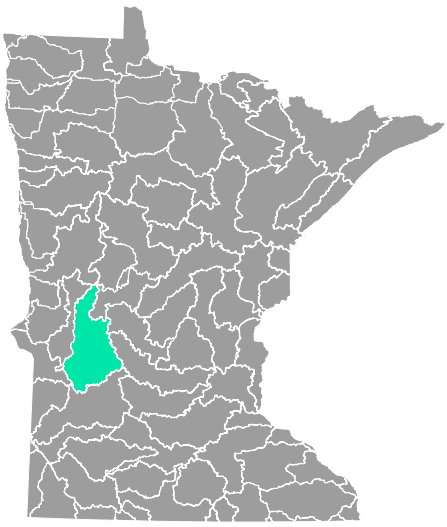
Watershed assessment and trends update

Chippewa River Watershed

Minnesota River Basin

Why is it important?

Figure 1. Chippewa watershed western Minnesota.



Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to determine if waters are fishable and swimmable. While local and state agencies monitor some aspects of water quality on an ongoing basis, the Minnesota Pollution Control Agency (MPCA) and local partners conduct much more comprehensive and intensive biological and water chemistry monitoring of streams and major lakes in each of the state's 80 watersheds every 10 years. This document is an update since it reports on results from the first re-visit to the Chippewa River Watershed. The purpose of this second round of monitor is to detect any changes in water quality. State agencies, including the MPCA, and partners use this information to refine strategies for waters that are healthy and need protection along with waters that are degraded and need restoration.

The Chippewa River Watershed is a heavily farmed area with most of the native prairie grassland and wetlands converted to row crops. Surface waters in the Chippewa River Watershed have been drastically altered with the installation of subsurface drain tiles and channelization of streams.

These alterations led to lakes and wetlands being drained, causing long lasting effects on the surface water, reducing recreational opportunities, and harming aquatic life. Some major effects of the altered water ways include increased flooding and erosion, leading to higher levels of turbidity and sedimentation in waterways and property loss. Although many of the smaller tributaries to the Chippewa River have been altered, there are still recreational opportunities on the Chippewa River. Many people in the area enjoy canoeing and kayaking on the river, affording the opportunity to experience the outdoors and wildlife. Continued monitoring can provide a better understanding of watershed conditions so that water quality issues can be immediately addressed.

Is the water quality improving?

Over the past decade, scientists observed some changes in water quality in the Chippewa River Watershed. Continued problems in the watershed include elevated concentrations of bacteria (*E. coli*), excess suspended sediment (TSS), high amounts of nutrients (mainly in lakes), and low levels of dissolved oxygen.

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.

Picture 1. Outlet Creek in the Chippewa River watershed.

Compared to 2009 results, IBI scores for macroinvertebrates increased significantly in 2019 across the Chippewa River Watershed. Stream fish communities across the watershed did not improve significantly. Fish sampling was disrupted in 2019 due to high flows and in 2020 due to COVID-19 restrictions, reducing the amount of comparable fish community data. Due to this disruption, it is difficult to conclusively state whether or not fish community conditions improved in rivers and streams across the watershed.

- Stream macroinvertebrate communities exhibited a net improvement in biological condition with five new impairments in the watershed and eight that were either de-listed or corrected on the 2022 Impaired Waters List, bringing the new total of macroinvertebrate impairments down to 25.
- Three new fish impairments were added to the Impaired Waters List for the Chippewa River Watershed. There are currently 27 fish impairments on rivers and streams in the watershed.
- Two small streams, County Ditch 15 and Unnamed Creek, are being de-listed from the 2022 Impaired Waters List for fish. Both streams indicated healthier fish communities with higher IBI scores in 2019. At this time, it is not possible to determine if these improved IBI scores are due to restoration activities.
- Trend analysis for three key water pollutants (nitrate, phosphorus, and suspended sediment) was done for the period 2008-2019 at the monitoring station near the outlet of the watershed. Nitrate levels increased, phosphorus levels decreased, and sediment showed no change.
- Average annual streamflow has increased dramatically in the Chippewa River both in the longer term (500% increase over the past 80 years) and shorter term (four of the top 10 average annual stream flows have occurred since 2011). Increasing, versus more stable, stream flows are generally a negative for water quality.
- The northern-most section of Shakopee Creek saw the greatest fish community improvement in the watershed. The fish community increased in diversity and had less tolerant species. One major difference was the presence of common carp in 2009 but none were present in the most recent sample.
- For lakes with long-term data sets, 40% are seeing improvements in water quality and 52% are showing no change.
- Reno Lake will be de-listed for nutrients.

