µg/L in 2018. The lake's summer average chlorophyll *a* concentration declined from 9.5 µg/L in 2006 to 2.4 µg/L in 2018. The lake's summer average Secchi disc transparency increased from 2.3 meters in 2006 to 3.9 meters in 2018 (Figure 6-1).

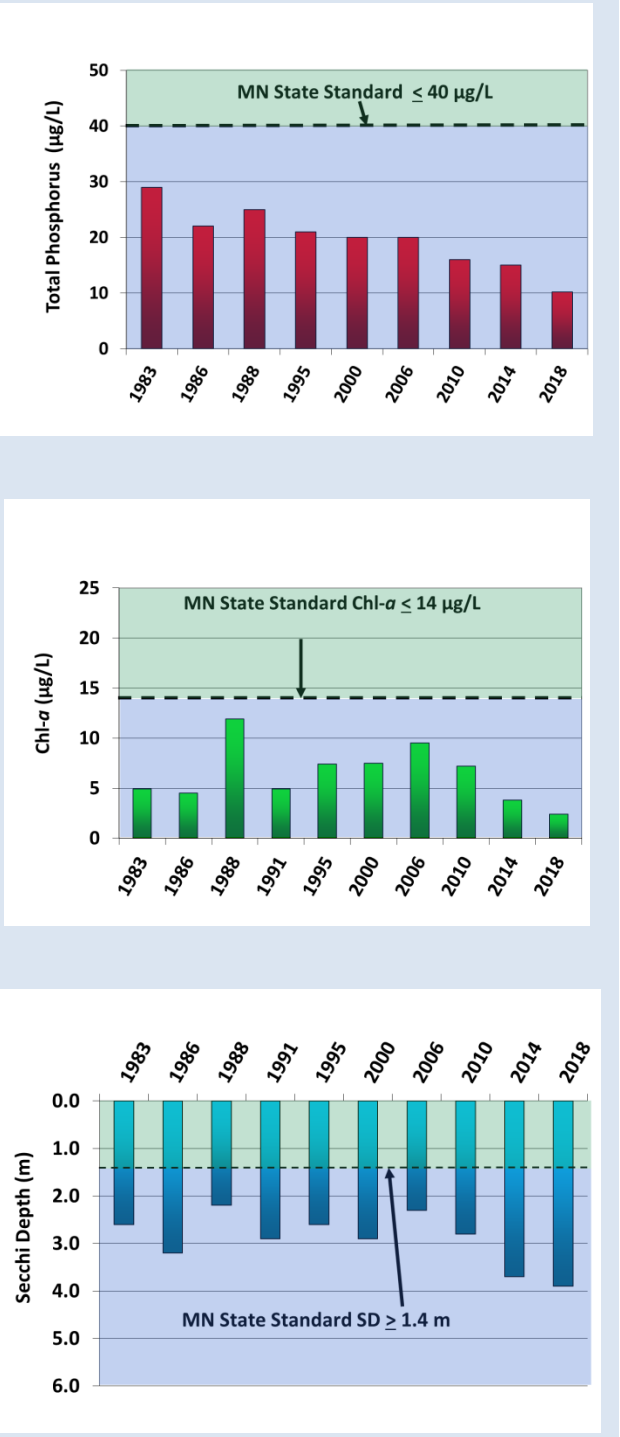


Figure 6-1 **Bush Lake summer average total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom) values during 1983-2018.**

6.3 Phytoplankton and Zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Bush Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals).

Phytoplankton numbers throughout the period of record have reflected the lake's excellent water quality (Figure 6-2). Green algae, diatoms, and cryptomonads, good sources of food for zooplankton, have been well represented throughout the monitoring period. Blue-green algae, which are associated with water quality problems, were consistently present in low numbers, but were never problematic.

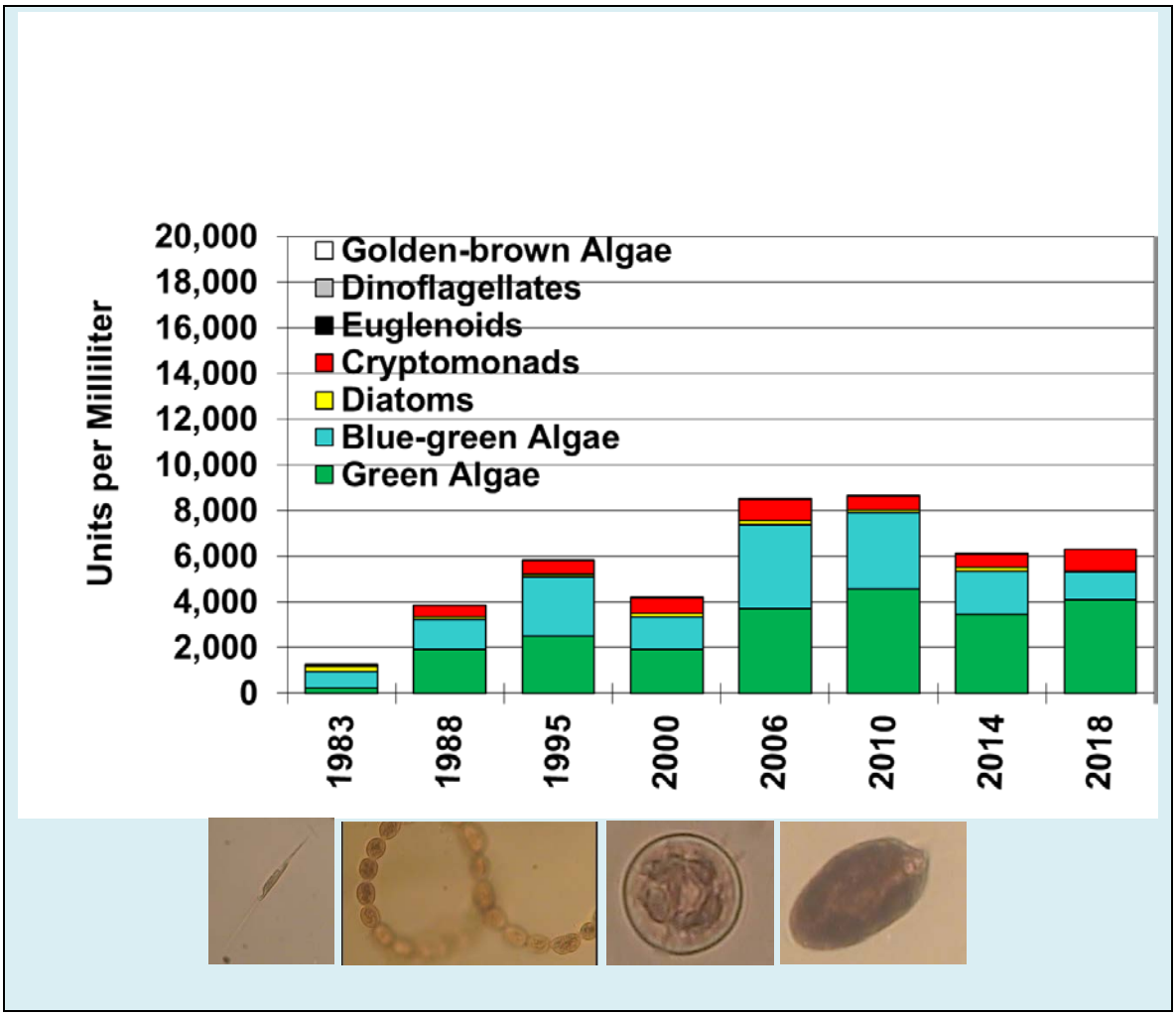


Figure 6-2 **Top, Bush Lake 1983-2018 summer average phytoplankton numbers and bottom, microscopic pictures of phytoplankton species from the lake , from left to right, *Schroederia Judayi* (green algae) *Dolichospermum flosaquae* (blue-green algae), *Stephanodiscus Hantzschii* (diatom), and *Cryptomonas erosa* (cryptomonad).**

The composition of the 2018 zooplankton community was consistent with recent years, with all three groups of zooplankton (rotifers, copepods, and cladocerans) represented (Figure 6-3). In 2018, the summer average number of zooplankton was well above previous summer averages (Figure 6-3). The 2018 average was heavily influenced by large numbers of the rotifer, *Keratella cochlearis* (Figure 6-3) during June – 11,144,913 per square meter. The number of *Keratella cochlearis* declined by an order of magnitude between June and July and then remained at the lower level during the remainder of the monitoring period. We hypothesize that the late spring in 2018 delayed the spawning/hatching and development of planktivorous fish to a later time than typically occurs in the lake. This delay would have delayed the time period when predation impacts from the newly hatched fish began. When the mouth

size of newly hatched planktivorous fish reaches a size that enables them to prey upon zooplankton, the numbers of zooplankton generally decline. The atypical high numbers of *Keratella cochlearis* in June 2018 may reflect the delay in predation impacts from the newly hatched fish while the order of magnitude reduction in July may reflect predation impacts from the newly hatched fish. The decline of all three zooplankton groups in the lake between June and July support the hypothesis of fish predation impacts during this period - cladocerans declined by 75 percent, adult copepods declined by 58 percent, and rotifers declined by 94 percent.

During the period of record, small rotifers and copepods have generally dominated the community, but cladocerans, including large-bodied species such as *Daphnia galeata* (Figure 6-3) have consistently been present. Cladocerans graze more heavily on algae than small rotifers and copepods and have a greater impact on the lake's water quality. However, the dominance by small rotifers and copepods, which have limited impact on the lake's water quality, indicates lake water quality management efforts should focus on management of phosphorus, a nutrient that contributes to algae growth.

