Watershed assessment and trends update

Cannon River Watershed

Lower Mississippi River Basin

Summary

The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (MNDNR), and multiple partners have completed a study of the Cannon River watershed, which includes the river itself, it's largest tributary the Straight River, along with other tributaries and over 90 lakes. With regionally important cities and extensive agriculture within this watershed, water quality is at particular risk from human activity, however the study found several encouraging trends since the last assessment ten years ago. Index of Biological Integrity (IBI) scores for the health of fish and macroinvertebrate communities across the watershed showed significant increases. Pollutant loads of total suspended solids, total phosphorus, and Nitrate-Nitrite showed decreasing trends. Continued conservation and remediation efforts by local partners will protect or improve water quality within this watershed.

Instead of relying on chemical testing of the water alone, scientists reached their conclusions through studying the variety of fish and bugs living in the waters. Doing so offers a more comprehensive understanding of the watershed's health over time. Volunteer water quality monitors contributed to the assessment, which is funded by Minnesota's Clean Water Land and Legacy Amendment. Results from this sampling effort will shape decisions on watershed management and pollution reduction measures for years to come.

Watershed Study

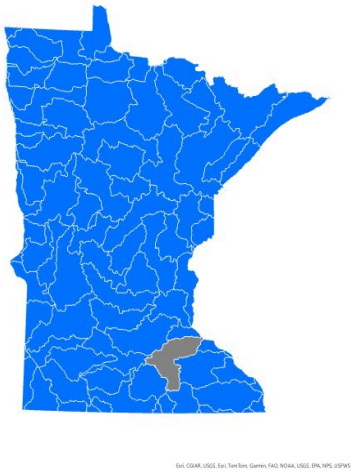
Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable. While local partners and state agencies monitor water quality on an ongoing basis, the MPCA and local partners conduct an intensive exam of major lakes and streams in each of the state's 80 watersheds every 10 years to detect any changes in water quality. This intensive monitoring looks at fish and macroinvertebrate communities as well as water chemistry to gauge water quality. The partners use the data to see which waters are healthy and need protection and which are impaired and need restoration. Waters are considered impaired if they fail to meet water quality standards.

The MPCA and partners monitored water quality conditions in 2011-2012 and again in 2022-2023. Additionally, chemistry data were collected by local partners between 2013-2023. Monitoring data collected between 2013-2023 were used in the latest round of assessments for the Cannon River Watershed, focusing on whether or not waterbodies 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.

Changes in water quality

To detect changes in water quality, this recurring exam looks at fish and macroinvertebrate communities as well as water chemistry. Scientists use a tool called the IBI to assess the health of aquatic communities in lakes, rivers, streams, and wetlands. High IBI scores indicate a healthy aquatic community, which can only be achieved when water quality, habitat, and hydrology are minimally disturbed by human activities. The MPCA uses fish and macroinvertebrate IBIs to assess the health of rivers and streams in Minnesota, while MNDNR employs a fish IBI to assess the health of lakes.

Figure 1. Cannon River Watershed within



While the biological condition in individual streams may have improved or declined between 2011 and 2022, the overall health of fish and macroinvertebrate communities increased over this period. Macroinvertebrates are small 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 2011 results, IBI scores for macroinvertebrates—on average—increased by 6.4 points in 2022 across the Cannon River watershed. Similarly, fish IBI scores increased by 7 points on average across the watershed's rivers and streams in 2022.

There were 22 new impairment listings found in this current study, 12 in lakes and 10 in streams. All lakes with new impairment listings were due to not meeting fish IBI criteria of this ecoregion, and new stream impairment listings include issues of elevated bacteria and excess nutrients. Additionally, the following changes were observed:

- Fish IBI scores increased at a total of 27 stream monitoring stations. Only 10 monitoring stations showed a decrease in Fish IBI scores.
- The Cannon River at biological monitoring station 11LM097 showed the greatest increase in fish IBI score between 2011 and 2022, with an increase of 35 points. As a result, the only reach on the Cannon River mainstem impaired for the fish community previously, this reach will be delisted for an impaired fish community.
- Macroinvertebrate IBI scores increased at a total of 22 stream monitoring stations, while 13 stations showed a decrease in macroinvertebrate IBI scores.

MPCA scientists monitored the fish and bugs, along with several water quality parameters, in the Cannon River watershed as part of the statewide effort to gauge the health of major lakes and rivers.