- During the period of 2008-2018, landowners undertook a significant number of conservation and best management practices in the Chippewa River Watershed with the help of federal, state, and local conservation agencies. Some of the known practices undertaken during this period include 2091 acres of new filter strips, 196 water and sediment control structures, 44,389 acres of reduced tillage practices, 10,093 acres of cover crops, and 44 stream channel stabilization and shoreline protection projects. (For more detail on conservation efforts, see: https://public.tableau.com/shared/3H5ZX9X3S?%3AshowVizHome=no)

Highlights of monitoring

- After initially being listed as impaired in 2009, a long-term monitoring station on Mud Creek has consistently yielded macroinvertebrate IBI scores indicative of a healthy community and is among the streams being de-listed from the 2022 Impaired Waters List. Delisting a stream from the Impaired Waters List means the stream's water quality is improving. A healthier macroinvertebrate community, increasing IBI score, is indicative of improving water quality.
- The Chippewa River Watershed demonstrates fairly good fish diversity with 50 different species captured in the most recent sample. This is average for similar watersheds within the area.
- Lake aquatic life assessments, based on fish community indicators, are a new component of watershed assessments with 32 lakes assessed this cycle in the Chippewa River Watershed.
- Several lakes in this watershed support fish Species of Greatest Conservation Need (a list of species identified as most in need of conservation action) such as Hornyhead Chub, Least Darter, and Pugnose Shiner.
- Several streams support Hornyhead Chub, and one supports Largescale Stoneroller, both species are identified as Species of Greatest Conservation Need.
- The MudPuppy, Necturus maculosus, a Species of Greatest Conservation Need, was found in 2016 by sampling conducted by the DNR in the Chippewa River: one near Milan and one near Benson. Since this species is sensitive to pollution and siltation, the presence of Mudpuppy could indicate improving water quality.
- Sixty-eight lakes were assessed for aquatic recreation. New nutrients impairments were discovered on eight lakes, resulting in 39 lakes now being on the impaired waters list for nutrients.

Picture 2. Biologist electrofishing on the Chippewa River.

Sampling fish in the watershed's rivers and streams experienced challenges due to high water levels and COVID-19. Monitoring fish communities was scheduled to happen in 2019, but biologist were only able to sample 18 sites out of 51 due to increased precipitation. The remaining sites were scheduled to be sampled in 2020, but those activities were postponed due to the pandemic. Therefore, 24 stream sites were sampled for fish in 2021 to account for these disruptions.

Success story

Outlet Creek, which begins at the outlet of Lake Minnewaska and flows into Lake Emily, was found to be impaired for aquatic macroinvertebrates based on 2009 monitoring. The 2015 Chippewa Stressor Identification Report noted that Outlet Creek biology was impacted by a number of stressors including high turbidity, high phosphorus, and low dissolved oxygen.

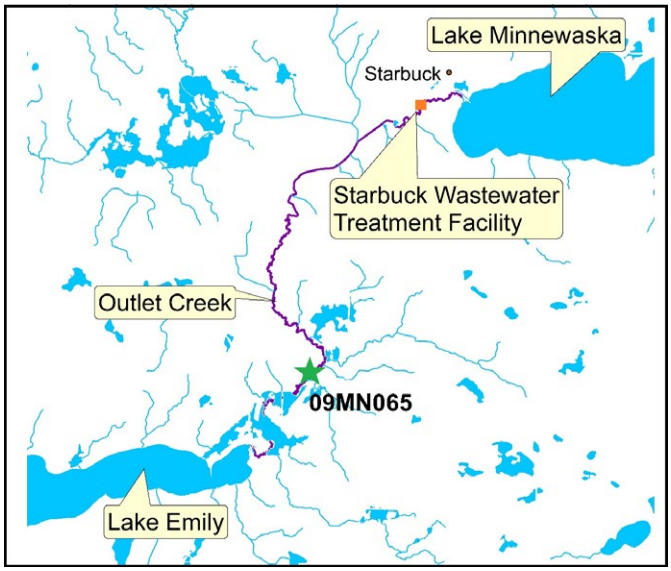
Since 2009, the Pope Soil and Water Conservation District has used state and federal funding to work with farmers to plant buffer strips, plant cover crops, and install over 153 separate BMP projects to reduce the amount of pollution entering the lake and streams. To decrease delivery of sediment and phosphorus, farmers installed 53 water and sediment control basins along Outlet Creek. In addition, significant cropland nutrient management changes and livestock rotational grazing projects were undertaken along this reach.