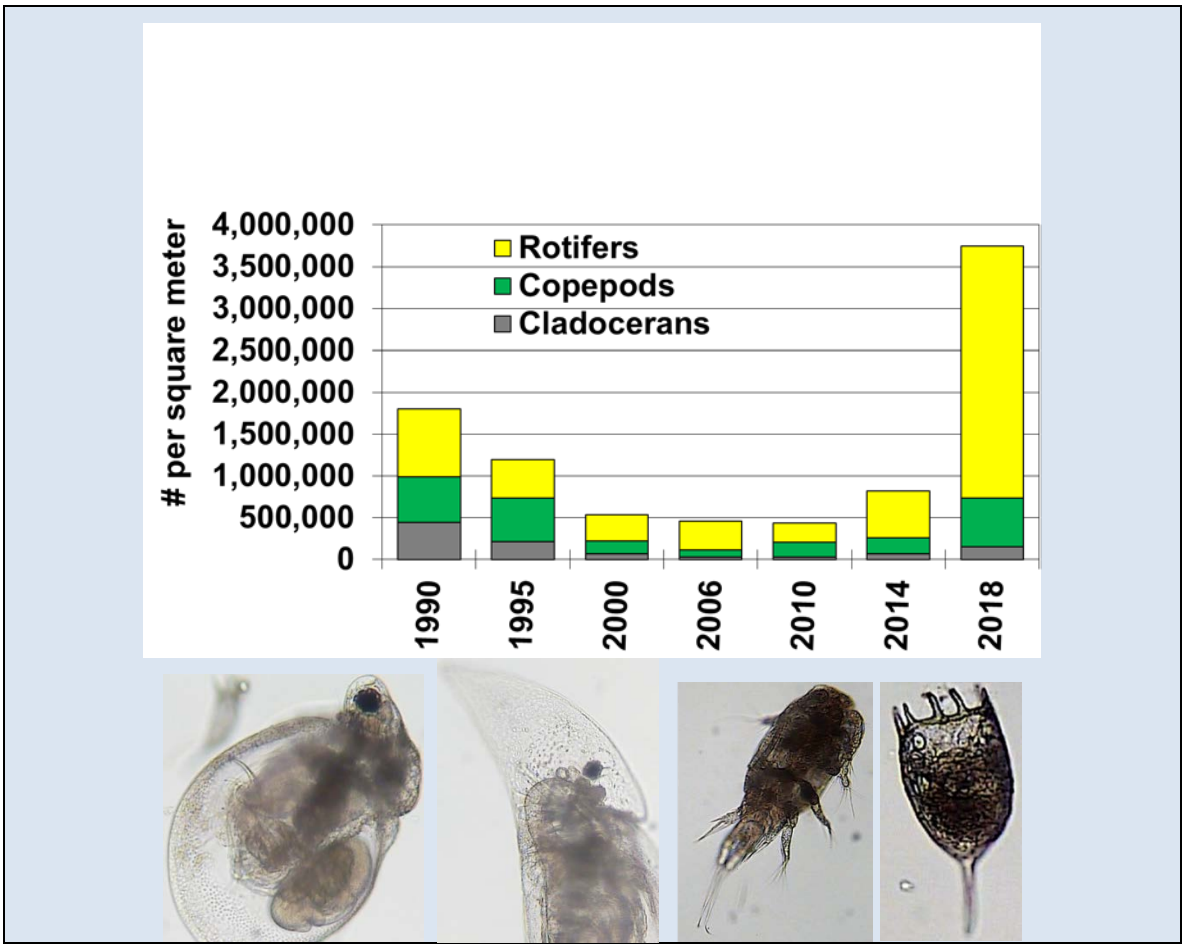


Figure 6-3 **Top, 1990-2018 Bush Lake zooplankton numbers and bottom, microscopic pictures of zooplankton species from the lake, from left to right, *Ceriodaphnia sp*. (cladoceran), *Daphnia retrocurva* (cladoceran), *Cyclops sp*. (copepod), and *Keratella cochlearis* (rotifer).**

6.4 Aquatic Plants

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

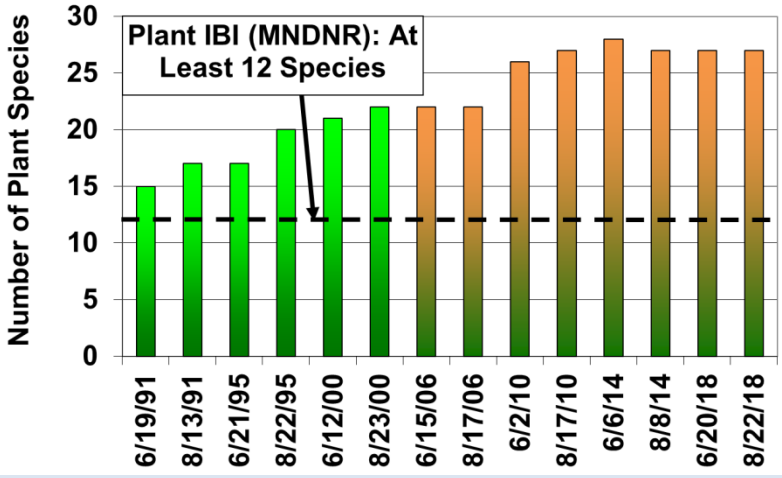


Figure 6-4A

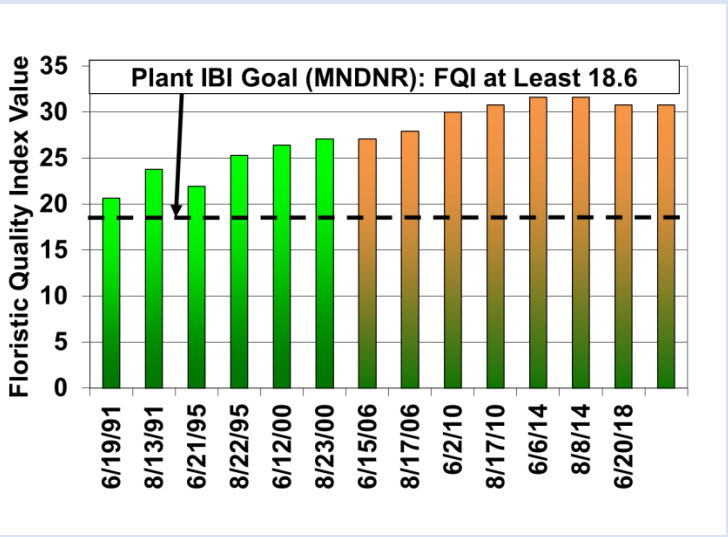


Figure 6-4B

Figure 6-4 **1991-2018 Bush Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).**

The District conducted qualitative aquatic plant surveys of Bush Lake in June and August of 2018. Maps showing survey results are included in Appendix B. Plant survey data from 1991 through 2018 were assessed to determine plant IBI trends. Figure 6-4 shows the Bush Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold. The green bars depict data collected before completion of the AIS management projects while the orange bars depict data collected during and after completion of the AIS management projects.

- **Number of species:** A deeper lake (maximum depth of at least 15 feet) is considered impaired when it has fewer than 12 species. During the period examined, the number of species in Bush Lake ranged from 15 to 28, better than the impairment threshold since monitoring began in 1991. Higher numbers

of plant species have been observed since 2010 than in previous years (Figure 6-4A). The increase in number of plant species is a positive result of the AIS management projects completed by the USACE ERDC.

- **FQI values (quality of species):** The impairment threshold for deeper lakes, as measured by FQI, is a minimum value of 18.6. During the period examined, FQI values ranged from 20.7 to 31.6, consistently better than the impairment threshold since monitoring began in 1991 (Figure 6-4B). Higher FQI values have been observed since 2010 than previous years (Figure 6-4B). The increase in FQI values is likely a positive result of the AIS management projects completed by the USACE ERDC.
- **2018 results:** Both the number of species in the lake and FQI values exceeded the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants (Figure 6-4).

Despite the CLP and EWM management efforts during 2004 through 2007, both species have increased in prevalence and density since the project concluded. In 2018, CLP and EWM were prevalent throughout the lake ranging in density from light to heavy.

6.5 Conclusions and Recommendations

2018 results indicate that Bush Lake met MPCA water quality standards for chlorides, Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a* in 2018. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

In 2018, two aquatic invasive species (AIS), CLP and EWM, were prevalent throughout the lake ranging in density from light to heavy.

As identified in the *Nine Mile Creek Watershed District Water Management Plan (*2017, amended 2018), the District plans to update the Use Attainability Analysis for Bush Lake in 2022. Additional water quality and biological monitoring data will be collected from Bush Lake in 2021 to support completion of the study.

7 Smetana Lake

Smetana Lake is located in Eden Prairie, with the south fork of the creek flowing through the lake. The lake has a surface area of 52 acres, a maximum depth of 10 feet, and a mean depth of 5 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

In 2008, the Nine Mile Creek Watershed District completed several water quality improvement projects in and upstream of Bryant Lake, including a wetland restoration along County Ditch 34 and an alum treatment to reduce phosphorus loading from lake bottom sediments. These improvements in Bryant Lake also resulted in improvements in downstream Smetana Lake.

In 2018, the Nine Mile Creek Watershed District monitored Smetana Lake for:

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

Monitoring results are discussed in the following paragraphs.

7.1 Chlorides

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

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. In 2018, chloride concentrations failed to meet the MPCA standard of 230 mg/L or less on two occasions, May 14 (244 mg/L) and June 12 (264 mg/L). The MPCA considers two or more exceedances of the chronic standard in three years to be an impairment. Although Smetana Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations in Smetana Lake:** From a high of 264 mg/L, measured in June, to a low of 159 mg/L, measured in July.
- **Average 2018 concentration:** 195 mg/L.

In 2016, the last year monitored by the District, chloride concentrations in Smetana Lake ranged from a high of 137 mg/L, measured in May, to a low of 78 mg/L, measured in August.

7.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2018, the lake's water quality was excellent. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 37 and 6 µg/L, respectively. The lake's summer average Secchi disc transparency was 2.1 meters (Figure 7-1). All three parameters met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

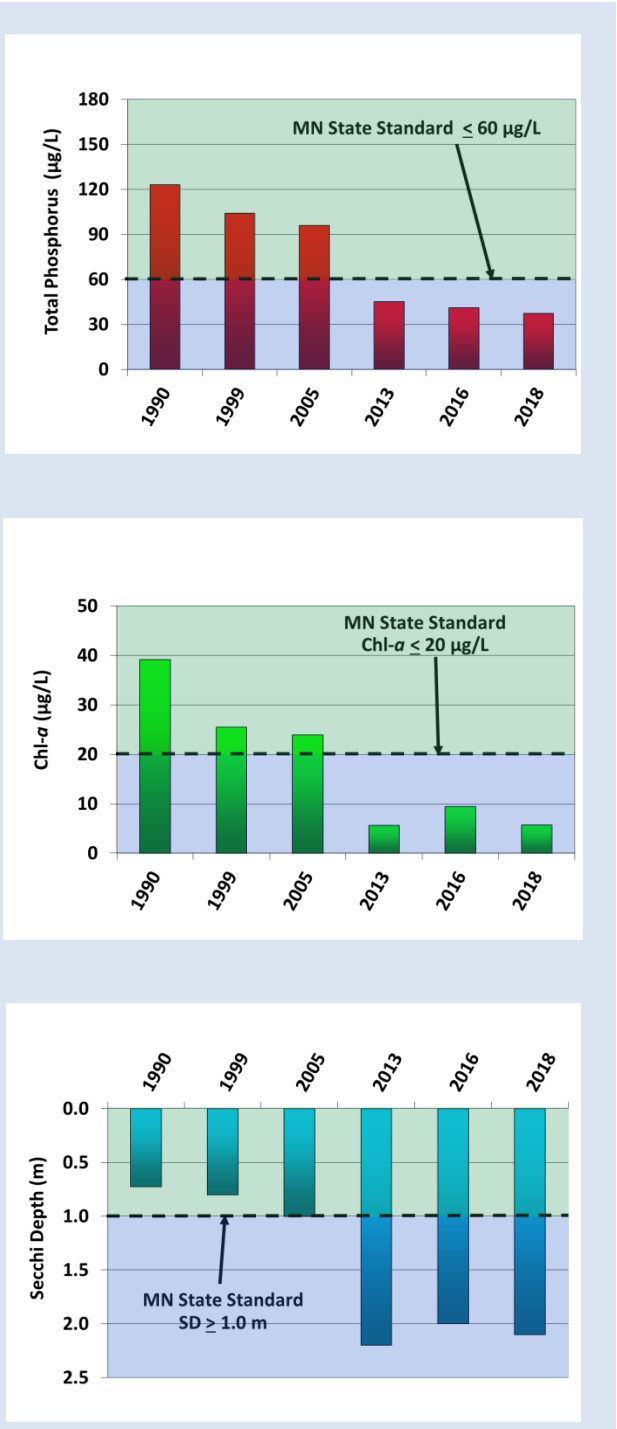


Figure 7-1 Smetana Lake summer average total phosphorus (top) , chlorophyll *a* (middle), and Secchi disc (bottom) values during 1990-2018.

