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2018 Annual Water Quality Report

Prepared for:

Shingle Creek and West Mississippi Watershed Management Commissions

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(Appendices are available at http://www.shinglecreek.org/water-quality.html.)

Executive Summary

The Shingle Creek and West Mississippi Watershed Management Commissions annually monitor water quality in the lakes, streams and outfalls of the watersheds. The Commissions' technical staff obtains the stream and some lake water quality, fisheries and vegetation data while volunteers also collect lake water quality and stream and wetland macroinvertebrate data.

Water quality in a given year is influenced by the amount of precipitation and the type of precipitation events. Overall, 2018 had more precipitation than the long-term average for this area (Appendix A), with September experiencing 4.55 inches more rain than average. This example of annual variability illustrates why long-term monitoring is necessary to determine potential trends in the data and what may be considered natural variability.

Water quality in Shingle Creek and Bass Creek and in the outfalls of the West Mississippi watershed is typical of urban streams in the Twin Cities metropolitan area. Water in these streams and outfalls is dominated by watershed runoff. Both Shingle Creek and Bass Creek are listed as Impaired Waters for chloride, bacteria, biota, and dissolved oxygen.

The lakes in Shingle Creek are typical of urban lakes. Thirteen of the 16 lakes were originally listed as Impaired Waters of the State due to excess nutrients. TMDLs and Implementation Plans have been approved for all the Impaired Waters, and the Commission and its member cities have been actively implementing improvements.

Trends in water quality are mostly stable, but water quality projects and best management practices continue to be implemented throughout the watershed. These include improved erosion control and street sweeping in the watershed; the ban on phosphorus in fertilizer; retrofits of best management practices in the watershed, both as part of redevelopment and as stand-alone projects; and stream stabilization projects reducing bank erosion. In part as a result of these measures, some water quality improvements have been observed. For example, the water quality in Shingle Creek at the outlet monitoring site in Minneapolis (SC-0) shows statistically significant decreasing trends in total phosphorus (TP) and total suspended solids (TSS) concentrations. There are also more lakes showing improving trends than deteriorating trends in TP, chlorophyll and/or Secchi depth.

1.0 Introduction

BACKGROUND

Minnesota Administrative Rule 8410.0100 Subp.5 requires watershed management organizations to conduct monitoring programs "capable of producing accurate data to the extent necessary to determine whether the water quality and quantity goals of the organization are being achieved."

The Shingle Creek and West Mississippi Watershed Management Commissions (WMC) began monitoring water quality and streamflow in 1990. In Shingle Creek, 12 sites were monitored from 1990–1992, however monitoring was discontinued from 1992–1995. Shingle Creek monitoring has since resumed on an annual basis at two long-term monitoring sites (SC-0 and SC-3) (Figure 1-1). In 2013, a third routine stream monitoring site was added near the outlet of Bass Creek (BCP). The West Mississippi WMC monitored water quality and streamflow from 1990-1992 at two outfall sites in the Oxbow Creek and Mattson Brook watersheds (Figure 1-1). Results indicated very little flow in these tributaries and no water quality or quantity problems or concerns. Thus, the Commission chose to discontinue monitoring after the 1992 monitoring season. In 2010, the Commission elected to once again monitor water quality and flow at 2-3 outfall monitoring sites per year in the West Mississippi watershed.

Thirteen of the sixteen lakes in Shingle Creek are periodically monitored for water quality by volunteers through the Citizen Assisted Monitoring program (CAMP) (Figure 1-1). Additionally, Wenck staff conducts intensive monitoring on two lakes per year as part of the 5-year TMDL review for these lakes. High school volunteers coordinated by Hennepin County Environmental Services (HCES) perform macroinvertebrate monitoring at various locations in the watersheds (Figure 1-1). HCES also coordinates wetland monitoring by adult volunteers (Figure 1-1).

OBJECTIVES

The Shingle Creek and West Mississippi WMCs have established monitoring objectives to guide their monitoring programs. The following objectives have been established for stream, outfall and lake monitoring in both watersheds:

- To quantify the current status of streams/outfalls and lakes (Shingle Creek only) throughout the watershed in comparison to state water quality standards established for nutrients, turbidity, chloride, bacteria, and other parameters currently regulated by the State.
- To quantify changes over time, or trends, in stream and lake water quality in the Shingle Creek and West Mississippi watersheds.
- To quantify the effectiveness of implemented BMPs throughout the watershed for the protection of water quality.

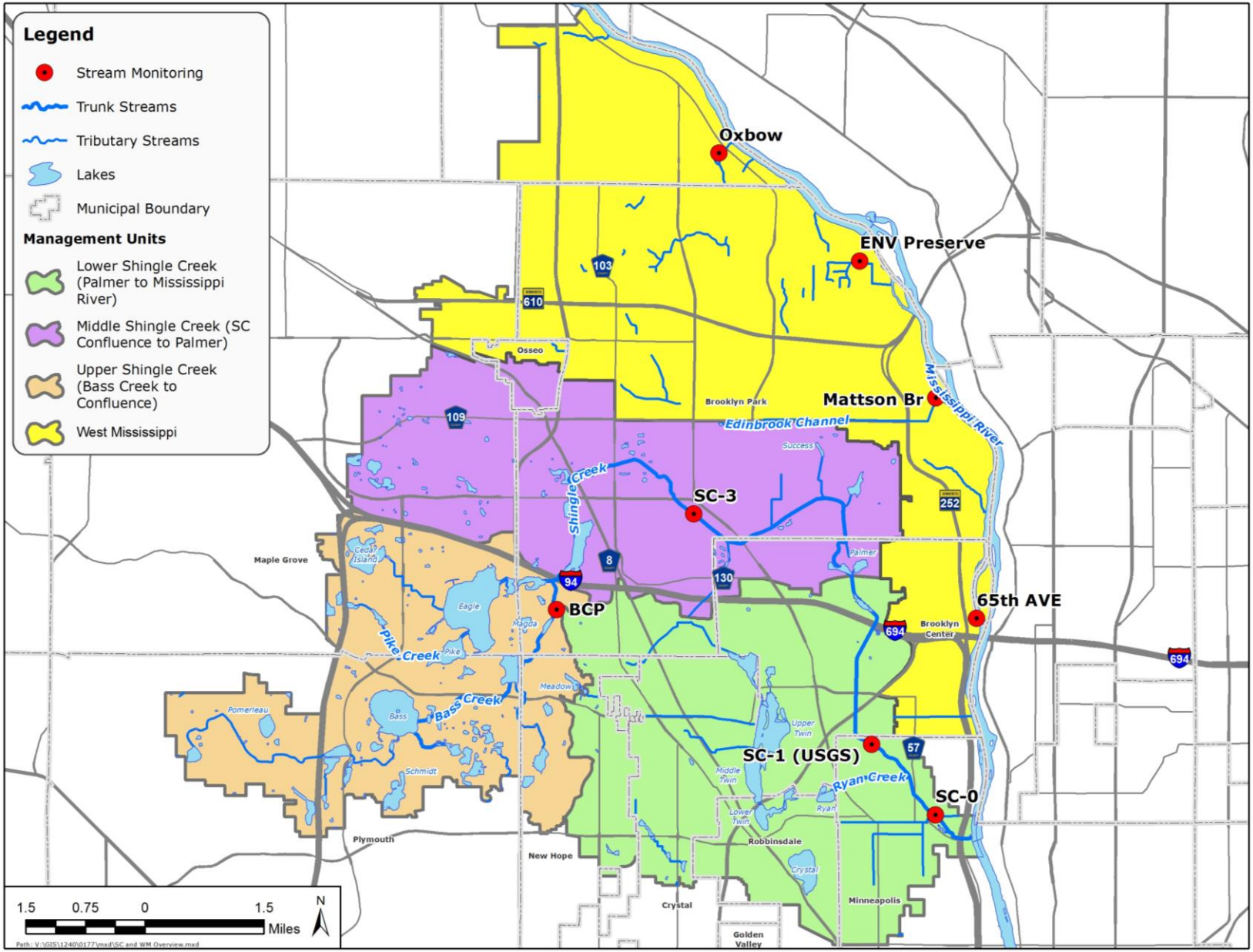

Figure 1-1. Shingle Creek and West Mississippi management units, streams, lakes, and monitoring sites.

TMDLS AND IMPLEMENTATION PLANS

The majority of the lakes in the Shingle Creek watershed do not meet state standards for water quality and are included on the Minnesota Pollution Control Agency (MPCA) 303(d) List of Impaired Waters. The 303(d) list is named after the section of the federal Clean Water Act that requires states to set water quality standards and to assess conditions in lakes, rivers, and streams to determine if those standards are being met. If the standards are not met, a Total Maximum Daily Load (TMDL) study must be completed to identify the course of action needed to restore the resource to meet state standards. Table 1-1 below shows the Impaired Waters in the Shingle Creek watershed. Regional or statewide impairments that affect the watershed are also noted in Table 1-1 and are being sponsored by the MPCA. The Commission has completed TMDLs for the balance of the impairments.

Each TMDL establishes a water quality goal and a pollutant load reduction to achieve that goal. A separate TMDL Implementation Plan sets forth actions that will be undertaken by various stakeholders. Those actions include the continuation and expansion of lake and stream monitoring to assess progress toward the load reductions and water quality goals.

Schmidt, Lower Twin, and Ryan Lakes were delisted, or removed from the 303(d) list by the MPCA in 2014. Actions taken in the watershed and lakes have improved water quality to state standards. Those lakes are now considered to be "protection lakes," and the focus has shifted to maintaining or continuing to improve water quality.

Table 1-1. Impaired Waters in the Shingle Creek watershed.

Water Resource	Impairment	Date TMDL Approved	5-year Review
Bass Lake	Nutrients	9/25/09	Completed 2017
Cedar Island Lake	Nutrients	4/14/10	Completed 2018
Crystal Lake	Nutrients	3/25/09	Completed 2016
Eagle Lake	Nutrients	4/14/10	Completed 2018
Lake Magda	Nutrients	9/30/10	2019
Meadow Lake	Nutrients	3/23/10	2019
Pike Lake	Nutrients	4/14/10	Completed 2018
Pomerleau Lake	Nutrients	9/25/09	Completed 2017
Ryan Lake	Nutrients	11/9/07	Completed 2014
Schmidt Lake	Nutrients	9/25/09	Completed 2017
Upper, Middle, and Lower Twin Lake	Nutrients Mercury in fish PFOS, PCB in fish	11/9/07 3/27/07 (MPCA) Not yet begun (MPCA)	Completed 2014
Shingle Creek	Chloride	2/14/07	Completed 2014
Shingle Creek	Dissolved oxygen	11/4/11	2019-20
Shingle Creek	Biota-macroinvertebrates	11/4/11	2019-20
Shingle Creek	*E. coli*	11/20/14 (MPCA)	2019-20
Bass Creek	Biota-fish	11/4/11	2019-20
Bass Creek	Chloride	Metro wide TMDL (MPCA)	2020

2.0 Overview of 2018 Monitoring Efforts

2018 monitoring activities in the Shingle Creek and West Mississippi watersheds included stream and outfall monitoring, lake monitoring, and volunteer wetland monitoring. Each of these efforts are described below in more detail.

STREAM AND OUTFALL MONITORING

Continuous flow measurements and water quality samples were collected by the Commission at six locations in the Shingle Creek and West Mississippi watersheds. Two of the stations, Oxbow Creek and Environmental Preserve (ENVP), are located in the West Mississippi Management Unit (Figure 1-1). The other stations include Bass Creek Park (BCP), SC-3, and SC-0 and are located in the Upper, Middle, and Lower Shingle Creek Management Units, respectively (Figure 1-1). Additionally, the USGS, in partnership with the Shingle Creek WMC, monitored continuous flow at station SC-1 in the Lower Shingle Creek Management near the outlet of Shingle Creek. Each monitoring station is described in more detail in Sections 3.0 through 6.0.

Stream stage height (water level) was continuously recorded from May through October at all monitoring stations in 2018. Stage height was used to calculate stream discharge using site-specific stage-discharge relationships (Appendix C). Routine water quality grab samples were collected once per month at the West Mississippi sites and two times per month at the Shingle Creek sites. In addition to water quality grab samples, at least two storm composite samples were collected at each Shingle Creek monitoring station and one storm composite sample was collected at each West Mississippi monitoring station using automated sampling equipment. Routine samples at each Shingle Creek site were analyzed for total phosphorus (TP), orthophosphorus (ortho-P), total dissolved phosphorus (TDP), total suspended solids (TSS), total Kjehldal nitrogen (TKN), nitrate/nitrite (NO2/NO3) and chloride. Routine samples at each West Mississippi site were analyzed for TP, ortho-P, TSS, and chloride. Storm samples were analyzed for the same parameters with the exception of chloride. Field parameters were also recorded during each routine site visit, including dissolved oxygen (DO), temperature, pH, and conductivity.

Overall, rainfall in the Shingle Creek and West Mississippi Watersheds was approximately 3.7 inches above normal (1992-2018) (Appendix A). During the first half of 2018 (January to June), precipitation was 1.1 inches below normal, while the second half of 2018 (July through December) was 4.9 inches above normal. This pattern resulted in normal low-flow conditions throughout the watersheds during spring and early summer with an increase in flow conditions during late summer into the fall. September's precipitation was 4.6 inches above normal and drove the second half of the year statistics. In a normal year, we typically see higher flow conditions during spring and early summer followed by low-flow conditions in the late summer and early fall. However, 2016 experienced a similar precipitation pattern to that of 2018 where greater rainfall events are beginning to occur more frequently late in the year.

In 2018, stream pollutant concentrations were similar to prior years. More detailed results of the stream and outfall flow and water quality sampling are presented in the following sections and in Appendices A-C. Sections 4.0 through 7.0 of this report provide more in-depth analysis of the impairment status within each management unit.

LAKE MONITORING

There are 16 lakes in the Shingle Creek watershed, and none in the West Mississippi watershed. The Shingle Creek WMC has monitored 14 of the lakes routinely since 1996 through the Citizen Assisted Lake Monitoring Program (CAMP) and the Commission's Intensive Lake Monitoring Program (Palmer and Curtis Lakes have not been monitored). The CAMP was initiated by the Met Council to supplement the water quality monitoring performed by Met Council staff and to increase knowledge of water quality of Metro area lakes. Volunteers in the program monitor their lake every other week from mid-April to mid-October. They measure surface water temperature, Secchi depth, and collect surface water samples that are analyzed by the Met Council for TP, TKN, and chlorophyll-a.

The Commission's Intensive Lake Monitoring Program was established in 2012. Through this program, each lake in the watershed is monitored approximately every five years to evaluate protection efforts for lakes that are not impaired, and to assess progress toward achieving the TMDLs and state water quality standards for the impaired lakes. Monitoring activities include early and late season vegetation surveys, sediment core collection, fish community surveys and bi-weekly water quality sampling, including water column sampling. The methods and sampling techniques for biological communities and more thorough summaries are outlined in the Appendix E.

Six lakes were monitored in 2018. Crystal and Ryan Lakes were the two lakes selected for the Commission's Intensive Lake Monitoring in 2018, while Upper, Middle and Lower Twin Lakes were sampled under the EPA Section 319 carp management grant project. Bass Lake was also assessed by Three Rivers Park District and CAMP with Wenck conducting SAV monitoring in 2018. A detailed review of the 2018 lake data is presented in Appendix E.

VOLUNTEER MONITORING

Both Commissions have sponsored volunteer opportunities for students and adults to undertake lake, stream and wetlands monitoring. The Citizen Assisted Monitoring Program (CAMP) is managed by the Metropolitan Council. The Shingle Creek Commission participates by recruiting and training volunteers and paying a modest fee each year for lab sample processing and consumables. In 2018, Bass Lake was monitored through CAMP and that data can be found in the Upper Shingle Creek Management Unit section below.

Both Commissions work with Hennepin County Energy and Environment to offer opportunities for high school students to monitor stream macroinvertebrates (RiverWatch) and for adult volunteers to monitor wetland health (Wetland Health Evaluation Program, WHEP). WHEP data is presented in Appendix D.

3.0 Figure Interpretation

The following sections contain dot charts that summarize the most recent (blue circle and year label) and historic (open black circle) water quality conditions and biota health indices (Figure 3.1). Each dot within the chart represents the percent difference from the respective impairment threshold/criteria for each parameter. Positive percent difference values (red shaded area) are exceedances of the standard while negative percent difference values (green shaded area) are conditions meeting standards. Values that deviate from the standard by more than double (> ±100%) are represented by a black open circle with a 'x' through it. These values are also reported as ± 110% (i.e. Fig 3.1 – Chloride). Parameters with no value assignment are current data gaps (i.e. Fig 3.1 – *E. coli*). Stream and lake specific metrics, standards and data manipulations are reported in the following subsections.

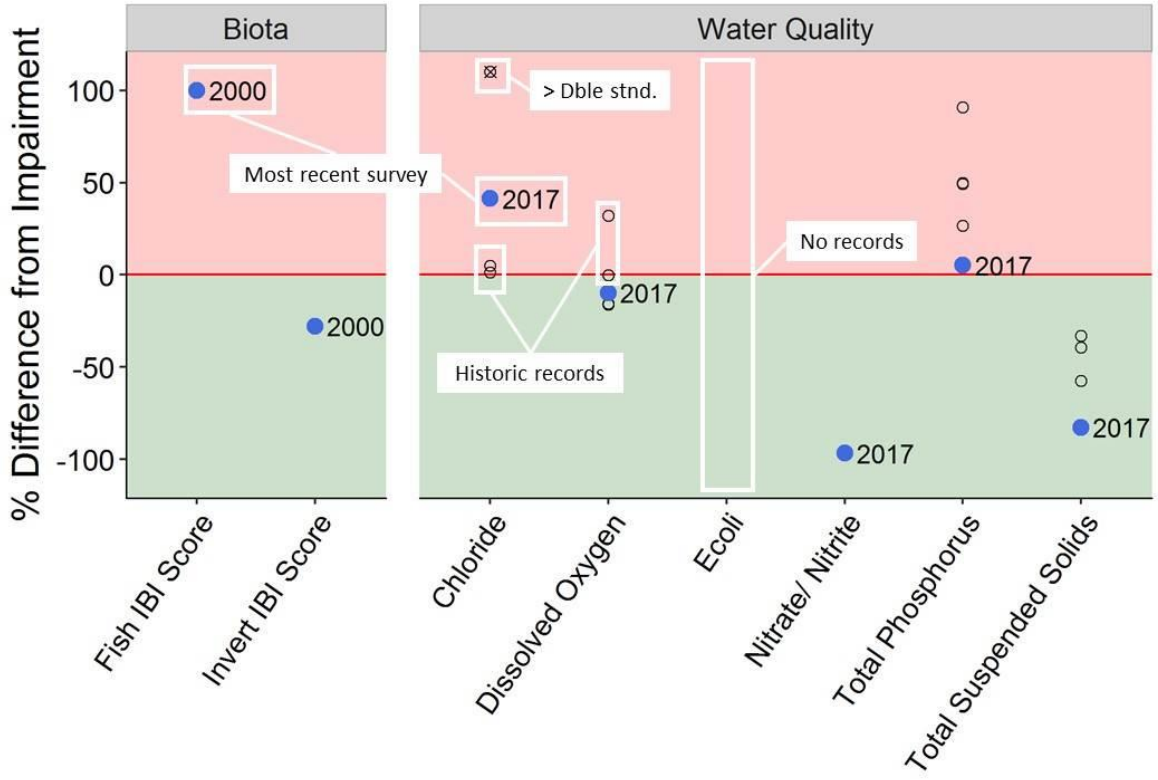

Figure 3-1. Example of data summary reporting for a stream sample site.