The Starbuck Wastewater Treatment Facility was issued a new discharge permit in 2018 putting daily and annual limits on the amount of phosphorus it can discharge in to Outlet Creek (Figure 2.). The facility already had a State Discharge Restriction (SDR) limit of 1.0 milligrams per liter (mg/L), calendar month average, January-December, set in 2011 to protect Lake Emily. Lake Emily was listed as impaired for nutrients in 2002, but is now fully supporting aquatic life.

Stream monitoring has not been done to determine the effect these efforts had on water chemistry levels. Biological samples collected at station 09MN065 (Figure 2.) in 2019 and 2020 indicate that macroinvertebrates are now healthy. Ultimately, the influence of climatic differences between these two time periods can't be ruled out (see Trends section), none the less, the improvement is encouraging and highlights the potential for achieving water quality goals in a short amount of time.

Picture 3. Outlet Creek

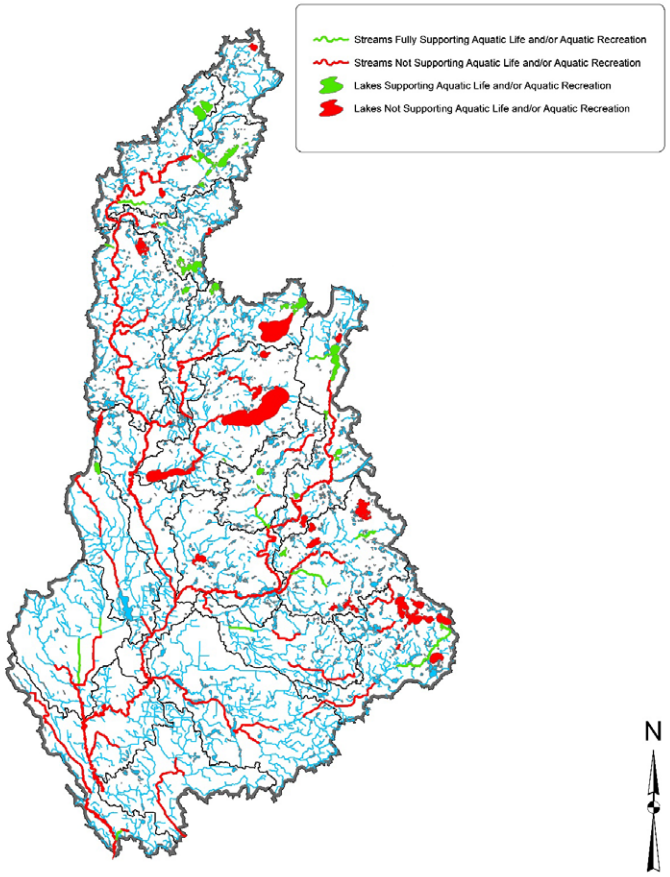
Figure 2. Starbuck Wastewater Treatment Facility discharged to Outlet Creek



Watershed assessment results

The MPCA and partners monitored water quality conditions in 2007-2008 and again in 2017-2018. Chemistry data collected by local partners between 2009 and 2018 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.

Figure 3. Assessment results for aquatic life and aquatic recreation of lakes and streams in the Chippewa River Watershed.