The District's completed a water quality improvement projects in Bryant Lake have substantially improved the water quality of Smetana Lake. For the period prior to the start of the Bryant Lake water quality improvement projects (1990-2005), the Smetana Lake average summer total phosphorus and chlorophyll *a* concentrations were 108 and 30 µg/L and the average summer Secchi disc transparency was 0.8 meters. For the period after the completion of the Bryant Lake water quality improvement project (2013-2018), the Smetana Lake average summer total phosphorus and chlorophyll *a* concentrations were 41 and 7 µg/L and the average Secchi disc transparency was 2.1 meters (Figure 7-1). All Smetana Lake water quality measurements after the completion of the Bryant Lake water quality improvement project have met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4).

7.3 Phytoplankton and Zooplankton

Samples of phytoplankton, microscopic aquatic plants, were collected from Smetana Lake to evaluate water quality and the quality of food available to zooplankton (microscopic animals). Phytoplankton numbers during the monitoring period of 1990 through 2018 followed a pattern similar to that of the water quality parameters, both reflecting the substantial improvement in water quality of Smetana Lake resulting from the Bryant Lake water quality improvement projects. For the period prior to the start of the water quality improvement projects (1990-2005), the average summer phytoplankton number was 14,573 per milliliter. For the period after the completion of the water quality improvement projects (2013-2018), the average summer phytoplankton number was 5,541 per milliliter. Blue-green algae numbers were much lower after the completion of the water quality improvement projects – pre-project average blue-green numbers were 6,938 units per milliliter compared with post-project average blue-green numbers of 747 units per milliliter (Figure 7-2).

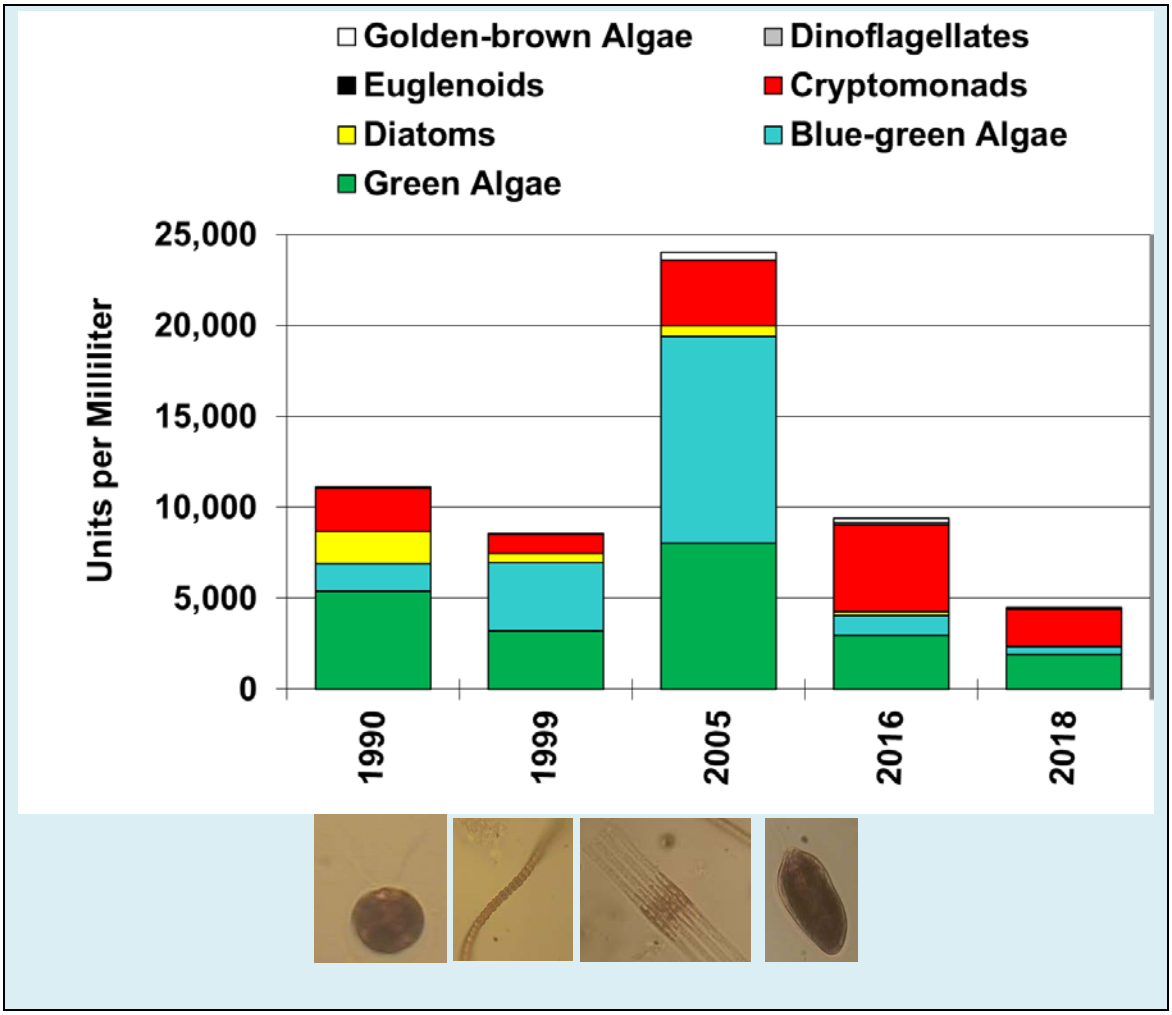


Figure 7-2 **Top, Smetana Lake 1990-2018 summer average phytoplankton numbers and bottom, microscopic pictures of phytoplankton species from the lake , from left to right, Chlamydomonas globosa (green algae) Dolichospermum affine (blue-green algae), Fragilaria crotonensis (diatom), and Cryptomonas erosa (cryptomonad).**

The composition of the 2018 zooplankton community was consistent with recent years, with all three groups of zooplankton (rotifers, copepods, and cladocerans) represented (Figure 7-3). During the period of record, small rotifers, copepods, and small cladocerans have generally dominated the community. Because small rotifers, copepods, and small cladocerans do not graze as heavily on algae as the larger cladocerans, they generally have limited impact on the lake's water quality. This suggests that future Smetana Lake water quality management efforts should focus on management of phosphorus, a nutrient that contributes to algae growth.

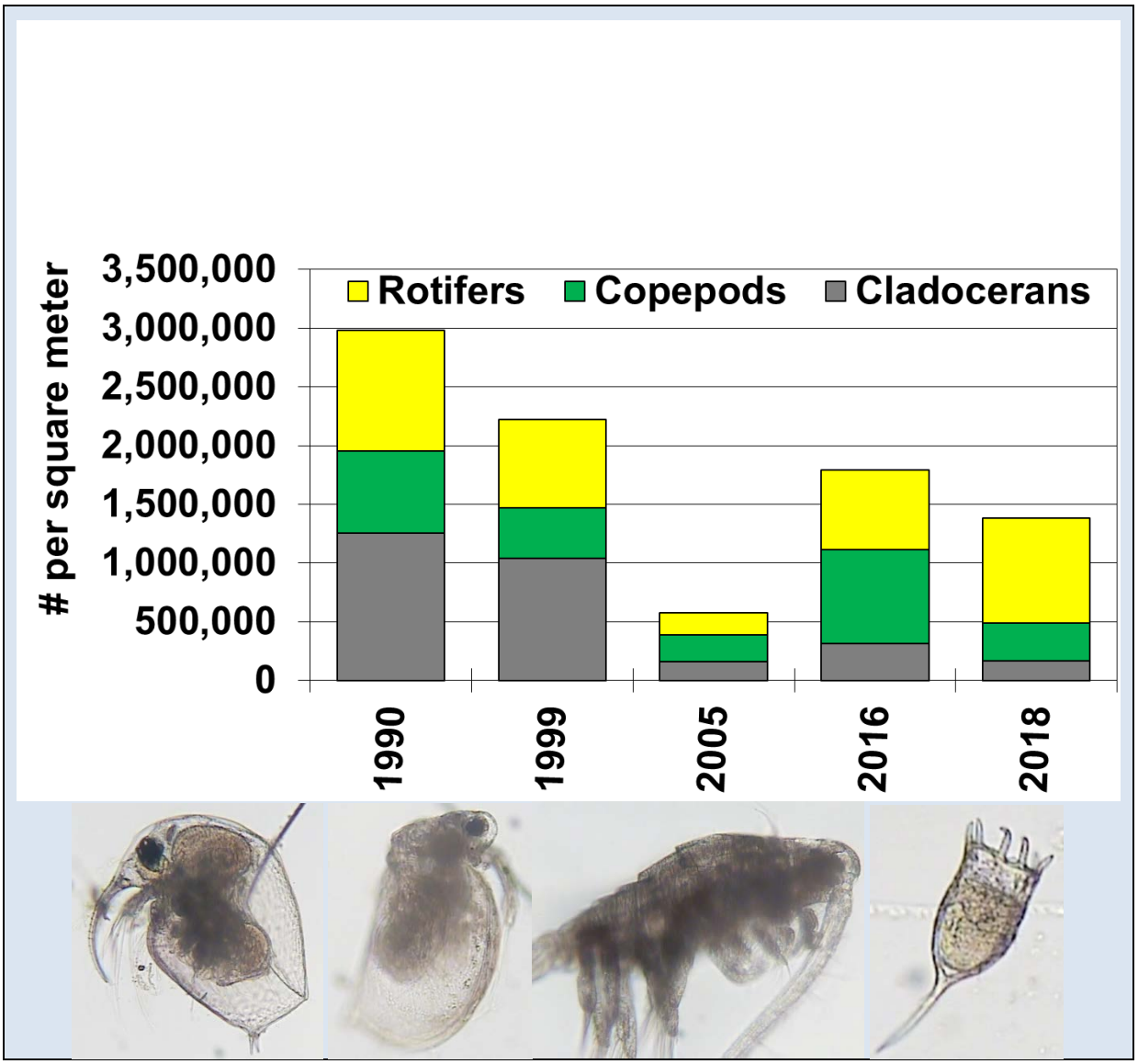


Figure 7-3 **Top, 1990-2018 Smetana Lake zooplankton numbers and bottom, microscopic pictures of zooplankton species from the lake, from left to right, Bosmina longirostris. (cladoceran), Ceriodaphnia sp. (cladoceran), Diaptomus sp. (copepod), and Keratella cochlearis (rotifer)..**