- Pollutant loads for total suspended solids, Total Phosphorus, and Nitrate-Nitrite showed decreasing trends

Landowners have installed hundreds of best management practices to improve water quality, but many more are needed. It takes time for these practices to show results.

Highlights of monitoring

- Biological monitoring station 04LM120 on the Straight River downstream of Owatonna scored the highest fish IBI in the watershed in 2022, with a score of 92 points.
- A total of 73 species of fish were sampled in streams. A noteworthy species, the blue sucker, is a state species of concern and was sampled on the Cannon River.
- A long-term biological monitoring station is located within the Cannon River watershed, providing an in-depth evaluation of aquatic communities and their habitat along a coldwater section of Belle Creek.
- Biological monitoring station 11LM004 on Turtle Creek had the highest macroinvertebrate IBI in the watershed in 2022 with a score of 74 points. This site had a diverse community of aquatic insects, including a caddisfly species (Helicopsyche borealis) that constructs a case that looks like a snail shell!
- Proposed delisting of an E. coli impairment on an 8.5-mile section of the Cannon River (WID 07040002-501). Water quality monitoring efforts in 2022 and 2023 concentrated on collecting a more robust data set in this WID and the assessment showed that E. coli levels were now meeting water quality standards for aquatic recreation.
- Delisting of a total suspended solids (TSS) impairment on a 5.7-mile section of the Straight River (WID 07040002-503). The current assessment used the most recent 10-years of data and both TSS and Secchi tube (STUBE) are now well below their impairment thresholds.
- Of the 44 lakes assessed, no additional impairments for nutrients were added in this watershed. Lake chemistry conditions are showing no trend with conditions holding steady, neither degrading nor improving currently.
- A total of 40 fish species were collected in lakes during fish IBI sampling. Of these, 9 are considered intolerant species—susceptible to pollution, shoreline habitat disturbance, and watershed disturbance. Notable species included Least Darter, a State Species of Concern and the Pugnose Shiner is State Threatened.
- Fish, Roemhildts, Kelly & Dudley, Rays, and Beaver lakes all supported healthy fish communities based on recent monitoring.

Success story

Across the Cannon River watershed, much work is being done to protect and improve surface water quality, groundwater quality, and soil health. Passing through the watershed it is easy to notice the prevalence of this work. Local government units are partnering with landowners to implement projects throughout the watershed. These projects include reduced tillage, cover crops, septic system improvement, grassed waterways, water/sediment control basins, and grade stabilization among others.

Cover crop planted within a field of Soybeans.

One notable partnership in the watershed is the Cannon River Joint Powers Organization. This organization was created in 2020, and is made up of the six counties, six county soil and water conservation districts, cities, watershed districts, lake associations, townships, and various other organizations that are stakeholders within the watershed. This partnership was created to implement the Cannon River Watershed Management plan that was developed from the Cannon River One Watershed, One Plan with the help of the Minnesota Board of Soil and Water Resources (BWSR). The goal of the plan is to implement best management practices within the watershed to attain water quality and natural resource management objectives. https://www.cannonriverwatershedmn.gov/.

On a smaller minor watershed scale, The Farmers Protecting Rice Creek Project is active to protect and improve the water quality in Rice Creek/Trout Brook, a trout stream in Rice County. Local organizations such as Rice Soil and Watershed District, Clean River Partners, Fishers and Farmer Partnership among others are teaming up with farmers to implement best management practices to protect and improve water quality in this tributary of the Cannon River. A significant achievement of this effort thus far is the approximately 1000 acres of cropland planted in cover crops within this 4182-acre minor watershed.

Overall, water quality and natural resource issues are important to many local organizations and residents within the Cannon River watershed, with many efforts working to improve and protect these resources.

Watershed assessment results

Streams and rivers

Overall, about just over a quarter of the stream reaches support aquatic life (Figure 2) in the Cannon River watershed. Across the watershed, the fish community seems to be healthier, often meeting aquatic life use standards, while the condition of the macroinvertebrate community across the watershed oftentimes shows more impacts from stressors (Figure 5).

