Watershed assessment and trends update

Vermillion River Watershed

Lower Mississippi River Basin

Why is it important?

Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable. While local partners and state agencies monitor water quality on an ongoing basis, the Minnesota Pollution Control Agency (MPCA) and local partners conduct an intensive exam of major lakes and streams in each of the state's 80 watersheds every 10 years to detect any changes in water quality. This intensive exam looks at fish and macroinvertebrate communities as well as water chemistry to gauge water quality. Partners use this information to prioritize waters that are healthy and need protection along with waters that are degraded and need restoration.

The Mississippi River – Lake Pepin (MRLP) Watershed is the watershed scale upon which MPCA's 10-year monitoring schedule is based. It has two distinct portions bisected by the Cannon River, a northern portion represented by the Vermillion River and a southern portion represented by several creeks that flow into Lake Pepin. MPCA's initial exam of this watershed took place in 2011 using data collected 2000-2009, thus establishing baseline conditions for MPCA's 10 year monitoring cycle. A second examination of the watershed is based on monitoring data collected 2010-2019 and assessments conducted in 2020. The focus of this update report is on 2020 results for the Vermillion River Watershed, a separate report for the tributaries to Lake Pepin includes the latest results from the southern portion of the watershed.

The Vermillion River and some of its tributaries are somewhat unique in the opportunities they provide for trout fishing in such close proximity to a major metropolitan area. Brown trout, previously stocked by the Department of Natural Resources (DNR), are now self-sustaining in the watershed and stocking brook trout is being considered. In addition, lakes are fairly sparse in the watershed but are often the centerpiece of local and regional parks, providing aquatic recreational activities such as swimming, fishing, and boating.

Is the water quality improving?

An initial glance at the latest assessment results for the watershed may give the impression that conditions have degraded over the past decade. However, the implementation of new rules and water quality standards since the watershed was last monitored by the MPCA in 2008 are responsible for many of the new impairments stemming from this latest round of assessments. These include the adoption of a tiered aquatic life use (TALU) framework, replacement of turbidity standards with total suspended solids (TSS) standards, and biological assessments of lake aquatic life.

Scientists use a tool called the Index of Biological Integrity (IBI) to assess the biological condition of aquatic communities. 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. Compared to 2008 results, IBI scores for both fish and macroinvertebrates increased substantially in 2018 among the monitoring stations in the Vermillion River Watershed. These results are a hopeful sign that the biological condition of rivers and streams in the watershed is improving.

Hundreds of best management practices have been adopted across the watershed and channel restoration work has been accomplished to improve water quality through the collaborative efforts of local, state, and federal government entities as well as private landowners and organizations. More efforts are needed to address current water quality issues and to protect waters currently supporting their designated uses:

- Based on the latest round of assessments, several new aquatic life impairments were added onto streams already on the Impaired Waters List: seven TSS, two dissolved oxygen, and one aluminum.
- Several biological impairments (six fish/five macroinvertebrate) resulted from revisions to water quality standards, allowing the assessment of channelized streams that were not assessed in 2011 or officially recognizing proposals made in 2011 to change aquatic life class designations (i.e., warm vs cold) of certain stream reaches.
- No new impairments were added for lakes. Scientists determined that three lakes were supporting aquatic life and five were supporting aquatic recreation. The East Bay of Marion Lake was the only one found to be supporting both designated uses.
- Several lakes had sufficient data sets for evaluation of water clarity trends and all were either improving or remaining stable.
- After rerouting effluent from the Empire Wastewater Treatment Plant to the Mississippi River in 2008, the Vermillion River has experienced significant reductions in nitrate and phosphorus concentrations.

Highlights of monitoring

- While many streams in the watershed are impaired for aquatic life, current fish and macroinvertebrate IBI scores suggest that conditions are improving.
- Marion Lake was assessed with a fish IBI for lakes and found to be supporting aquatic life.
- Biological monitoring crews encountered favorable flow conditions during the summer of 2018 and were able to sample all sites.
- MPCA staff collected, measured, and released a 20-inch brown trout on the South Branch Vermillion River. A 24 incher was collected in the watershed in 2008! The smallest individuals recorded were < 3 inches long, signs of a reproducing population.