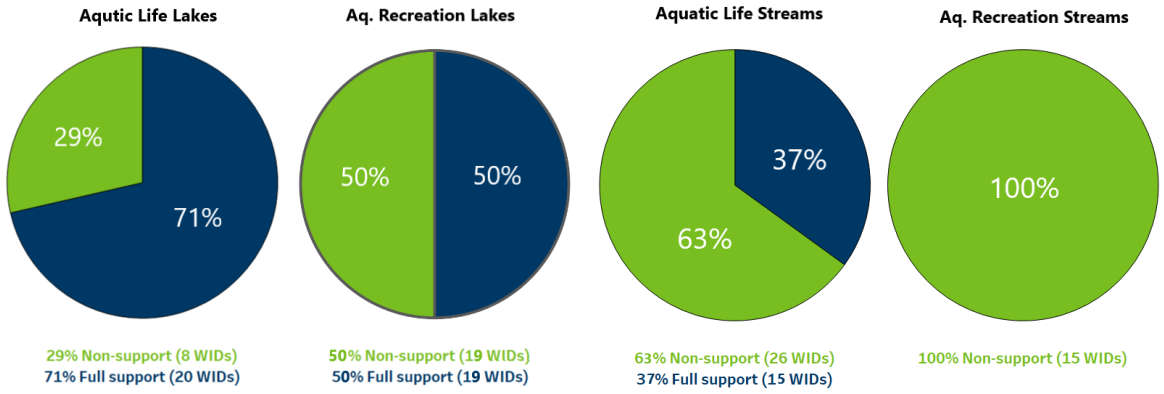


Streams and rivers

Fish and macroinvertebrate communities are a direct measure of aquatic life in the rivers and streams. Based on the first round of assessments, 42 stream segments were determined impaired for aquatic life. The second round of assessments determined 19 more streams are impaired, but nine impaired streams were found to support aquatic life and are being delisted. This second round of monitoring brings the total impaired streams for aquatic life in the Chippewa River Watershed to 50. There were 15 streams where the fish community did not meet the water quality standards and 24 streams met water quality standards. On a whole, 65% of the streams sampled in 2019 do not meet water quality standards for aquatic life and 35% are fully supporting (Figure 3.).

Two small streams, County Ditch 15 (09MN030) and Unnamed Creek (07MN036), are being delisted for fish. Both stream's fish communities' IBI scores improved significantly from 2009 to 2019. Unnamed creek (07MN036) saw an increase in fish species diversity; in 2009, eight species were captured, and in 2019, 15 species were captured. County Ditch 15 (09MN030) saw a shift from high numbers of tolerant individuals to higher numbers general individuals; in 2009, 123 fathead minnows were captured which was the most abundant species, and in 2019 1 fathead minnow was captured with Largemouth bass being the most abundant species. This change from very tolerant to more sensitive species is a sign that the stream is improving.

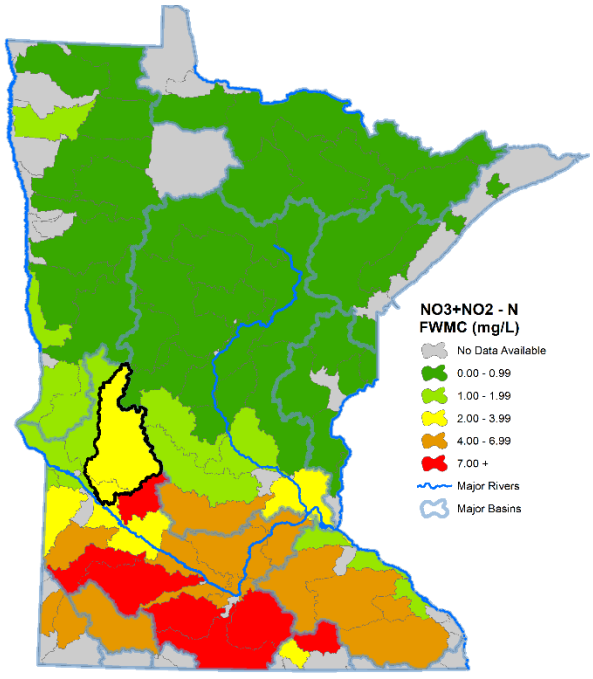
Figure 4. Watershed assessment results for aquatic life in streams and aquatic recreation in streams and lakes by watershed ID (WID).