7.4 Aquatic Plants

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

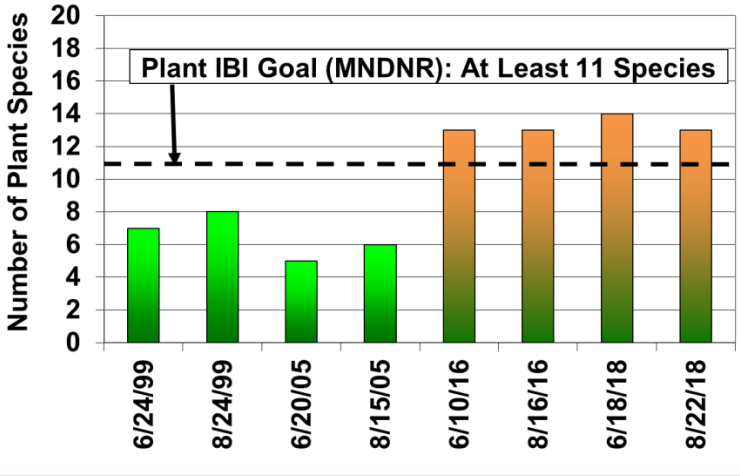


Figure 7-4A

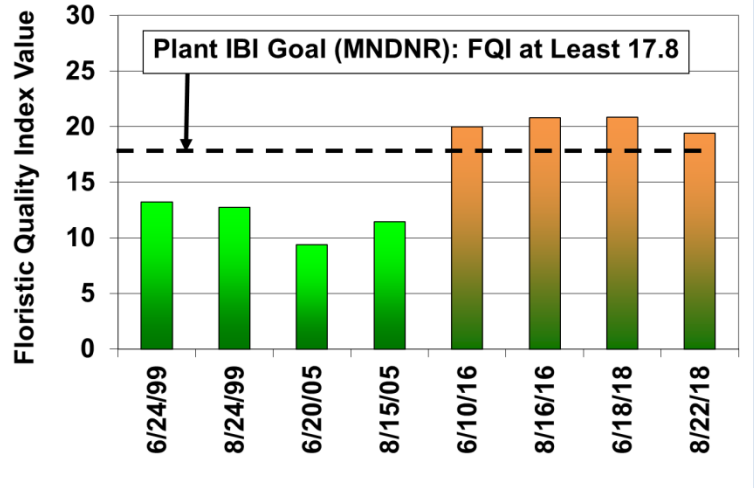


Figure 7-4B

Figure 7-4 1999-2018 Smetana Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

The District conducted qualitative aquatic plant surveys of Smetana Lake in June and August of 2018. Maps showing survey results are included in Appendix B. Plant survey data from 1999 through 2018 were assessed to determine plant IBI trends. Figure 7-4 shows the Smetana Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold. The green bars depict data collected before completion of the Bryant Lake water quality improvement project while the orange bars depict data collected after completion of the water quality improvement project.

- **Number of species:** A shallow lake is considered impaired when it has fewer than 11 species. During the period examined, the number of species in Smetana Lake ranged from 7 to 14 and has been better than the impairment threshold since completion of the Bryant Lake water quality improvement

project (Figure 7-4A). The increase in species numbers is a positive result of the water quality improvement project.

- **FQI values (quality of species):** The impairment threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values ranged from 9.4 to 20.9, better than the threshold since completion of the Bryant Lake water quality improvement project (Figure 7-4B). The increase in FQI is a positive result of the water quality improvement project.
- **2018 results:** Both the number of species in the lake and FQI values were better than the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants (Figure 7-4).

In 2018, curly-leaf pondweed (CLP) was prevalent in Smetana Lake, with densities ranging from light to moderate. CLP expanded in both coverage and density between 2016 and 2018. This expansion is unfavorable for the Smetana Lake plant community. In addition, because CLP turions may be carried downstream to Normandale Lake by the creek, the additional turions produced by the additional CLP in the Smetana Lake could increase the number of CLP turions conveyed downstream to Normandale Lake by the creek.

7.5 Conclusions and Recommendations

2018 monitoring results indicate that Smetana Lake met MPCA water quality standards for Secchi disc (measure of clarity), and total phosphorus, and chlorophyll *a* concentrations in 2018.

2018 results indicate Smetana Lake did not meet the MPCA water quality standard for chlorides. Although Smetana Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. It is recommended that the District work with the City of Eden Prairie to identify and implement management measures to reduce chloride runoff from the lake's watershed.

According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired. However, the expansion of CLP in the lake during the past two years is unfavorable for the Smetana Lake native plant community and could increase the number of CLP turions conveyed downstream to Normandale Lake by the creek. As identified in their *Nine Mile Creek Watershed District Water Management Plan* (2017, amended 2018), the District plans to update the Use Attainability Analysis for Smetana Lake in 2019. Recommendations for future aquatic plant management activities will be considered as part of that study.

Continuation of water quality and biological monitoring is recommended to periodically assess the condition of the lake's water quality and biological community and identify trends.

8 Normandale Lake

Normandale Lake is located in the northwestern portion of Bloomington. Normandale Lake was created as a direct result of the Mount Normandale Lake flood control project, implemented in the late-1970s.

The lake has a water surface of approximately 116 acres, maximum depth of approximately 9 feet, and a mean depth of 3.0 feet at the normal water surface elevation of approximately 808 feet. At this elevation, the lake volume is approximately 290 acre-feet.

The lake is shallow enough for aquatic plants (i.e., macrophytes) to grow over the entire lake bed. The water level in the lake is controlled mainly by weather conditions (snowmelt, rainfall, and evaporation) and by the elevation of the outlet structure located at the east side of Normandale Lake.

Figure 8-1 Normandale Lake, pictured above, is a shallow lake created as a flood control project

In 2018, the District began implementation of a water quality improvement project for Normandale Lake. A drawdown of the lake was completed in fall of 2018 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed (CLP), an invasive plant species, which dies off in late-June, senesces, and adds phosphorus to the lake. This summer addition of phosphorus fuels algal growth and degrades lake water quality. An alum treatment is planned for spring of 2019 to reduce the release of phosphorus from lake bottom sediments into the water column. In the summer of 2019, plant and turion surveys are planned to determine whether CLP and/or CLP turions survived the drawdown. If so, herbicide treatments would begin in 2020 to control the remaining CLP.

In 2018, the Nine Mile Creek Watershed District monitored Normandale Lake for:

- Water chemistry (nutrients, chlorophyll *a*, chloride)
- Water quality measurements (e.g., clarity, dissolved oxygen)
- Macrophytes (aquatic plants)

Monitoring results are discussed in the following paragraphs.

8.1 Chlorides

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. When snow and ice melts, the salt goes with it, washing into lakes, streams, wetlands, and groundwater. It only takes

1 teaspoon of road salt to permanently pollute 5 gallons of water. And, once in the water, it is very difficult and expensive to remove chloride.

Because high concentrations of chloride can harm fish and plant life, MPCA has established a chronic exposure chloride standard of 230 mg/L or less. In 2018, chloride concentrations failed to meet the MPCA standard of 230 mg/L or less on two occasions, May 14 (253 mg/L) and June 12 (258 mg/L). The MPCA considers two or more exceedances of the chronic standard in 3 years to be an impairment. Although Normandale Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. The range and average of observed concentrations are summarized below:

- **Range of 2018 chloride concentrations in Normandale Lake:** From a high of 258 mg/L, measured in June, to a low of 142 mg/L, measured in July.
- **Average 2018 concentration:** 194 mg/L.

In 2016, the last year monitored by NMCWD, chloride concentrations in Normandale Lake ranged from a high of 235 mg/L, measured in April, to a low of 55 mg/L, measured in September. The April concentration exceeded the MPCA standard of 230 mg/L or less.

Figure 8-2 In 2018, chloride concentrations exceeded the MPCA standard of 230 mg/L on two occasions, May 14 (253 mg/L) and June 12 (258 mg/L), in Normandale Lake, pictured above.

8.2 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2018, the lake's water quality was good. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 44 µg/L and 5.1 µg/L respectively. The lake's summer average Secchi disc transparency was 1.5 meters. All three parameters met the Minnesota State Water Quality Standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Graphs showing the total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency measurements for all 2018 monitoring events are included in Appendix A.

Review of the monitoring data suggests that the water quality of Normandale Lake was better in 2018 than 2016. The lake's summer average total phosphorus concentration declined from 92 µg/L in 2016 to 44 µg/L in 2018. The lake's summer average chlorophyll *a* concentration declined from 16.7 µg/L in 2016 to 5.1 µg/L in 2018. The lake's summer average Secchi disc transparency increased from 1.2 meters in 2006 to 1.5 meters in 2018 (Figure 8-3).