Watershed results

Monitoring data collected between 2010 and 2019 by the MPCA and DNR as well as partners such as Dakota County Soil and Water Conservation District (SWCD), Scott SWCD, and Metropolitan Council Environmental Services (MCES) were used in the 2020 surface water quality assessments. The purpose of these assessments is to determine whether lakes and streams are supporting their aquatic life and aquatic recreation designated uses (Figure 1). This was accomplished by comparing individual measurements of parameters such as 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.

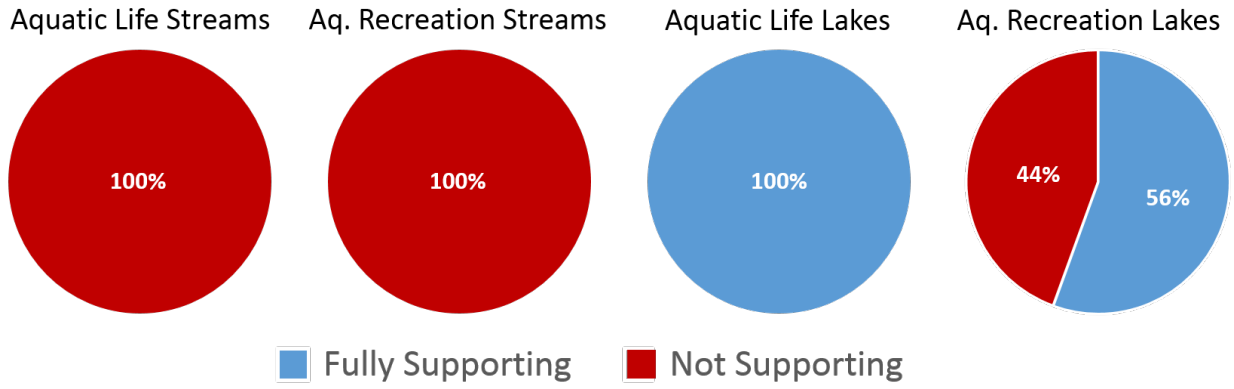

Figure 1. 2020 assessment results for aquatic life and aquatic recreation of streams and lakes in the Vermillion River Watershed.

Several additional water quality issues were identified on stream reaches already listed on the Minnesota's Impaired Waters List. A total of seven new TSS impairments were added onto the list of impairments for virtually the entire length of the Vermillion River (excluding a section that is already listed for Turbidity) and three of its tributaries (Figure 2). All but one of these reaches were not supporting aquatic life prior to the 2020 assessments. Additionally, two channelized, cold water streams (North Creek and South Creek) were listed as impaired due to low dissolved oxygen concentrations. A section of the Vermillion River downstream of Farmington was found to have high concentrations of aluminum, which is toxic to aquatic organisms, and thus was listed as impaired.

Subsequent to MPCA's initial watershed assessment in 2011, a TALU framework was adopted into Minnesota's water quality standards. This new framework allowed channelized streams in the watershed—not assessed in 2011—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. As a result, two modified use streams were determined to be biologically impaired: North Creek (fish) and Unnamed tributary to Rice Lake (fish and macroinvertebrates). Additionally, three cold water streams (South Creek, Middle Creek, the lower section of North Creek) were determined to be impaired based on fish and macroinvertebrate IBI scores (Figure 2). Currently, a modified use does not exist for cold water streams, therefore these streams were assessed according to a general aquatic life use designation.

In the 2011 assessments, water quality standards recognized the lower section of the South Branch Vermillion River (-707) as a warm water stream, but MPCA biologists proposed that its designated use be changed to cold water aquatic life so as to be in agreement with DNR's Trout Stream designation. At that time, it was determined to be impaired for both fish and macroinvertebrates (based on cold water criteria); however, those impairment listings were excluded from the Impaired Waters List until water quality standards were officially updated on June 8, 2020 to reflect the cold water nature of this reach. These two impairments from 2011 therefore appear as 'new' impairments on the 2022 Impaired Waters List.