In the Chippewa River Watershed, elevated bacteria, suspended sediment, and low dissolved oxygen were prevalent across the watershed. New impairments for dissolved oxygen were added on segments of Cottonwood Creek, Little Chippewa River, and two Unnamed Creeks (-627 and -708). An additional impairment for *E. coli* was added on the Chippewa River/County Ditch 60 portion that flows into Stowe Lake (northern portion of watershed), resembling bacteria problems the rest of the river experiences downstream. The section of the Chippewa that flows from Stowe Lake has excess nutrients, and is the first reach in the watershed to be listed for such. However, the mouth of the Chippewa is also vulnerable to a future nutrient impairment, and should be prioritized for protection to keep phosphorus concentrations in check and prevent future nutrients impairments.

While many of the results in this report are based on once-a-decade monitoring, there are also three Watershed Pollutant Load Monitoring Network (WPLMN) stations that operate every year on an on-going basis. These include a watershed "outlet" station, as well as two upstream subwatershed stations — one on the main branch of the Chippewa River near Clontarf, and one on the East Branch of the Chippewa River near Benson. The long-term nature of these three stations is critical for trend analysis, measuring between-year differences in pollutant loading, and helping to determine pollutant sources. A fourth station, on the Shakopee Creek tributary, operated from 2013-2018, but was dropped from the network.

Figure 5. Average levels of nitrate by major Minnesota watersheds, the Chippewa outlined in black.



Compared to other major watersheds in Minnesota, the Chippewa exhibits moderate levels of nitrate, phosphorus, and sediment. Figure 5 shows this for nitrate. Similar maps, as well as an interactive data viewer can be found at https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring.

The results from the subwatershed stations indicate substantially lower levels of nitrate at the upstream Clontarf station, and somewhat lower levels of phosphorus and sediment from the East Branch of the Chippewa River. Levels of all three are all higher in the southern portion of the watershed, with significant contributions from Shakopee Creek.

Lakes

The watershed has approximately 334 publicly accessible lakes. Thirty-nine of these lakes are considered impaired for nutrients, and as a result are more prone to excessive algae blooms in the summer months, reducing recreation opportunities. Of those lakes, eight of the impairments were added this assessment. Alternatively, 19 lakes were found to have good water quality and support aquatic recreation. Two lakes, Reno and Middle, which were previously listed as impaired for nutrients will be removed from the list of nutrient impaired lakes due to their improved water quality. However Reno will remain on the impaired waters list due to its newly added fish impairment.

Fish communities are a reflection of the cumulative effects of natural and human-caused influences in lakes. Thirty-two of the lakes within the Chippewa River Watershed were assessed for aquatic life using a fish-based IBI developed for Minnesota lakes. There were 19 lakes assessed as fully supporting aquatic life, two of those lakes contain exceptional fish communities and an additional eight lakes were assessed as not supporting aquatic life use. Thirteen lakes within this watershed are deep and have complex shorelines. Most of the fully supporting lakes in this group had healthy shorelines providing habitat for fish communities, while most of the not supporting lakes had unhealthy shoreline with little to no habitat.

Overall fish diversity was fairly high relative to other Minnesota watersheds. This is likely influenced by the connectivity of many lakes, and the tributaries to the Chippewa River, making species colonization in lakes possible. Across the Chippewa River Watershed, 54 total fish species were captured in 32 lakes during fish IBI sampling. Twelve of these species are considered to be intolerant to anthropogenic shoreline and watershed stressors within the watershed such as Rock bass and Smallmouth bass, while six species were considered to be tolerant to these stressors such as Black Bullhead and Common Carp.

Trends

A key objective of the 2019-2021 monitoring effort was to evaluate if and how water quality has changed since 2009 (Figure 6). 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 Chippewa River Watershed:

