Watershed assessment and trends update

St. Louis River Watershed

Lake Superior Basin

Why is it important?

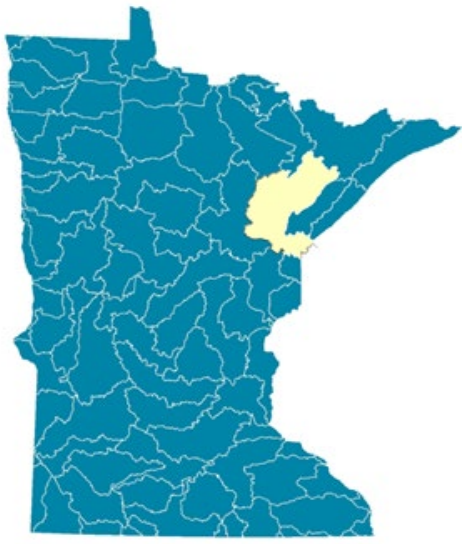
Water quality monitoring is essential in determining whether lakes and streams meet water quality standards designed for protecting beneficial uses like fishing and swimming. Regional and local water-stewardship groups, along with state, federal, and tribal agencies, monitor their respective watersheds on an ongoing basis. Once every 10 years, the Minnesota Pollution Control Agency (MPCA), local partners, and the Minnesota Department of Natural Resources (MNDNR) conduct monitoring of lakes and streams in each of the state's 80 major watersheds. These repeated monitoring efforts examine fish and macroinvertebrate assemblages, as well as water chemistry data to assess the health of aquatic ecosystems. Following data collection, MPCA staff and local partners collaboratively review monitoring results to determine if waterbodies are healthy, stressed, or impaired. Furthermore, there is an evaluation of how conditions have changed over the previous 10 years. These assessments help prioritize work going forward by highlighting candidates for restoration and protection.

Waterbodies in the St. Louis River Watershed are generally in good condition, reflecting the healthy forests and wetlands found throughout much of the watershed. While most streams and lakes are healthy, improvements can be made in some portions of the watershed. Locating areas in need of restoration and highlighting areas for protection helps preserve the good water quality for future generations in both the St. Louis River Watershed, and in Lake Superior.

Is the water quality improving?

Over the past decade, scientists observed several changes in water quality in the St. Louis River Watershed. Thirty-two stream segments and lakes received new impairments in Cycle II (22 on the 2022 list and 10 sulfate impairments from the 2020 list). Ten aquatic life use impairments were removed from Minnesota's Impaired Waters List. Some of these reclassifications are the result of restoration activities; the fish community of East Swan Creek improved, likely due to a bridge replacement on a road crossing that previously inhibited fish passage. In other cases, specific reasons for apparent improvement in condition are not yet well understood and may in part be related to changes in sampling techniques or data interpretation. Lake clarity monitoring showed that more lakes had increasing or stable trends rather than decreasing clarity.

The St. Louis River Watershed is located in northeast Minnesota, extending north to Babbitt, west to Hibbing, and south to Duluth.



Fish and macroinvertebrate assemblages showed improvements in Manganika Creek, following upgrades to the Virginia wastewater treatment plant. The plant increased the efficacy of phosphorus and mercury removal. This project retooled and replaced old equipment, earning an honor award from the American Council of Engineering Companies, Minnesota Chapter (ACEC/MN). Additional chemistry monitoring has been requested to better gauge the changes in water quality, and to hopefully support removing Manganika Creek from the impaired waters list.

MPCA biologists prepare to collect a fish sample on the Whiteface River.

Highlights of monitoring

- The Fond du Lac Band of Lake Superior Chippewa (FDL) has federal Clean Water Act jurisdiction for lakes and streams on the reservation. FDL and MPCA worked together to monitor and/or assess 31 lakes and streams wholly, partially, or forming the boundary within the Fond du Lac Reservation. Biologists from both organizations met to discuss data collected over the past 10 years and determined there were no new water quality impairments within the Fond du Lac Reservation. More information about FDL's water quality program is available on Fond du Lac's environmental program webpage.
- High chloride levels have been identified on some of Duluth's urban streams, including Kingsbury, Keene, and Miller Creeks. The MPCA and local partners continue to promote programs such as Smart Salting, designed to improve the effectiveness of salt application, while maintaining safe roads and sidewalks.
- Urban Brook Trout populations on Keene Creek have been the subject of restoration efforts conducted by the South St. Louis Soil Water and Conservation District (SSLSWCD). The SSLSWCD has partnered with Trout Unlimited to reduce sediment levels via streambank stabilization. Keene Creek remains a priority as outlined in the St. Louis River One Watershed One Plan document.
- Nineteen miles of the Whiteface River have been assigned an "exceptional" aquatic life use, based on consistently high fish and macroinvertebrate Index of Biological Integrity (IBI) scores. Biological data from the late 1990s through the present are indicative of a healthy and stable ecosystem. The exceptional use designation confers a higher level of protection for aquatic life in these reaches of the Whiteface River.
- The fish community of Long Lake near Goodland includes Least Darter and Pugnose Shiner, Species of Greatest Conservation Need that require high quality habitat and excellent water quality. The FIBI score was well above the impairment threshold and is the highest score across the St. Louis River Watershed.

Success story

Over a four-year period (2018-2021), MPCA staff completed an intensive monitoring effort within the Midway River Subwatershed. Some of the region's best Brook Trout streams flow through this area, making it a high priority for protection and restoration efforts. Protection efforts were targeted at cold-water inputs such as small tributaries and springs. During this study, over 60 miles of previously unmapped streams were delineated, several springs were submitted to MNDNR's statewide spring inventory, and road crossings with improperly sized culverts were identified. Seventy-four road-stream crossings were assessed, revealing that nearly half were acting as potential barriers to fish passage. Some of these road crossings may be prioritized for improvement, particularly where they appear to be negatively impacting fish communities.