3.1 Streams

Stream metrics and respective threshold criteria reported in the dot charts are:

- Dissolved Oxygen (DO) [1] = 5 mg/L = MPCA standard
- Total Phosphorus (TP) [1] = 100 ug/L = MPCA standard
- Total Suspended Solids (TSS) [1] = 30 mg/L = MPCA standard
- Nitrate/ Nitrite (NO_3/NO_2) [1] = 4.9 mg/L= MPCA draft aquatic toxicity chronic standard
- Chloride [2] = 230 mg/L = MPCA standard
- *Escherichia coli* (*E. coli*) [3] = 126 cfu/100mL = MPCA standard

- Fish Indices of Biotic Integrity (Fish IBI) [4] = 42 = MPCA standard
- Invert Indices of Biotic Integrity (Invert IBI) [5] = 43 = MPCA standard

[1] Summer month average (6/1 - 9/30)
[2] Winter month average (11/1 - 4/30)
[3] Monthly geomean from previous 10 years
[4] Low gradient IBI standard
[5] Southern forest glide pool IBI standard

3.2 Deep Lakes

Deep lake metrics and respective threshold criteria reported in the dot charts are:

- Chlorophyll-*a* (Chl-a) [1] = 14 µg/L = MPCA standard
- Total Phosphorus (TP) [1] = 0.04 mg/L = MPCA standard
- Secchi Depth [1] = 1.4 m = MPCA standard
- Floristic Quality Index (FQI) = 18.6 = MnDNR 2B standard
- Species Richness = 12 = MnDNR 2B standard
- Common Carp Density = 100 kg/ha = critical impairment threshold
- Fish IBI Tool #2 [2] = 45 = MnDNR standard
- Fish IBI Tool #4 [2] = 39 = MnDNR standard
- Fish IBI Tool #7 [2] = 37 = MnDNR standard

[1] Summer month average (6/1 - 9/30)
[2] Fish IBI tool is determine by MnDNR lake class grouping

3.3 Shallow Lakes

Shallow lake metrics and respective threshold criteria reported in the dot charts are:

- Chlorophyll-*a* (Chl-a) [1] = 20 µg/L = MPCA standard
- Total Phosphorus (TP) [1] = 0.06 mg/L = MPCA standard
- Secchi Depth [1] = 1.0 m = MPCA standard
- Floristic Quality Index (FQI) = 17.8 = MnDNR 2B standard
- Species Richness = 11 = MnDNR 2B standard
- Common Carp Density = 100 kg/ha = critical impairment threshold

[1] Summer month average (6/1 - 9/30)

4.0 West Mississippi Management Unit

WEST MISSISSIPPI MANAGEMENT UNIT OVERVIEW

The West Mississippi Management Unit encompasses the entire West Mississippi Watershed Management Commission jurisdictional boundary. This management unit covers 16,000 acres across five municipalities in Hennepin County. Brooklyn Park (64%) covers a majority of the management unit, with Champlin (20%), Brooklyn Center (11%), Maple Grove (5%), and Osseo (1%) making up the rest (Figure 4-1 and Table 4-1).

The West Mississippi Management Unit is highly developed, however there is still approximately 1,000 acres (7% of management unit) of agricultural land still in production within the City of Brooklyn Park in the western portion of the watershed. Most of the developed land in the watershed is single family residential and therefore the most common land use classification is low-moderate impervious development (38%). Due to soil conditions within the watershed, there are no lakes and very few wetlands. Land use for the West Mississippi Management Unit is summarized in Table 4-1.

One of the defining characteristics of the West Mississippi Management Unit is its sandy, well-draining soils. Much of the watershed is located within the Anoka Sand Plain and therefore approximately 88% of the management unit contains type A, A/D, or B soils (Table 4-1). Soil type for the West Mississippi Management Unit is summarized in Table 4-1.

There are four major outfalls in West Mississippi: Oxbow, Environmental Preserve, Mattson Brook, and 65th Avenue outfalls. Located in Champlin, the Oxbow storm sewer outfall consists of a series of storm sewer pipes that drain approximately 1,167 acres of land in Champlin and Maple Grove. The Environmental Preserve is a small stream located in Brooklyn Park. This stream drains approximately 2,160 acres upstream of Brooklyn Park's Environmental Preserve and outlets to a small wetland in the Coon Rapids Dam Regional Park. Mattson Brook is another small surface channel/stream that drains most of central Brooklyn Park (approximately 3,500 acres) and includes a tributary, Edinbrook/Century Channel. The 65th Avenue outfall is located in Brooklyn Center at the northeast corner of the Highway 252 and Interstate 694 interchange. This outfall drains approximately 590 acres of land in Brooklyn Center, which includes runoff from the commercial and industrial land west of Highway 252. The remainder of the West Mississippi Management Unit is made up of a series of small outfalls with relatively small drainage areas that discharge directly to the Mississippi River.

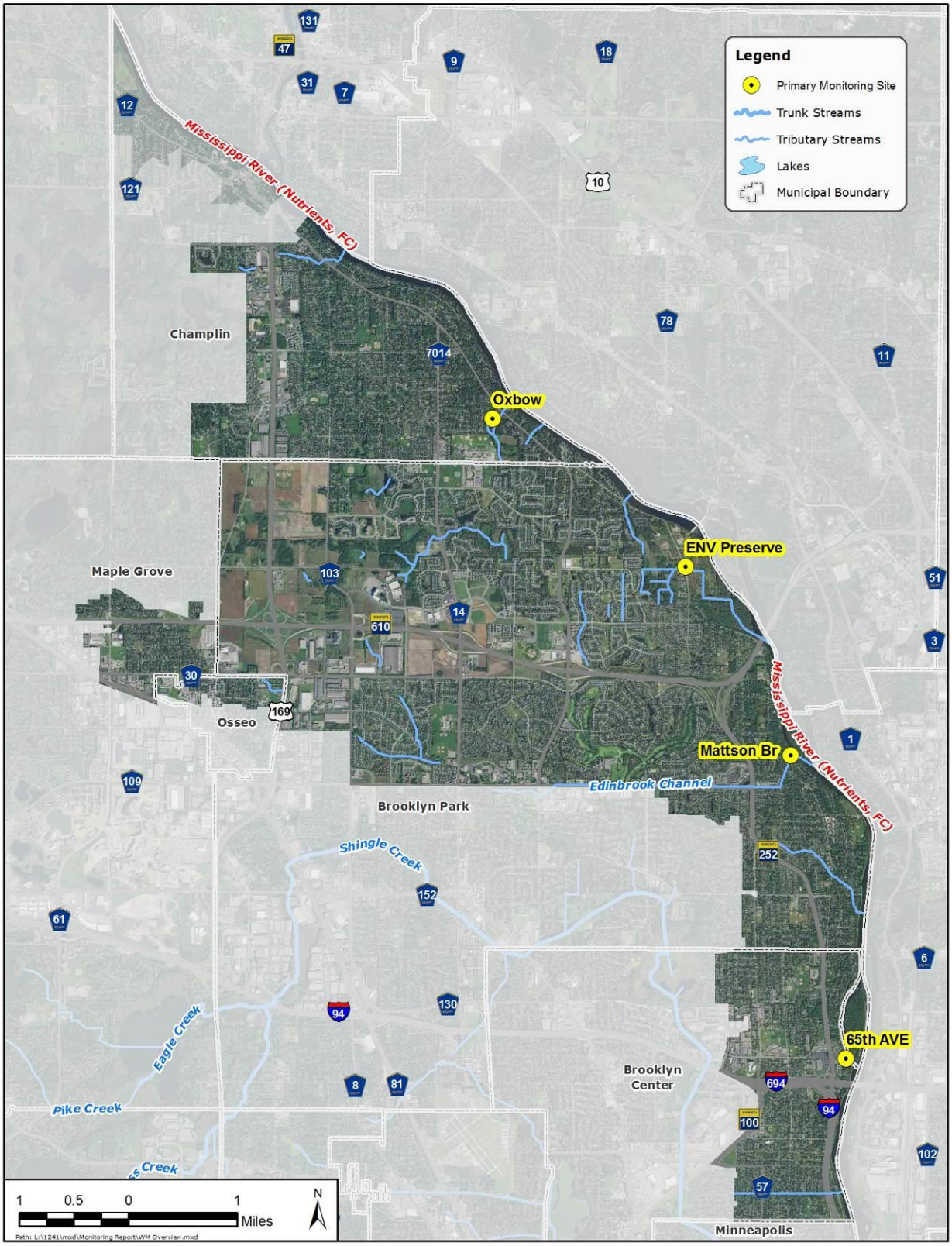

Figure 4-1. West Mississippi Management Unit Overview

Table 4-1. West Mississippi Management Unit water resources and land features.

Streams/Outfalls	Type	Impairment Status
65th Ave Outfall	Storm sewer/Intermittent	Not Assessed
Mattson Brook	Storm sewer/Intermittent	Not Assessed
Environmental Preserve	Storm sewer/Intermittent	Not Assessed
Oxbow Creek	Storm sewer/Intermittent	Not Assessed

Lakes	Type	Impairment Status
None		

Cities	Acres	Percent
Brooklyn Park	9,920	64%
Champlin	3,123	20%
Brooklyn Center	1,693	11%
Maple Grove	559	5%
Osseo	190	1%

Landuse	Acres	Percent
Low-Moderate Impervious (5-50%)	6,062	38%
Highly Impervious (51-100%)	4,078	25%
Grassland/Shrubland	2,679	17%
Agriculture	1,105	7%
Wetland	850	5%
Forest	669	4%
Open Water	618	4%

Soil Type	Acres	Percent
A	7,910	51%
A/D	4,419	29%
B	1,221	8%
B/D	320	2%
C	30	<1%
C/D	58	<1%
Not Assessed (Heavily Disturbed)	1,032	7%

Untreated Area	Acres
Not Yet Estimated	

OUTFALL MONITORING CURRENT CONDITIONS AND TRENDS

The West Mississippi WMC monitored water quality and streamflow from 1990-1992 at two of the four major outfalls (Oxbow Creek and Mattson Brook). Results indicated very little flow in these tributaries and no water quality or quantity problems or concerns. Thus, the Commission chose to discontinue monitoring after the 1992 monitoring season. In 2010, the Commission elected to once again monitor water quality and flow at two outfall monitoring sites per year in the West Mississippi watershed.

Due to the extensive storm stewer infrastructure and other drainage alterations, the four major outfalls in West Mississippi are likely considered Class 7 waters. By definition, Class 7 waters are "limited resource value waters and are typically not protected for aquatic life and recreation due to lack of water, lack of habitat, or extensive physical alteration." While these outfalls are not subject to water quality standards/assessments, they all discharge to the Mississippi River, which is a Class 2B water that is currently impaired for bacteria and

nutrients (TP). Thus, the Class 2B water quality standards developed by the State of Minnesota provide a good benchmark to evaluate water quality of the four major outfalls.

Below is a general summary and description of current water quality conditions of each outfall based on recent monitoring data (2010 through 2018). At this time, we were not able to calculate long-term data trends due to the limited amount of data for each site.

4.1 Oxbow Outfall

Water Quality

- TP concentrations currently exceed Class 2B standards.
- Ortho-phosphorus concentrations (not shown on figure) were relatively high, indicating that phosphorus loads are coming from both dissolved and particulate sources.
- TSS and chloride levels are below standards.

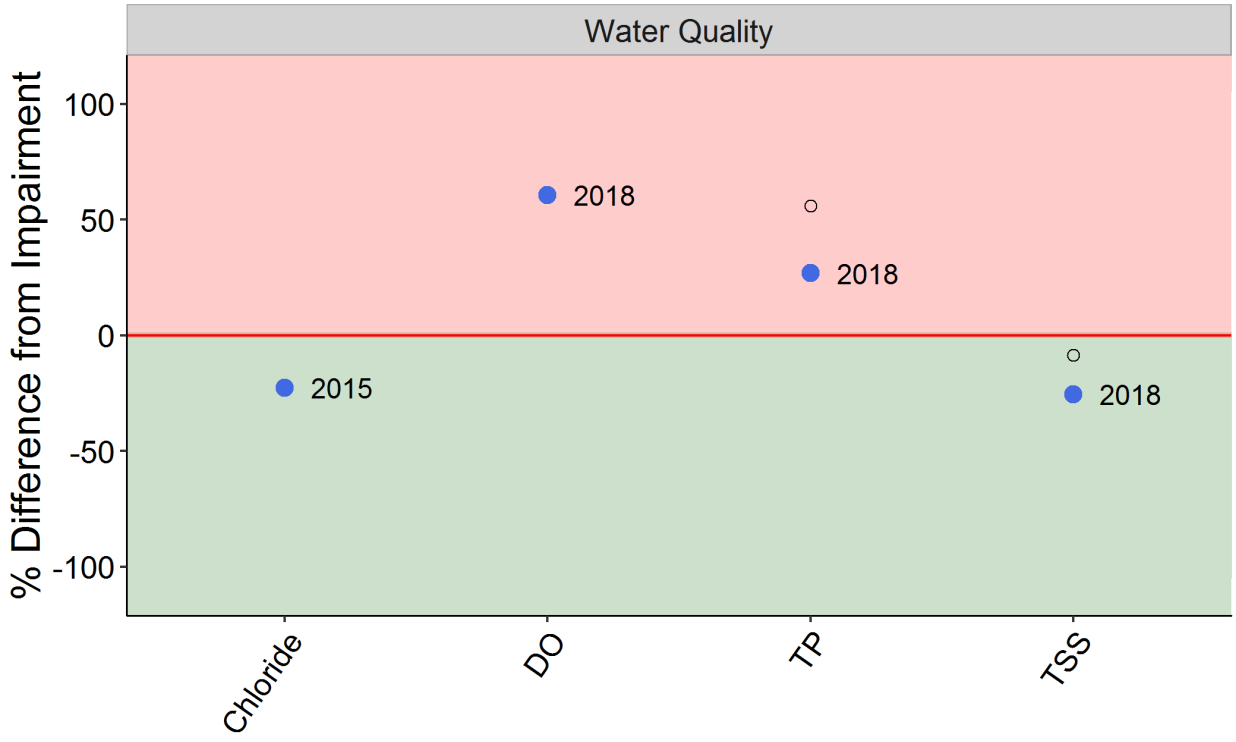

Figure 4-2. Oxbow Outfall water quality summary (since 2010).

Recommendations

- Water quality monitoring will occur in 2020.
- 2020 monitoring should include measurement of E. coli concentrations.
- Winter chloride sampling should be considered.

4.2 Environmental Preserve Outfall

Water Quality

- TP, TSS and DO concentrations exceed standards.
- 2018 TP and DO concentrations were the highest above the standard observed to date.
- This was the first recorded year in which the average TSS concentration exceeded standards. However, TSS concentrations measured during routine sampling events were, with one exception, always below the TSS standard. Conversely, samples taken during storms had very high TSS concentrations and are responsible for driving up the 2018 average TSS concentration.
- NO_3/NO_2 and chloride concentrations are well below standards, although these parameters have not been monitored since 2011.

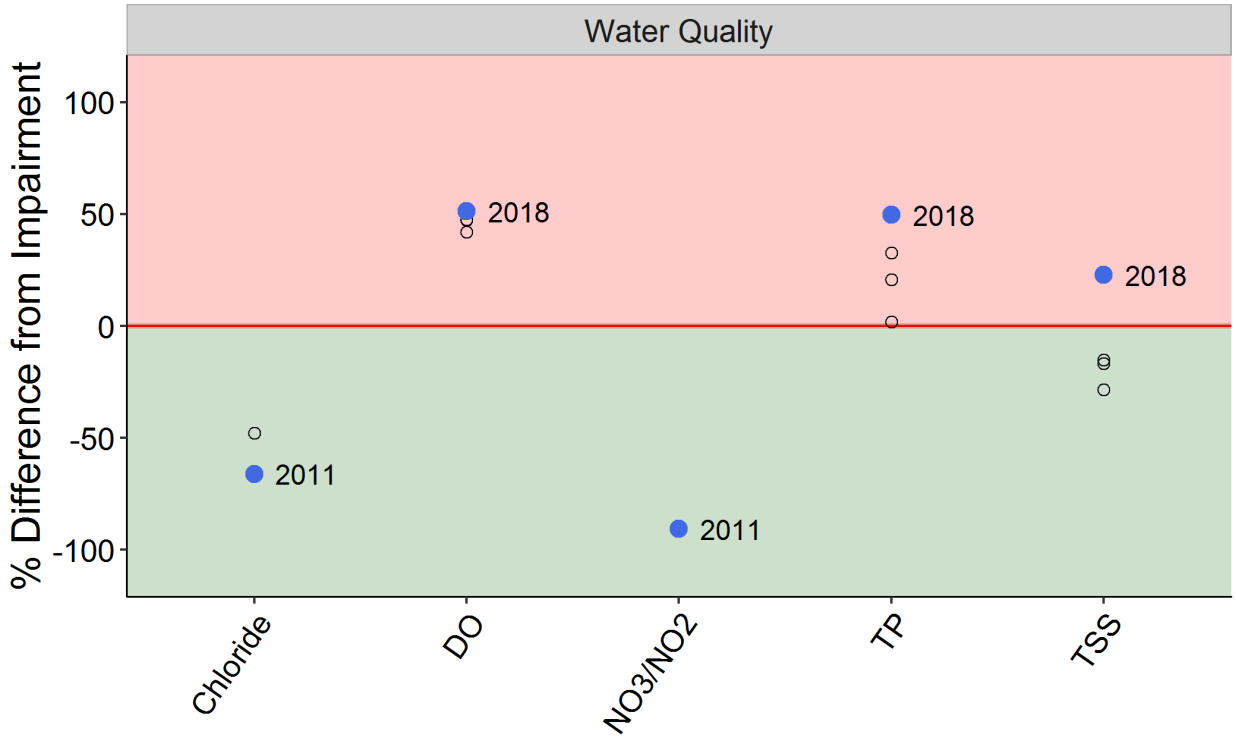

Figure 4-3. Environmental Preserve Outfall water quality summary (since 2010).