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

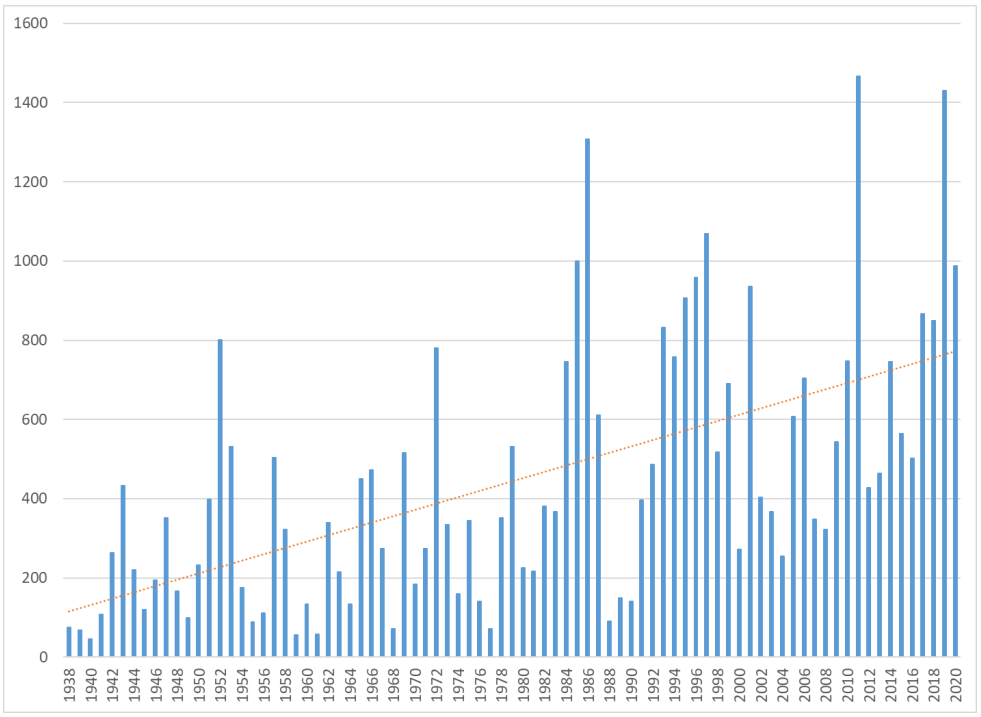
Figure 6. Change in water quality in the Chippewa River Watershed.

Streamflow and pollutant concentrations

Trend analysis for nitrate, phosphorus, and suspended sediment concentrations was done for the period 2008-2019 at the monitoring station near the outlet of the watershed. Nitrate concentrations showed an increasing trend, phosphorus showed a decreasing trend, and sediment concentrations showed no change. Trend analysis was not possible at the subwatershed stations as they have not be operating quite long enough; this analysis will be possible in the future.

Increasing nitrate levels have been seen in many rivers throughout the state. Changing cropping practices, expanding agricultural drainage, and climate change have been identified as contributing factors. As noted earlier, nitrate levels in the Chippewa are moderate compared to other watersheds in Minnesota. It would be desirable to arrest the increasing trend to at least maintain moderate levels.

Figure 7. Chippewa River average annual flow (CFS).



The factors linked to increasing nitrate, plus others, impact phosphorus and sediment. Thus, the lack of a trend for sediment and the decreasing phosphorus levels could be viewed as a positive and the result of concerted state and local watershed management efforts, including changes to some agricultural practices.

Average annual streamflow has increased dramatically in the Chippewa both in the longer term — 500% increase over the past 80 years, and shorter term — four of the top 10 average annual stream flows have occurred since 2011 (Figure 7.). Increased streamflow has implications for stream channel conditions, property and safety, and pollutant loading. Additional water results in increased channel erosion and sediment deposition, which can degrade habitat for fish and other river life. Flooding threatens the property and safety of watershed residents. More water means that larger pollutant loads to downstream resources including the lower Chippewa, the Minnesota River, the Mississippi River, and Lake Pepin, even if the concentrations of these pollutants are stable. While increasing precipitation is certainly an important factor in the streamflow increase, expanding agricultural drainage and land use changes are also important.