MPCA staff display a Brook Trout sampled from a tributary to Rocky Run Creek. Small cold-water streams that are connected to larger systems make excellent habitat for young Brook Trout.

Watershed assessment results

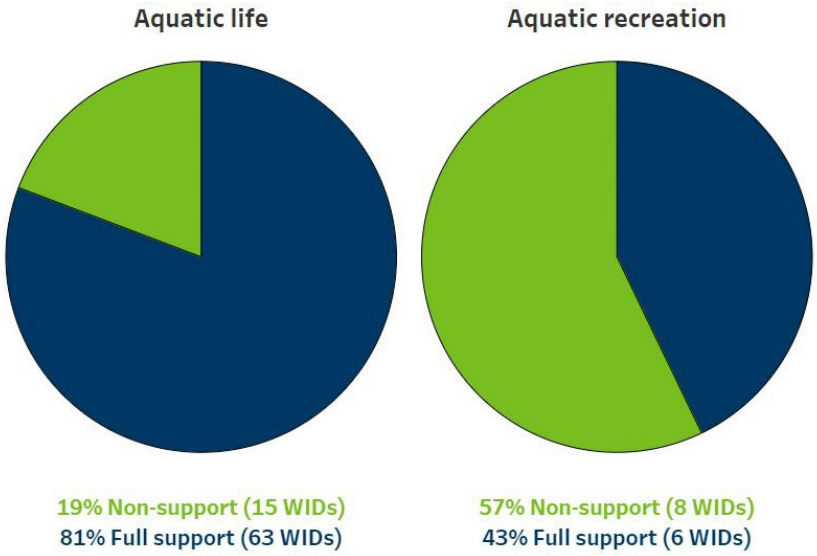
The MPCA and local partners monitored water quality conditions in 2009-2010 (Cycle I) and again in 2019-2020 (Cycle II). Additional data from within this 10-year window was also used for assessment. These assessments focus on whether waterbodies are meeting water quality standards for aquatic life, recreation, and consumption. The overall goal is to determine which waters are healthy, and in need of protection, or are polluted and require restoration.

Streams and rivers

Overall, aquatic life in streams and rivers within the St. Louis River Watershed appears very healthy. Of the 78 stream reaches assessed in Cycle II, 63 of them (81%) support aquatic life (Figure 1). The generally high quality of rivers and streams throughout the watershed reflects intact riparian zones and a relative lack of anthropogenic disturbance.

Throughout the entire watershed, there were eight stream reaches with new aquatic life use impairments based on FIBI, total suspended sediments (TSS), aluminum, chloride, or dissolved oxygen. Several of these impairments are associated with urban settings in the Duluth area, while TSS issues found in lower reaches of the St. Louis and Whiteface Rivers may be related to cumulative erosion throughout the watershed. Six additional stream segments were highlighted as "vulnerable" during the assessment process. The vulnerable status may be thought of as "nearly impaired." The rationale behind highlighting these streams centers around the relative ease and cost effectiveness associated with improving streams that are near the impairment threshold, as opposed to streams that have further degraded. One example of a vulnerable resource is Barber Creek. This stream receives treated wastewater from the Central Iron Range Sanitary Sewer District and was the only stream that displayed a decline in both fish and macroinvertebrate communities between Cycle I and Cycle II. Continued decline in these communities may result in an impairment on this reach. The causes of this decline should be investigated and addressed to prevent a future impairment.

Figure 1. Watershed assessment results for aquatic life and aquatic recreation in streams and rivers.



Within this large watershed, there are discernible patterns throughout portions of the watershed, and longitudinally along the St. Louis River. The northeast portion of the watershed (upstream of the Embarrass River confluence) is in excellent condition. Few impairments have been identified in this region; biological indicators are healthy and stable, and concentrations of TSS are low. Of particular note is a 19-mile-long stretch of the Whiteface River between Palo Creek and the Paleface River, which was assigned an exceptional aquatic life use based on high IBI scores for both fish and macroinvertebrate communities (Figure 2).

In contrast, the Swan River and other subwatersheds draining the central Iron Range are in relatively poor condition, when compared to other regions in the St. Louis River Watershed. The Swan River carries a high sediment load and elevated levels of bacteria, resulting in aquatic life and aquatic recreation impairments on portions of the river (Figure 2). The MPCA's Watershed Pollutant Load Monitoring Network (WPLMN) indicates that the Swan River carries the highest TSS loads within the entire St. Louis River Watershed. The Swan River Subwatershed also includes the "vulnerable" Barber Creek, which displayed the most negative change in IBI performance between monitoring cycles throughout the watershed (Figure 7). Macroinvertebrate IBI scores on the St. Louis River mainstem decline just downstream of the Swan River confluence, while TSS concentrations increase. The Swan River Subwatershed is a priority area in the One Watershed One Plan document, where its influence on the condition of the St. Louis River will be investigated and addressed.

The southernmost portion of the watershed contains several impaired urban streams in the Duluth area. New aquatic life impairments based on elevated levels of chloride were found on Kingsbury and Keene Creeks (Figure 2). Chloride impairments are rare throughout the watershed and tend to be found in urban areas where application of road salt is concentrated. Chloride is a particularly troublesome pollutant in aquatic systems due to its persistence in the environment and widespread use in water softening and de-icing applications. It should be noted that chloride has not been monitored in many streams across the watershed, and the problem may be more widespread than is currently understood. MPCA water monitoring shows that chloride concentrations are increasing in lakes, streams, and groundwater throughout the state.

