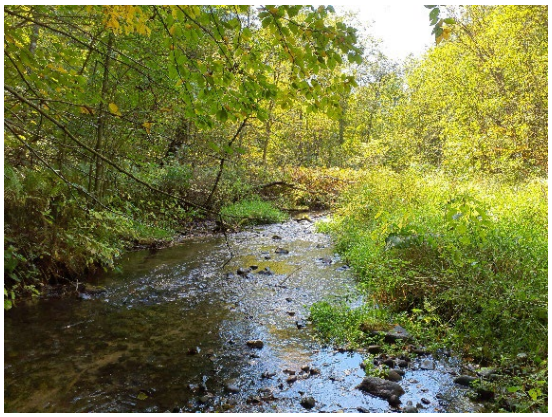
Watershed assessment and trends update

Lower St. Croix River Watershed

St. Croix River Basin

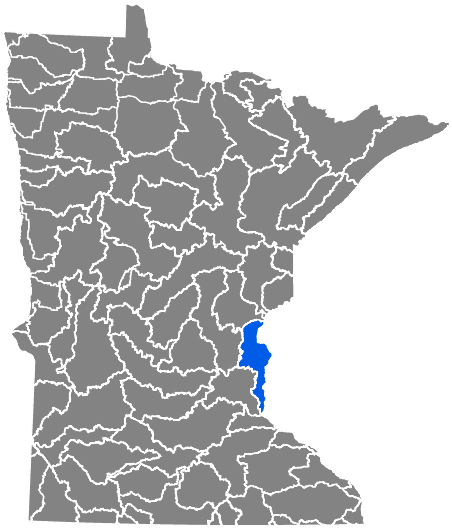


Why is it important?

Occupying an area of approximately 2,500 square miles in Minnesota and Wisconsin, the Lower St. Croix River Watershed comprises the lowermost portion of the St. Croix River Basin. This report details water quality monitoring and assessment efforts in the 915 square miles of the watershed in east central Minnesota. The area is drained by several streams and rivers that flow directly into the St. Croix River between Taylors Falls and its confluence with the Mississippi River.

This scenic and ecologically diverse region provides ample outdoor recreation opportunities to residents and regional tourists. The four state parks within this watershed draw more than 500,000 annual visitors. The Minnesota portion of this watershed constitutes approximately 12% of the total land area of the St. Croix River Basin and directly contributes to the water quality in the St. Croix River mainstem. As one of the original eight rivers that were designated for protection under the National Wild and Scenic Rivers Act of 1968, the St. Croix River has long been regarded among the nation's most treasured reaches of flowing water.

Figure 1: Minnesota's 80 major river drainages. Lower St. Croix River Watershed is highlighted in blue.



Water monitoring is essential to determine whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable. The Minnesota Pollution Control Agency (MPCA) and local partners conduct an intensive analysis of major lakes and streams in each of the state's 80 major watersheds every 10 years to detect changes in water quality. The wealth of data collected and analyzed in the 2009 effort to assess the condition of water quality in the Lower St. Croix River Watershed provides a baseline for comparison with extensive chemical and biological sampling conducted in 2019. In both cycles of monitoring, scientists examined levels of chemical pollutants, bacteria, and water clarity as well as the biological condition of two aquatic communities (fish and aquatic macroinvertebrates) to determine if waters within this watershed are healthy or in need of restoration. A comparison between the two sampling efforts provides a powerful mechanism for determining if water quality is improving or declining. Partners use this information to refine priorities and strategies for waters that are healthy and need protection along with waters that are degraded and need restoration.

Is the water quality improving?

Over the past decade, scientists observed some positive changes in water quality in the Lower St. Croix River Watershed. Several lakes with existing nutrient impairments have been proposed to have their impairments removed from the Impaired Waters List (IWL). Many waterbodies in the watershed remain healthy and unpolluted. While some water bodies have shown improvements, others show newly observed signs of degradation. Continued problems include elevated bacteria, low dissolved oxygen levels, shoreline habitat loss, and excess nutrients in lakes. While the biological condition in individual streams may have improved or declined between the first cycle of sampling in 2009 and the second cycle of sampling in 2019, the overall health of fish and macroinvertebrate (bug) communities did not change significantly over this period.

Results of these monitoring efforts indicate that restoration efforts and land management best practices have contributed to improved water quality in several water bodies throughout the watershed, while other waters show evidence of declining water quality:

- Nine lakes with aquatic recreation impairments for excess nutrients have shown such marked improvement that proposals to remove these lakes from the IWL have been approved by the MPCA and are pending approval by U.S. Environmental Protection Agency (EPA). Six lakes in the watershed were newly identified to have excessive levels of nutrients and have been added to the IWL.
- Two stream reaches had aquatic life use impairments (one for fish, one for macroinvertebrates) that have been proposed to be removed from the IWL. Seven stream reaches were newly determined to have unhealthy populations of fish and/or macroinvertebrates (bugs). Two streams saw improvement to both the fish and macroinvertebrate communities.
- More than a third of assessed stream reaches were found to have low levels of harmful bacteria and are fully supporting aquatic recreation. Four reaches of stream were newly identified to have unhealthy levels of harmful bacteria.
- More than 40% of assessed stream reaches were determined to have low levels of pollution that impact biological communities (fully supporting aquatic life), however eight streams were newly identified to have water quality conditions that are harmful to fish and/or macroinvertebrate communities.
- Forty-five lakes, ponds, and wetlands show an improving trend in water clarity.