Recommendations

- Water quality monitoring will occur in 2020, which will help provide context to the high TP and TSS concentrations observed in 2018.
- 2020 monitoring should include measurement of E. coli concentrations.
- Winter chloride sampling should be considered.

4.3 Mattson Brook Outfall

Water Quality

- This site was not monitored in 2018. It was most recently monitored in 2017.
- TSS and TP concentrations met standards in 2017 and were the lowest (best) since sampling began in 2010.
- Ortho-phosphorus concentrations (not shown on figure) were relatively high, indicating that phosphorus loads are coming from both dissolved and particulate sources.
- DO and chloride concentrations exceeded standards.
- NO_3/NO_2 concentrations are well below the standard, although this parameter has not been monitored since 2011.

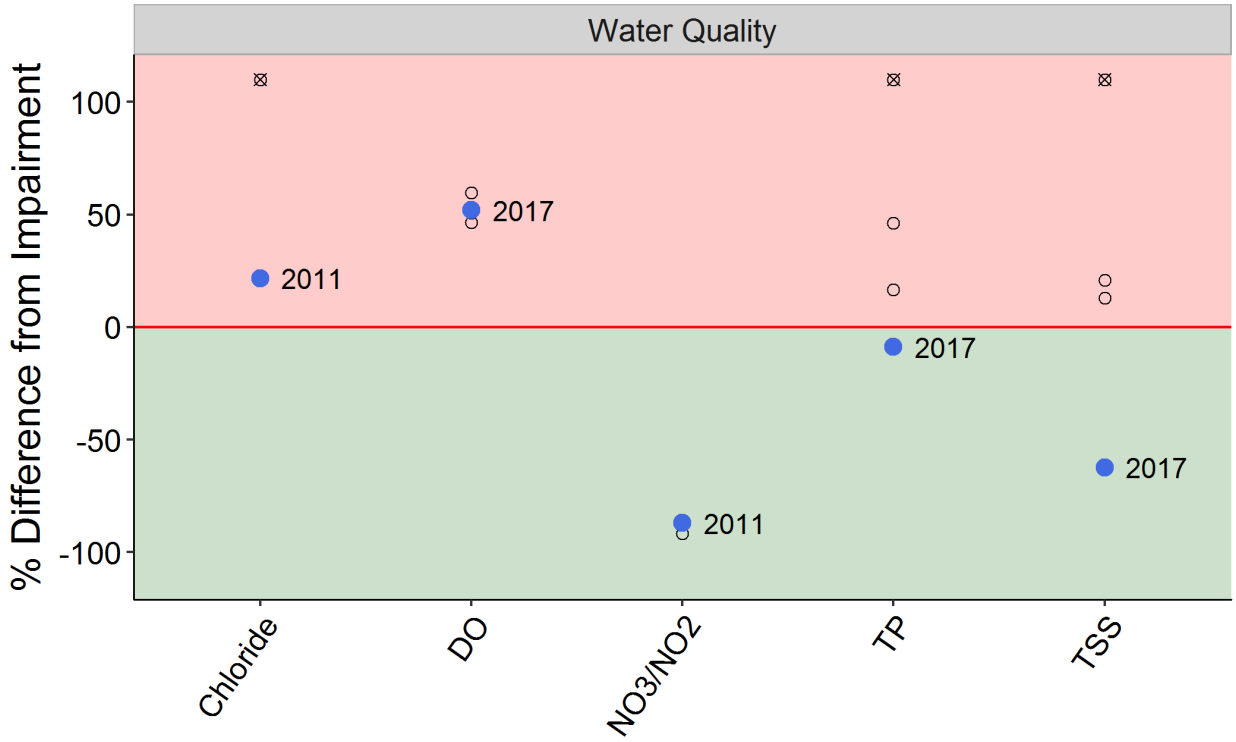

Figure 4-4. Mattson Brook Outfall water quality summary (since 2010).

Recommendations

- Water quality monitoring will occur in 2019.
- 2019 monitoring will include measurement of E. coli concentrations.
- Winter chloride sampling should be considered.

4.4 65th Ave Outfall

Water Quality

- This site was not monitored in 2018. It was most recently monitored in 2017.
- TSS and TP met standards in 2017 and were the lowest (best) observed since sampling began in 2010.
- DO and chloride concentrations routinely exceed standards at this site.
- NO_3/NO_2 concentrations are well below the standard, although this parameter has not been monitored since 2011.

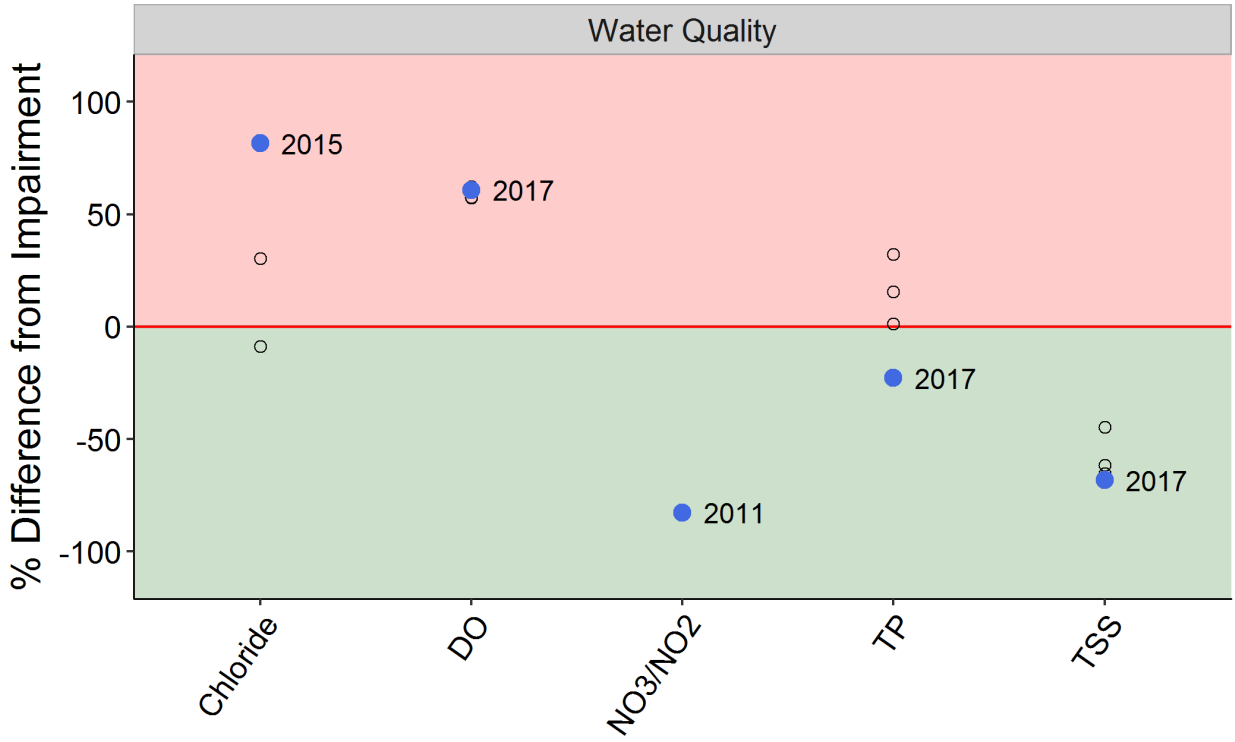

Figure 4-5. 65th Ave Outfall water quality summary (since 2010).

Recommendations

- Water quality monitoring will occur in 2019.
- 2019 monitoring will include measurement of E. coli concentrations.
- Winter chloride sampling should be considered.

5.0 Upper Shingle Creek Management Unit

UPPER SHINGLE CREEK MANAGEMENT UNIT OVERVIEW

The Upper Shingle Creek Management Unit is the headwaters of the Shingle Creek watershed and covers approximately 8,300 acres across four municipalities in Hennepin County. Plymouth (53%) and Maple Grove (30%) make up a majority of this management unit, with New Hope (12%) and Brooklyn Park (5%) also having small portions (Figure 5-1 and Table 5-1).

Lakes and wetlands are a common feature in the Upper Shingle Creek Management Unit. The Bass Chain of Lakes is located in the City of Plymouth and includes Bass, Schmidt and Pomerleau Lakes. Bass and Schmidt are shallow lakes, while Pomerleau Lake is a deep lake. The major inflow to Bass Lake and out of the lake is Bass Creek. Bass Creek starts as a series of wetlands west of Vicksburg Lane in Plymouth and flows east into New Hope and then north to where it meets Eagle Creek just south of Interstate 694 in Brooklyn Park.

The other major lake chain in the Upper Shingle Creek Management Unit is the Eagle Chain of Lakes. This chain includes Eagle, Cedar Island, and Pike Lakes. The Eagle Chain of Lakes is primarily in the City of Maple Grove, however portions of Pike Lake and the watershed draining to Pike Lake are located in Plymouth. Eagle Lake outlets to Eagle Creek which flows a short distance through a series of wetlands prior to its confluence with Bass Creek just south of Interstate 694 in Brooklyn Park.

Lake Magda and Meadow Lake are two shallow lakes in the Upper Shingle Creek Management Unit. Lake Magda is a small (10 acre) lake located Brooklyn Park. Meadow Lake is also a very small lake (12 acres) located in New Hope. Both lakes have relatively small contributing watersheds.

The Upper Shingle Creek Management Unit is almost fully developed, however it was one of the last areas in the Shingle Creek watershed to develop. Thus, much of this management unit was developed under stormwater management rules and therefore has some level of water quality treatment. Most of the water quality treatment throughout the watershed consists of stormwater ponds and wetlands. A recent desktop analysis determined that approximately 66 acres of the watershed flows directly to Bass Creek with no water quality treatment (see Table 4-1). By comparison, the Middle and Lower Shingle Creek Management Units have approximately 1,700 and 2,000 acres of untreated area, respectively, that discharge directly to Shingle Creek.

Land use within the Upper Shingle Creek Management Unit is predominantly high impervious urban development (28%) and low-moderate impervious urban development (26%). While this management unit is almost fully developed, it has significantly less impervious coverage (54%) compared to the Middle (73%) and Lower (84%) Shingle Creek Management Units. The Upper Shingle Creek Management Unit also has the highest percentage of wetlands and open water (lake) features compared to the other Shingle Creek management units.

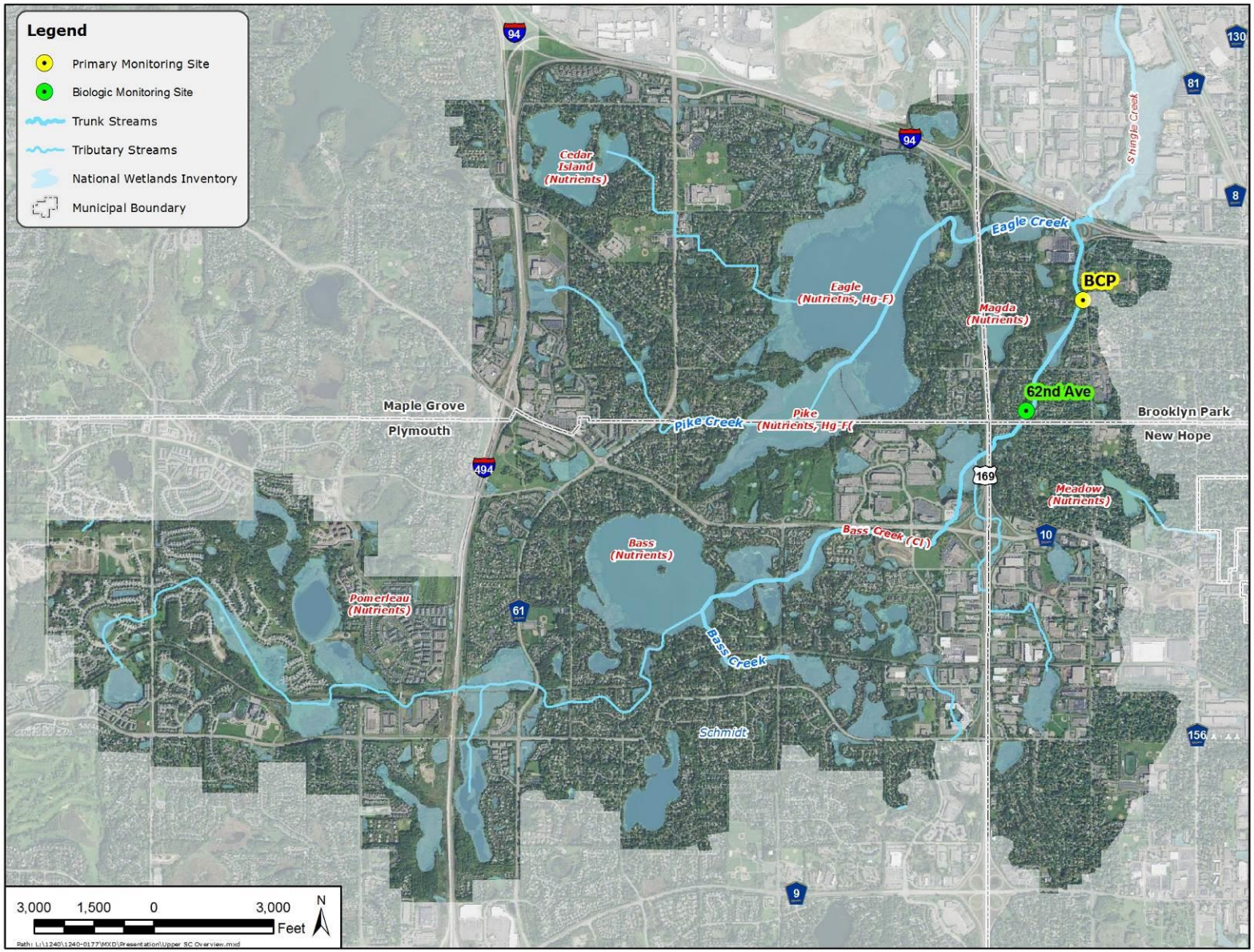

Figure 5-1. Upper Shingle Creek Management Unit Overview.

Table 5-1. Upper Shingle Creek Management Unit water resources and land features.

Streams	Type	Impairment Status
Bass Creek (07010206-784)	Class 2B	Impaired (Cl, Biota – Fish)
Eagle Creek (07010206-671)	Class 2B	Not Assessed
Pike Creek (07010206-667)	Class 2B	Not Assessed

Lakes	Type	Impairment Status
Pomerleau	Deep Lake	Impaired (nutrients)
Curtis	Shallow Lake	No Data
Schmidt	Shallow Lake	Not Impaired (de-listed in 2016)
Bass	Shallow Lake	Impaired (nutrients)
Meadow	Shallow Lake	Impaired (nutrients)
Magda	Shallow Lake	Impaired (nutrients)
Cedar Island	Shallow Lake	Impaired (nutrients)
Pike	Shallow Lake	Impaired (nutrients)
Eagle	Deep Lake	Impaired (nutrients)

Cities	Acres	Percent
Plymouth	4,417	53%
Maple Grove	2,477	30%
New Hope	965	12%
Brooklyn Park	463	6%

Landuse	Acres	Percent
Highly Impervious (51-100%)	2,367	28%
Low-Moderate Impervious (5-50%)	2,165	26%
Wetlands	1,250	15%
Grassland and Shrubland	1,104	13%
Open Water	665	8%
Forest	617	7%
Agriculture	154	2%

Soil Type	Acres	Percent
A	2,346	28%
A/D	2	<1%
B	1,892	23%
B/D	1,006	12%
C	89	1%
C/D	1,003	12%
Water	736	9%
Not Assessed (Heavily Disturbed)	1,249	15%

Untreated Area (Creek Corridor)	Acres
Maple Grove	48
Plymouth	18

5.1 Monitoring History

STREAMS

Stream flow and water quality are monitored at one location, Bass Creek Park (BCP), in the Upper Shingle Creek Management Unit. BCP is in Brooklyn Park and drains approximately 65% of the Upper Shingle Creek Management Unit. This station was monitored briefly in 2000 by the MPCA as part of a water quality assessment project, which determined that Bass Creek was impaired for chloride and biotic integrity as measured by Fish IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the Fish IBI impairment. The Commission began monitoring the BCP site in 2013 to continually assess water quality conditions in Bass Creek and measure progress toward achieving the TMDLs. Bass Creek is considered a Class 2B water and is subject to the North Central Hardwood Forest Class 2B water quality standards.

LAKES

Lake water quality has been monitored for eight lakes in the Upper Shingle Creek Management Unit (excluding Curtis Lake) since at least the mid-1990s. All the monitored lakes in the Upper Management Unit were classified as impaired for nutrients (TP) in the early 2000s.

5.1.1 Bass Lake Chain

- The Bass Lake chain of lakes includes Bass, Schmidt and Pomerleau Lakes.
- Bass Lake's water quality and submerged aquatic vegetation community was sampled in 2018 and observed concentrations or score that did not meet water quality standards or biological thresholds.
- Historically, Pomerleau and Bass Lake tend to exceed water quality standards while Schmidt Lake tends to flip between slightly exceeding and meeting standards.
- Schmidt Lake was listed as impaired in 2002 and this listing was based on limited data at that time from the 1990s. The lake was recently removed from the State's 303(d) list of impaired waters in 2016. There does not appear to be any clear trend in the water quality data for Schmidt Lake over the past 10 years and the lake has consistently met water quality standards since the early 2000s.
- Bass and Pomerleau Lakes will be undergoing aluminum sulfate treatments in 2019.