Biological communities

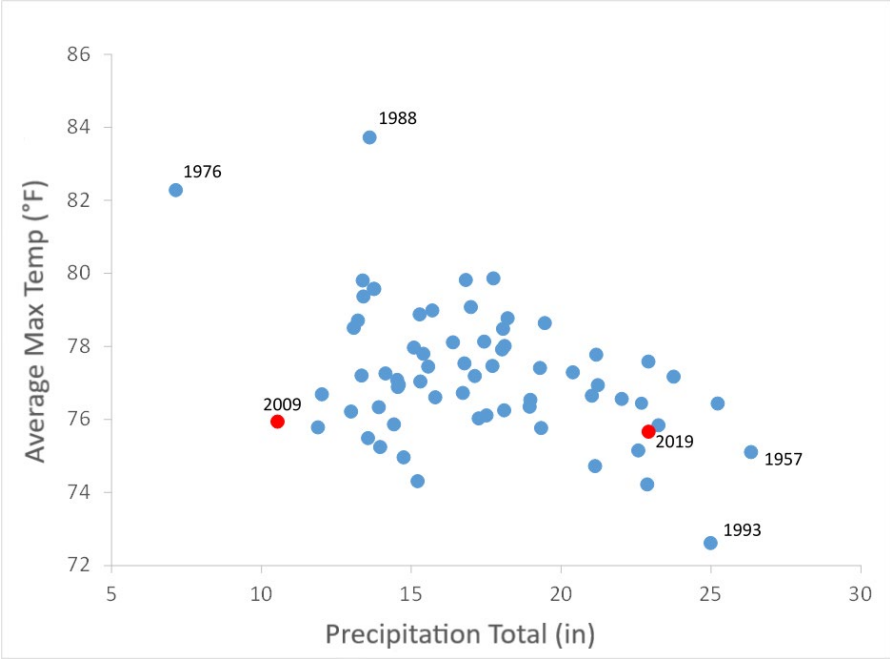
Fish and macroinvertebrate IBI scores were used to evaluate if the biological condition of the watershed's rivers and streams has changed between time periods. Independent statistical tests were run on each community with 38 sites included in the macroinvertebrate analysis and 17 sites in the fish analysis (i.e., sites sampled in both time periods). The average macroinvertebrate IBI score for the Chippewa River Watershed increased by nine points between 2009 and 2019, representing a significant improvement in biological condition (Figure 6.). Fish IBI scores across the watershed increased by four points, this however does not represent a significant change in biological condition over the 10-year period. The fish IBI score change analysis was affected by the persistently high flows in 2019 and COVID-19 in 2020 disruptions. These disruptions reduced the amount of comparable fish community data making it difficult to conclusively state whether or not fish community conditions improved in rivers and streams across the watershed.

Context for these results is provided by a characterization of the climatic conditions that occurred during biological monitoring in 2009 and 2019. In 2009, the Chippewa River Watershed experienced an extreme drought (-7.0 in) and was near normal in terms of air temperature (-0.9 ° F) during the May to September time period (Figure 8.). Conversely, the watershed had above-normal rainfall (+5.4 in) and was abnormally cool (-1.2 ° F) in 2019 over the May to September time period. It is also worth pointing out that there were rainfall deficits during the three summers prior to 2009 monitoring activities and above-normal rainfall during the five summers prior to 2019; potentially exacerbating the observed differences between those monitoring years. Overall, given the dry conditions affecting the watershed in 2009 and the wetter-than-average and cooler conditions present in 2019, there is a high likelihood 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 periods.

Clarity of lakes

In the Chippewa River Watershed, 42 lakes had sufficient transparency data (50 Secchi measurements, eight years of data) to conduct a water clarity trend analysis. Much of the transparency data was collected by local volunteer scientists through the MPCA's Volunteer Water Monitoring Program. Those data end up playing a large role in statewide data analysis, which helps inform water quality assessments and track trends over time. Similar to statewide results, most lakes in the watershed do not exhibit a significant trend and more lakes have improving clarity than declining. Three lakes had a decreasing clarity trend: Hoff, Red Rock, and Villard. Seventeen lakes had improving clarity, including Strandness, Monson, and Simon which are currently impaired.

Figure 8. Characterization of air temperature and rainfall conditions for May-September period (1953-2019) for the Chippewa River watershed.



Climate

The Chippewa River Watershed now receives on average 2.1 additional inches of rain compared to the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense. In addition, temperatures in the watershed have increased by about 1.1 degree (F) in spring and fall over this time period. Increased rainfall and temperature can worsen existing water quality problems. More precipitation and reduced snow cover can increase soil erosion, pollutant runoff, and streamflow. Increased streamflow in turn can lead to stream channel erosion and degraded habitat for fish and other aquatic life. Longer growing seasons with higher temperatures can lead to more algal blooms. These changes will complicate efforts to protect and restore the watershed. For further details, see DNR climate summary for the Chippewa River Watershed.

For more information

This study of the Chippewa 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 Chippewa 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 Chippewa River webpage, or search for "Chippewa River" on the MPCA website.

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