Highlights of monitoring

- Lawrence Creek has a high-quality biological community and excellent in-stream and riparian habitat. Fish and macroinvertebrate Index of Biological Integrity (IBI) scores as well as habitat scores at this site are among the highest in the state. The fish community at this site is dominated by naturally reproducing brook trout, which are exceptionally sensitive to degradations to water quality. These outstanding attributes have placed this stream into the “Exceptional Use” category for aquatic life. Streams in this category are held to the most stringent expectations to ensure protection from degradation. In 2020, much of the upstream watershed was protected as a MN DNR Scientific and Natural Area, safeguarding its high-quality status into the future. A photo of the monitoring station on Lawrence Creek appears at the top of the report.

- Data collected in 2002 indicated that Goose Creek had an unhealthy fish population. High-scoring samples from 2011 and 2019 indicate that Goose Creek is presently supporting a healthy fish community. Since 2002, new assessment methodologies have been developed, and IBIs for this stream class have been updated. A reanalysis of the 2002 data along with recent scores indicate that the impairment on Goose Creek should be corrected to reflect the healthy condition of the fish community. A proposal to remove the fish impairment from the IWL has been approved by the MPCA and is pending approval by EPA.
- The fish community in the lower Sunrise River is exceptionally diverse, balanced, and indicative of high water quality. Twenty-seven species of fish were collected at a single site near the town of Sunrise, including several species that are highly sensitive to changes in water quality.
- The Sunrise River was found to be impaired for aquatic macroinvertebrates based on monitoring conducted in 2006 and 2009. Samples collected in 2019 and 2020 indicate that the macroinvertebrate community is now much healthier, with all recent samples scoring well above the impairment threshold. While the influence of climatic differences between these two time periods may have played a significant role in the improved MIBI scores, it is nonetheless a positive trend to see, and highlights the importance of continued monitoring of our impaired waters.
- Several lakes that fully support aquatic life were found to harbor populations of rare and sensitive fish species such as the pugnose shiner and least darter, which are respectively designated as "Threatened" and "Special Concern" by MN DNR.
- Lake Elmo is unique and biologically significant in that it supports the southernmost Minnesota population of cisco, an important sensitive coldwater fish species.

Figure 2: Fish species sampled in the Sunrise River that are sensitive to declines in water quality: burbot, logperch, northern hogsucker, hornyhead chub (clockwise from top left).

Success stories

Restoration efforts have led to nine lakes with formerly unhealthy levels of nutrients being removed from the IWL.

- Lily Lake – This small urban lake has seen a large number of restoration activities focused on reducing sediment and nutrients from entering the lake. Nutrient and water clarity standards are now being met.
- East Boot Lake – An approved restoration plan and collaboration with the Natural Resource Conservation Service led to the installation of an Animal Waste Management System on a 75-cow dairy farm on East Boot Lake. Voluntary efforts by the dairy farmer were supported by partnerships with local units of government and successfully improved the lake's water quality. Additional information can be found at https://www.cmscwd.org/east-boot-lake.
- Hay Lake – An approved restoration plan, community engagement by lakeshore owners, and a partnership with farmers allowed for cattle exclusion from the lake and native prairie shoreline buffers to be installed. Stormwater reduction and control systems have also been recently required for all new and redevelopment parcels around the lake. Water quality improvements in the lake have been documented, and the nutrient listing will be removed. Additional info can be found at https://www.cmscwd.org/hay-lake.
- A source of un-ionized ammonia (a chemical that is harmful to aquatic life) was identified and mitigated in a tributary of the Sunrise River.
- The Chisago Lakes Wastewater Treatment Plant (WWTP) discharges to an unnamed ditch that flows into the Sunrise River. Levels of ammonia in the stream were high enough to be harmful to aquatic life and had the potential to impact aquatic life in the Sunrise River. As such, the permit for the WWTP was reissued in 2010 with new seasonal restrictions in the allowable amount of ammonia in the water. Monitoring of this unnamed ditch was required in the permit to determine if levels of the chemical were improving. Monitoring of the stream demonstrated that the new permit requirements were effectively reducing levels of the chemical and protecting the Sunrise River downstream of the plant. The un-ionized ammonia impairment will be removed from the IWL.

Watershed assessment results

The MPCA and partners monitored water quality conditions in 2009-2010 and again in 2019-2020. Chemistry data collected by local partners between 2009 and 2019 were used for assessment. The data used to assess the condition of Minnesota waterbodies focus on whether or not they are meeting water quality standards for aquatic life, recreation, and consumption. The overall goal of these assessments is to ultimately determine which waters are healthy and in need of protection or are polluted and require restoration.