5.1.2 Eagle Lake Chain

- The Eagle Lake chain of lakes includes Eagle, Pike and Cedar Island Lakes. Common Carp population assessments were the only monitoring activities within the chain in 2018.
- Common carp do not appear to be a concern for the chain of lakes. Additional fisheries information on the shallow lakes of this chain would be informative to assess impact on water quality.
- Cedar Island and Pike Lakes have consistently exceeded water quality standards over the past 10 years. Cedar Island has some of the highest TP and chlorophyll-a concentrations of any lake monitored in the Shingle Creek watershed.
- There is no trend in water quality for Cedar Island and Pike Lakes and they remain impaired.
- Eagle Lake has met standards in 2 of the past 4 years in which it has been monitored, however the 10-year average still exceeds State standards.

5.1.3 Lake Magda and Meadow Lake

- Meadow was last sampled in 2016, Magda was last sampled in 2017.
- Meadow Lake and Lake Magda have consistently exceeded water quality standards over the past 10 years. These systems have 5-year TMDL reviews occurring in 2019.
- Both lakes have fish communities that may be leading to water quality impairments, a turbid water state, and a poor vegetation community.

5.2 Bass Creek Park (BCP) Stream Reach

Water Quality

- TSS, NO_3/NO_2 and DO concentrations meet their respective standards, although DO concentrations are near the impairment threshold.
- TP and chloride concentrations exceed their respective standards.
- Orthophosphate (SRP) as a fraction of TP is higher at this site than at other sites on Shingle Creek.

Biota

- Fish and macroinvertebrate IBI scores did not met biological impairment thresholds.
- 2010 biotic stressor ID highlighted DO, chloride, system flashiness, historic straightening and armoring as possible candidate stressors.
- The continued use of chlorides within the watershed and the increased size and intensity of storm events is a continued and growing concern for biota within the system.

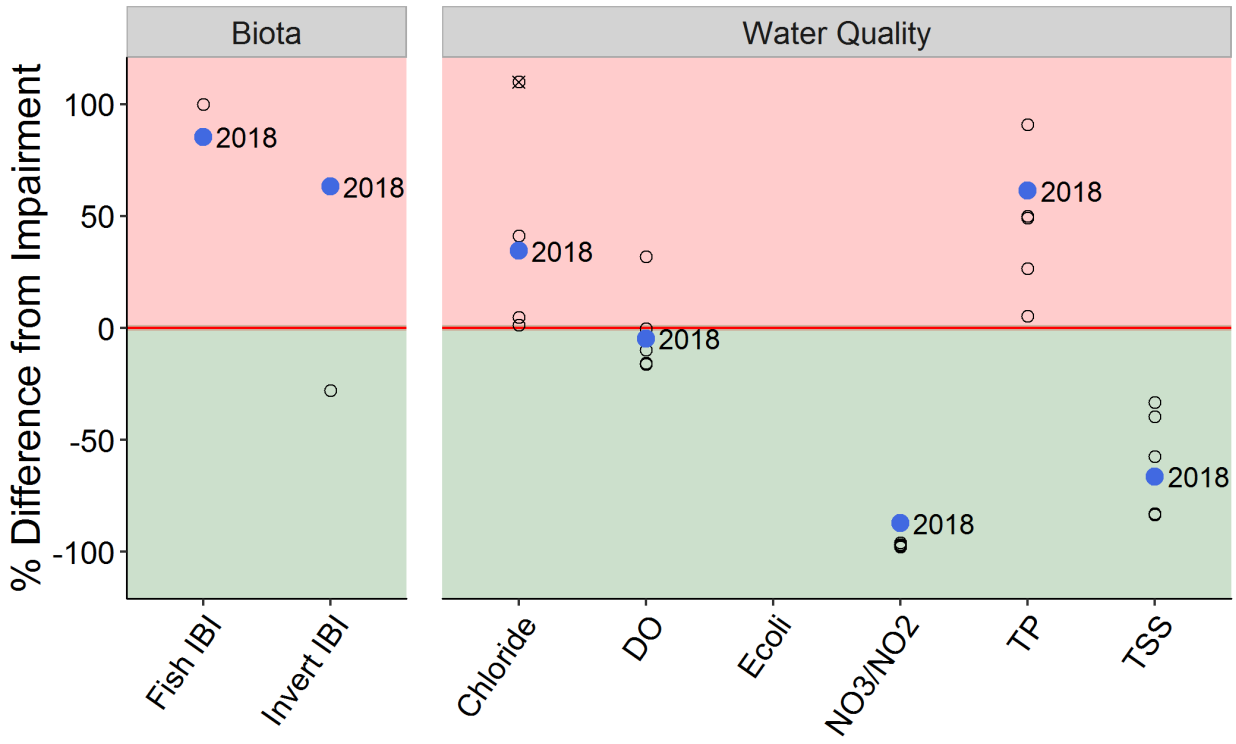

Figure 5-2. Bass Creek Park stream water quality and biota health summary since 2000.

Recommendations

- Water quality monitoring will occur in 2019.
- 2019 monitoring will include measurement of E. coli concentrations.
- The EPA-funded SRP Reduction Project will begin in 2019 and one test location is on Bass Creek just upstream of BCP (Cherokee Wetland).
- Efforts to restore biological health should be considered. The Shingle Creek DO/Biotic TMDL review will occur in 2019 and 2020.
- Increased biotic assessments in conjunction with habitat assessments could begin to tease apart the impact of the numerous biotic stressors influence the stream.

5.3 Bass Lake

Water Quality

- TP, Chl-a, and Secchi depth within Bass Lake are relatively poor.
- Historic trend assessment: TP and Chl-a are increasing, Secchi depth is decreasing.

Fisheries

- Relatively healthy, diverse and balanced trophic structure resulting in a healthy community.
- Common carp are not a concern within the lake.

Vegetation

- Is near biological standards yet dominated by undesirable levels of coontail that impact recreation for select property owners.
- Curlyleaf pondweed is a concern on the lake and is treated annually by the lake association.
- Improved water quality conditions may improve vegetation community health.

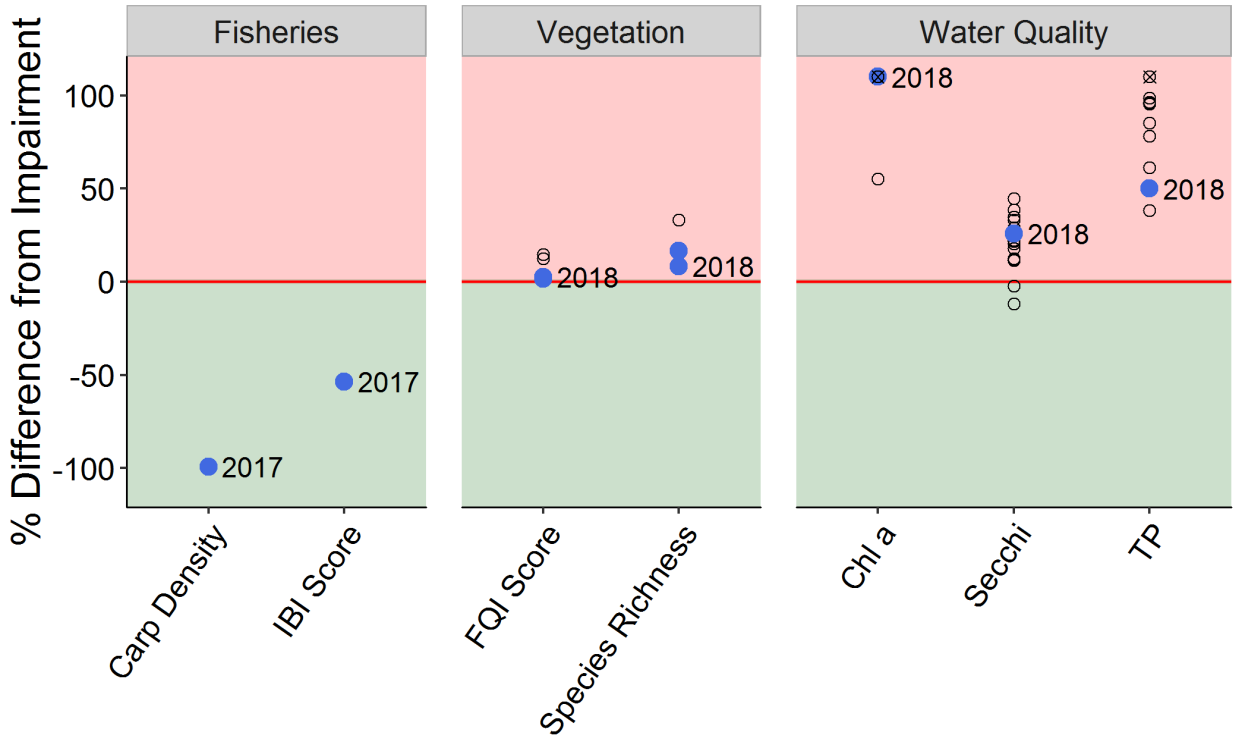

Figure 5-3. Biota and water quality summary (since 2000) for Bass Lake.

Recommendations

- Bass Lake will be receiving an alum sulfate treatment in 2019 to reduce internal loads resulting from summer hypoxia within the lake. Treatment is expected to improve all three water quality parameters and possibly the vegetation community.
- Follow up water quality and biological monitoring will occur in 2019 post alum treatment.
- Assist the lake association with SAV management planning and treatment (occurring in 2019-2022).

5.4 Schmidt Lake

Water Quality

- TP, Chl-a, and Secchi have annual records of both meeting and exceeding standards. Based on the most recent monitoring data (2017), TP exceeded, while Chl-a and Secchi depth both meet water quality standards.
- Historic trend assessment: TP is decreasing, Secchi depth is increasing.

Fisheries

- The most recent fish community surveys were conducted in 2011 and can be found here: http://www.plymouthmn.gov/home/showdocument?id=7422.
- The lake does not currently meet the size and/or lake class grouping to be evaluated with MnDNR IBI tools.

Vegetation

- The vegetation community was observed as biologically impaired. Vegetation impairments often result from poor water quality and/or poor fish community health. The lake association has managed aquatic vegetation in past years.

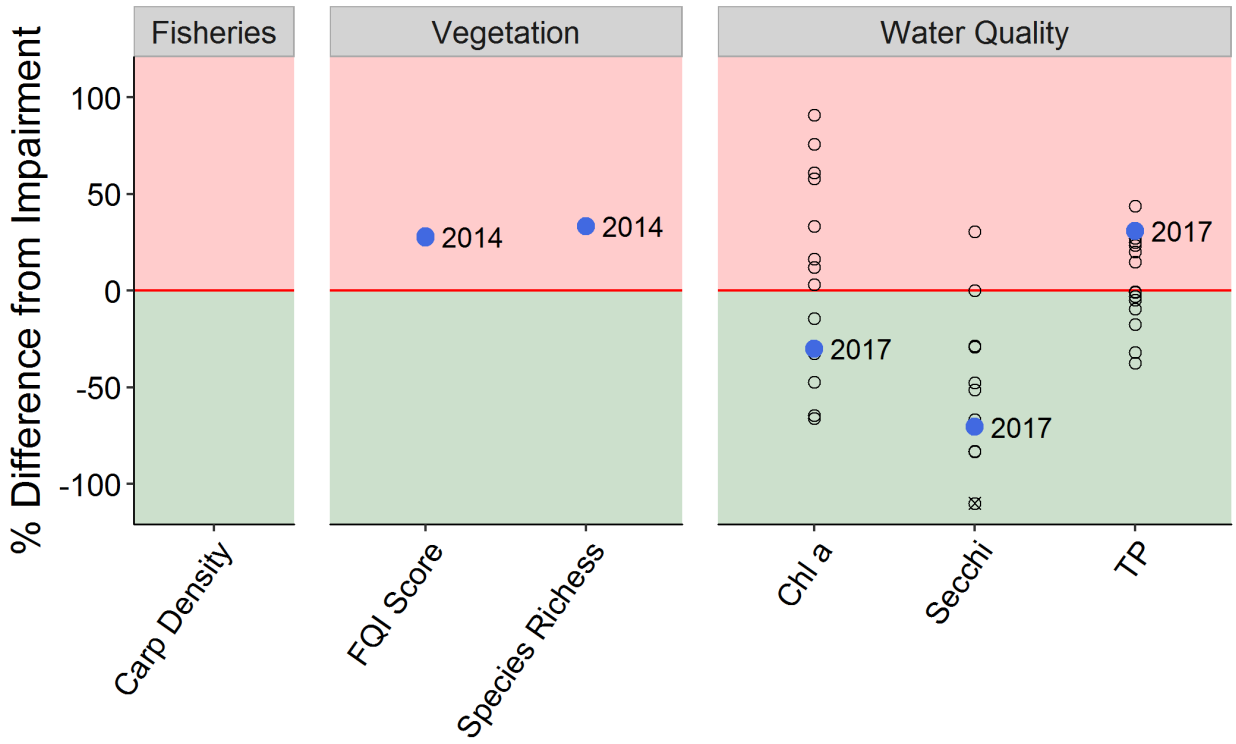

Figure 5-4. Biota and water quality summary (since 2000) for Schmidt Lake.

Recommendations

- The vegetation, fisheries and water quality will be sampled in 2019 as part of the routine lake monitoring program.

5.5 Pomerleau Lake

Water Quality

- TP, Chl-a, and Secchi all met water quality standards 2017 (most recent monitoring efforts). 2017 experienced the best water quality on record since 2000.
- Historic trend assessment: Chl-a is decreasing (improving), while other parameters showed no trend.

Fisheries

- 2017 surveys observed a relatively low amount of stress tolerant fish, suggesting fish community health has been improved from historic surveys efforts.
- It is possible that a change in the fish community was one factor in the improved water quality conditions seen in 2017 as omnivorous fish (i.e. black bullhead) can cause water quality impairments at high densities.
- The lake was not sampled using standard common carp survey techniques, however, no carp were observed during standard trap and gill net surveys.

Vegetation

- In 2017, the vegetation community was observed to decrease in both species richness and quality species between spring and summer surveys and did not meet biological health thresholds.
- Overall, a limited number of species were observed with select species dominating the community. Vegetation growth was relatively abundant with dense surface growth around most of the lake's perimeter. CLP was present in spring assessments.

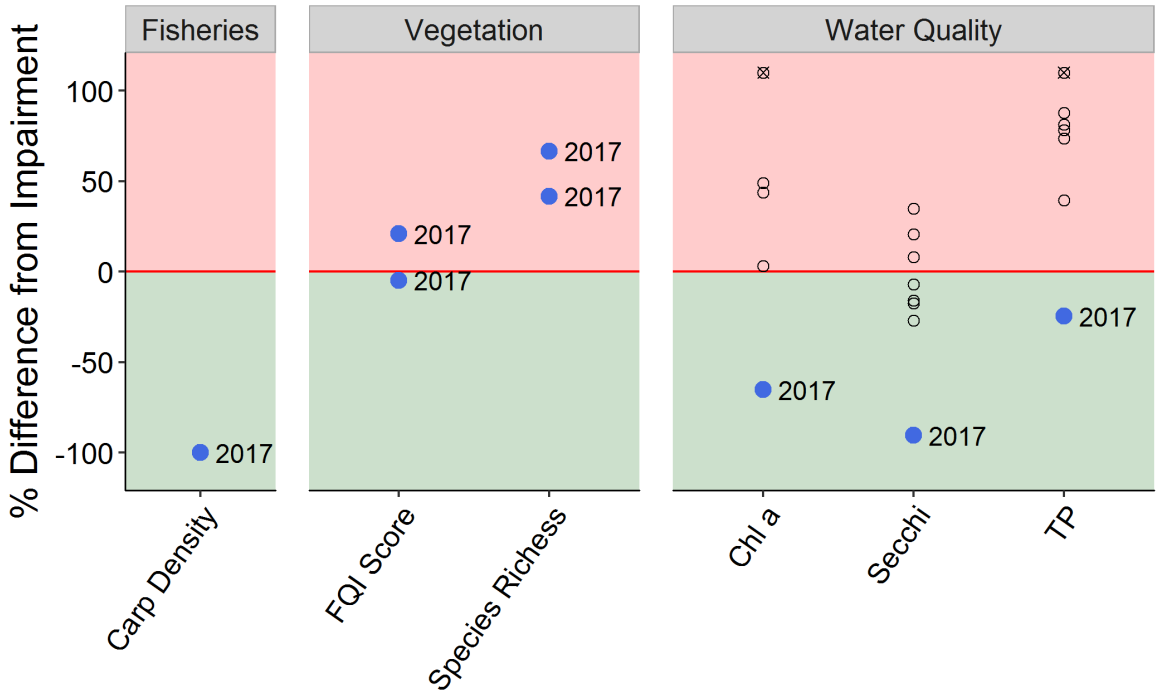

Figure 5-5. Biota and water quality summary (since 2000) for Pomerleau Lake.

Recommendations

- The lake is receiving an aluminum sulfate treatment in 2019.
- The impact of fisheries on the lake is unknown but suspected to have a significant impact.
- SAV management may be warranted from the Commission post 2019 alum treatment.

5.6 Cedar Island Lake

Water Quality

- All three-water quality parameters are poor and exceed standards with Chl-a and TP more than double the impairment threshold (many annual occurrences).
- Historic trend assessment: Chl-a is increasing and Secchi depth is decreasing.

Fisheries

- A rotenone treatment was completed in the past to address rough fish, but no data is available regarding the outcomes.
- Cedar Island is a shallow lake with water quality that could be driven by the fish community.

Vegetation

- The vegetation community is biologically impaired and lacked both diversity of species and quality of species.
- An impaired vegetation community may be explained by reduced water quality conditions as high nutrients and limited light penetration can favor a few select species.