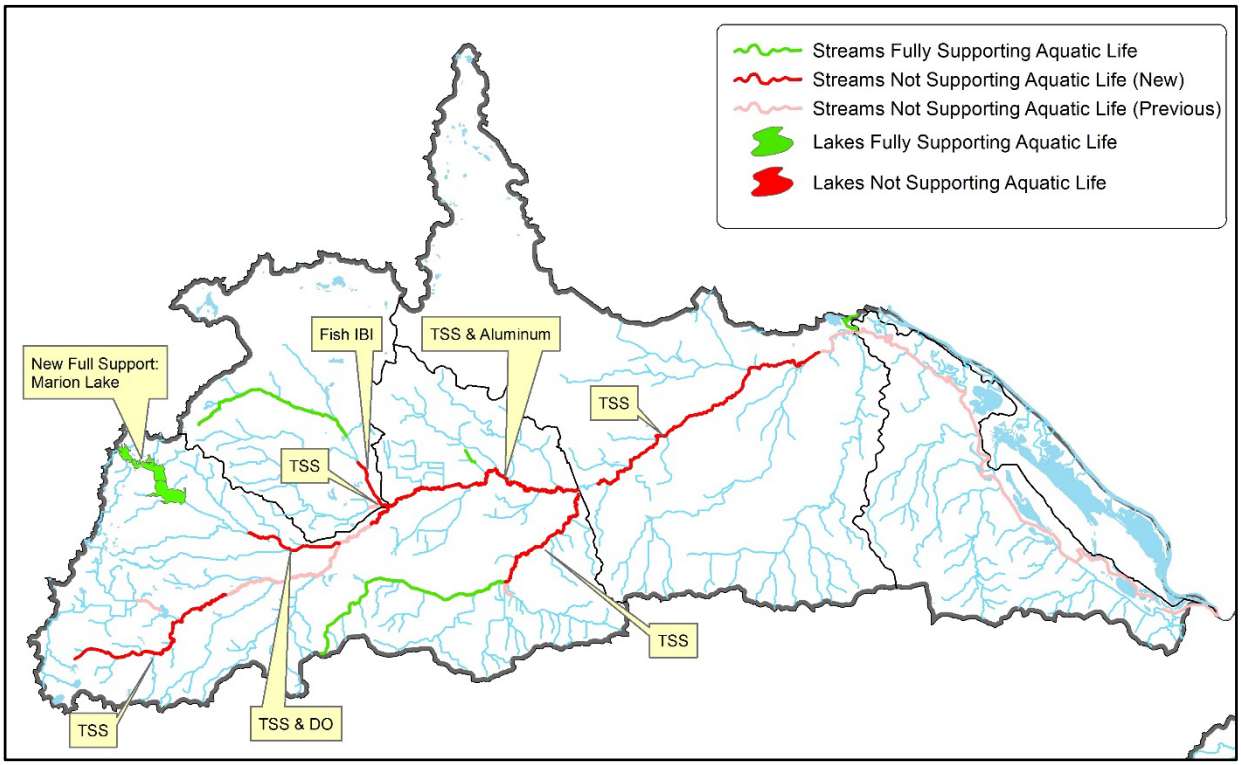

Figure 2. Assessment results for aquatic life on rivers, streams, and lakes. New impairments specified for each water body in text boxes. Full support streams from previous assessments.

There were no sections of stream found to be fully supporting aquatic life in the Vermillion River in 2020. Two streams, Unnamed creek (-680) and the warm water portion of the South Branch Vermillion River (-706), determined to be fully supporting aquatic life in 2011 were not evaluated in the latest assessments. Their status remains fully supporting and thus should be considered in any watershed protection planning efforts.

Based on past assessments, several streams are impaired for aquatic recreation due to excess E. coli concentrations, including multiple sections of the south branch and main stem of the Vermillion River. Bacteria concentrations were again measured in 2018 and the results indicate continued impairment of these streams and rivers. No streams in this watershed have been determined to fully support aquatic recreation (Figure 1).

A total of nine lakes were assessed for aquatic recreational use via lake eutrophication standards for total phosphorus, chlorophyll-a, and Secchi transparency. Results indicated a mix of lakes meeting standards versus some designated as impaired. Four lakes, Alimagnet, Long, Farquar, and an unnamed lake in Lakeville (ID # 19-0349) were assessed as impaired for aquatic recreation. Five lakes fully supported aquatic recreation: Marion, Marcott (two lakes have this name), Horseshoe, and Cobblestone. Long and Farquar lakes have approved implementation plans with restoration plans ongoing. For all nine lakes, assessment results did not change over the 10 years between monitoring cycles. Marion Lake was assessed for aquatic life based on the lake fish IBI and was found to be meeting the standard.