Streams and rivers

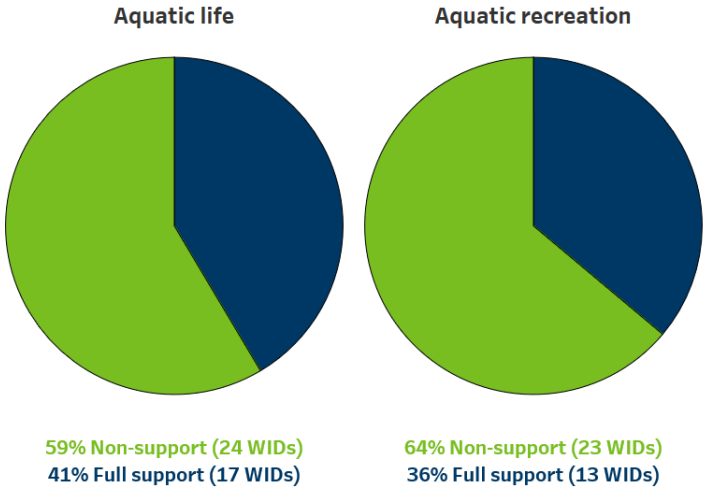
The MPCA and local partners monitored water quality conditions in the Lower St. Croix River Watershed in 2009 and again 2019. The data used to assess the condition of Minnesota waterbodies focus on whether they meet water quality standards for aquatic life, aquatic recreation, and consumption of fish. This was accomplished by comparing individual measurements of parameters such as total suspended solids (TSS), dissolved oxygen, and IBI scores to established water quality criteria. The primary outcome of this process is

the identification of waters that are polluted and need to be restored along with waters that are healthy and need to be protected.

The health and quality (biologic condition) of aquatic communities are evaluated by using population samples to calculate an Index of Biological Integrity (IBI). High IBI scores indicate a healthy community of fish or macroinvertebrates, and a healthy community indicates that water quality, habitat, and hydrology are minimally disturbed by human activities. Macroinvertebrates are animals that can be seen with the naked eye and have no backbone such as aquatic insects (adult or larval stages), crayfish, and snails.

Overall, more than 40% of the stream reaches in the Lower St. Croix River Watershed that were assessed were determined to support both healthy fish and macroinvertebrate communities (Full Support). The remaining 60% of stream reaches that were assessed exhibit impairments to either or both fish and macroinvertebrate communities. Through the most recent assessment cycle in 2020, eight reaches of stream were newly determined to be impaired for aquatic life use based on fish and/or macroinvertebrate community data.

Figure 3: Watershed assessment results for aquatic life use and aquatic recreation support in streams.



Fish and macroinvertebrate communities are a direct measure of aquatic life in rivers and streams. Between 2009 and 2019 cycles of biological monitoring in the Lower St. Croix River Watershed, the MPCA adopted new rules to assess aquatic life in channelized streams and ditches associated with a Tiered Aquatic Life Use framework (TALU). This new framework allowed channelized streams in the watershed — not assessed in 2009 — to be assessed against reasonable aquatic life goals if they were legally altered prior to the advent of the Clean Water Act and currently demonstrate habitat-limiting conditions for fish or macroinvertebrate communities. This framework also allows the designation of streams that exhibit exceptional aquatic communities or a much higher quality than would be expected for supporting general aquatic life use goals. Two reaches of stream in this watershed met the standards for exceptional aquatic life: Lawrence Creek, and the lower reach of the Sunrise River. A channelized reach of the Sunrise River upstream of Comfort Lake was determined to be supporting aquatic life for modified use.

In general, stream water chemistry assessments showed pollution levels that were similar to what they were 10 years ago. While two streams were successfully improved enough to remove their impairments from the Impaired Waters List, there were also a number of new impairments identified. Watershed impairment indicators include excessive suspended solids, low dissolved oxygen, unhealthy levels of bacteria, and elevated river nutrients.

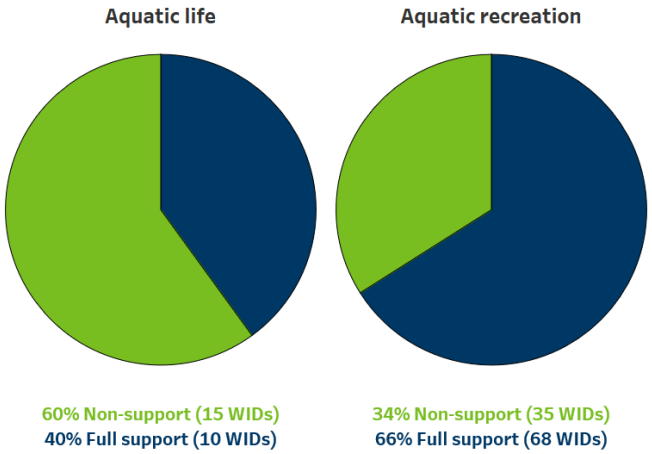
Many streams throughout the watershed fully support aquatic recreation (have low levels of harmful bacteria), but high bacteria concentrations continue to impair recreation on 15 other reaches of streams (3 are new impairments; the Sunrise River below the Kost Dam shows levels of bacteria that are nearing the impairment threshold). A new TSS impairment was identified on Kelle Creek, which means that five reaches of this stream are now impaired for TSS. Ten streams showed unhealthy levels of the chemical nutrient phosphorus. Eighteen stream sections currently have an impairment to aquatic life use, five of which are new to this assessment cycle. Of those 18 impaired reaches of stream, six sections have both a biological and a chemical impairment listed.