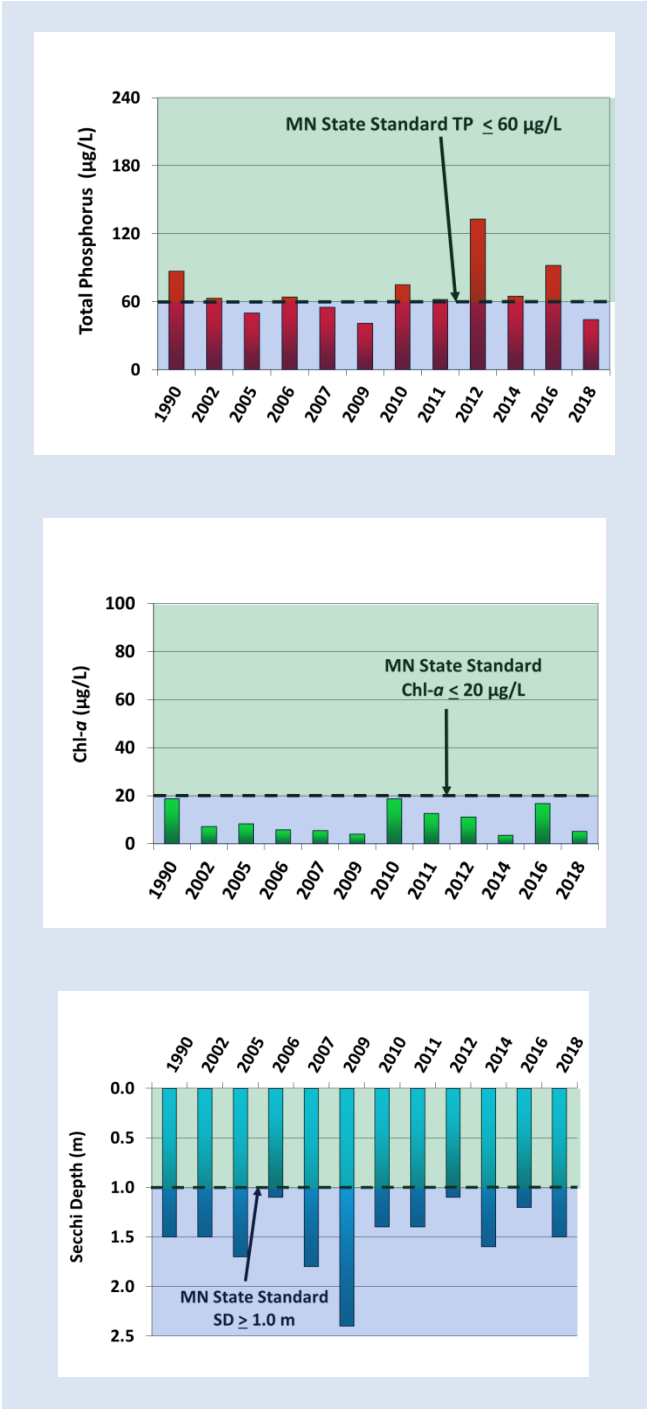


Figure 8-3 Normandale Lake summer average total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom) values during 1990-2018.

8.3 Aquatic Plants

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

The District conducted point-intercept and biomass aquatic plant surveys of Normandale Lake in June and August of 2018. Results are included in Appendix C. Plant survey data from 2002 through 2018 were assessed to determine plant IBI trends. Figure 8-4 shows the Normandale Lake number of species and FQI scores for that period compared to the proposed MDNR plant IBI impairment threshold.

- **Number of species:** A shallow lake (maximum depth less than 15 feet) is considered impaired when it has fewer than 11 species. During the period examined, the number of species in Normandale Lake ranged from 9 to 18. The number of species in the lake was better than the impairment threshold since 2009. Higher numbers of plant species have been observed since August of 2016 than in previous years (Figure 8-4A).

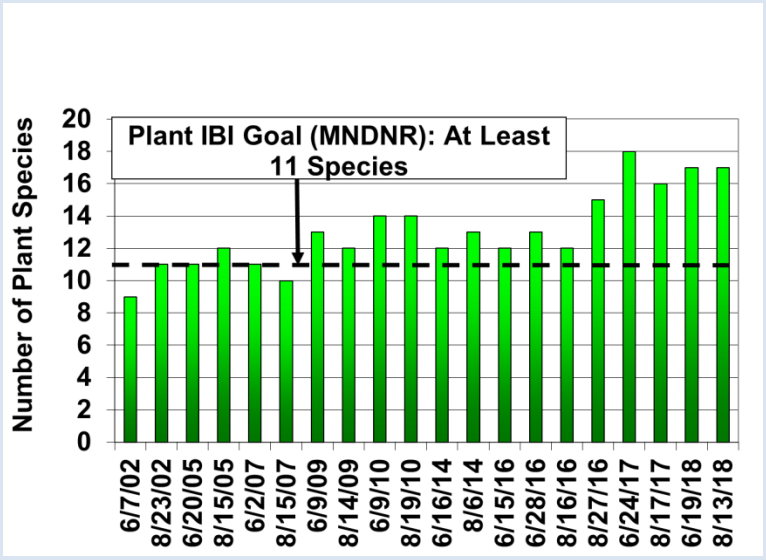


Figure 8-4A

- **FQI values (quality of species):** The impairment threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values ranged from 14.7 to 22.9. FQI scores have been consistently better than the impairment threshold since August 2014 (Figure 8-4B).

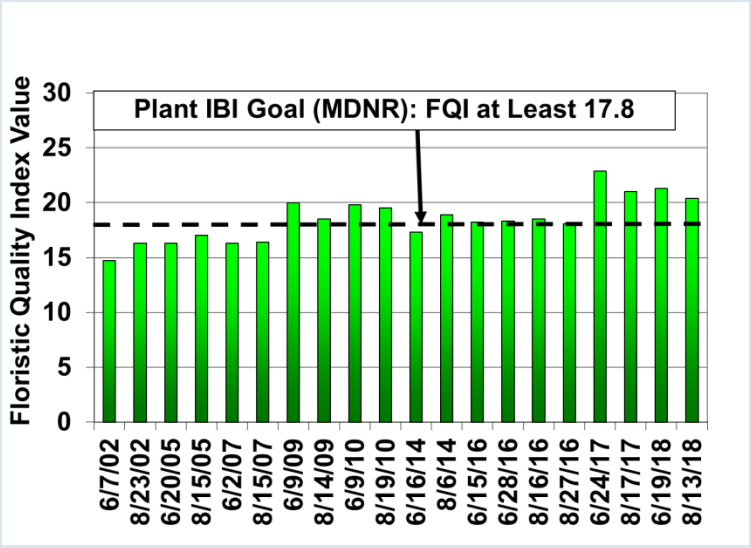


Figure 8-4B

- **2018 results:** Both the number of species in the lake and FQI values were better than the minimum IBI thresholds that define impairment. As such, the waters would not be considered impaired for aquatic plants (Figure 8-4).

Figure 8-4 2002-2018 Normandale Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

In 2018, two aquatic invasive species were known to be present in Normandale Lake:

- **Curly-leaf pondweed (*Potamogeton crispus*):** Detailed aquatic plant surveys and biomass estimations were conducted in Normandale Lake in 2016, 2017, and 2018 in preparation for and as part of the ongoing Normandale Lake improvement project. The discussion below summarizes the curly-leaf pondweed (CLP) results.

  In 2018, curly-leaf pondweed (CLP) was found at 50 percent of sample points in June (Figure 8-5A) and 7 percent of sample points in August. The frequency reduction in August was due to a natural die-off which generally occurs in late-June.

  An assessment of CLP frequency during 2016 through 2018 indicates CLP frequency in June 2018 was much lower than June 2017 and relatively similar to June 2016 (Figure 8-5A). An assessment of CLP biomass during 2017 and 2018 indicates CLP biomass declined by an order of magnitude in 2018. Biomass samples were collected from 30 of the 125 plant survey points during 2017 and 2018. CLP was observed at 25 of the 30 biomass sample points in 2017 and at 15 of the biomass sample points in 2018. The CLP average wet weight per sample point at the biomass sample points with CLP was 230 grams in 2017 and 20 grams in 2018 (Figure 8-5B). It is hypothesized that the long winter of 2017-2018 reduced the survival of CLP in the lake, resulting in lower CLP frequency and biomass during 2018. In 2018, the reduced biomass of CLP in the lake reduced CLP phosphorus loading following its late June die-off and contributed toward improved water quality.

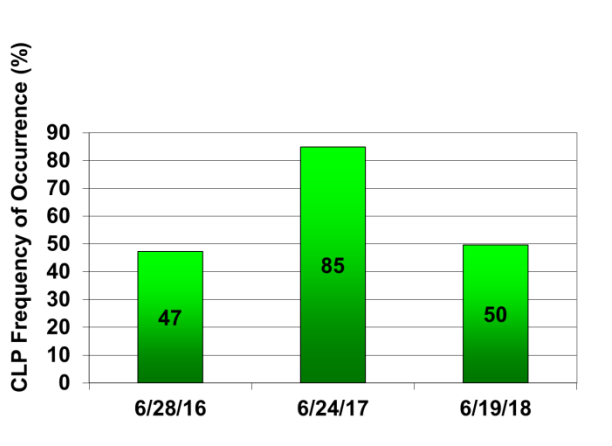


Figure 8-5A

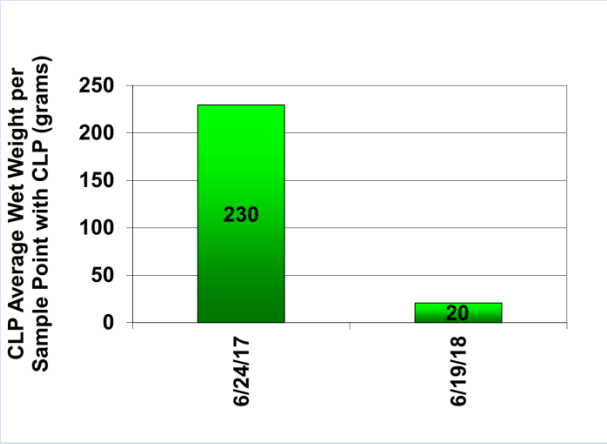


Figure 8-5B

Figure 8-5 2016-2018 Normandale Lake CLP Frequency of Occurrence Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom)

- **Eurasian watermilfoil (*Myriophyllum spicatum*):** Eurasian watermilfoil was first observed in Normandale Lake in June 2017 when it was collected on the rake at three locations and visually observed at two additional locations. It was not observed in the lake in August 2017. In June 2018, Eurasian watermilfoil (EWM) was not collected on the rake, but was visually observed at two locations. In August 2018, EWM was collected on the rake at one location and visually observed along the north shoreline, where it was beginning to form EWM beds. A EWM "bed" is an area where EWM makes up more than half of the area's plants and is generally continuous with clearly defined borders.

8.4 Conclusions and Recommendations

2018 results indicate that Normandale Lake met MPCA water quality standards for Secchi disc (measure of clarity), total phosphorus, and chlorophyll *a*. According to the Minnesota Department of Natural Resources (MDNR) plant IBI, the lake's plant community is not impaired.

In 2018, Normandale Lake did not meet the MPCA water quality standard for chlorides. Although Normandale Lake has not been listed by the MPCA as impaired for chlorides, the 2018 data indicate the lake meets the MPCA criterion for impairment. It is recommended that the District work with entities in the watershed to identify and implement measures to reduce chloride runoff from the lake's watershed.