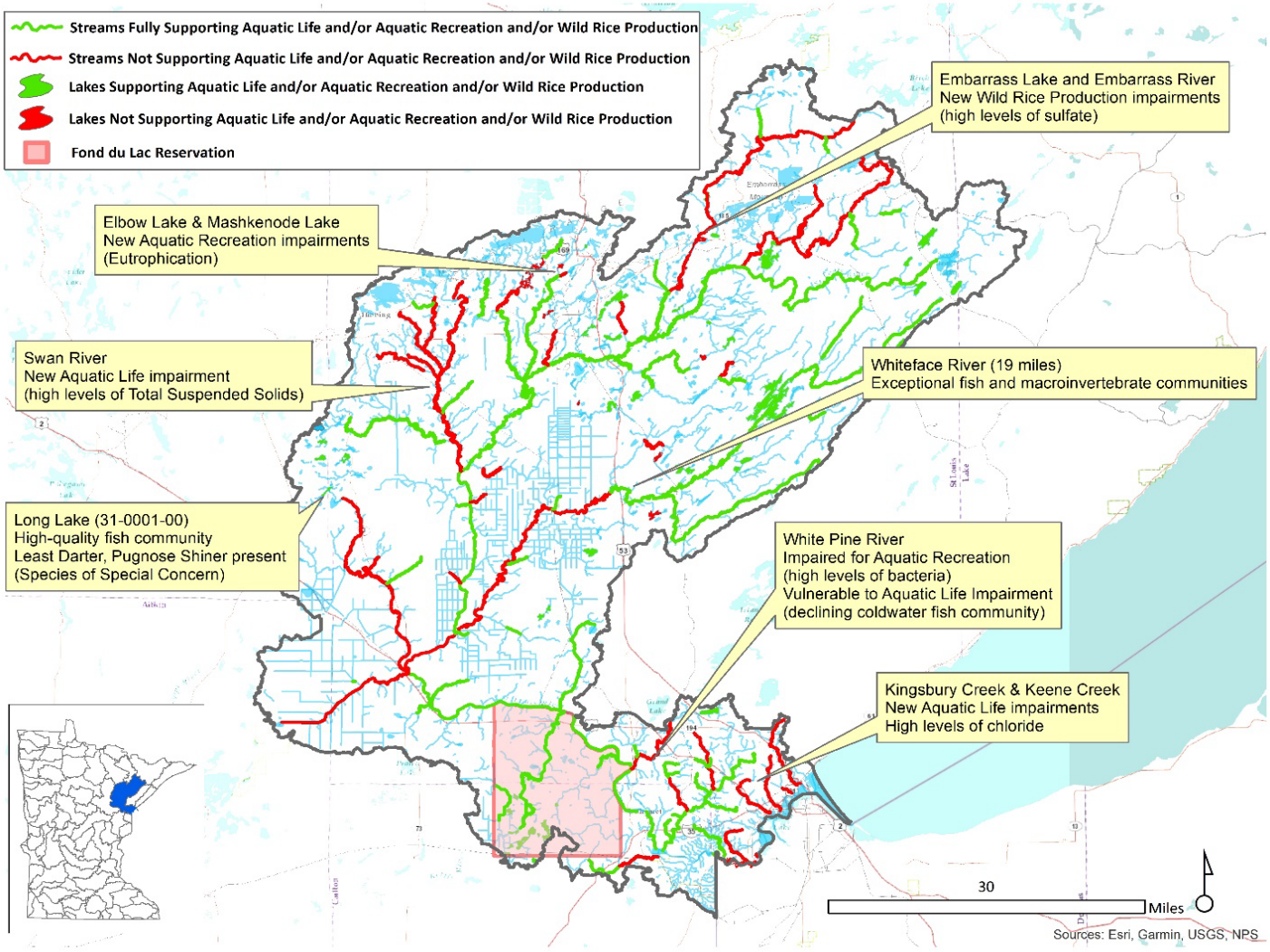
St. Louis River Area of Concern

The lowest portion of the St. Louis River was designated as an area of concern (AOC) by the Great Lakes Commission in 1987. This section of the river was historically impacted by unregulated discharge of industrial material and municipal wastewater. Alterations that occurred lower in the estuary to create the ports of Duluth and Superior impacted several hundred acres of aquatic habitat by dredging and filling wetlands and shallow waterways. These historic impacts resulted in nine impairments across the AOC. State and tribal agencies in Minnesota and Wisconsin have worked with federal agencies and local partners to reduce contaminant levels and restore habitat; and conditions continue to improve. All Remedial Action Plan efforts for the AOC are scheduled for completion by 2026, with an anticipated delisting in 2030. As work progresses, several beneficial use impairments have already been addressed, including degraded aesthetics, excessive sediment and nutrient levels, fish tumors, and most recently, the fish and wildlife population was recommended for removal. More information about the St. Louis River AOC is available on the St. Louis River Area of Concern resources webpage.

Aquatic recreation

Aquatic recreation is monitored on a smaller scale than aquatic life; only 14 stream segments were monitored and assessed in Cycle II. Of these, 43% indicate full support for aquatic recreation (Figure 1). Streams monitored for aquatic recreation are hand-picked and focus on larger rivers and areas with known or suspected bacterial issues. Bacteria impairments were identified or reaffirmed on small urban streams in Duluth and the Iron Range, as well as the Floodwood River and East Savanna River. Both the Floodwood and East Savanna Rivers have higher proportions of agricultural land and feedlots in their contributing watersheds when compared to other streams in the St. Louis River Watershed.

Figure 2. Assessment results for aquatic life, aquatic recreation, and wild rice production on waterbodies in the St. Louis River Watershed. The Fond du Lac Band of Lake Superior Chippewa (FDL) has federal Clean Water Act jurisdiction for lakes and streams on the reservation.