Lakes

Many lakes throughout the watershed show signs of improving water quality. Nine lakes that were previously listed for excessive nutrients have successfully been removed from the IWL. Three of those lakes have documentation of successful restoration efforts (Lily, East Boot, and Hay lakes).

There are now 68 lakes that fully support recreational uses, and 35 lakes that are impaired for nutrients (eight lakes show potential for future delisting). Fourteen other lakes show nutrient levels that may be exceeding the impairment threshold, but not enough data were gathered to be conclusive. The largest proportion of lakes in need of improvements to water quality are found in the central portions of the watershed where population growth, housing developments, and agricultural land uses are most prevalent.

Figure 4: Watershed assessment results for aquatic life use and aquatic recreation support in lakes.



New to this assessment cycle are aquatic life assessments based on fish communities in lakes. The employment of a biological assemblage in addition to the various chemical parameters that were analyzed in previous assessments provides a broader basis for examining water quality and its impacts to aquatic life. Several lakes with new aquatic life use impairments due to unhealthy fish populations are lakes that also exhibit improving water quality and are proposed to have their aquatic recreation impairments removed. Fish communities may respond slowly to these improvements or may be adversely impacted by other stressors such as habitat loss and shoreline alterations.

Fish community surveys were completed for 24 lakes. The following lakes were found to have impaired fish communities: Bone, East Rush, Goose (North and South basins), Green (Little Green and Main basins), Horseshoe, Jane, Kroon, North Center, North Lindstrom, South Center, South Lindstrom, and West Rush Lake. The fish communities in Big Carnelian and Big Marine lakes showed signs of degradation and are vulnerable to a future aquatic life use impairment. Stressors that are likely influencing these communities include excess nutrient inputs from agricultural and urban land uses and degraded and/or developed shorelines. Despite generally high development and disturbance within the watershed, nine lakes fully support aquatic life use and several, including Elmo and Forest lakes, exhibit potential to support exceptional fish communities at times.

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 different aspects of water quality were analyzed to provide as robust a picture as possible of what is happening in the Lower St. Croix River Watershed:

1. Streamflow and pollutant concentrations: sediment (total suspended solids), TP, and nitrogen (nitrate)
2. Biological communities
3. Clarity of lakes
4. Climate

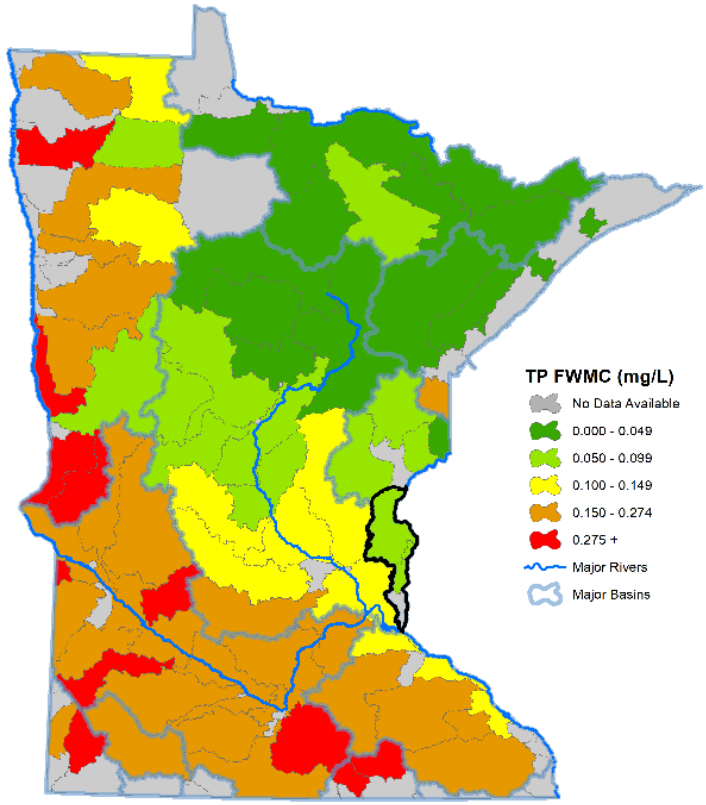


Figure 5: Average total phosphorus flow weighted mean concentrations by major watershed from 2007-2017. The Lower St. Croix River Watershed is outlined in black.