Pollutant load monitoring

Water sampling is conducted by Dakota County SWCD through a partnership with MCES's Watershed Outlet Monitoring Program (WOMP). The WOMP program is part of MCES's Stream and Tributary River monitoring program in the Water Resources section. More information about the sampling efforts can be found at: https://metrocouncil.org/Wastewater-Water/Services/Water-Quality-Management/Stream-Monitoring-Assessment/Mississippi-River-Tributary-Streams-Assessment.aspx

Water samples that support load calculations are collected at the Vermillion River Falls in Hastings, Minnesota. The resulting water quality data and stream discharge information is paired together to produce pollutant load information. There is a long data record at this site stemming back to 1995. Notably, over the period of 1995-2019, the average TSS flow weighted mean concentration (FWMC) was 39 mg/L, which is low compared to the majority of Southern Minnesota watersheds. There have been targeted efforts by local conservation agencies and groups that have implemented several nonpoint source best management practices that help with protecting the soil. The following links shows where those BMPs were implemented:

https://dakotacounty.maps.arcgis.com/apps/webappviewer/index.html?id=304d2225249d4fd3ab3f510e0ff62a7f

https://dakotaswcd.org/conservation-projects/

Trends

A key objective of the 2018 monitoring effort was to evaluate if and how water quality has changed since 2008. 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 Vermillion River Watershed:

1) Streamflow, and the pollutants: sediment (total suspended solids), total phosphorus, and nitrogen (nitrate)
2) Fish and aquatic macroinvertebrate communities
3) Clarity of lakes
4) Climate

Streamflow, and the pollutants suspended solids, phosphorus, and nitrate

The most notable water quality change in the watershed occurred in March 2008 when Empire Wastewater Treatment Plant effluent was rerouted directly to the Mississippi River and no longer discharged into the Vermillion River. There were significant reductions in nitrate and total phosphorus (TP) concentrations at the monitoring station in Hastings. There were not any significant trends in regards to TSS.

From 1998-2007, the average nitrate concentration was 5.1 mg/L. In recent years (2012-2019), concentrations were stable with an average of 2.9 mg/L, representing a 44% reduction in nitrate. Similarly, between 1995 and 2008, the average TP concentration was 0.57 mg/L. After 2008, the average TP FWMC was reduced to 0.14 mg/L, representing a 75% reduction (Figure 3).

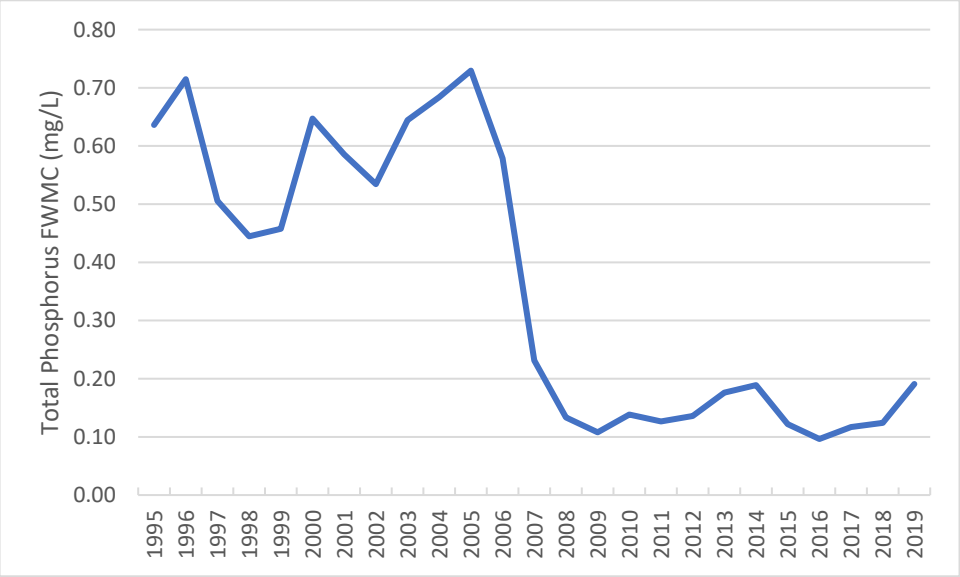

Figure 3. Vermillion River total phosphorus concentrations at Hastings.

In the longer-term (since 1974) both precipitation in the watershed and flow in the Vermillion River show an increasing trend (Figure 4). The magnitude of the trend appears similar suggesting that the flow increase can generally be attributed to precipitation. It is important to note that within longer-term trends, there is normal variation or oscillation. If one only looked at the data from 1995 on, for example, there is no clear trend in precipitation or streamflow.