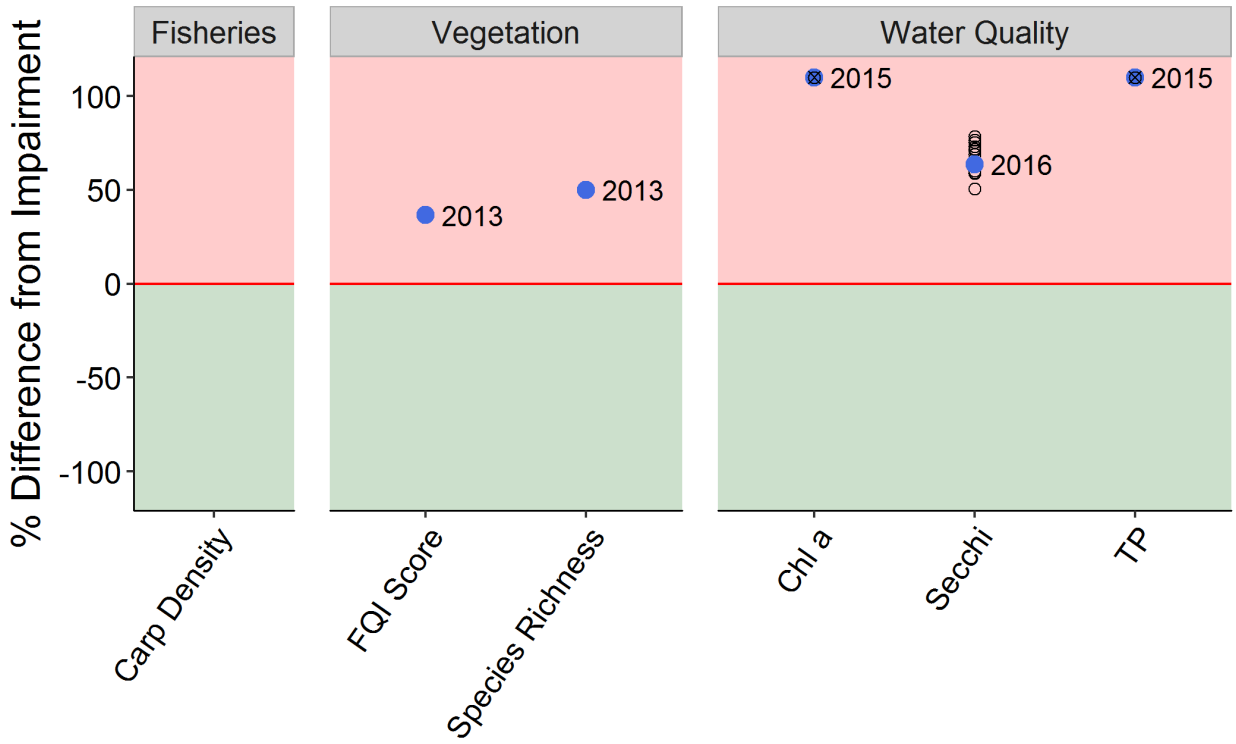

Figure 5-6. Biota and water quality summary (since 2000) for Cedar Island Lake.

Recommendations

- The influence of the fishery is unknown but suspected to be a driver of water quality within the lake.
- Fisheries survey information today suggests a large fish population and a history of unsuccessful management activities (rotenone, stocking, etc.).

5.7 Eagle Lake

Water Quality

- Water quality has historic variability with the most recent data suggesting impaired water quality. Secchi depth was the only 2017 parameter observed to be meeting standards.
- Historic trend assessment: TP is increasing and Secchi depth is decreasing.

Fisheries

- The MnDNR conducted an IBI assessment in 2011 and observed a fish community that was right at the biological impairment threshold.
- No common carp were observed during population assessment, therefore, common carp are not believed to impact water quality in Eagle Lake at this time.

Vegetation

- Spring and summer surveys in 2015 found a vegetation community that increased in species richness and vegetation quality and is meeting biological health conditions.
- Generally, high light penetration and bathymetric diversity provide ample growing conditions for various species within the lake.
- A large presence of curlyleaf pondweed exists in the lake and senesces by early summer.

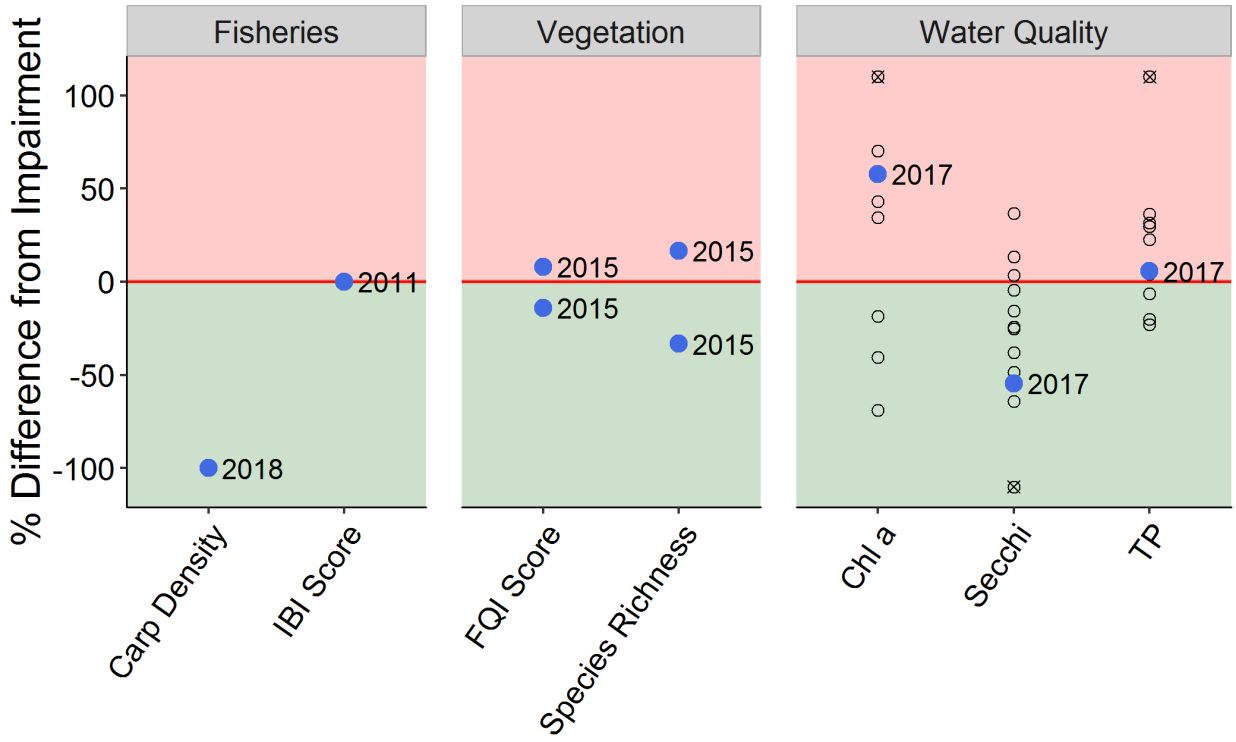

Figure 5-7. Biota and water quality summary (since 2000) for Eagle Lake.

Recommendations

- Continued efforts to improve water quality may ensure that vegetation quality within the lake continues to meet biological health standards.
- Implement recommendations from recently completed 5-year TMDL review for Eagle Lake.

5.8 Pike Lake

Water Quality

- Overall water quality is poor and not meeting water quality standards.
- Historic trend assessment: TP is increasing.

Fisheries

- Most recent fish surveys were conducted in Fall of 2015 and observed a large insectivore presence compared to other trophic guilds. 2015 netting surveys were outside the typical summer sampling period for fish and comparisons to other surveys is cautioned.
- With a large surface connection to Eagle, the exchange of individuals is likely high between the lakes.
- No common carp were observed during population assessment, therefore, common carp are not believed to impact water quality in Pike Lake at this time.

Vegetation

- The vegetation community is biologically impaired and lacked both diversity of species and quality of species.
- An impaired vegetation community may be explained by poor water quality conditions as high nutrients and limited light penetration can favor a degraded vegetation community.

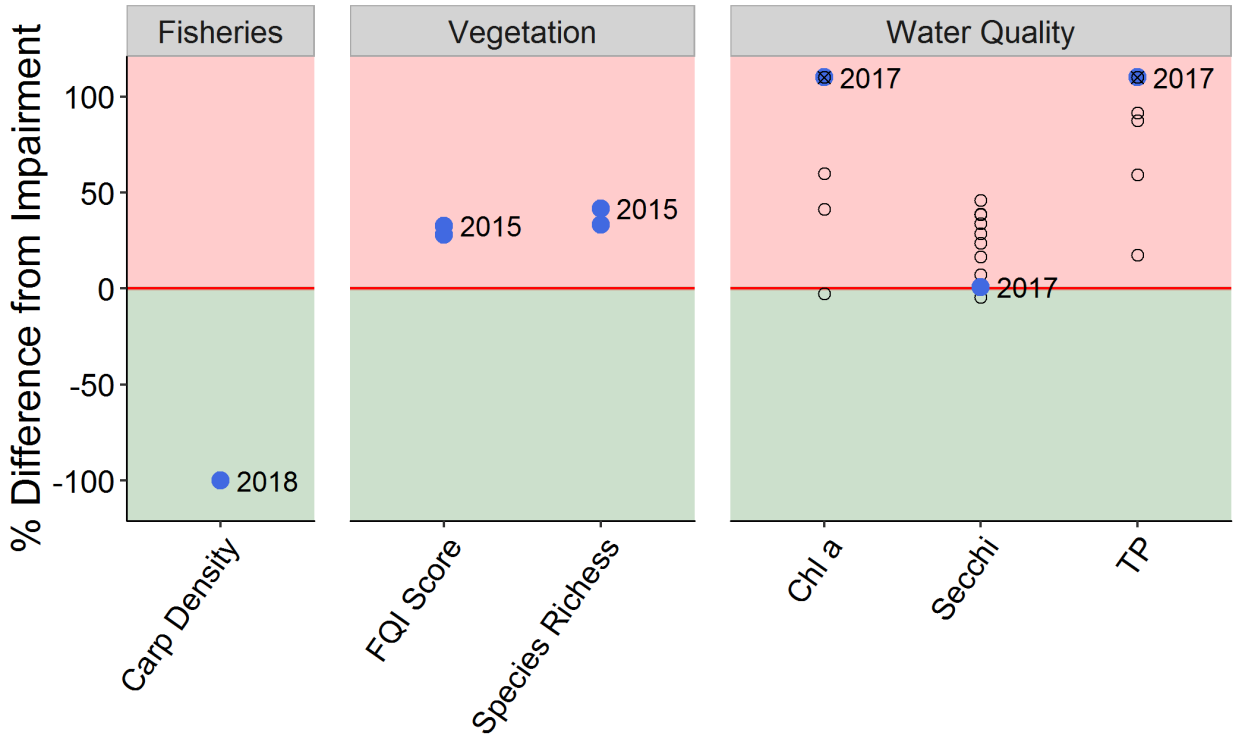

Figure 5-8. Biota and water quality summary (since 2000) for Pike Lake.

Recommendations

- Continued efforts to reduce nutrient loading.
- Implement recommendations from recently completed 5-year TMDL review for Eagle Lake.

5.9 Magda Lake

Water Quality

- Water quality is degraded and does not meet water quality standards.
- Brown milky water conditions were observed in the lake after precipitation events which likely resulted from storm sewer inputs during summer street repairs within the watershed.
- Historic trend assessment: No trends observed.

Fisheries.

- Fisheries survey conducted in 2017 did not observe common carp, however, a large population of bullheads and an imbalanced fishery were observed.
- Water quality has the potential to be greatly influenced by the fish community in shallow lakes. It is likely that the current fish community is contributing to impairments within the lake.

Vegetation

- The vegetation community is biologically impaired and vegetation health decreased through the open water season.
- Poor water quality impedes the ability of native plants to grow as they quickly become light limited.

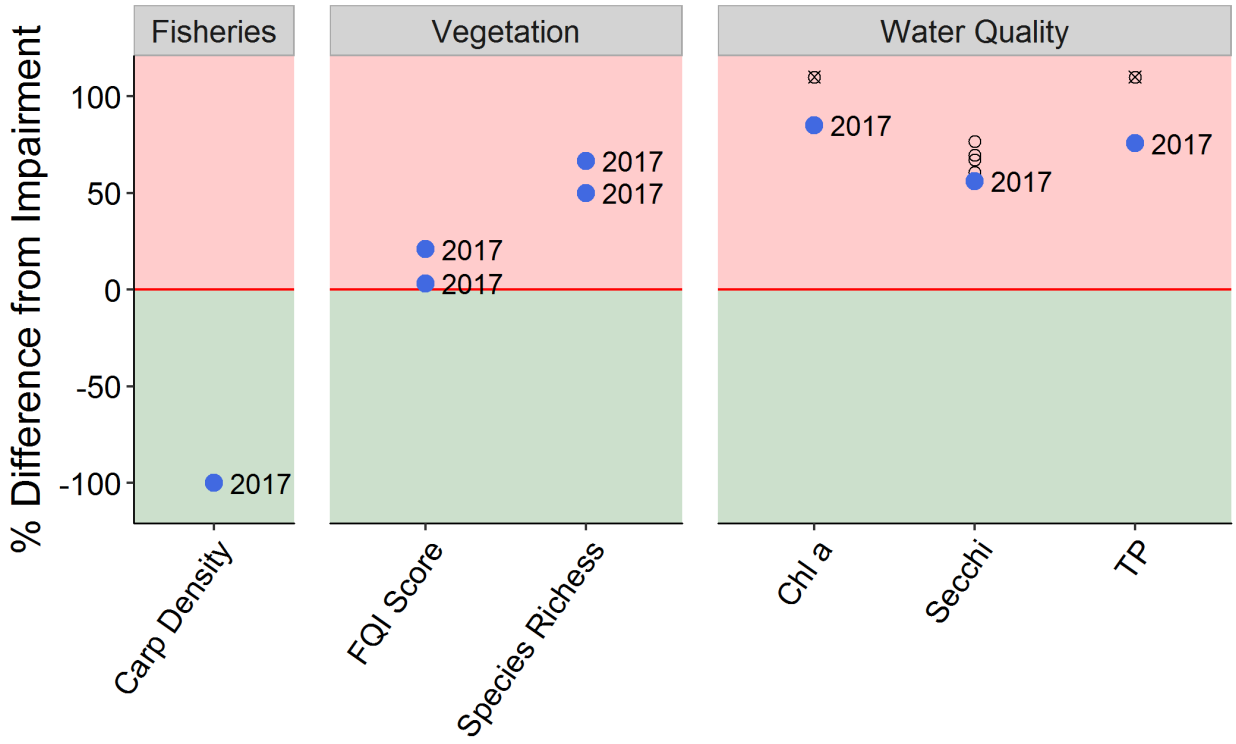

Figure 5-9. Biota and water quality summary (since 2000) for Magda Lake.

Recommendations

- Efforts to remove fish or maintain a healthy fishery should become a priority to increase water quality and biotic community health.
- Implement findings of 5-year TMDL review when study is completed in 2019.

5.10 Meadow Lake

Water Quality

- Water quality is degraded and does not meet water quality standards.
- Historic trend assessment: No trends observed.

Fisheries

- Fisheries survey conducted in 2017 did not observe common carp, however, a large population of fathead minnows was observed.
- Water quality has the potential to be greatly influenced by the fish community in shallow lakes. We believe that the current fish community is contributing to impairments within the lake.

Vegetation

- Vegetation quantity and quality are below impairments thresholds and are likely the result of poor water quality conditions.
- Vegetation health decreased across the open water season as water quality decreased.

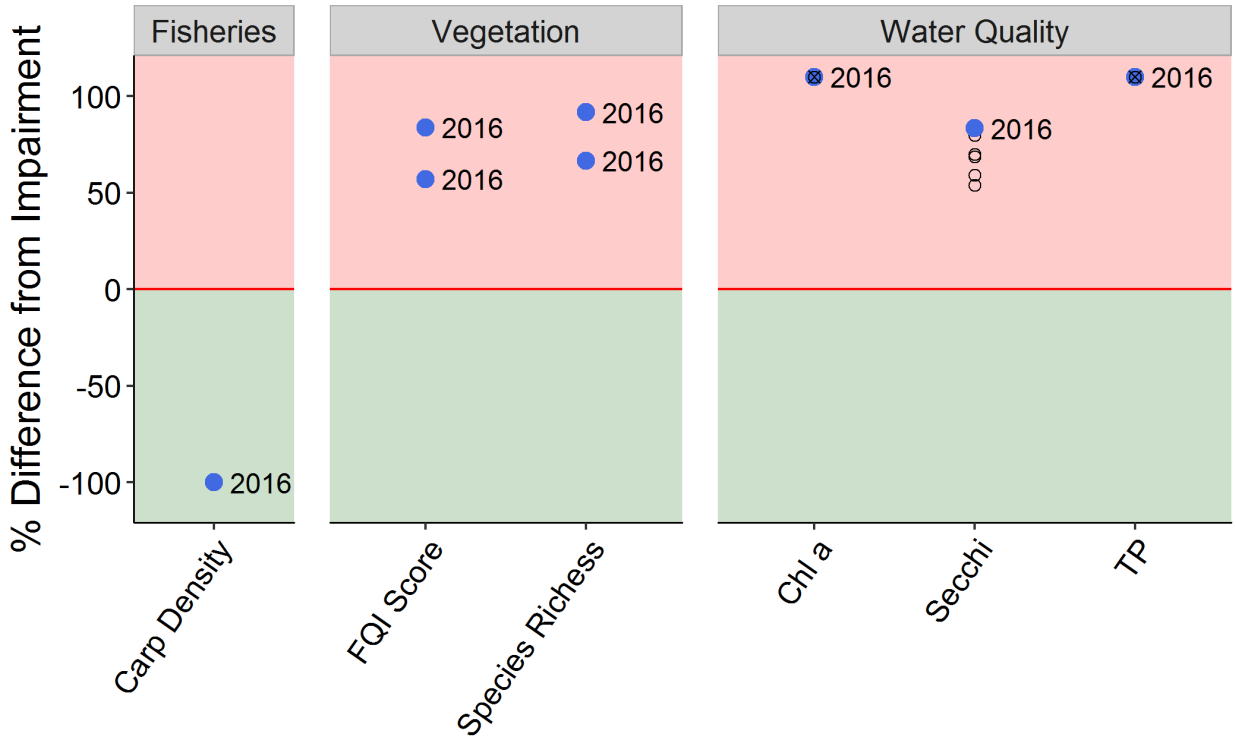

Figure 5-10. Biota and water quality summary (since 2000) for Meadow Lake.

Recommendations

- A greater fisheries assessment and efforts to keep fish out of Meadow Lake will likely have a significant impact on the water quality and vegetation community health.
- Implement findings of 5-year TMDL review when study is completed in 2019.

6.0 Middle Shingle Creek Management Unit

MIDDLE SHINGLE CREEK MANAGEMENT UNIT OVERVIEW

The Middle Shingle Creek Management Unit covers Shingle Creek from the confluence of Eagle and Bass Creeks to Palmer Lake in Brooklyn Park. This management unit covers approximately 9,500 acres across four municipalities in Hennepin County. A majority of the management unit is located in Brooklyn Park (62%), with the rest covering portions of Maple Grove (27%), Brooklyn Center (8%), and Osseo (3%) (Figure 6-1 and Table 6-1).