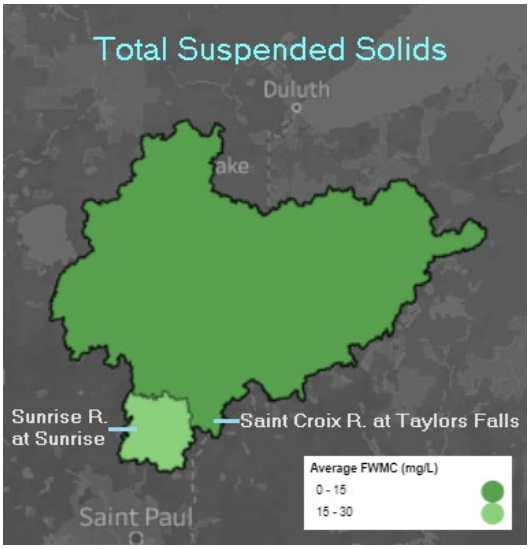
Streamflow and pollutant concentrations

The Lower St. Croix River has low overall levels of TSS and nitrate. Phosphorus levels are slightly elevated when compared to many northern Minnesota rivers, but remain fairly low when compared to rivers in other parts of the state. Overall water quality is generally very good, but not perfect. The map below shows statewide monitoring results for phosphorus. Similar maps for other pollutants and supporting data can be found at https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring.

In addition to the Watershed Pollutant Load Monitoring Network site at Taylors Falls that has been operating every year since 2009, there is one subwatershed-scale site on the Sunrise River that has been operating since 2008. The Sunrise River has relatively low levels of nitrate (0.928 mg/L), but concentrations are noticeably higher than they are for the Lower St. Croix River (0.207 mg/L), making the Sunrise a net contributor of this pollutant (Table 1). Phosphorus levels on the Sunrise River (0.091 mg/L) are somewhat elevated compared to the Lower St. Croix River (0.052 mg/L) and are a contributor to elevated phosphorus levels found on the lower reaches of the St. Croix River. TSS concentrations on the Sunrise are also slightly elevated comparted to the Lower St. Croix (Figure 6).

The Lower St. Croix River at Taylors Falls is the primary driver for phosphorus and TSS at the outlet site at Stillwater. The average TSS load from the St. Croix River at Taylors Falls is 113% of the average load measured at Stillwater (monitored by Metropolitan Council Environmental Services) and the average TSS load is 142% of the average load measured at Stillwater. Loading proportions greater than 100% are likely the result of TSS and phosphorus attached to that TSS settling out when water slows down as the river approaches Lake St. Croix. Nitrate inputs from the watershed have a lesser impact, with the Lower St. Croix contributing the equivalent of 73% of the average suspended solids load measured at Stillwater.

Figure 6: Average TSS flow weighted mean concentration for the Lower St. Croix River Watershed and Sunrise River Subwatershed. Outlined portion of the St. Croix Watershed shows all drainage area upstream of Taylors Falls, including the Upper St. Croix Watershed.



The Lower St. Croix has a modest impact on nitrate, phosphorus, and TSS loads on the Mississippi River. The average TSS, phosphorus, and nitrate load from the Lower St. Croix River is the equivalent of 7%, 9%, and 2% respectively of the average load measured at Lock and Dam 3. The St. Croix at Taylors Falls averages 22% of the flow volume at Lock and Dam 3. Lock and Dam 3 is the furthest downstream monitoring site on the Mississippi River above Lake Pepin (monitored by Metropolitan Council Environmental Services).

Continuous annual streamflow (discharge) data is available for the St. Croix River at St. Croix Falls since 1911. While early years show substantially less flow on average, there is no clear trend since 1950 (Figure 7). The relative stability of Lower St. Croix streamflow contrasts with increasing stream flow on many other Minnesota rivers, though it is noteworthy that the last five years on record (2016-2020) were all above the 80th percentile for average annual flow at this site.

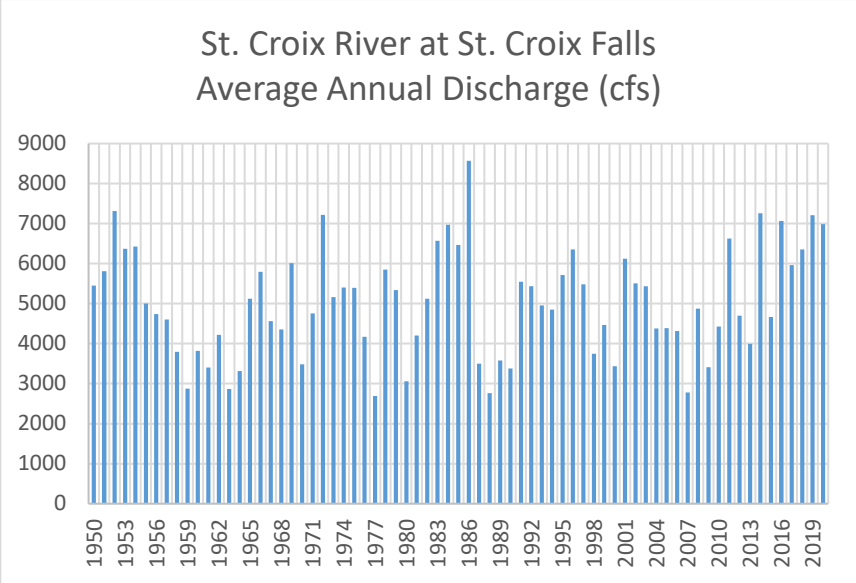
Trend analysis on TSS, phosphorus, and nitrate concentrations in the Lower St. Croix was performed to determine if changes over time are statistically significant. Nitrate concentrations show a significant increase for the period of 2008-2019, though overall concentrations remain relatively low. Phosphorus shows a statistically significant decrease during the same period. This trend is promising because phosphorus is the only parameter of the three considered that might be seen as slightly elevated. No trend was detected for TSS.