In 2018, two aquatic invasive species (AIS), CLP and EWM, were present in the lake. CLP was observed at about half of the sample locations in June. EWM occurred at low levels in June and August, but was beginning to form EWM beds along the north shoreline in August.

In 2018, the District began implementation of a water quality improvement project for Normandale Lake. A drawdown of the lake was completed in fall of 2018 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed (CLP). An alum treatment is planned for spring of 2019. In the summer of 2019, plant and turion surveys are planned to determine whether CLP and/or turions survived the drawdown. If so, herbicide treatments would begin in 2020 to control the remaining CLP.

Continuation of water quality and biological monitoring is recommended in upcoming years to assess the impacts of the improvement project(s) on the condition of the lake's water quality and biological community.

9 Nine Mile Creek Stream Monitoring

Because the primary use of Nine Mile Creek is ecological – a place for fish and aquatic life to live – the focus of the Nine Mile Creek monitoring program is evaluation of the stream's fish and aquatic life community as well as the ecosystem components essential for the survival of fish and aquatic life (Figure 9-1). The 2018 Nine Mile Creek monitoring program included:

- Annual monitoring of the fish community during summer.
- Annual monitoring of the macroinvertebrate community during October.
- Annual habitat monitoring during summer (i.e., stream substrate type, depth of fine sediment, percent embeddedness, and length of eroded streambank).
- March through October monthly measurements of specific conductance, dissolved oxygen, pH, temperature, turbidity, and flow.

Figure 9-1 The primary use of Nine Mile Creek is a place for fish and aquatic life to live, such as the shorthead redhorse fish swimming in the Main Stem of Nine Mile Creek at Station ECU-7C, pictured above.

Monitoring locations are shown on Figure 1-1.

Data collected during 2018 were evaluated to determine whether:

- Specific conductance, dissolved oxygen, pH, and temperature, levels met Minnesota Pollution Control Agency (MPCA) standards for Class 2B waters published in Minnesota Rules 7050.
- Flow and water quality data were consistent with historical values.
- 2018 fish and aquatic life communities were consistent with the stream's ecological use determined from assessments completed in 1997 and 2003.
- The 2018 fish and invertebrate communities were consistent with historical data.

9.1 Nine Mile Creek Water Quality

In 2018, the levels of specific conductance, dissolved oxygen, pH, temperature, and turbidity in Nine Mile Creek generally met MPCA standards for Minnesota Class 2B waters (MPCA Standard). Overall, the 2018 values were within MPCA standards 84 percent of the time. The South Fork and Main Stem met MPCA standards most frequently (85 percent of the time) followed by the North Fork (81 percent of the time). In 2018, the specific conductance criterion was met less frequently than other MPCA standards. All Nine Mile

Creek temperature and pH measurements, 90 percent of the dissolved oxygen measurements, and 45 percent of the specific conductance measurements met MPCA standards.

Specific conductance measurements failed to meet the MPCA standard more frequently in 2018 than 2017 when 64 percent of specific conductance measurements met MPCA standards. Specific conductance is a measure of the conductive ions in water from dissolved and inorganic materials such as alkalis, chlorides, sulfides, and carbonate compounds. The discharge of chlorides from deicing chemicals (salt) to the creek for a longer period of time in 2018 than 2017 likely contributed to specific conductance measurements that exceeded the MPCA standard more frequently. In 2018, snow and the associated application of deicing chemicals (e.g., salt) continued through April and snowmelt continued into May. The MPCA has listed Nine Mile Creek as impaired for chlorides since 2004.

As in previous years, the North Fork locations met the MPCA standard for specific conductance less frequently than other sampling locations—28 percent of the North Fork measurements met the MPCA specific conductance standard in 2018 compared with 50 percent of Main Stem and 63 percent of South Fork measurements.

In 2018, higher specific conductance was observed on the Main Stem compared to measurements from previous years. The average specific conductance values from all three Main Stem locations (ECU-7A, ECU-7B, and ECU-7C) were the highest averages since monitoring began in 1997 and exceeded the MPCA standard of 1,000 µmhos per centimeter.

- **ECU-7A:** 2018 average specific conductance of 1,103 µmhos per centimeter compared with a range of 599 µmhos per centimeter (1998) to 1,033 µmhos per centimeter (2013) during 1997 through 2017

- **ECU-7B:** 2018 average specific conductance of 1,111 µmhos per centimeter compared with a range of 593 µmhos per centimeter (1998) to 1,043 µmhos per centimeter (2013) during 1997 through 2017

- **ECU-7C:** 2018 average specific conductance of 1,084 µmhos per centimeter compared with a range of 594 µmhos per centimeter (1998) to 1,004 µmhos per centimeter (2003) during 1997 through 2017

The unusually long 2018 winter and addition of chlorides found in the deicing chemicals (salt) to the creek for a longer period of time likely caused Main Stem specific conductance measurements to be higher in 2018 than in previous years.

The North Fork of Nine Mile Creek met the MPCA dissolved oxygen standard for Minnesota Class 2B waters more frequently than the Main Stem and South Fork locations in 2018—97 percent of North Fork dissolved oxygen measurements met the MPCA standard compared with 92 percent of Main Stem and 79 percent of South Fork measurements.

A precipitation event on July 1, 2018 increased discharge in the headwaters reaches of the North Fork (ECU-1A-1) and South Fork (ECU-3A, influencing the 2018 averages at these locations such that the 2018 discharge averages were the highest to date. Additionally, the July 1 precipitation event greatly increased turbidity at North Fork locations ECU-1A-1, ECU-2, and N2 such that the 2018 averages were the highest to date. Pictures of (ECU-1A-1) before and after the July 1 precipitation event are shown in Figure 9-2 and Figure 9-3.

Figure 9-2 Pictured above, the North Fork location ECU-1A-1 on June 4, 2018.

Figure 9-3 Pictured above, the North Fork location ECU-1A-1 on July 1, 2018 after a precipitation event increased discharge and turbidity.

The unusually long winter of 2018 and snowmelt extending into May likely reduced pH values at North Fork ECU-1-A-1 such that values lower than the historical range were measured during March through May of 2018.

Snowmelt runoff likely increased turbidity at South Fork N2 such that a value higher than the historical range was observed in March of 2018.

Precipitation events reduced pH values at North Fork ECU-1-A-1 such that values lower than the historical range were observed in July and September of 2018.

A precipitation event on July 1 resulted in:

- Specific conductance values below the historical range at South Fork EU-3A and North Fork ECU-1A-1 and N3
- A discharge value higher than the historical range at North Fork ECU-1A-1 and South Fork ECU-3A
- A turbidity value higher than the historical range at North Fork ECU-2

The dissolved oxygen value at South Fork N2 was higher than the historical range in June. The cause for the higher value is not apparent.

9.2 Ecological Use

Ecological use is a term used to describe the fish assemblage/aquatic life use that the stream has the capacity to support per the stream's flow, water quality, and habitat characteristics. The ecological uses are broken into the following categories:

- Coldwater Fish (Class A)
- Warmwater Sport Fish (Class B)
- Intolerant Forage Fish (Class C)
- Tolerant Forage Fish (Class D
- Tolerant Macroinvertebrates (Class E)

A review of the data indicates the 2018 water quality and stream habitat fully supported the ecological uses of Nine Mile Creek determined from assessments completed during 1997 and 2003. The 2018 fish communities in the North Fork, South Fork, and middle Main Stem (ECU-7B) location were consistent with their ecological uses verifying that the stream was supporting the fish communities that it had the capacity to support. However, the fish community found in upstream (ECU-7A) and downstream (ECU-7C) Main Stem locations were poorer than their designated ecological uses, despite water quality and habitat measurements indicating their ecological uses were supported. The 2018 fish communities at ECU-7A and ECU-7C met the criteria for a tolerant forage fish community, an indicator of average to poor water quality, compared with their designated ecological uses of intolerant forage fish, an indicator of better water quality and habitat).

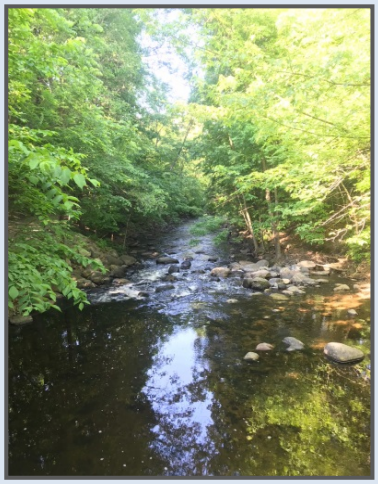


Figure 9-4 **In 2018, fewer fish were collected from the most downstream Main Stem location, ECU-7C, pictured above, than had been collected annually at this location during the past decade.**

In 2018, fewer fish were collected from ECU-7C (Figure 9-4) than had been collected annually from this location during the past decade. The types of fish collected in 2018 were similar to recent years, but the low numbers of fish prevented this stream reach from meeting the threshold required for designation as an intolerant forage fish community. In 2018, ECU-7C noted a collection rate of 0.47 fish per meter (136 fish collected from 289 meter sample reach) which fell short of the threshold of 0.5 fish per meter (at least 1 fish collected per 2 meter sample reach) for designation as an intolerant forage fish community. During 2008 through 2017, the fish collection rate from this location ranged from 0.70 to 1.98 fish per meter. Because the types of fish collected from ECU-7C in 2018 were similar to previous years, the stream would have met the criteria for designation as an intolerant forage fish community if a higher number of fish had been collected.

Figure 9-5 **In 2018, a tolerant forage fish assemblage, an indicator of average to poor water quality, was observed at the most upstream Main Stem location, ECU-7A, pictured above.**

The 2018 tolerant forage fish community at ECU-7A (Figure 9-5) was comparable to the communities observed at this location during the past 4 years, but was a poorer community than its designated ecological use of an intolerant forage fish community. A tolerant forage fish assemblage indicates average to poor water quality while an intolerant forage fish community indicates better water quality and habitat conditions. Over time, frequent fluctuations in the fish community have been observed at this location, varying between warmwater sportfish, intolerant forage fish, and tolerant forage fish. Changes in the fish community have been attributed to varying oxygen conditions due to impacts from upstream Marsh Lake. Water exiting the marsh may have either lower or higher oxygen levels than downstream locations, depending upon biological processes occurring within the marsh.

In 2018, the fish community at the most downstream North Fork location, ECU-2A was intolerant forage fish, which is better than the designated ecological use for this location (tolerant forage fish) and of higher quality than the fish communities observed in recent years (Figure 9-6) and (Figure 9-7). The improved fish community in 2018 may be a result of the Edina stream stabilization project completed during 2017 through 2018.