The Middle Shingle Creek Management Unit is fully developed. Most of the eastern portion of the management unit (Brooklyn Park and Brooklyn Center) was developed in the 1960s and 1970s with minimal stormwater treatment. The western portion of the watershed, particularly Maple Grove, was developed more recently in the 1980s and 1990s and therefore much of this area has some level of stormwater quality treatment. A recent desktop analysis determined that there are approximately 1,700 acres of the watershed flowing directly to Shingle Creek with minimal water quality treatment, most of which is in the City of Brooklyn Park (see Table 6-1).

Land use within the Middle Shingle Creek Management Unit is predominantly high impervious urban development (45%) and low-moderate impervious urban development (28%). In general, development through the Shingle Creek watershed occurred from east to west and therefore the Middle Shingle Creek Management Unit has the second most impervious coverage of the three management units. Lakes are a not a common feature in the Middle Shingle Creek Management Unit. Lake Success is the only lake in the watershed by DNR definition. Palmer Lake is another shallow water body located in this management unit, however it is classified as a wetland by DNR standards.

Similar to the West Mississippi Management Unit, the Middle Shingle Creek Management Unit is characterized by sandy, well-draining soils. Approximately 62% of the management unit contains type A, A/D, or B soils. Soil type for the Middle Shingle Creek Management Unit is summarized in Table 6-1.

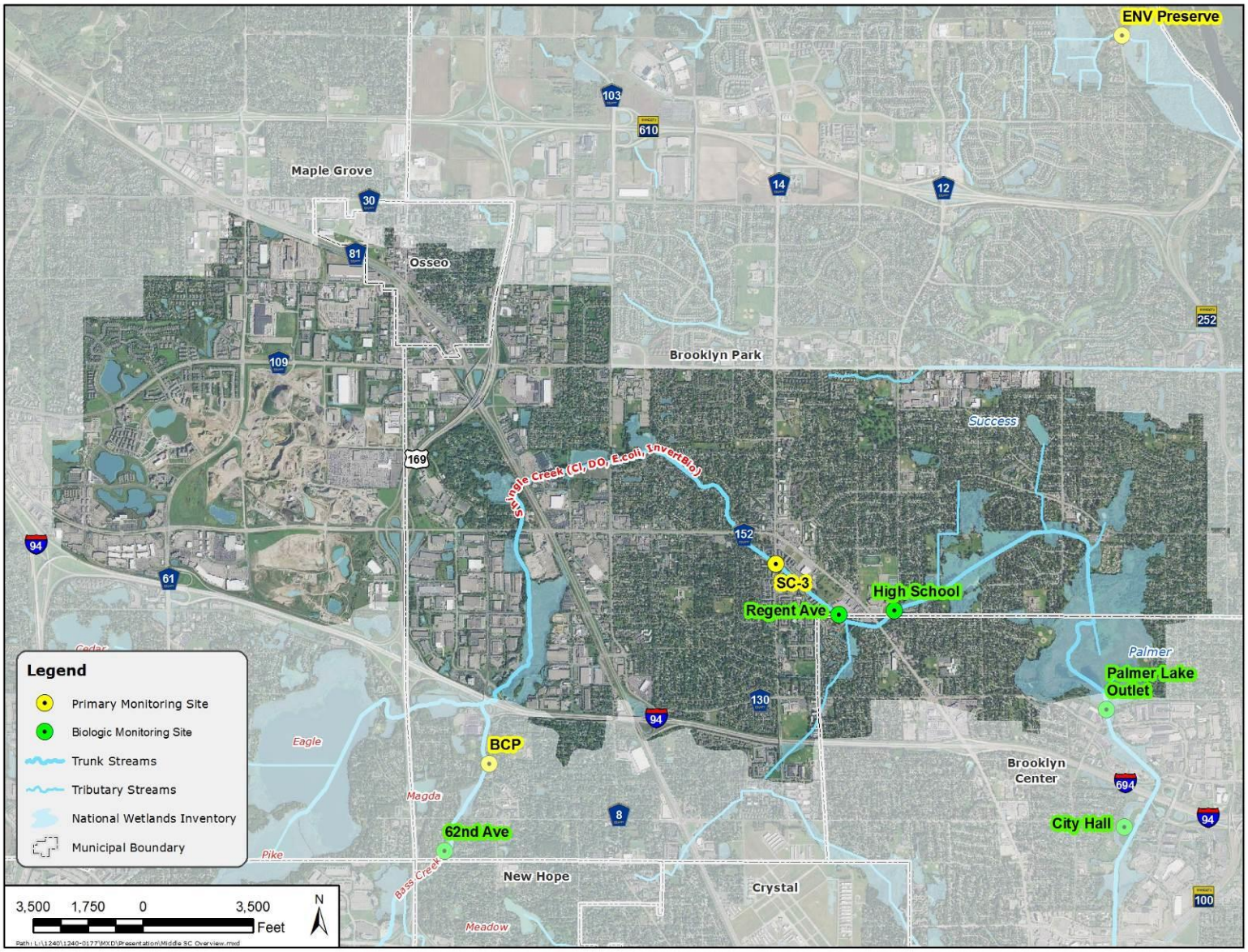

Figure 6-1. Middle Shingle Creek Management Unit Overview.

Table 6-1. Middle Shingle Creek Management Unit water resources and land features.

Streams	Type	Impairment Status
Shingle Creek (07010206-506)	Class 2B	Impaired (Cl, DO, *E. coli*, Biota – Invert.)

Lakes	Type	Impairment Status
Palmer	Shallow	Not Assessed
Success	Shallow	Not Impaired

Cities	Acres	Percent
Brooklyn Park	5,839	62%
Maple Grove	2,558	27%
Brooklyn Center	769	8%
Osseo	273	3%

Landuse	Acres	Percent
Highly Impervious (51-100%)	4,215	45%
Low-Moderate Impervious (5-50%)	2,645	28%
Grassland and Shrubland	1,422	15%
Wetlands	893	9%
Forest	236	3%
Agriculture	19	<1%
Open Water	10	<1%

Soil Type	Acres	Percent
A	2,943	31%
A/D	2,138	23%
B	772	8%
B/D	228	2%
C	36	<1%
C/D	39	<1%
Water	86	1%
Not Assessed (Heavily Disturbed)	3,197	34%

Untreated Area (Direct)	Acres
Brooklyn Park	1,637
Brooklyn Center	95

6.1 Monitoring History

STREAMS

Stream flow and water quality have been monitored at one location, SC-3, in the Middle Shingle Creek Management Unit. This station is located at the intersection of Shingle Creek and Brooklyn Boulevard in Brooklyn Park. This monitoring location drains approximately 54% of the Middle Shingle Creek Management Unit. The Shingle Creek WMC began monitoring this station in the early 2002. Shingle Creek was placed on the State's 303(d) list of impaired waterbodies in 1998 for chloride, in 2004 for DO, and in 2006 for macroinvertebrate IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the DO and macroinvertebrate IBI impairments. The Commission has continued to monitor this station every year since the completion of the TMDLs to assess water quality conditions in the Middle Shingle Creek Management Unit and measure progress toward achieving the TMDLs. Shingle Creek is considered a Class 2B water and is therefore subject to the North Central Hardwood Forest Class 2B water quality standards for streams.

Four main water quality parameters of concern have been sampled at the SC-3 monitoring station since 2002: TSS, TP, dissolved oxygen (DO), and chloride. The dot charts depict the current condition and associated Class 2B water quality standard. Monitoring results for other water quality parameters not covered in this section (ortho-P, TKN and nitrate) are presented in Appendices C. Also included in dot charts is the fish/macroinvertebrate IBI monitoring. Fish and macroinvertebrate IBI assessments were performed at the sample locations to provide an update to dated (2000) assessments along Shingle Creek.

Below is a general summary of the current conditions of the four main water quality parameters of concern and IBI monitoring results in the Middle Shingle Creek Management Unit.

LAKES

Lake water quality has been monitored on the only lake in the Middle Shingle Creek Management Unit, Lake Success, since the 1990s (Palmer Lake is a considered wetland for monitoring purposes).

Historic water quality sampling on Lake Success has focused on three main parameters: TP, chlorophyll-a, and Secchi depth (transparency). Lake Success is not currently meeting state water quality standards for water quality parameters, however it is currently not listed on the 303(d) list of impaired waters. Lake Success was monitored by the Commission in 2016 through the Intensive Lake Monitoring program.

The fish community was assessed on Palmer Lake as it is a flow-through wetland habitat for Shingle Creek and suspected to serve as a carp nursery. Results of the 2018 survey are presented in Section 6.4.

6.2 SC-3 Stream Reach

Water Quality

- TP concentrations have not met standards in most years and did not meet standards in 2018. TSS, chloride and DO concentrations also frequently have not meet their respective standards, although in 2018, DO and TSS met standards.
- NO_3/NO_2 concentrations are consistently below the impairment threshold.
- Chloride was over double the standard concentration.

Biota

- 2018 fish and macroinvertebrate IBI scores did not meet standards.
- 2010 biotic stressor ID highlighted DO, chloride, system flashiness, historic straightening and armoring as possible candidate stressors. Areas of the site were extremely silty (a common habitat impairment).
- The continued use of chlorides within the watershed and the increased size and intensity of storm events is a continued and growing concern for biota within the system.

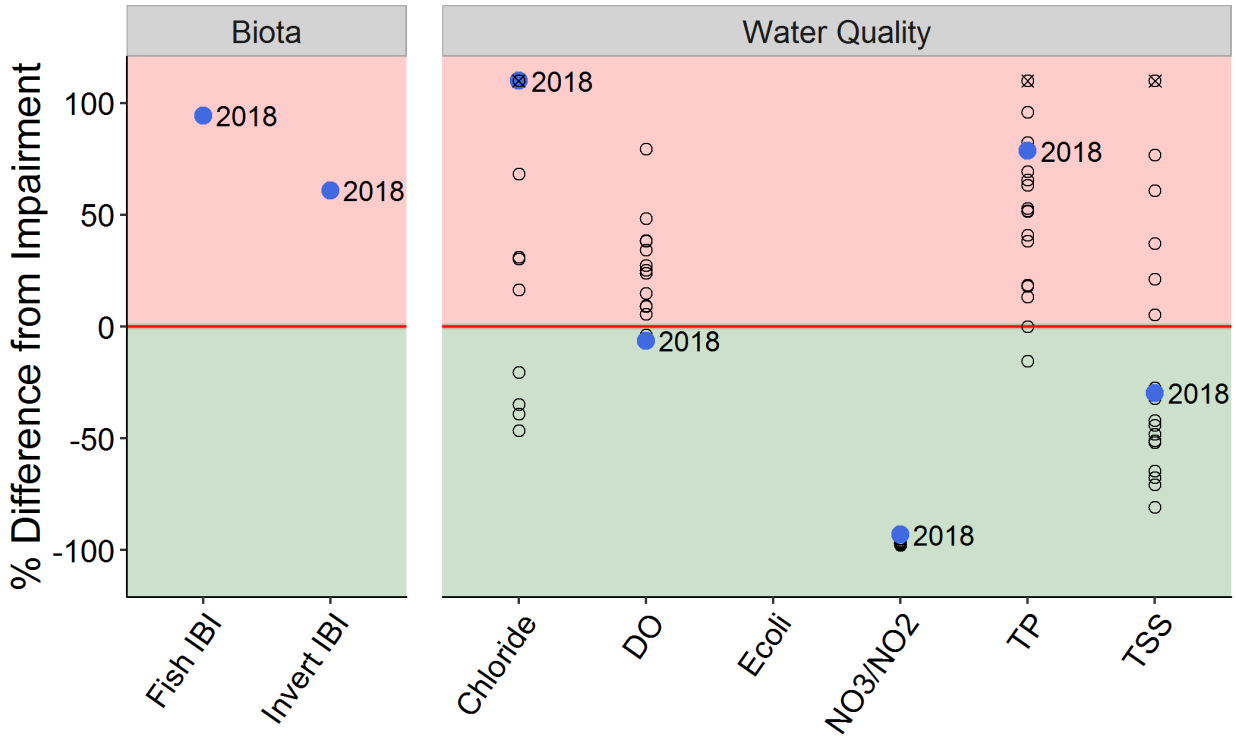

Figure 6-2. SC-3 stream water quality and biota health summary since 2000.

Recommendations

- Water quality monitoring will occur in 2019.
- 2019 monitoring will include measurement of E. coli concentrations.
- Review and investigate ways to reduce chloride impact on stream.
- Investigate and restore biotic health within the stream reach.
- Increased biotic assessments in conjunction with habitat assessments could begin to tease apart the impact of the numerous biotic stressors influence the stream.
- Implement findings of DO and biotic TMDL Review which will be completed in 2020

6.3 Lake Success

Water Quality

- Most recent monitoring efforts (2016) indicate TP and Secchi were not meeting standards, while Chl-a was slightly above impairment threshold. Overall water quality is poor.
- Historic trend assessment: Secchi depth is decreasing.

Fisheries

- No fisheries assessment has been conducted.

Vegetation

- No vegetation was observed in spring or summer surveys.

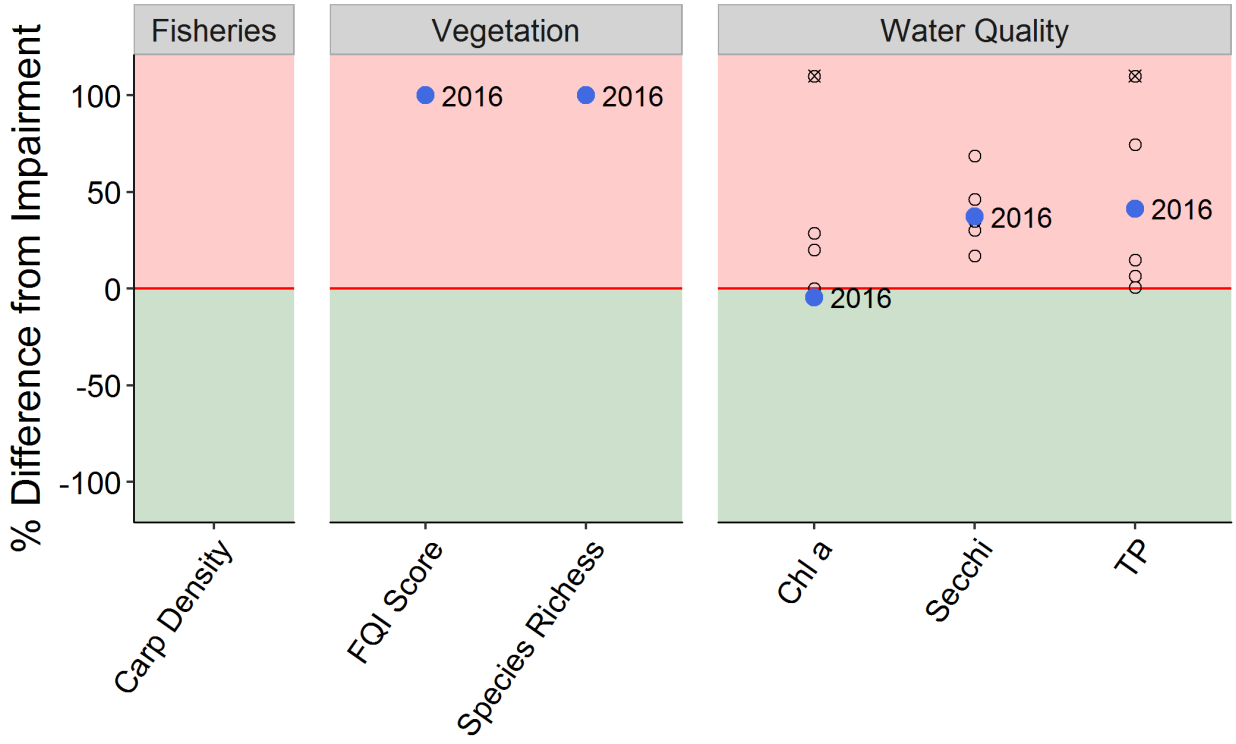

Figure 6-3. Biota and water quality summary (since 2000) for Lake Success.

Recommendations

- Conduct a fish community assessment.
- Investigate why there is no vegetation growth.

6.4 Palmer Lake

Fisheries

- Wenck conducted a shallow lake fish assessment on Palmer Lake in 2018 to determine if common carp utilized the lake/wetland.
- A very tolerant fish community was observed, and a large number of adult common carp were observed swimming within the lake.
- >80 young of year carp were captured suggesting that Palmer Lake is a nursery habitat for carp.

Table 6.1. Fish summary from shallow lake fish assessment.

Black Bullhead	Count	4
	Mass (g)	102
Northern Pike	Count	1
	Mass (g)	71
Common Carp	Count	87
	Mass (g)	925
Largemouth Bass	Count	2
	Mass (g)	12
Fathead Minnow	Count	41
	Mass (g)	54
Central Mudminnow	Count	4
	Mass (g)	27
Spotfin Shiner	Count	1
	Mass (g)	7
Hybrid Sunfish	Count	5
	Mass (g)	4

Vegetation

- Fortin consulting was observed out on the lake conducting a vegetative AIS assessment.
- Wenck observed very little vegetation overall but did notice small amounts of curlyleaf pondweed in the basin.

Recommendations

- The overall biotic health of Palmer Lake is significantly degraded. The in lake and wetland fringe habitat is filled with tolerant and/or invasive species.
- The wetland sediment is very fine particles that are easily moved and may be contributing to degraded and impaired conditions within the lake.

7.0 Lower Shingle Creek Management Unit

LOWER SHINGLE CREEK MANAGEMENT UNIT OVERVIEW

The Lower Shingle Creek Management Unit covers Shingle Creek from the outlet of Palmer Lake in Brooklyn Center to the creek's confluence with Mississippi River in Minneapolis. This management unit covers approximately 11,000 acres across six municipalities in Hennepin County. This management unit is split fairly evenly between Brooklyn Center (27%), Crystal (23%), Minneapolis (19%), Robbinsdale (14%), New Hope (10%), and Brooklyn Park (7%) (Figure 7-1 and Table 7-1).