Table 1: Percent of total load contributed by the St. Croix River at Taylors Falls before reaching the St. Croix River at Stillwater prior to the confluence with the Mississippi River (left) and the Mississippi River before it reaches Iowa (right).

	St. Croix at Stillwater	Mississippi at Lock and Dam 3
Suspended solids	142%	7%
Phosphorus	113%	9%
Nitrate	73%	2%

As noted previously, the long-term streamflow record for the Lower Saint Croix River suggests relative stability, but persistently elevated flows in recent years suggest the possibility that flows are beginning to increase with time. Persistent high flows may lead to more pollutant loading, even if pollutant concentrations are stable. Because loads represent the total amount of a pollutant moving through a system, this way of measuring water quality is important for downstream resources such as Lake Saint Croix and the Mississippi River, where these pollutants may accumulate. It should be noted that 2021 flows that have yet to be finalized will almost certainly reflect a low flow year on the Lower Saint Croix.

Figure 7: Average annual discharge for the Lower St. Croix River.



Biological communities

Fish and macroinvertebrate IBI scores were used to evaluate if the biological condition of the watershed's rivers and streams has changed between time periods. The comparison between cycle one and cycle two data for this watershed was somewhat hampered due to flow conditions in 2009 that resulted in numerous stations not being sampled, particularly for macroinvertebrates which are sampled later in the summer. Only 11 stations were sampled for macroinvertebrates in both cycles, while 20 stations were sampled for fish in both cycles of monitoring.

Independent statistical tests, comparing data collected between monitoring cycle one and two, were run on each biological community. The average macroinvertebrate IBI score for the Lower St. Croix River Watershed showed a slight (9 point) increase between 2009 and 2019, but not enough to say with confidence that biological condition has improved. It is however a strong indication that the biological condition of macroinvertebrate communities across the watershed is not in decline. Likewise with fish community scores, the comparison of scores between 2009 and 2019 was indicative of a stable biological condition with a small (1.3 point) gain in average IBI score.

Clarity of lakes

Water transparency is typically a good indicator of overall lake water quality. As water clarity increases, there is a greater likelihood that water quality standards are being met. Water clarity recordings for this trend analysis date back to 1971 (where available). There are 167 lakes with some level of transparency data in this watershed, thanks in large part to volunteer monitoring. Of those lakes, 61 of them have enough data to estimate a long-term change in clarity. An improving trend was noted in 45 lakes, while only 16 show a decline (5 of those lakes with declining trends are getting new nutrient impairment listings). Many of the high-use recreational lakes had improving water clarity trends (North Center, North Lindstrom, East Rush, Big Marine), and a few of the lakes with improving water clarity were approved for nutrient delistings. Some lakes, for example Big Carnelian Lake, show an overall increasing trend in clarity since 1971, but have actually experienced reduced water clarity in the 10 most recent years of observations.

Climate

Comparisons between the 30 most recent years of climatological data against the historical averages indicate that the Lower St. Croix River Watershed now receives an additional 2.3 inches of precipitation and the average annual temperature has increased by 1.3 degrees F. Increases in precipitation and temperature can worsen existing water quality problems and be detrimental to aquatic communities. The relatively high proportion of forested landcover and wetlands in the watershed may provide more resilience to the long-term effects of a changing climate. For more information, see the DNR climate summary for the Lower St. Croix River Watershed.

Prior to sampling in 2009, the Lower St. Croix Watershed had experienced four consecutive years of decreasing precipitation, which culminated in drought conditions in 2009. Conversely, sampling conditions in 2019 took place after four years of average to above average flow conditions. Long- and short-term precipitation cycles are directly related to flow conditions, and can have a significant impact on biological communities. Long-term dry conditions, like those that were experienced in 2009, can result in low flow conditions that are stressful to biological communities. The comparison of invertebrate community health between the two sampling periods was highly impacted by the low flow conditions in 2009, as it resulted in nearly half of the targeted stations not having assessable invertebrate community data. The persistent average to above average flow conditions preceding the 2019 sampling collection resulted in optimal sampling conditions, and was likely reflected in the overall health of the communities that were sampled. Given the difference in flow conditions between our two sampling periods, it is highly likely that the perceived increase, albeit non-significant, was due in part to the changes in precipitation and stream flow conditions.

Figure 8: Characterization of rainfall conditions for May-September period (1969-2019) for the Lower St. Croix River Watershed.