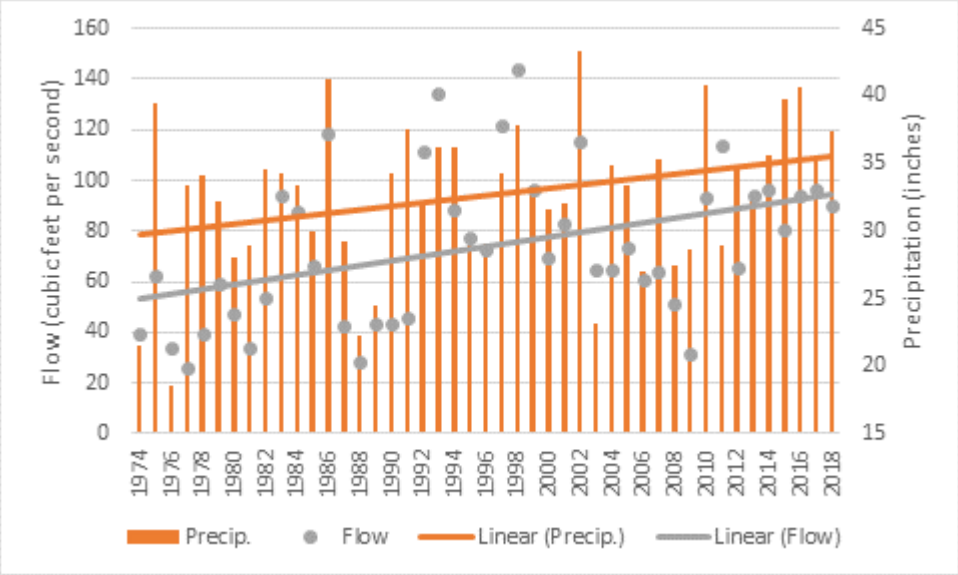

Figure 4. Mean annual flow of the Vermillion River near Empire, MN and annual precipitation for the entire Mississippi River – Lake Pepin Watershed.

Fish and macroinvertebrate communities

Fish and macroinvertebrate IBI scores were used to evaluate if biological condition of the watershed's rivers and streams has changed between time periods. Independent statistical tests were run on each community with seven sites included in each analysis (i.e., sites sampled in both time periods). The average macroinvertebrate IBI score for the Vermillion River Watershed increased by 13 points between 2008 and 2018, representing a significant improvement in biological condition. Similarly, fish IBI scores across the watershed increased by 10 points, also a significant improvement (Figure 5).

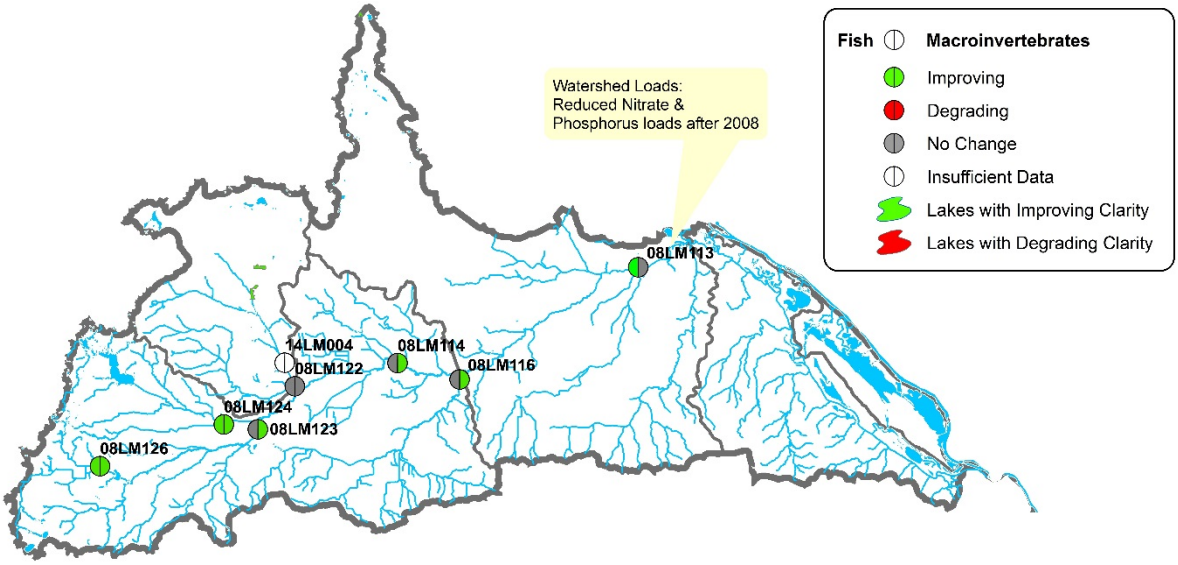

Figure 5. Biological condition comparison for each community type between 2008 and 2018.