Lakes are a common feature in the Lower Shingle Creek Management Unit. The Twin Chain of Lakes is located in Crystal, Brooklyn Center, and Robbinsdale and includes Upper Twin, Middle Twin and Lower Twin Lakes. Upper (118 acres) and Lower Twin (30 acres) are shallow lakes, while Middle Twin Lake (54 acres) is a deep lake. Flow through the lake chain is from north to south or from Upper to Middle to Lower Twin. Lower Twin Lake outlets over a weir located at France Avenue to a small channel (Ryan Creek) that flows downstream to Ryan Lake. Ryan Lake is a small (15 acres) deep lake located in Robbinsdale, Brooklyn Center, and Minneapolis. Ryan Lake outlets to Ryan Creek which flows east to where it discharges to Shingle Creek near 49th Ave N in Minneapolis. Crystal Lake is the other lake in the Lower Shingle Creek Management Unit. Crystal Lake is a moderate sized (89 acres) deep lake located in the City of Robbinsdale.

The Lower Shingle Creek Management Unit is fully developed. Most of this management unit was developed in the 1950s and 1960s or earlier and therefore has minimal stormwater treatment. A recent desktop analysis determined that there are approximately 2,000 acres of the watershed flowing directly to Shingle Creek with no water quality treatment, most of which is in Minneapolis (see Table 7-1).

Land use within the Lower Shingle Creek Management Unit is predominantly high impervious urban development (71%). In general, development through the Shingle Creek watershed occurred from east to west and therefore the Lower Shingle Creek Management Unit has the highest impervious coverage of the three Shingle Creek Management Units. The remainder of land in the Lower Shingle Creek Management Unit is split between grassland and shrubland (13%), low-moderate impervious urban development (8%), open water (3%), wetlands (3%) and forest (2%) (see Table 7-1).

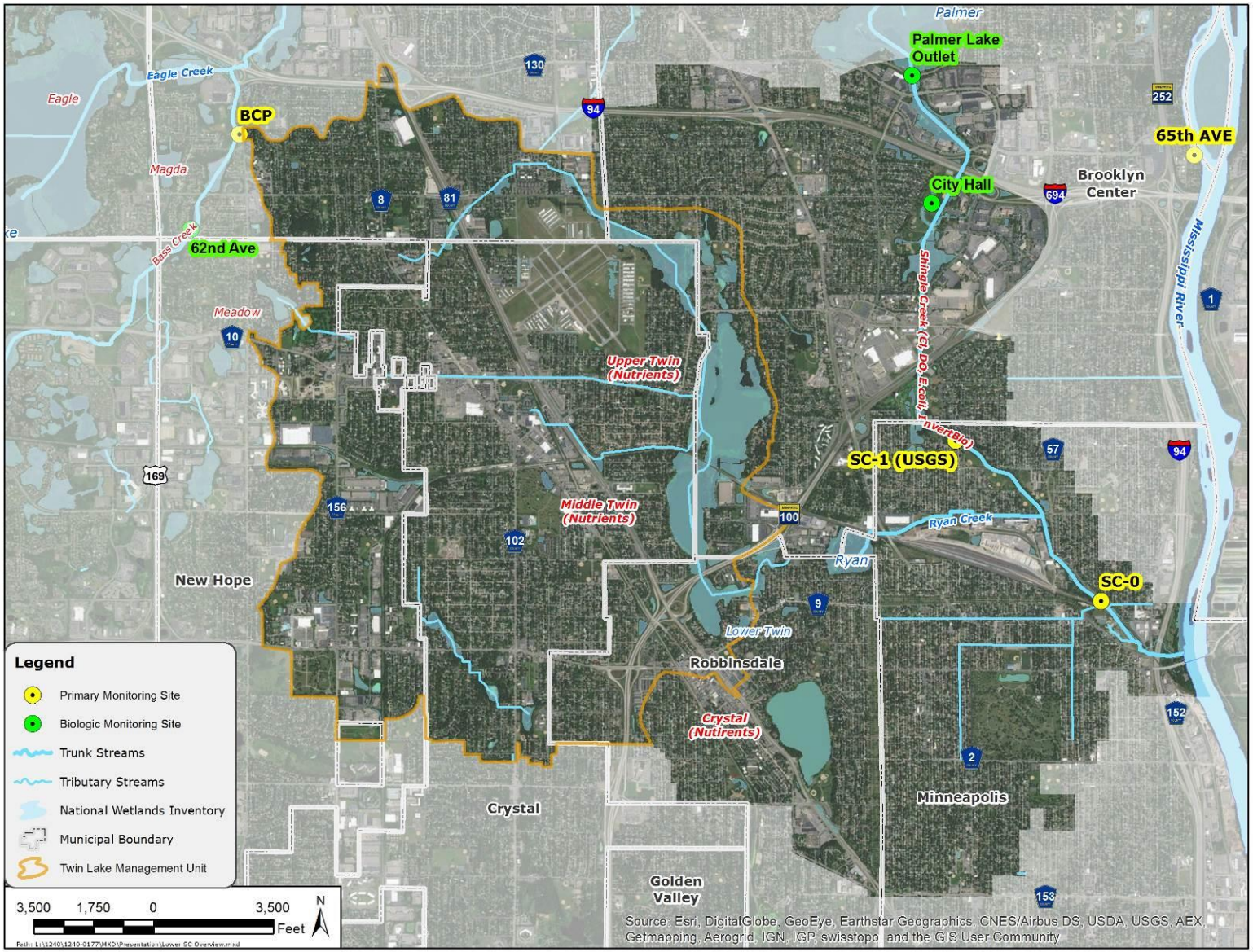

Figure 7-1. Lower Shingle Creek Management Unit Overview.

Table 7-1. Lower Shingle Creek Management Unit water resources and land features.

Streams	Type	Impairment Status
Shingle Creek (07010206-506)	Class 2B	Impaired (Cl, DO, *E. coli*, Biota – Invert.)
Ryan Creek (07010206-536)	Class 2B	Not Assessed

Lakes	Type	Impairment Status
Crystal	Deep Lake	Impaired (nutrients)
Upper Twin	Shallow Lake	Impaired (nutrients)
Middle Twin	Deep Lake	Impaired (nutrients)
Lower Twin	Shallow Lake	Not Impaired (de-listed in 2016)
Ryan	Shallow Lake	Not Impaired (de-listed in 2016)

Cities	Acres	Percent
Brooklyn Center	2,902	27%
Crystal	2,515	23%
Minneapolis	2,048	19%
Robbinsdale	1,485	14%
New Hope	1,092	10%
Brooklyn Park	810	7%

Landuse	Acres	Percent
Highly Impervious (51-100%)	7,700	71%
Grassland and Shrubland	1,425	13%
Low-Mod Impervious (5-50%)	835	8%
Open Water	370	3%
Wetlands	309	3%
Forest	196	2%
Agriculture	16	0%

Soil Type	Acres	Percent
A	2,346	28%
A/D	2	<1%
B	1,892	23%
B/D	1,006	12%
C	89	1%
C/D	1,003	12%
Water	736	9%
Not Assessed (heavily disturbed)	1,249	15%

Untreated Area (Direct to Creek)	Acres
Minneapolis	1,342
Brooklyn Center	301
Robbinsdale	295
Crystal	57

7.1 Monitoring History

STREAMS

Water quality has been monitored routinely at one location, SC-0, in the Lower Shingle Creek Management Unit. This station is located in Webber Park in Minneapolis just upstream of 45th Ave. The SC-0 monitoring station drains approximately 82% of the Lower Shingle Creek Management Unit, as well as the entire Middle and Upper Shingle Creek Management Units. The Shingle Creek WMC began monitoring this station routinely in 2002. Shingle Creek was placed on the State's 303(d) list of impaired waterbodies in 1998 for chloride, in 2004 for DO, and in 2006 for macroinvertebrate IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the DO and macroinvertebrate IBI impairments. The Commission has continued to monitor this station every year since the completion of the TMDLs to assess water quality conditions in the Middle Shingle Creek Management Unit and measure progress toward achieving the TMDLs. Shingle Creek is considered a Class 2B water and is therefore subject to the North Central Hardwood Forest Class 2B water quality standards for streams.

Four main water quality parameters of concern have been sampled at the SC-0 monitoring station since 2002: TSS, TP, dissolved oxygen (DO), and chloride. The dot charts depict the current condition and associated Class 2B water quality standard. Monitoring results for other water quality parameters not covered in this section (ortho-P, TKN and nitrate) are presented in Appendix C. Also included in the dot charts is the fish/macroinvertebrate IBI monitoring. Fish and macroinvertebrate IBI assessments were performed at the sample locations to provide an update to previous assessments along Shingle Creek. Additional fish and macroinvertebrate IBI assessments were performed by the MPCA at the USGS site since the 1990s with those results previously summarized in the 2017 Annual Report.

Below is a general summary of the current conditions of the four main water quality parameters of concern and IBI monitoring results in the Lower Shingle Creek Management Unit.

LAKES

Lake water quality has been monitored for all five lakes in the Lower Shingle Creek Management Unit since at least the mid-1990s. All of the lakes in the Lower Management Unit were assessed as impaired for nutrients (TP) in the early 2000s. TMDL studies for each lake were completed by the Commission and the MPCA through two different TMDL studies: The Twin and Ryan Lakes Nutrient TMDL (2007) and The Crystal Lake Nutrient TMDL (2008).

Historic water quality sampling on each lake has focused on three main parameters: TP, chlorophyll-a, and Secchi depth (transparency). In more recent years, biotic sampling has become a priority of the Commission and updates to both fisheries and the submerged aquatic vegetation community have been occurring. The following is a general summary of water quality conditions for each lake in the Lower Shingle Creek Management Unit since 2000.

Twin Lake Chain

- Upper Twin and Middle Twin Lakes have consistently exceeded water quality standards over the past 10 years.
- There does not appear to be any positive or negative trend in water quality for Upper Twin and Middle Twin and both lakes are still considered impaired.
- Lower Twin has met state water quality standards over the past 10 years and was removed from the State's 303(d) list of impaired waters in 2016.
- The biotic communities (fish and SAV) are severely degraded within the Twin Lakes.
- Common carp management is currently underway on the system as part of the Twin Lake Carp study.

Ryan Lake

- Similar to Lower Twin, Ryan Lake has met state water quality standards over the past 10 years and was recently removed from the State's 303(d) list of impaired waters in 2016.
- Ryan Lake fishery appears to be a boom-bust fishery that is susceptible to periodic winterkills.

Crystal Lake

- Crystal Lake has not met State water quality standards over the past 10 years.
- Carp populations persist at levels that can be contributing to water quality and habitat degradation.
- SAV impairments are severe with little to no vegetation observed in the system.

7.2 SC-0 Stream Reach

Water Quality

- TP, chloride and DO concentrations did not meet standards in 2018 and also have not met standards in most years.
- TSS concentrations met standards in 2018, but frequently have not met standards.

Biota

- Fish and macroinvertebrate IBI scores have never met biological impairment thresholds.
- Rusty crayfish is an aquatic invasive species that was observed frequently at the site and is the first documented occurrence within Shingle Creek.
- 2010 biotic stressor ID highlighted DO, chloride, system flashiness, historic straightening and armoring as primary stressors.
- The continued use of chloride within the watershed and the increased size and intensity of storm events is a continued and growing concern for biota within the system.

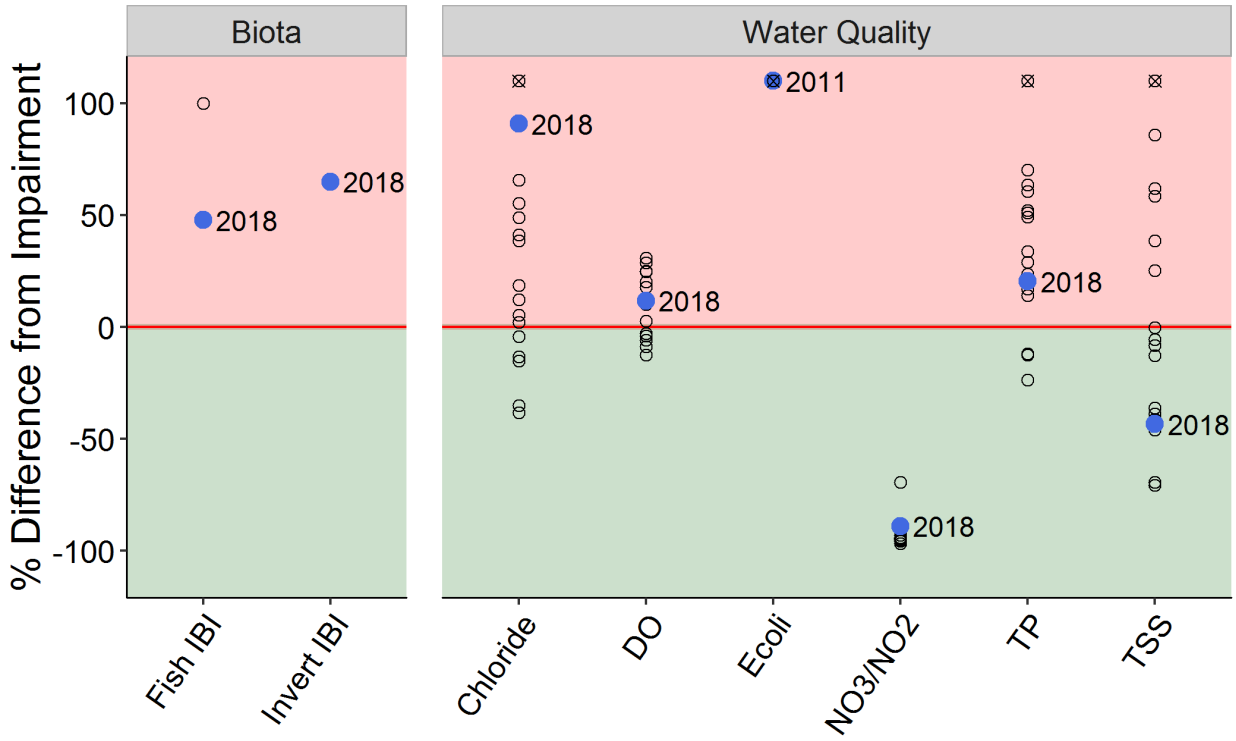

Figure 7-2. SC-0 stream water quality and biota health summary since 2000.

Recommendations

- Water quality monitoring will occur in 2019.
- 2019 monitoring will include measurement of E. coli concentrations.
- Develop a management plan for AIS, namely the Rusty Crayfish, for Shingle Creek.
- Investigate stressors impairing biotic community health with efforts oriented to improving biotic health in the stream.
- Continue biotic assessments in conjunction with habitat assessments in to tease apart the impact of the numerous stressors influencing the stream.
- Implement findings of DO and biotic TMDL Review which will be completed in 2020

7.3 Upper Twin Lake

Water Quality

- All three water quality parameters failed to meet state standards in 2018. Chl-a and TP were very poor and were more than double the impairment standard.
- Chl-a and TP are consistently above double the standards, suggesting serve impairment.

Fisheries

- Carp density exceeds the critical threshold by more than 100%.
- The IBI observed a relatively impaired fish community dominated by black bullheads.
- About 3,000 carp and 50,000 black bullhead were removed via winter seining in 2018.
- Removal targets for carp were not met for the Twin Lake system and continued removals are being pursued.

Vegetation

- Vegetation community is poor and lacked both species richness and quality of species. Community conditions degraded across the open water season.
- CLP treatment was conducted on 9.4 acres of the lake. CLP was notably down due to late winter snow cover on the lake.

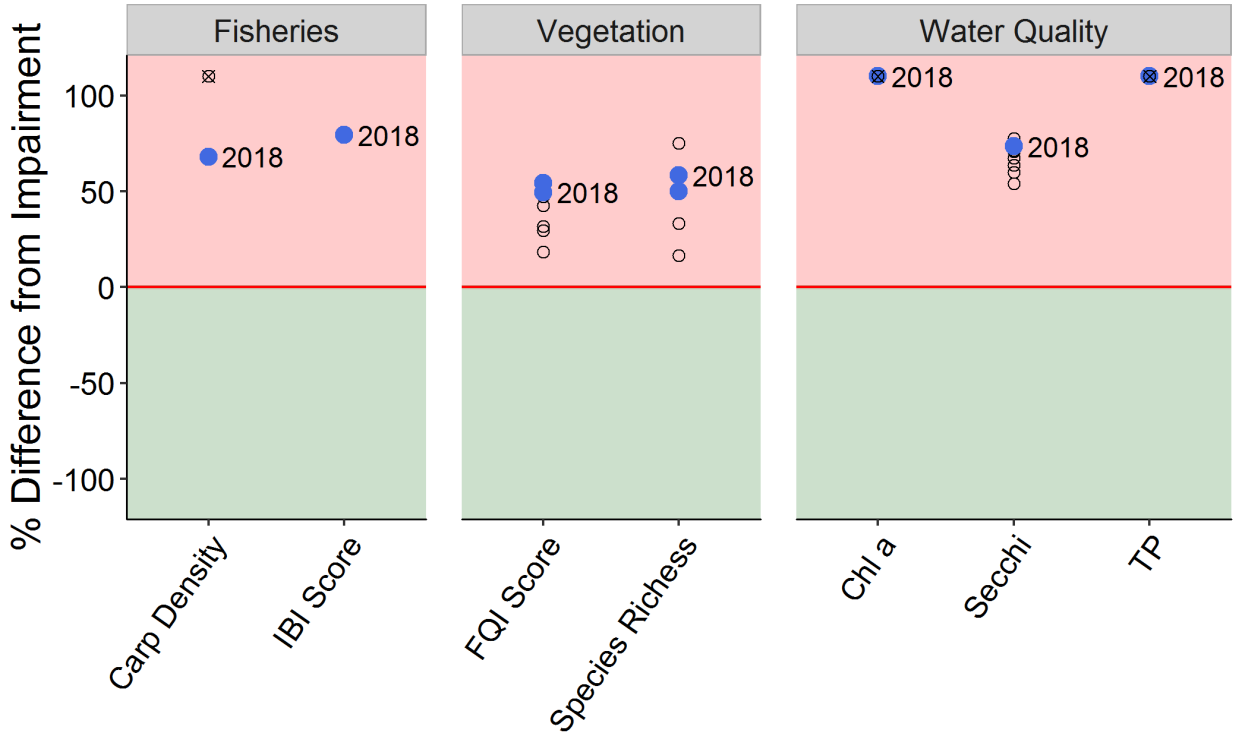

Figure 7-3. Biota and water quality summary (since 2000) for Upper Twin Lake.