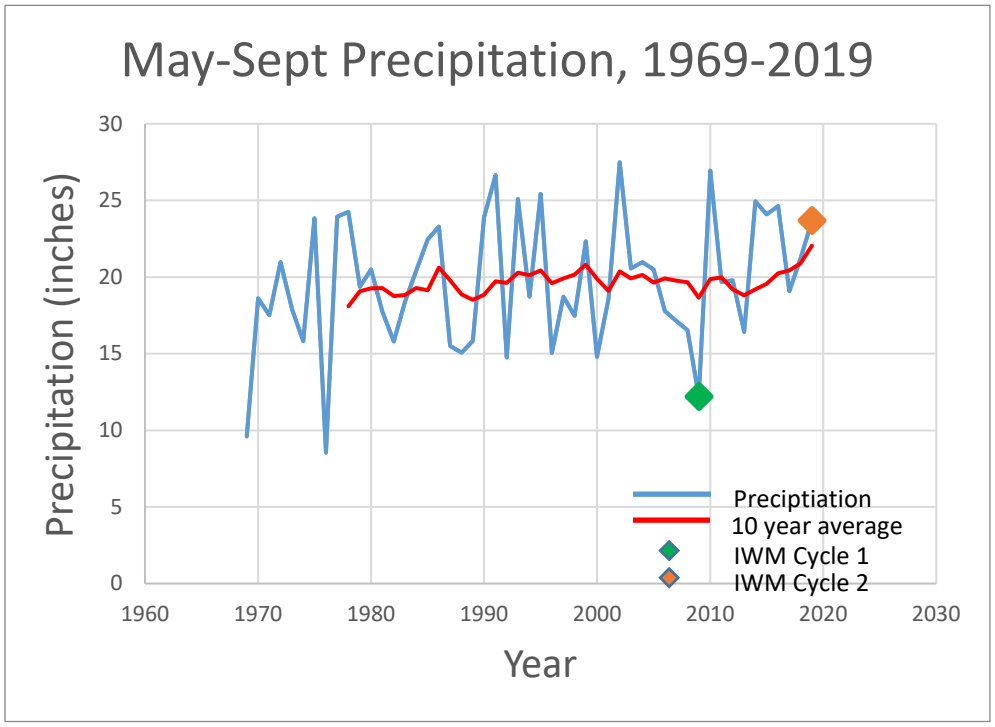


Figure 9: Changes in water quality in the Lower St. Croix River Watershed.