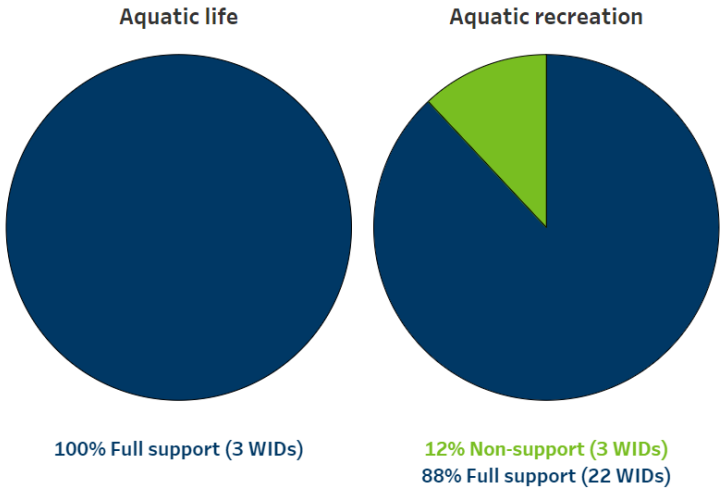
Lakes

Lakes in the St. Louis River Watershed are generally in good condition, with low amounts of nutrients and algae, due in large part to the forests and wetlands common in the basin. A total of 25 lakes were assessed to determine if they meet standards for aquatic recreation. Twenty-two of these lakes were found to support aquatic recreation, including the Whiteface Reservoir, Loon Lake near Aurora, and Esquagama Lake near Biwabik (Figure 3). Two new lakes were added to the Impaired Waters List, Elbow Lake near Iron, and Mashkenode Lake near Mountain Iron (Figure 2). Both lakes receive treated wastewater from Iron Range communities. Lakes historically assessed as impaired based on high amounts of nutrients and algae tend to be impacted by wastewater discharge, such as the West Two Rivers Reservoir, or shallow lakes with higher amounts of lakeshore development.

A program unique to Lake Superior tributaries is the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act. This program is run by the Minnesota Department of Health, and has identified five beaches within the St. Louis River Estuary as impaired for aquatic recreation due to elevated E. coli levels. Four of these beaches were re-evaluated in Cycle II and continued to indicate impairment. More information about beach monitoring is available on the Minnesota Lake Superior Beaches Monitoring Program website, and details about TMDL development are available at the Duluth Urban Area Streams Watershed website.

Fish-based indices of biological integrity for lakes were not available during Cycle I, but are now developed for some lake classes in the St. Louis River Watershed. Aquatic life assessments based on FIBI data were completed for three lakes by the MNDNR (Figure 3). The fish communities in Big, Long, and Pancake Lakes were all healthy as measured by the FIBI. The fish community of Helen Lake indicated support for aquatic life, but the only survey data available was more than 10 years old, and considered "expired" for use in Cycle II assessments. The healthy fish communities are likely due to low levels of development and disturbance within the contributing lakesheds. Long Lake near Goodland supports an excellent fish community, including the Least Darter and Pugnose Shiner, both of which are classified as Species of Greatest Conservation Need in Minnesota's Wildlife Action Plan.

Figure 3. Watershed assessment results for aquatic life and aquatic recreation in lakes.



Sulfate

The production and collection of wild rice has important social, cultural, nutritional, economic, and historical significance for many Minnesotans and Tribal Nations. Wild rice growth is negatively impacted by excess sulfate, which converts into sulfide within the sediment, ultimately damaging the roots of the plant. Minnesota has had a sulfate standard for wild rice waters since 1973. In 2021, the Environmental Protection Agency (EPA) added 32 waters to Minnesota's 2020 Impaired Waters List as impaired for sulfate. For the 2022 list, the MPCA has included these same 32 waters, in addition to three new impairments (Figure 3). Ten waterbodies in the St. Louis River Watershed have been identified as impaired for sulfate in this process. This includes six lakes, three rivers, and the upstream portion of the St. Louis River estuary. Lakes listed include North and South Cedar Island, Embarrass, Esquagama, Perch, and Wynne. The three stream segments represented are the Embarrass River, Partridge River, and Second Creek (Figure 2). While the next steps to address sulfate impairments in the St. Louis River Watershed are unclear at this time, the MPCA is committed to finding ways to reduce anthropogenic sulfate inputs using data driven science and best professional judgement. More information about sulfate is available on MPCA's sulfate and protecting wild rice webpage.

Trends

A key objective of the 2019 monitoring effort was to evaluate if and how water quality has changed since 2009. If water quality has improved, it is important to understand to what extent strategy development, planning, and implementation, based on the initial work and combined with actions that were already underway, may be responsible. It is equally important to understand if water quality does not appear to be changing, or is declining. Either way, the knowledge will help inform future activities.

Trends in four aspects of water quality were analyzed to provide a picture of what is happening in the St. Louis River Watershed:

1. Streamflow and pollutant concentrations
2. Biological communities
3. Clarity of lakes
4. Climate

Streamflow and pollutant concentrations

The Watershed Pollutant Load Monitoring Network (WPLMN) includes three sites on the St Louis River and three other sites within the watershed: the Whiteface River, Swan River, and Second Creek. Water samples are collected year-round at the WPLMN major station on the St. Louis River at Scanlon, while subwatershed stations are sampled annually from snow melt through October 31.