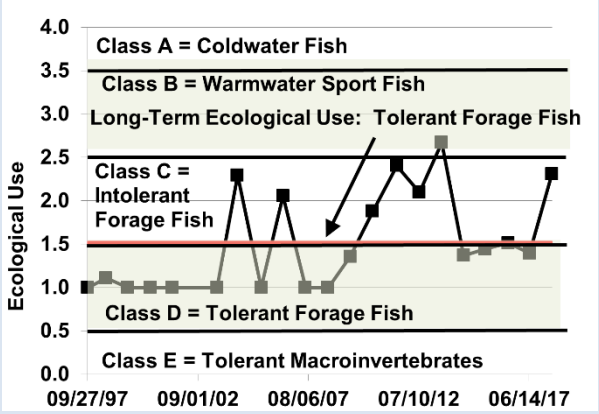


Figure 9-6 1997-2018 North Fork ECU-2A Ecological Use (Type of Fish Community)

9.3 Fish IBI

Fish collected from Nine Mile Creek in 2018 were assessed to determine whether the stream met the Fish Index of Biotic Integrity (IBI) used by the MPCA to determine biological impairment from 1997 until 2018. The Fish IBI used to assess Nine Mile Creek was developed during the Minnesota River Assessment Project (MRAP) during the mid-1990s to determine fish impairment in streams tributary to the Minnesota River, including Nine Mile Creek. The MRAP Fish IBI defined impairment as failing to meet a threshold score of 30 or greater out of a possible score of 60. Only streams with a watershed area of at least 5 square miles were obligated to comply with the MRAP Fish IBI impairment threshold. The 2018 fish data were assessed with the MNRAP Fish IBI to determine whether 2018 fish data were consistent with historical data.

Figure 9-7 In 2018, improvements in the fish and macroinvertebrate communities were observed at North Fork location ECU-2A, pictured above. The improvements may be a result of the Edina stream stabilization project completed during 2017 through 2018.

In 2018, two of the six Nine Mile Creek monitoring locations with a watershed area greater than 5 square miles met the MRAP Fish IBI standard –the most downstream North Fork location, ECU-2A (Figure 9-6), and the most downstream Main Stem location ECU-7C (Figure 9-4). The most downstream location of Nine Mile Creek, ECU-7C, has met the MRAP Fish IBI standard annually during 2003 through 2018 (Figure 9-9). All other locations have fluctuated between meeting or sometimes failing the standard during this time period. In 2006 and 2012, all Nine Mile Creek locations met the MRAP Fish IBI standard. The 2018 Fish IBI values were consistent with historical data Figure 9-9.

Habitat and water quality improvements from the North Fork (Hopkins) stream stabilization project have improved MRAP Fish IBI scores at North Fork location ECU-1A/1A-1 (Figure 9-2, Figure 9-3, and Figure 9-8). The pre-project MRAP Fish IBI score from ECU-1A/1A-1 was 26.4, which did not meet the

impairment threshold of at least 30. Following completion of the North Fork (Hopkins) stream stabilization project, MRAP Fish IBI scores from ECU-1A/1A-1 have consistently met the MRAP Fish IBI impairment threshold even though not required since the tributary watershed to this reach is less than 5 square miles (Figure 9-8).

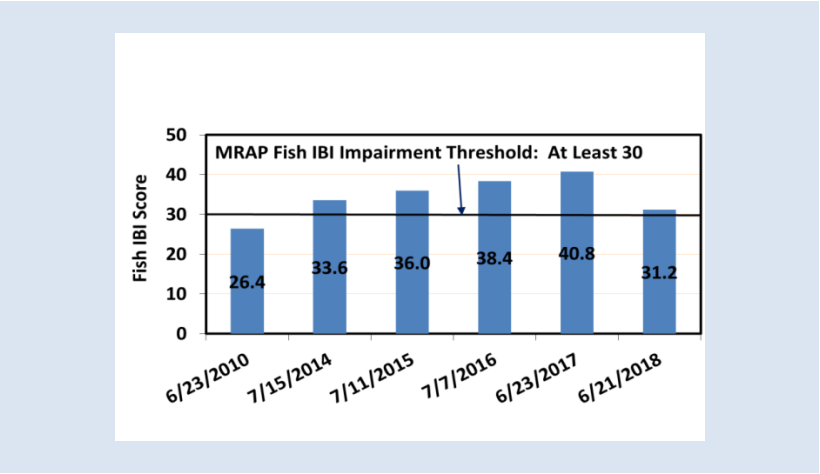


Figure 9-8 MRAP Fish IBI Scores for Nine Mile Creek Station ECU-1A/1A-1 during 2010 and 2014 2018

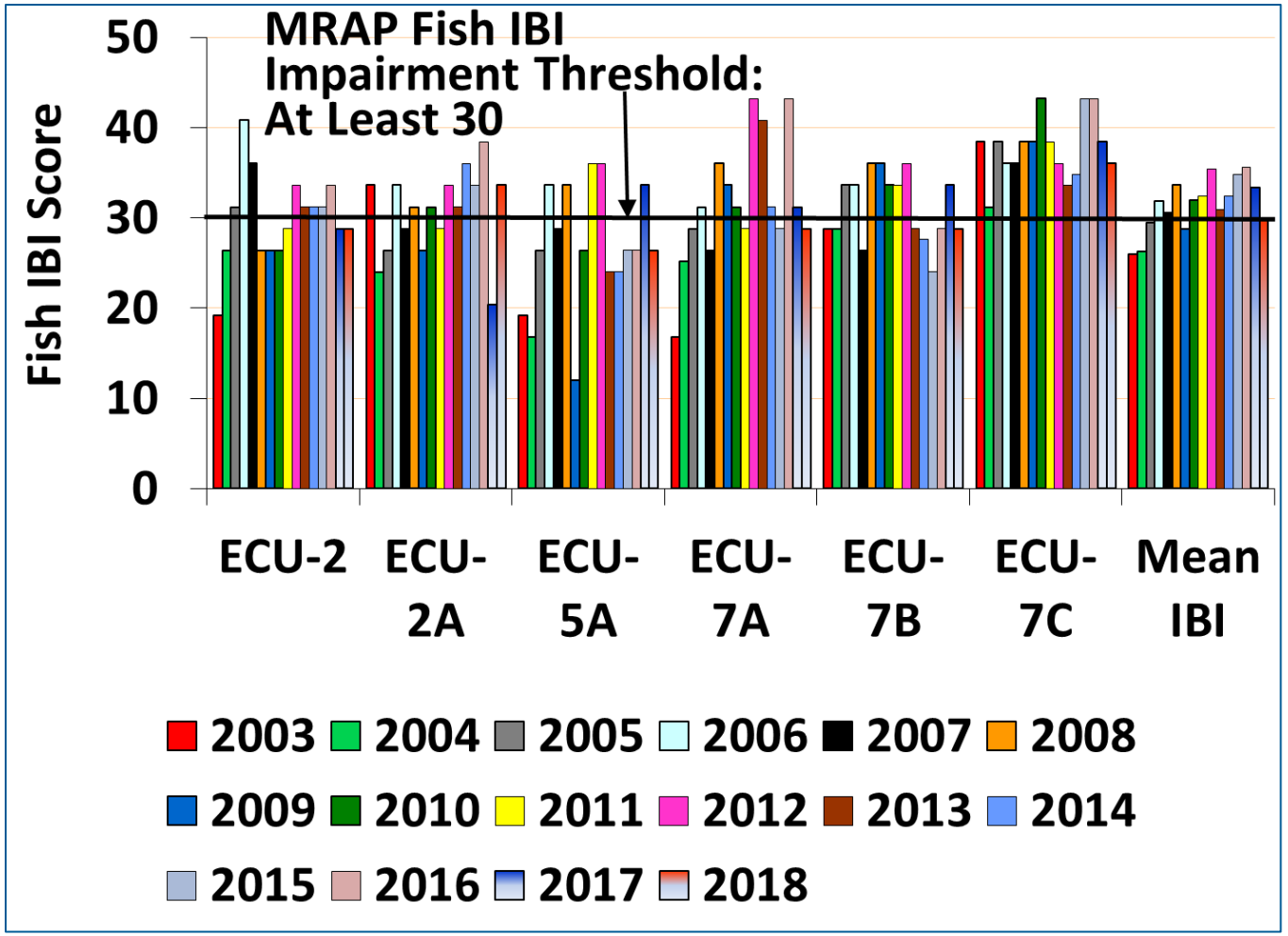


Figure 9-9 2003-2018 Nine Mile Creek MRAP Fish IBI Scores

9.4 Macroinvertebrates

Nine Mile Creek macroinvertebrates (bugs that can be seen with the naked eye) were assessed using two biotic indices to evaluate the water quality of Nine Mile Creek. The Hilsenhoff Biotic Index (HBI) was used to assess the long-term oxygen content of the stream. HBI assesses stream oxygen by determining the average tolerance of the macroinvertebrate community to low oxygen conditions. A second index, the Invertebrate Community Index (ICI), provides a broader view of the stream's water quality than the HBI, determining the average tolerance of the macroinvertebrate community to a wide range of pollutants.

In 2018, HBI and ICI scores from most locations were consistent with past scores. However, improvements in HBI (Figure 9-10) and ICI (Figure 9-11) scores were documented in 2018 for the most downstream North Fork location, ECU-2A (Figure 9-6). The 2018 improvement in HBI score was statistically significant. The 2018 improvements in HBI and ICI scores may be a result of the Edina stream stabilization project completed by the District during 2017 through 2018.