Recommendations

- Carp management efforts are on-going within the Twin Lake chain via Ryan Creek removals (spring 2019).
- Continue aquatic vegetation management plan and CLP treatments in 2019 and 2020.
- Monthly water quality sampling will be completed in 2019.

7.4 Middle Twin Lake

Water Quality

- TP just met WQ standards in 2018 while no other parameter did.
- In 2017, Chl-a was very poor at more than double impairment standard value, but it improved in 2018.
- Water quality has improved slightly since 2017but it is too early to tell whether this was the result of the large carp and bullhead removal effort during winter 2018 or simply annual variability.

Fisheries

- Carp density exceeds the critical threshold by more than double critical threshold.
- The IBI observed a relatively impaired fish community dominated by black bullheads.
- About 3,000 carp and 50,000 black bullhead were removed via winter seining in 2018.
- Removal targets for carp were not met for the Twin Lake system through 2018 removal efforts. Continued removals are being pursued in 2019.

Vegetation

- Vegetation community is poor and lacked both species richness and quality of species.
- EWM and CLP were sparsely observed in various locations across the lake.

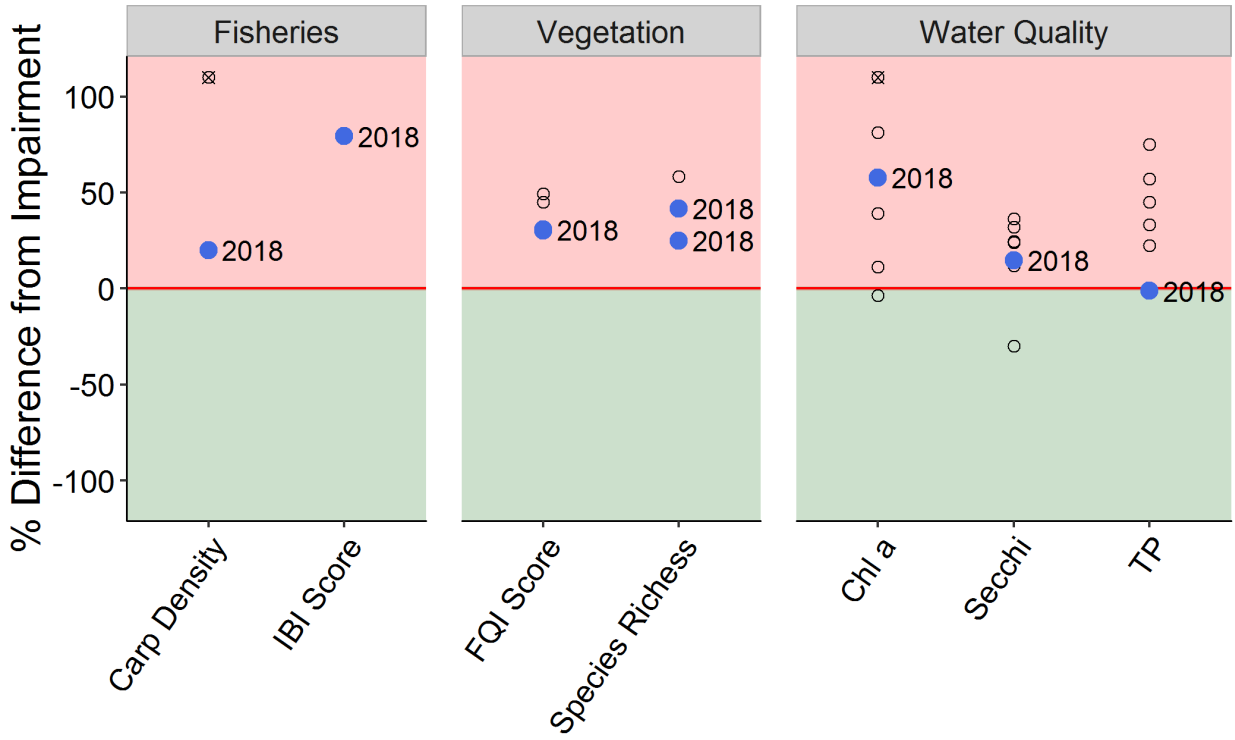

Figure 7-4. Biota and water quality summary (since 2000) for Middle Twin Lake.

Recommendations

- Common carp management efforts are on-going within the Twin Lake chain via Ryan Creek removals (spring 2019).
- Continued monitoring of the SAV will be important to restoring a healthy ecosystem.
- Monthly water quality sampling will be completed in 2019.

7.5 Lower Twin Lake

Water Quality

- 2018 monitoring indicate Chl-a and Secchi did not meet water quality standards while TP met the standard. Historic trend assessment: TP is decreasing and Secchi depth is increasing (both improving conditions).

Fisheries

- Carp density was less than threshold, however, the lake is well connected to the other Twin lakes and contributes to the overall carp density problem.
- The 2018 IBI score indicates an impaired fish community dominated by black bullheads.
- About 3,000 carp and 50,000 black bullhead were removed via winter seining in 2018.
- Removal targets for carp were not met for the Twin Lake system.
- A fish barrier was placed along Ryan Creek to prevent individuals from entering Lower Twin Lake from Ryan Lake.

Vegetation

- Vegetation community is poor and lacked both species richness and quality of species.
- CLP was sparsely observed within the basin.

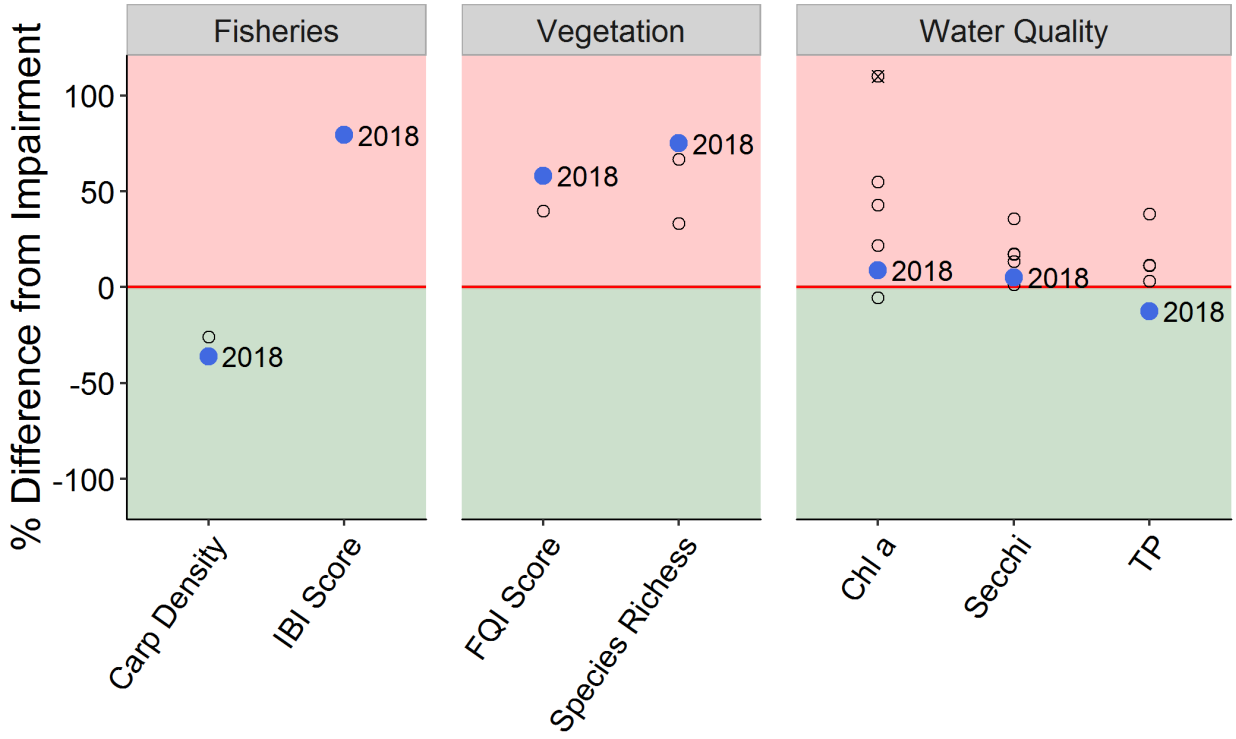

Figure 7-5. Biota and water quality summary (since 2000) for Lower Twin Lake.

Recommendations

- Continued carp management efforts are on-going within the Twin Lake chain (2019).
- Continued monitoring of the SAV will be important to restoring a healthy ecosystem.
- Monthly water quality sampling will be completed in 2019.

7.6 Ryan Lake

Water Quality

- Secchi (transparency) was exceptional early in 2018 (>5m) but declined over the season. Average annual Secchi depth for 2018 was well below the standard.
- TP and Chl-a did not meet state standards and declined over the open water season.

Fisheries

- The MnDNR had informed the Commission that they would be conducting standard fish community assessments in 2018, therefore, the Commission did not plan to duplicate assessment. Due to partial winterkill, the DNR didn't conduct the assessment so no standard netting occurred.
- Experienced a partial winter kill in 2018 (noted dead carp along shoreline).
- MnDNR did attempt to use as a walleye rearing pond in 2018, however, fry did not survive.

Vegetation

- Community had limited diversity and was dominated by an overabundance of coontail.

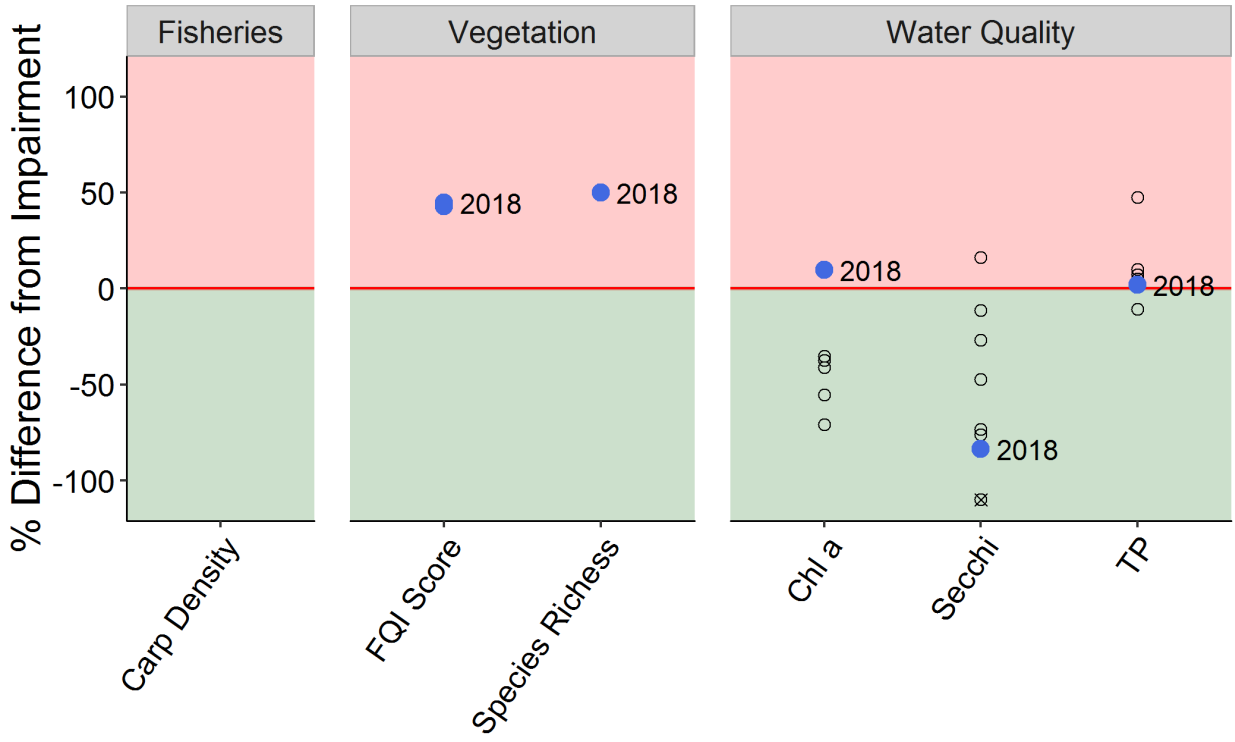

Figure 7-6. Biota and water quality summary (since 2000) for Ryan Lake.

Recommendations

- The MnDNR did not sample the fish community in 2018 via standard sampling methods. Therefore, this should be considered in future monitoring years by the Commission.
- Internal loading feasibility assessment has demonstrated the potential for high internal loading, however, lake response modeling suggests the internal load is not a significant proportion of the nutrient budget. As upstream lake water quality improves, internal load could become more significant.

7.7 Crystal Lake

Water Quality
- Significant algal blooms were observed on the lake, especially late summer.
- Water quality did not meet TP, Chl-a or Secchi standards.

Fisheries
- Common carp population assessment revealed densities at 126 kg/ha, which are above the critical threshold.

Vegetation
- Extremely limited vegetation growth was observed. Habitat conditions are extremely degraded within the lake.

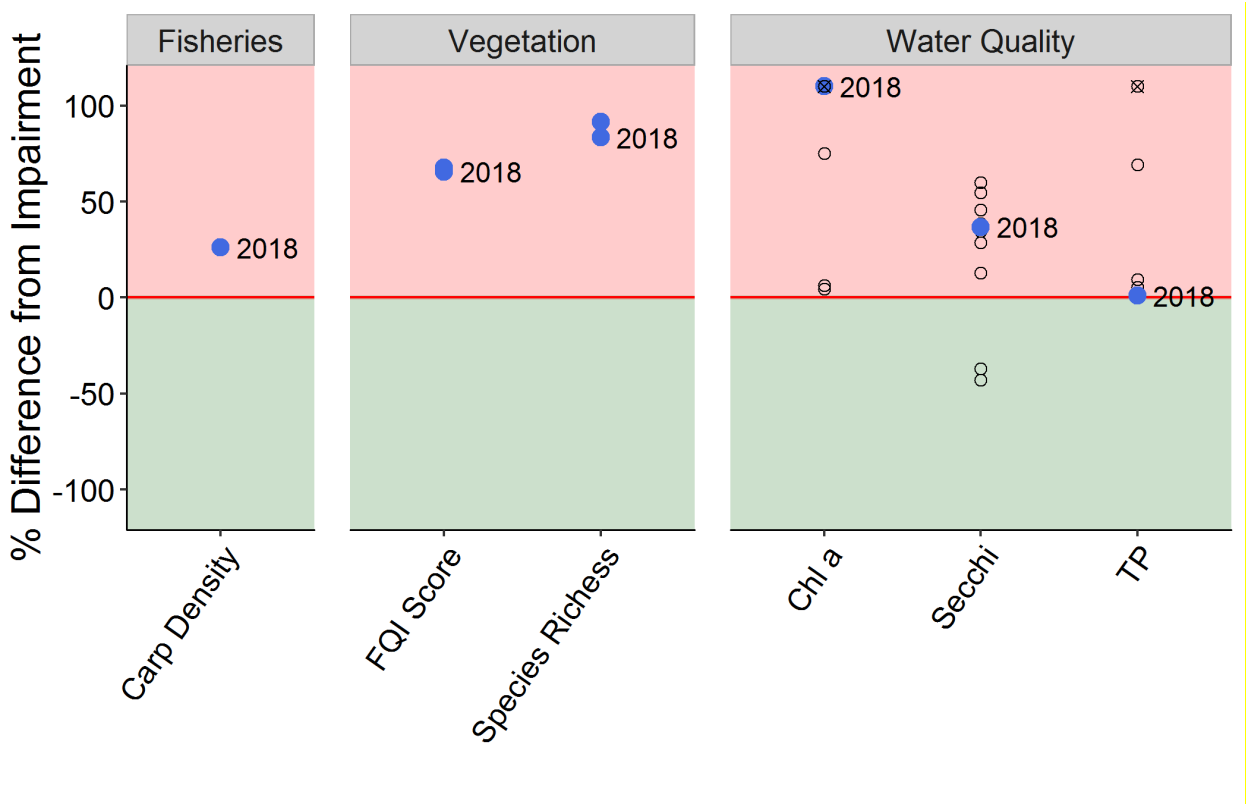

Figure 7-7. Biota and water quality summary (since 2000) for Crystal Lake.

Recommendations
- MnDNR is conducting a fisheries survey in 2019.
- Carp alone do not explain turbidity and lack of vegetation and greater research is needed to improve all aspects of Crystal Lake.
- Grant efforts are being pursued to further investigate internal loading and SAV concerns within the lake.

8.0 Recommendations

Results of the historic water quality monitoring for the four management units support the following conclusions and recommendations.

West Mississippi Management Unit

- Identify areas that currently have no water quality treatment and/or minimal treatment. Once these areas have been identified, they should be targeted for enhanced street sweeping and assessed for potential BMP retrofit opportunities.
- Identify bacteria sources and high potential loading areas.
- Salt management practices in the impervious areas upstream of the 65th Avenue outfall should be reviewed to determine potential sources of chloride at this location.

Upper Shingle Creek Management Unit

- TP concentrations currently exceed State standards near the outlet of Bass Creek, and monitoring indicates a high dissolved phosphorus component. The dissolved phosphorus is likely coming from the breakdown of organic matter and sediment release of phosphorus in the lakes, ponds and flow-through wetlands throughout the Upper Management Unit. Continue to identify ponds and wetlands in or near the main channel (such as the Cherokee wetland) that are currently releasing phosphorus and investigate strategies to decrease these loads. The SRP Reduction Project includes installing an in-stream filter between the Cherokee wetland and BCP to determine if dissolved P can be removed in-situ.
- Prepare for follow up assessment post aluminum sulfate treatments on Bass and Pomerleau Lakes. Consider both water quality and submerged aquatic vegetation sampling.
- Prepare for assisting with AIS management of CLP on Bass Lake.

Lower Shingle Creek Management Unit

- Continued common carp removals and post removal water quality, fisheries and SAV monitoring.
- CLP treatment, annual delineation and report will be conducted by the commission on the Twin Lakes for 2019 and 2020.
- Investigation into the severely degraded Crystal Lake is needed. Possible internal loading concern occurring on the lake.

Shingle Creek Watershed-Wide

- Identify bacteria sources and high potential loading areas.
- Continue to review and understand filter media that reduce bacteria and nutrient loading into Shingle Creek.
- Evaluate opportunities for additional stream restoration and habitat enhancement.
- Continue updating biotic community information in lakes and begin efforts to restore biotic health across the watershed.
- Continue to stabilize streambanks and enhance habitat along and in Shingle and Bass Creeks as opportunities arise.