Overall, this watershed has low levels of sediment (TSS), nitrate and phosphorus when compared to watersheds throughout the state and is similar to surrounding watersheds in northeast Minnesota (Figure 5). However, there are several systems within the watershed that have elevated levels of TSS and phosphorus when compared to the watershed as a whole, and neighboring watersheds along Lake Superior. Elevated levels of TSS have been detected on the lower portions of the St. Louis, Whiteface, and Swan Rivers (Table 1 and Figure 4). Despite carrying elevated levels of suspended sediments, the St. Louis River and Whiteface River support healthy aquatic macroinvertebrate and fish communities. Intact riparian areas including forests and wetlands help maintain the healthy biology of these systems. Nitrate is also somewhat higher at the Swan River site than other sampling locations within the watershed and is likely related to the differences in land use of the contributing subwatershed when compared to the watershed as a whole.

The major watershed outlet station at Scanlon has the longest data record and was analyzed to look at changes over time. Between 2008 and 2019, there were no significant trends in TSS, nitrate, or phosphorus.

Table 1. Comparison of average total flow weighted mean concentrations (FWMC) (2015-2019).

Station name	Station number	TSS Avg FWMC (mg/L)	NOX Avg FWMC (mg/L)	TP Avg FWMC (mg/L)
St. Louis River at Floodwood, CSAH8	S005-303	31	0.12	0.077
St. Louis River at Scanlon, MN	S005-089	16	0.14	0.044
St. Louis River nr Forbes, US53	S000-568	13	0.09	0.038
Whiteface River nr Meadowlands, CSAH5	S005-763	21	0.09	0.075
Swan River nr Toivola, CSAH5	S000-641	35	0.35	0.083
Second Creek nr Aurora	S007-023	3.7	0.04	0.017

Figure 4. Flow weighted mean concentrations of total suspended solids in subwatersheds of the St. Louis. The Fond du Lac Band of Lake Superior Chippewa (FDL) has federal Clean Water Act jurisdiction for lakes and streams on the reservation.

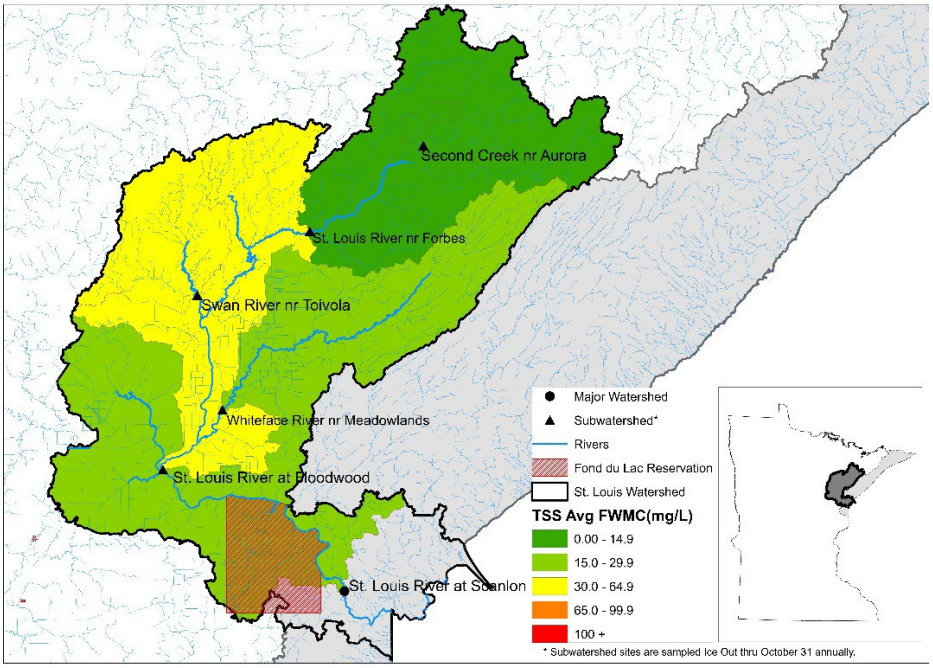
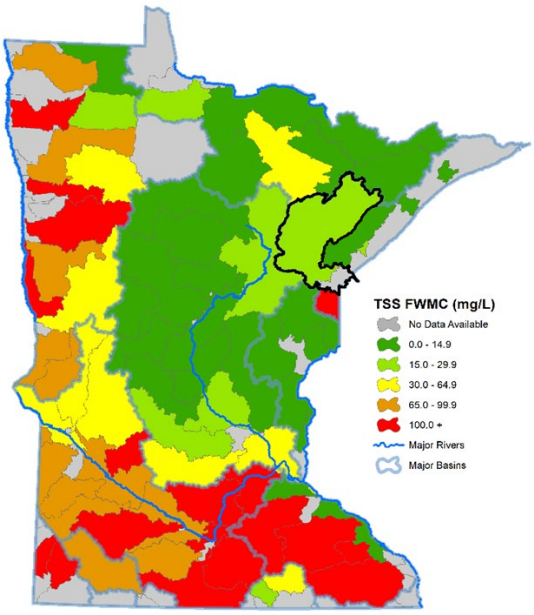
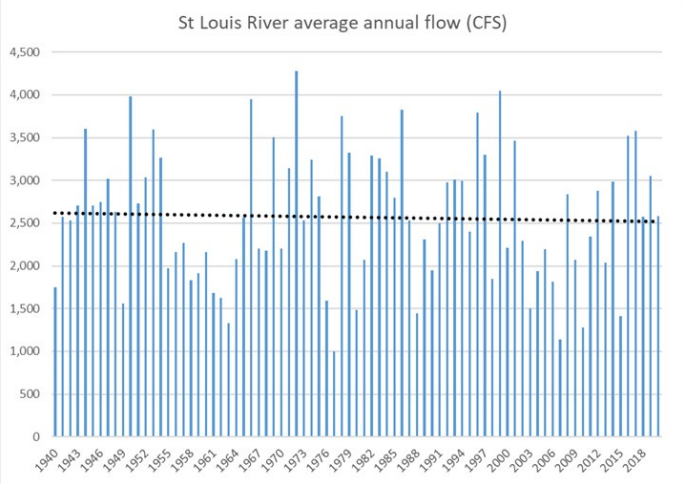


Figure 5. Flow weighted mean concentrations of total suspended solids (TSS) by watershed throughout the state.