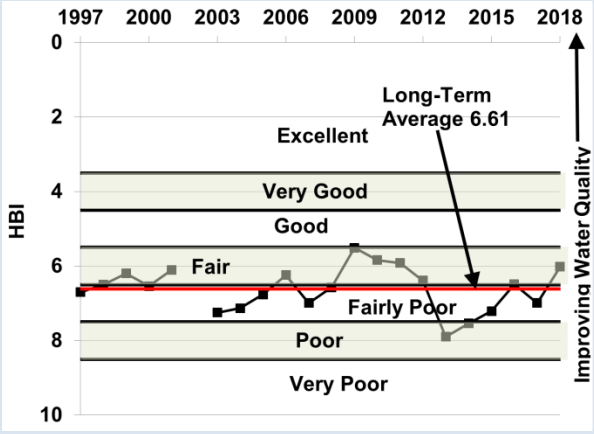


Figure 9-10 1987-2018 Nine Mile Creek HBI: Most Downstream North Fork Location, ECU-2A

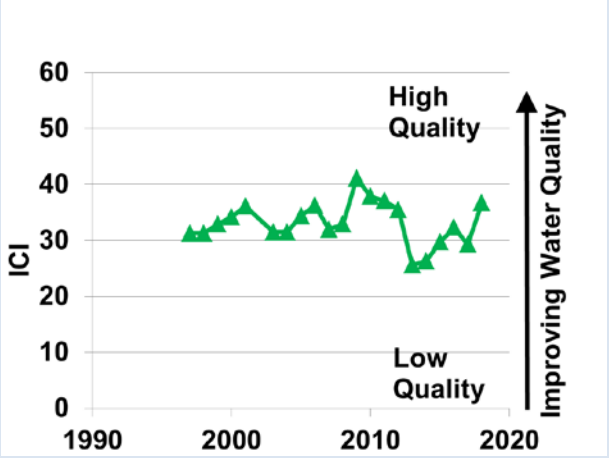


Figure 9-11 1997 2018 Nine Mile Creek ICI: Most Downstream North Fork Location, ECU-2A

The HBI and ICI values from the most upstream location on the Main Stem of Nine Mile Creek (ECU-7A) indicated water quality degradation occurred in 2018. The change in HBI score was statistically significant. The 2018 decline in water quality was preceded by improvement in 2017 and decline in 2016. Frequent fluctuations in both HBI and ICI values have occurred at this location during the period of record. (Figure 9-12 and Figure 9-13). These fluctuations are primarily due to the influence of Marsh Lake on the oxygen concentrations of downstream waters. Oxygen levels within Marsh Lake fluctuate due to biological activity within the marsh – plant photosynthesis during the day raises oxygen levels and at night plant respiration lowers oxygen levels. Water exiting the marsh may have either lower or higher oxygen levels than downstream locations, depending upon biological processes occurring within the marsh. The fluctuations in stream oxygen levels downstream of Marsh Lake cause changes in the macroinvertebrate assemblage, reflected by fluctuating HBI and ICI values. As noted previously, the fluctuating oxygen levels at this location also cause fluctuations in the fish community. Improved oxygen conditions have resulted in an improved fish community (e.g., intolerant forage fish) while poorer oxygen conditions have resulted in a poorer fish community (e.g., tolerant forage fish).

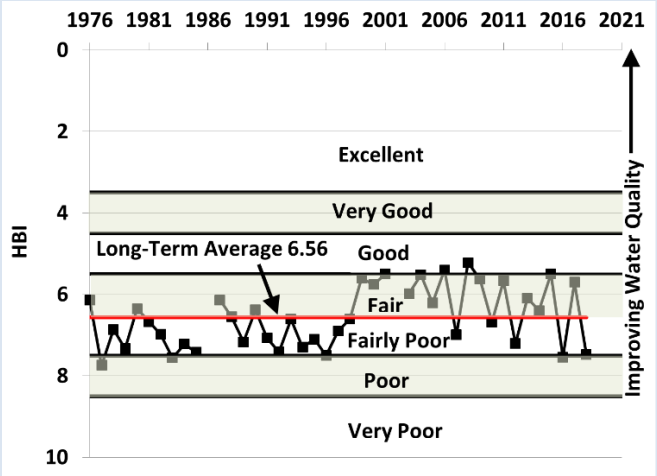


Figure 9-12 1997 2018 Nine Mile Creek HBI: Main Stem Station ECU-7A/N1

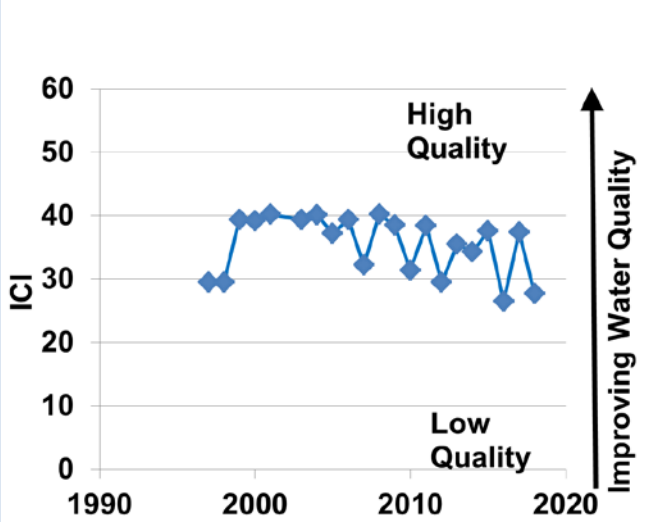


Figure 9-13 1997 2018 Nine Mile Creek ICI: Main Stem Station ECU-7A/N1

9.5 Conclusions and Recommendations

2018 Nine Mile Creek water quality and biological data are summarized in Table 9-1.

Overall, the 2018 water quality values were within MPCA standards 84 percent of the time. Individual sample locations met the MPCA standard from 78 to 94 percent of the time.

All water quality values from the Main Stem were within the historical range. South Fork locations ECU-3A and N2 each observed two values outside of the historical range. North Fork locations ECU-2 and N3 each observed one value outside of the historical range, and ECU-1A observed seven values outside of the historical range.

Figure 9-14 Deicing chemicals applied to roads and parking lots within the Nine Mile Creek watershed have been conveyed to the stream and resulted in high chloride concentrations in the stream. In 2018, 55 percent of chloride measurements failed to meet the MPCA standard.

Nine Mile Creek has been listed on the Minnesota Pollution Control Agency's (MPCA) 303(d) list since 2004 for impairment due to chloride levels in excess of the state water quality chronic standard of 230 milligrams per liter. Specific conductance is a measurement of the conductive ions in water from dissolved and inorganic materials, including chlorides, and as such provides an indication of changing chloride levels. In 2018, only 45 percent of specific conductance measurements from Nine Mile Creek met the MPCA standard. The 2018 average specific conductance values from the Main Stem were the highest annual averages to date. The higher average chloride concentrations on the Main Stem and the failure of Nine Mile Creek specific conductance values to meet the MPCA specific conductance standard more than half of the time are likely due to the longer than usual 2018 winter. This atypical winter included snow and the associated application of deicing chemicals through April and snowmelt continued into May.

In 2009, the District worked with the MPCA to complete a Chloride Total Maximum Daily Loads project to understand the sources of chloride loading to Nine Mile Creek and to determine recommended measures to address the problem. The study concluded that more than a third of the stream's chloride loading was from commercial and private applications of salt. Municipalities contributed another 40 percent of the load. The chloride loading reduction required to meet the MPCA standard was estimated at 62 percent. Recommended chloride management measures included a pilot-scale chloride loading study to determine sources and potential improvement measures for chloride loading reductions. In addition, a public education and training exchange with municipalities and private/commercial salt applicators was recommended.

In 2016, the Minnesota Pollution Control Agency prepared a Twin Cities Metro Chloride Management Plan (Plan). The Plan recommends a performance-based approach and use of a winter maintenance assessment tool (Smart Salting Assessment Tool, SSAt) to reduce chloride loading from watersheds. The SSAt is a free, web-based tool that can be used to assist public and private winter maintenance organizations in determining where opportunities exist to improve practices, make reductions in salt use, and track progress.

The completed Hopkins and Edina stream stabilization projects appear to have improved the fish and macroinvertebrate communities of the stabilized reaches. Improved fish and macroinvertebrate communities were documented at the most downstream North Fork location, ECU-2A, in 2018. The improved fish community resulting from the Hopkins stream stabilization project completed at the most upstream North Fork reach, ECU-1A-1, has been sustained since project completion. It is recommended that the District continue its efforts to identify and implement feasible stream stabilization projects.

Continued monitoring at the annual stream monitoring stations is recommended to maintain this long-term record of water quality and biota in Nine Mile Creek and to assess the biological community to determine changes in stream habitat or water quality that warrant further investigation or management measures.

Minnesota has adopted changes to its water quality standards that establish biological water quality standards for all Minnesota streams and rivers, including Nine Mile Creek. The changes were approved by the United States Environmental Protection Agency on June 26, 2018. Although the MPCA has assessed streams for biological impairment in the past, the MPCA water quality standards (Minn. Rule Chapters 7050 and 7052) did not previously contain biological standards. The MPCA intends to use a Fish IBI method to assess attainment of the standards that is different from the MRAP Fish IBI used to assess Nine Mile Creek for biological impairment. In addition, the MPCA has added a macroinvertebrate IBI to its biological water quality standards. It is recommended that in the future the District consider using the MPCA-recommended IBIs to assess the fish and macroinvertebrate communities of Nine Mile Creek to determine whether or not the stream is biologically impaired for fish and/or macroinvertebrates. If the stream is identified as biologically impaired using these methods, it is further recommended that the MPCA's fish IBI and macroinvertebrate IBI be applied to past fish and macroinvertebrate data from Nine Mile Creek to compare historic results using the two methods.

Table 9-1 Nine Mile Creek 2018 Water Quality and Biological Data Summary

Monitoring Station	% of Values Within MPCA Criteria (2018)	# of Values Outside of Historical Range (2018)	Potential Ecological Use Classification[1]	Actual Ecological Use: From Fish Data 2018	Historical Ecological Use (From Long-Term Fish Data)[1]	Attainable Ecological Use[1]	HBI Water Quality Classification from Invertebrate Data (2018)	ICI from Invertebrate Data (2018)
ECU-1A	78	7	E	D (1.11)	D(1.22)	D	7.70 (Poor)	27.0
ECU-2	81	1	D	D (1.17)	D (1.27)	D	6.15(Fair)	36.6
ECU-2A	81	0	D	C (2.31)	C (1.52)	D	6.02 (Fair)	36.7
N3	84	1	--	--	--	--	--	--
ECU-3A	94	2	E	D (1.13)	D (1.02)	E	8.00 (Poor)	26.1
N2	81	2	--	--	--	--	--	--
ECU-5A	81	0	D	D (1.00)	D (1.12)	D	7.92 (Poor)	26.5
ECU-7A/N1	81	0	D	D (1.31)	C (1.94)	C	7.48 (Fairly Poor)	27.7
ECU-7B	88	0	D	D (1.25)	D (1.39)	D	4.75 (Good)	41.1
ECU-7C	88	0	D	D (1.00)	C (1.88)	D	4.28 (Good)	40.0
Average	84	--`	D	D (1.29)	D (1.42)	D	6.54 (Fairly Poor)	32.7

[1] Ecological Use classification from *Nine Mile Creek Water Management Plan* (2004), from 2003 monitoring data, from 2003 fish data, and from 1974-2003 fish data: A = cold water sport fish, B = warm water sport fish, C = intolerant forage fish, intolerant macroinvertebrates, or a valuable population of tolerant forage fish; D = tolerant or very tolerant forage fish or rough fish or tolerant macroinvertebrates, and E = very tolerant macroinvertebrates or no aquatic life.

Appendices

(in Separate PDF)