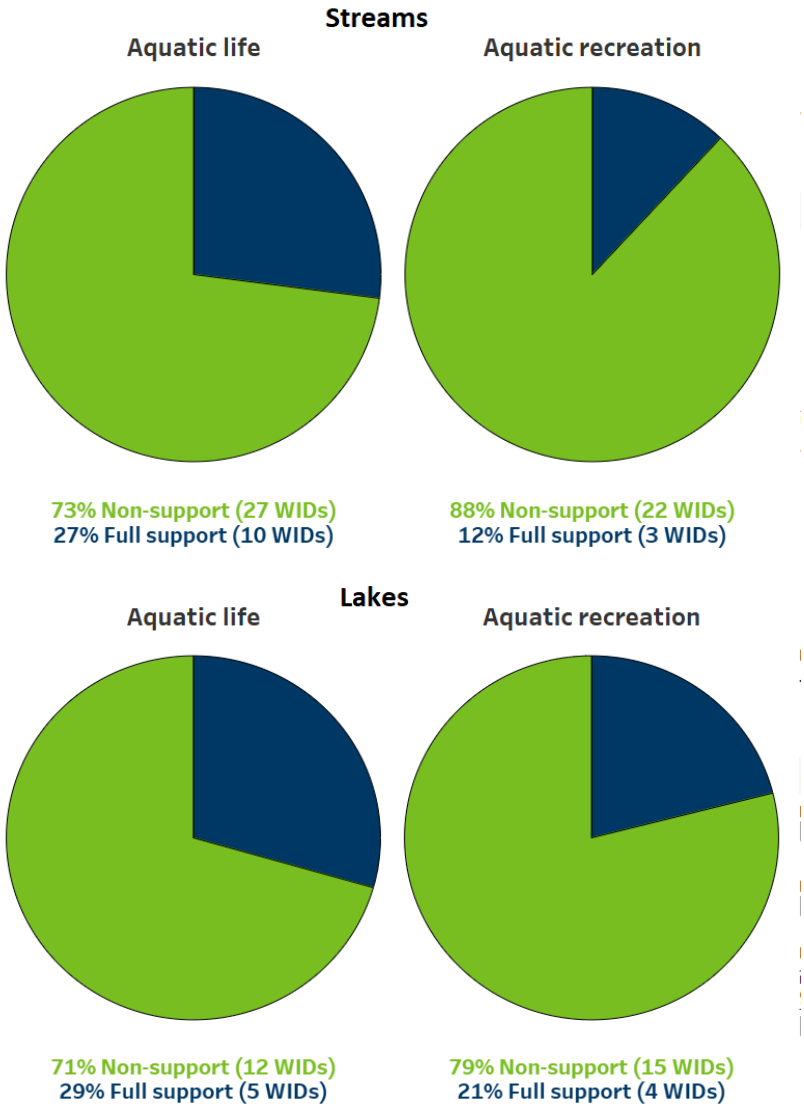
One new stream was found to have an impaired fish community based on recent sampling in 2022, adding to the ten existing fish impairments within the watershed. One previous fish impairment is proposed to be removed from the Impaired Waters list after it was found to be meeting aquatic life standards for the fish community based on the latest sampling effort.

Out of 38 stream WIDs with fish data, fish communities were found to be meeting aquatic life standards in 30 stream WIDs in the current assessment.

Four new stream sections were found to have impaired macroinvertebrate communities in 2022, raising the total number of macroinvertebrate impairments in the Cannon River watershed to 42. However, four previously listed macroinvertebrate impairments are currently proposed to be removed from the Impaired Waters list based on the latest IBI scores that demonstrate improved stream health.

Macroinvertebrates met aquatic life use expectations (i.e., had passing IBI scores) in 20 out of the 42 stream WIDs that had macroinvertebrate monitoring data in the latest round of assessment.

Figure 2. Watershed assessment results for aquatic life and aquatic recreation in streams and lakes.