Annual streamflow data was analyzed from 1940-present. Flow levels have varied over time, but have remained relatively stable in the long term (Figure 6). The northern forested portion of the watershed provides some resiliency to increased streamflow by absorbing precipitation and slowing runoff. Increased streamflow has negative implications for stream channel conditions and pollutant loading, including channel erosion and larger sediment loads. Protecting the healthy riparian conditions found throughout much of the watershed will help keep flow levels from increasing, benefitting the watershed as a whole.

Figure 6. St. Louis River annual flow (CFS).



Biological communities

Fish and macroinvertebrate communities serve as indicators of aquatic health, and are used by MPCA scientists to determine if rivers and streams are meeting aquatic life use goals. Trends in these and other aquatic life indicators provide signals as to whether water quality is improving or declining. In the St. Louis River Watershed, MPCA biologists observed a statistically significant improvement in stream macroinvertebrate index of biotic integrity (MIBI) scores between Cycle I and Cycle II.

Macroinvertebrates were monitored at 60 river and stream sites in both Cycle I and Cycle II; MIBI scores increased at 41 of the 60 sites, with an average increase of 6.4 points across the entire watershed. In contrast, fish index of biotic integrity (FIBI) scores increased by only 0.6 points, not a statistically significant difference between cycles. MNDNR biologists also use a fish community-based index of biological integrity to evaluate the condition of lakes; however, comparable lake FIBI data wasn't collected during the first assessment period, making it impossible to compare the biological condition of lakes between cycles.

The considerable improvement in MIBI scores across the St. Louis River Watershed may reflect improvements in water quality and/or habitat conditions. However, it is also important to note that other factors may have contributed to the improvement in MIBI scores. For example, macroinvertebrate sampling methods changed slightly between monitoring cycles to account for differences in habitats at various monitoring locations. Also, differences in weather patterns between each sampling period may have led to changes in stream flow, water temperature, dissolved

Table 2. Criteria used to characterize May-September rainfall and temperature conditions across the watershed. Likelihood of climate/weather influence on biological condition results: low; medium; high.

Departure from Avg. Maximum Temperature (°F)	Departure from Normal Precipitation Total (in)				
	< -6	< -2 to -6	-2 to +2	> +2 to +6	> +6
> +3	Extreme Drought Conditions	Moderate-Severe Rainfall Deficit & Extreme Heat	Near Normal Rainfall & Extreme Heat	Above Normal Rainfall & Extreme Heat	Extreme Flooding & Extreme Heat
> +1 to +3	Extreme Rainfall Deficit & Abnormally Hot	Moderate-Severe Rainfall Deficit & Abnormally Hot	Near Normal Rainfall & Abnormally Hot	Above Normal Rainfall & Abnormally Hot	Extreme Flooding & Abnormally Hot
-1 to +1	Extreme Rainfall Deficit & Normal Temps	Moderate-Severe Rainfall Deficit & Normal Temps	At or Near Normal Conditions	Above Normal Rainfall & Normal Temps	Extreme Flooding & Normal Temps
< -1 to -3	Extreme Rainfall Deficit & Abnormally Cool	Moderate-Severe Rainfall Deficit & Abnormally Cool	Near Normal Rainfall & Abnormally Cool	Above Normal Rainfall & Abnormally Cool	Extreme Flooding & Abnormally Cool
< -3	Extreme Rainfall Deficit & Cold	Moderate-Severe Rainfall Deficit & Cold	Near Normal Rainfall & Cold	Above Normal Rainfall & Cold	Extreme Flood Conditions

oxygen levels, habitat, and connectivity. In 2009 (Cycle I), the St. Louis River Watershed experienced a severe rainfall deficit (-5.5 in) and near normal temperatures (-0.7 °F) during the period that stream biological monitoring was conducted (May-September). In contrast, 2019 (Cycle II) precipitation levels were near normal (-0.6 in) and temperatures were abnormally cool (-2.9 °F) between May and September (Figure 9). Overall, given the dry conditions in 2009 and the relatively normal rainfall in 2019, there is a moderate likelihood that observed changes in biological condition are at least partially due to differences in climatic conditions between cycles (Table 2).

Figure 7. Characterization of air temperature and rainfall conditions for May-September period across the historical record of climate data for the St. Louis River Watershed. IWM years are highlighted in red.