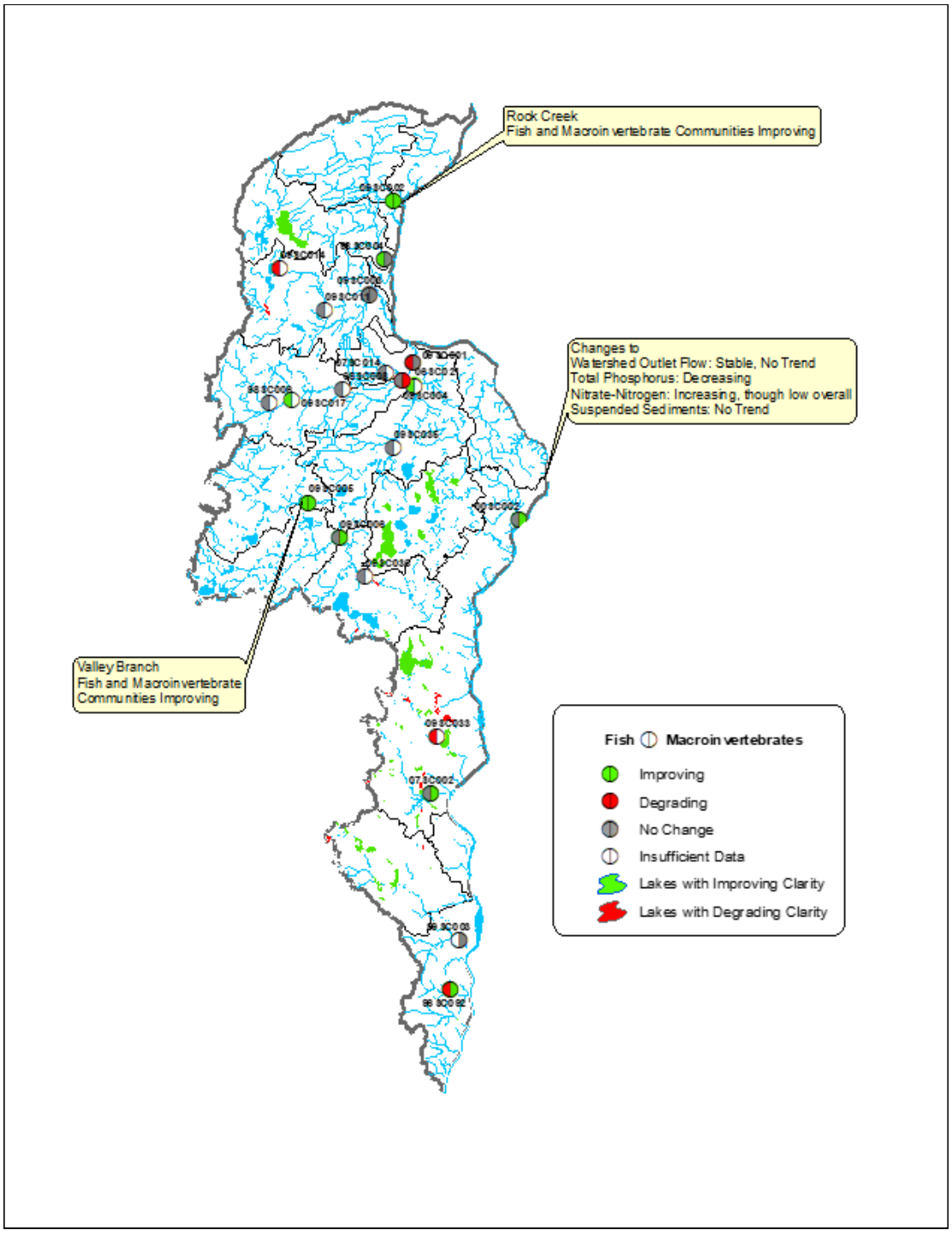
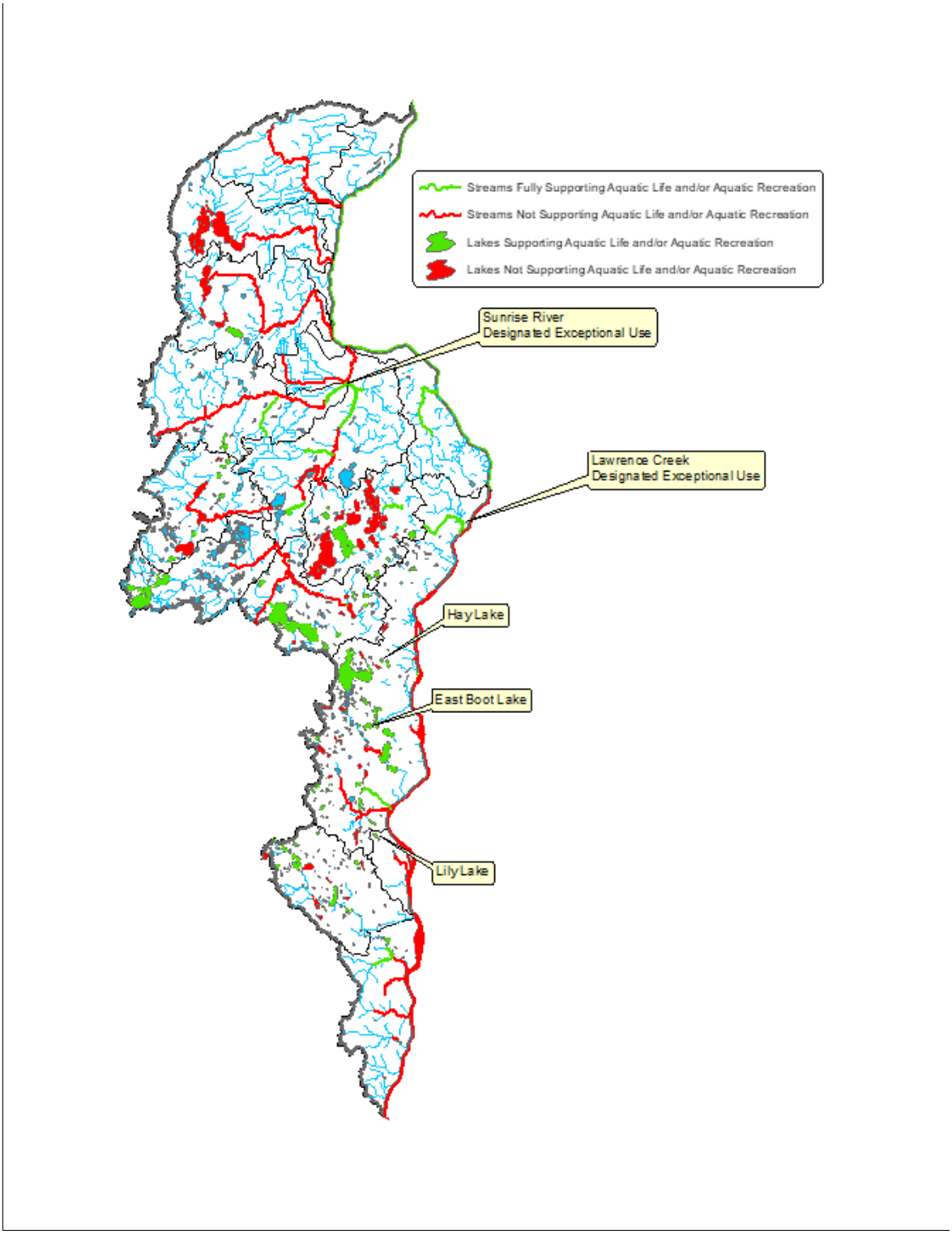


Figure 10: Aquatic life use and recreational use support/non-support in streams and lakes in the Lower St. Croix River Watershed highlighting lakes with successful restoration efforts and streams with Exceptional Aquatic Life Use designations.



For more information

This study of the Lower St. Croix 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 Lower St. Croix 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 the MPCA Lower St. Croix River webpage, or search for "Lower St. Croix River" on the MPCA website.

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CLEAN WATER LAND & LEGACY AMENDMENT