Context for the observed changes above is provided by a characterization of the conditions that occurred during biological monitoring in 2008 and 2018. In 2008, the watershed experienced a moderate to severe rainfall deficit (-5.0 in) and was abnormally cool (-1.3 ^{o}F) during the May to September time period. Meanwhile, the watershed had above normal rainfall (+3.8 in) and was abnormally hot (+1.6 ^{o}F) in 2018 between May and September. It is worth noting that a disproportionate amount of rainfall occurred in September of 2018, over 6 inches (~25% of May-Sept total), which was after biological monitoring operations had ceased in the watershed that year. Overall, given the dry conditions affecting the watershed in 2008 and the wetter than average conditions present in 2018 (Figures 4 & 6), there is a moderate likelihood that the observed changes in biological condition at either the watershed or individual site scale are at least partially due to differences in climatic conditions between the two monitoring periods.

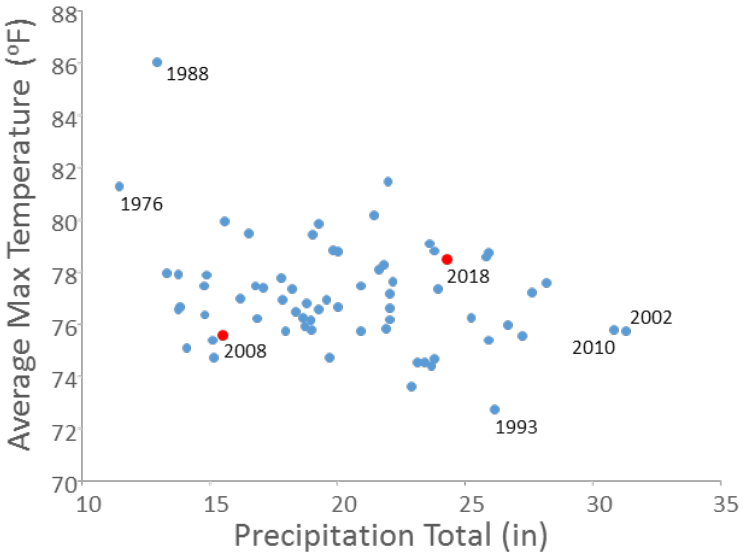

Figure 6. Characterization of air temperature and rainfall conditions for May-September period across the historical record of climate data for the entire Mississippi River – Lake Pepin Watershed. MPCA biological monitoring years highlighted in red.

Transparency of lakes

All nine lakes that were assessed in the watershed had long-term Secchi transparency datasets sufficient for trend statistics, often collected by citizen volunteers or cities. Three lakes, Horseshoe, Cobblestone, and Unnamed (19-0349) have improving water clarity; the remaining lakes have stable clarity.

Climate

The MRLP Watershed currently receives on average an additional 3.2 inches of rain annually compared to the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense. Meanwhile, the average annual temperature across the watershed has increased by about 1°F, with a more pronounced increase (+2.3°F) observed during the winter (Dec-Feb). More precipitation and reduced snow cover can increase soil erosion, pollutant runoff, and stream flow. Increased stream flow in turn can lead to in-stream channel erosion and degraded habitat for aquatic life. Longer growing seasons with higher temperatures can lead to more algal blooms, especially in lakes. These changes will complicate efforts to protect and restore the aquatic resources in the watershed. For a more comprehensive analysis of climate trends for the MRLP watershed, see:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/climate_summary_major_38.pdf

For more information	Stressor identification for new impairments and updates to the Watershed Restoration and Protection Strategy follow the completion of monitoring and assessment. For more information, go to the MPCA Mississippi River - Lake Pepin webpage, or search for "Mississippi River – Lake Pepin" on the MPCA website.

Contact

John Genet
Minnesota Pollution Control Agency
john.genet@state.mn.us
651-757-2386

CLEAN WATER LAND & LEGACY AMENDMENT