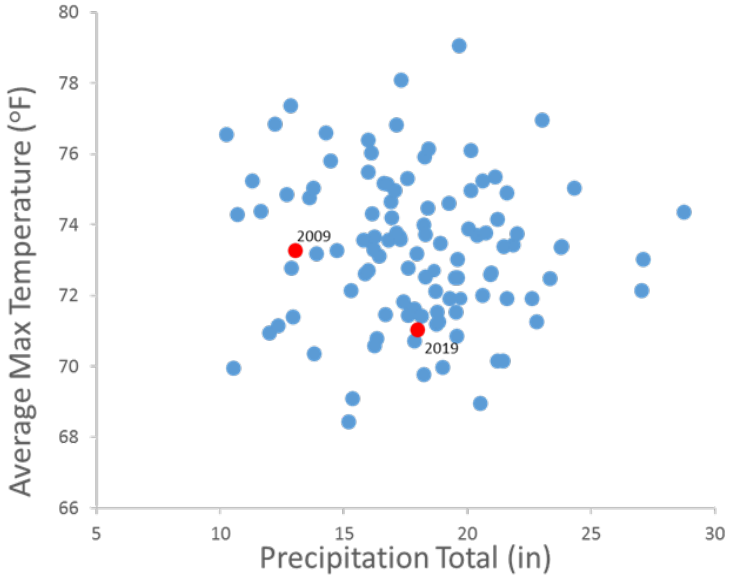
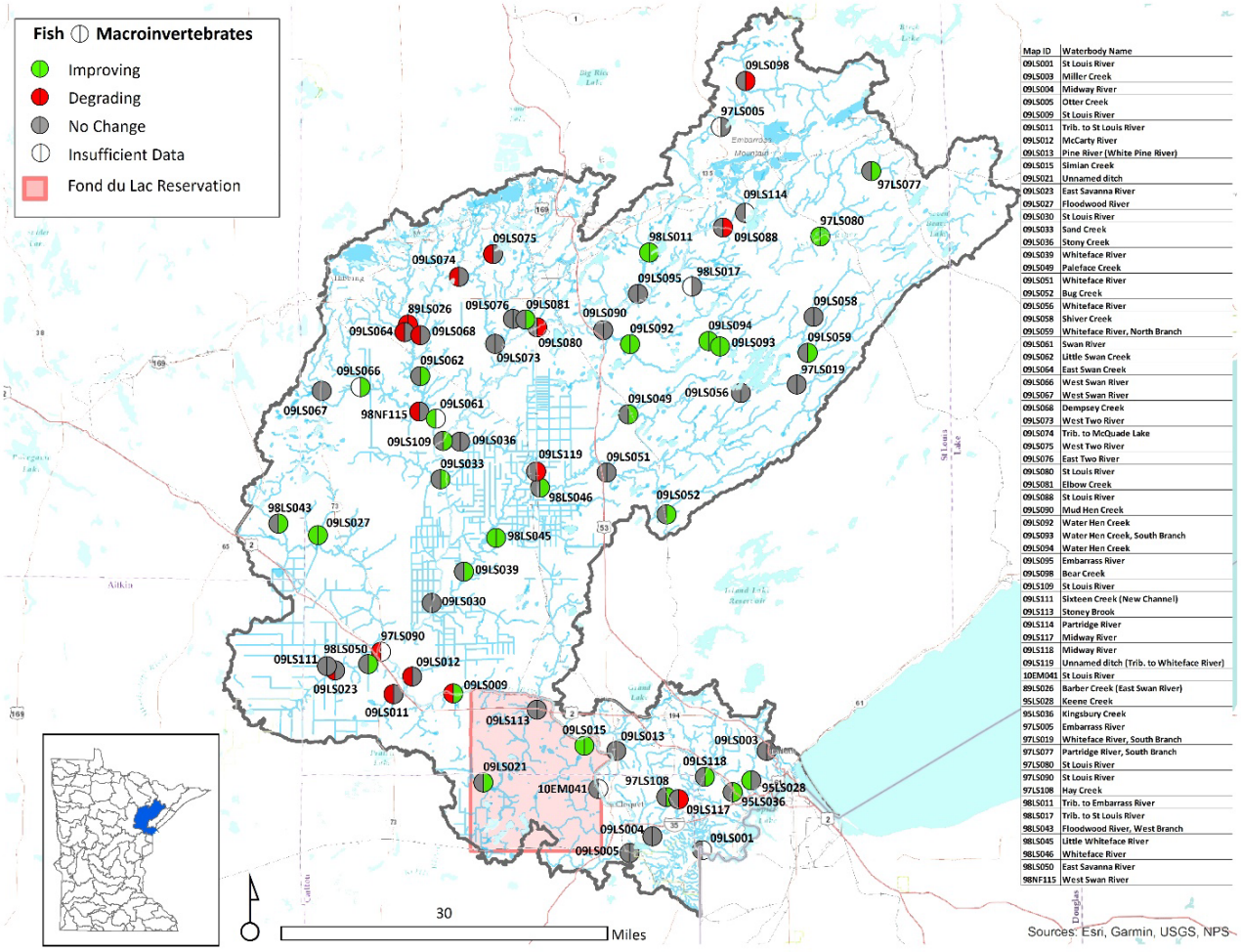


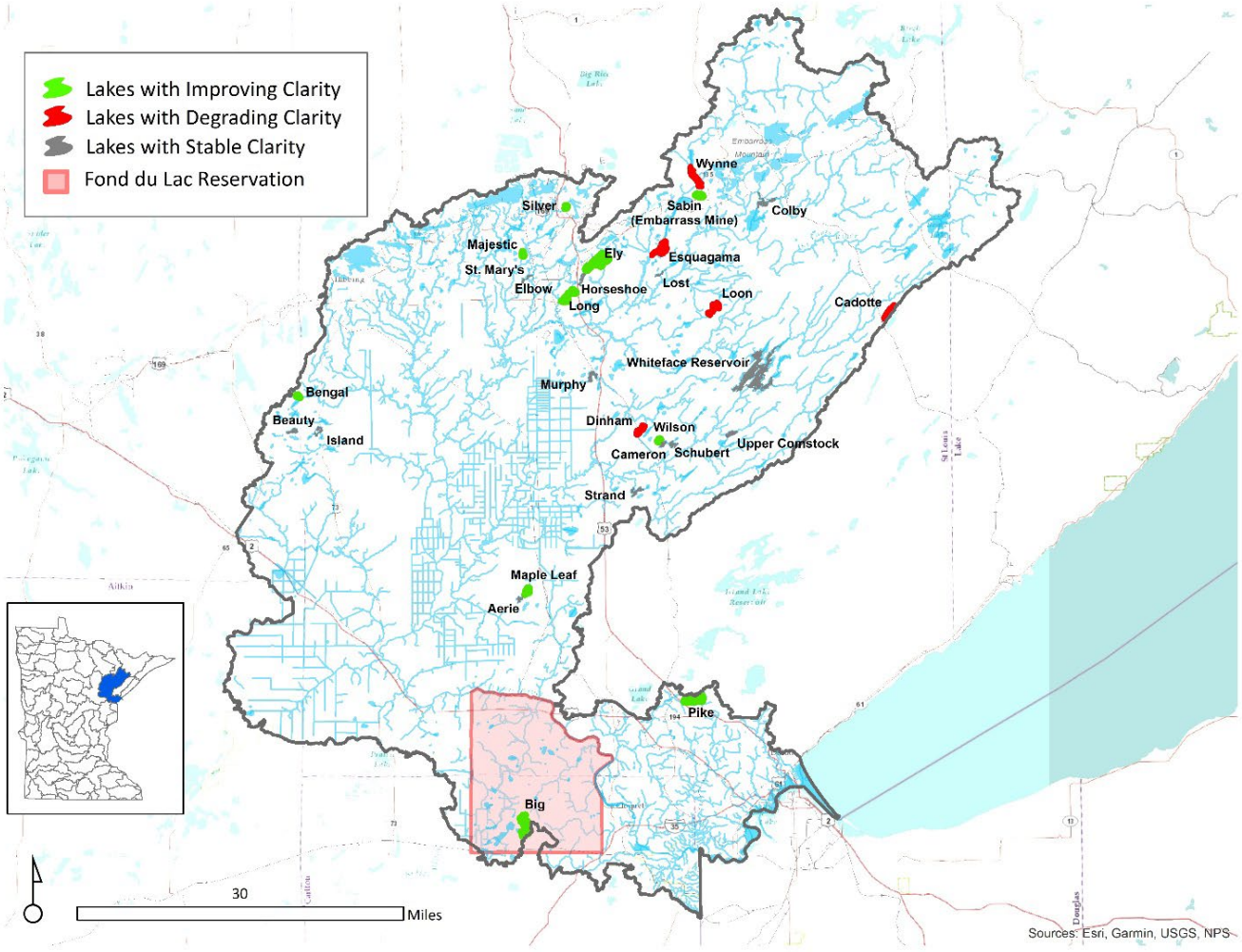
Figure 8. Change in biological indicators between Cycle I and Cycle II in the St. Louis River Watershed. The Fond du Lac Band of Lake Superior Chippewa (FDL) has federal Clean Water Act jurisdiction for lakes and streams on the reservation.



Clarity of lakes

Water clarity trends were evaluated through 2020 for lakes within the St. Louis River Watershed. Most of this data was available thanks to the dedicated work of citizens participating in the Volunteer Water Monitoring Program (VWMP). A total of 29 lakes had sufficient long-term data to run trend statistics. Transparency increased in 10 lakes, including Pike Lake near Duluth (where clarity has been influenced by the invasive zebra mussel), and Ely Lake near Eveleth (where clarity may increase further due to the 2021 discovery of zebra mussels). Transparency decreased in five lakes, including Cadotte, Loon, Wynne, Dinham, and Esquagama. These are high-quality lakes that met the MPCA's Secchi transparency standard, but showed significant reductions in clarity, ranging from 0.7 to 3 feet in clarity lost per decade. An additional 14 lakes had stable water clarity trends, including the Whiteface Reservoir, Murphy Lake, and Colby Lake (Figure 8). Big Lake is within the Fond du Lac Reservation, and while limited volunteer monitoring shows an increasing trend in clarity, Fond du Lac's water quality program has a more extensive dataset that indicates clarity is stable in this system.

Figure 9. Lake water clarity trends in the St. Louis River Watershed. The Fond du Lac Band of Lake Superior Chippewa (FDL) has federal Clean Water Act jurisdiction for lakes and streams on the reservation.



Climate

The MNDNR Climate Summary for Watersheds describes regional climate data (available from 1895 through 2018) and provides a comparison of the most recent 30-year average, against the entire data record. Compared with the historical average (1895-2018), the St. Louis River Watershed currently receives on average an additional 0.9 inches of rain. Most of this increase occurs in the fall (September-November, 0.5"). Meanwhile, the average annual temperature across the watershed has increased by 1.7° F, with a more pronounced increase (+3.0° F) observed during the winter (December-February). More precipitation and reduced snow cover can increase soil erosion, pollutant runoff, and stream flow. Increased stream flow can lead to in-stream channel erosion and degraded habitat for aquatic life. Longer growing seasons with higher temperatures can cause more algal blooms, especially in lakes. These changes will likely complicate efforts to protect and restore the aquatic resources in this watershed. For a more comprehensive analysis of climate trends for the St. Louis River Watershed see: Climate Summary for Watersheds, St. Louis River (state.mn.us)

For more information

This study of the St. Louis River Watershed was conducted as part of Minnesota's Watershed Approach to restoring and protecting water quality. Efforts to monitor, assess, study, and restore impaired waters, and to protect healthy waters are funded by Minnesota's Clean Water, Land and Legacy Amendment. Stressor identification for new impairments and updates to the Watershed Restoration and Protection Strategy follow the completion of monitoring and assessment. This approach allows for efficient and effective use of public resources in addressing water quality challenges across the state. The data and assessments produced by this study can inform local efforts to restore and protect waters in the St. Louis River Watershed, such as the One Watershed One Plan document, a comprehensive watershed management plan that targets projects to protect and restore the watershed's most valuable resources. For more information go to MPCA's St. Louis River webpage, or search for "St. Louis River" on the MPCA website.

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