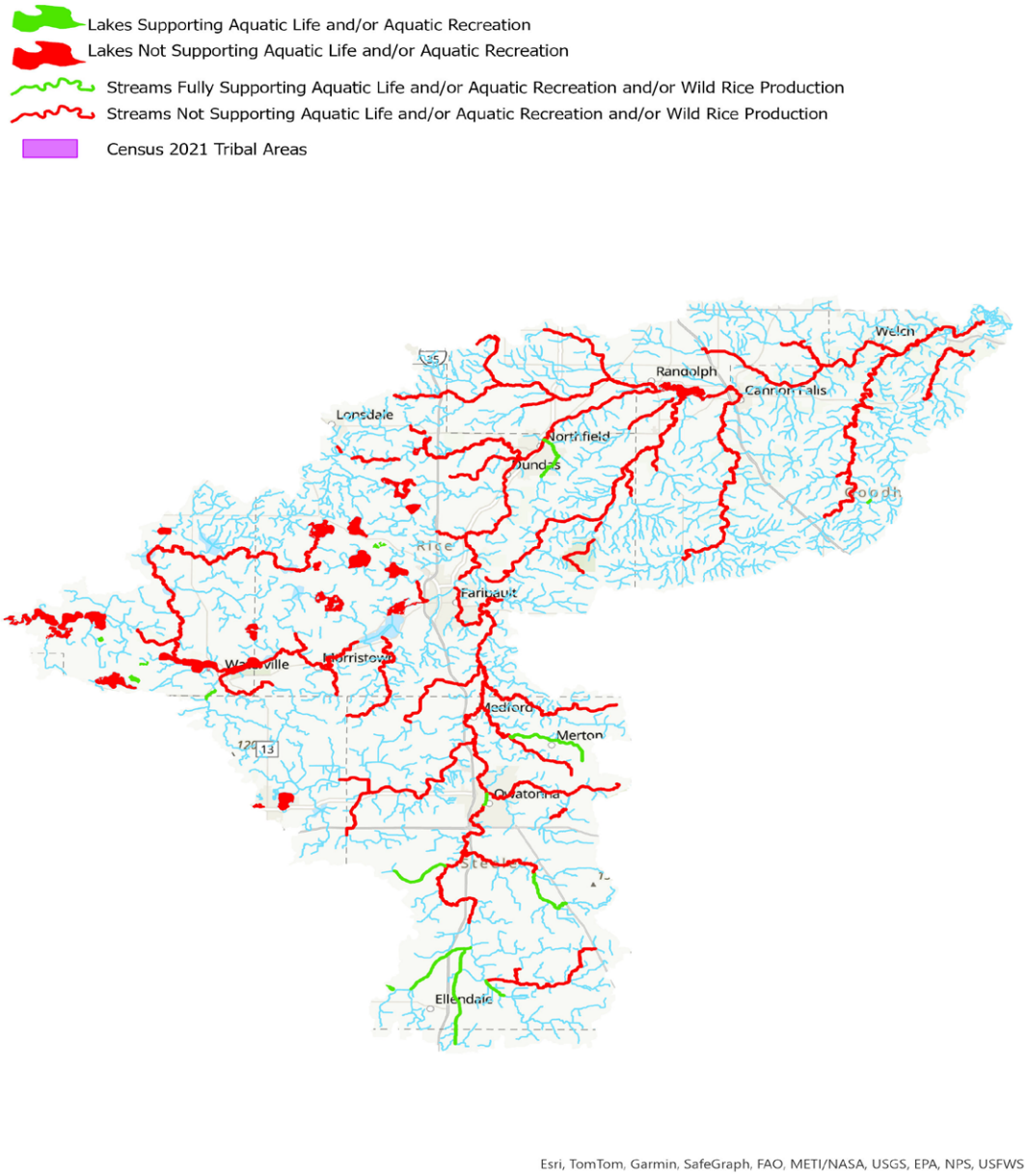
There were 15 new stream impairments found in the watershed during the latest assessments, with issues of elevated bacteria (7 WID's), excess nutrients (2 WID's), as well as degraded fish (1 WID) and macroinvertebrate (4 WID's) communities.

Lakes

In general, lakes assessed for water chemistry in the Cannon River watershed do show conditions holding steady, neither degrading nor improving. Five lakes were assessed as full support for aquatic life and had full support for aquatic recreation or data was insufficient to assess. Eleven lakes were assessed as not supporting aquatic life and were also assessed as either not supporting aquatic recreation or had insufficient data to assess. Data from 13 lakes was either inconclusive or insufficient to make assessment decisions for available parameters.

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. The Cannon River watershed contains numerous lakes, 20 of which were eligible to be assessed for aquatic life use based on fish IBI data. Other lakes in the basin were either subject to natural winterkill events (e.g., Sunfish) that adversely impacted fish or were too small for the fish IBI to be appropriate. Of the 20 eligible lakes, Roemhildts, Fish, Rays, Kelly & Dudley, and Beaver lakes were assessed as fully supporting aquatic life use. Efforts to protect the forested lands and undeveloped, natural shorelines associated with these lakes should continue to ensure the water quality and habitat remains intact to support the diverse suite of species residing in these lakes. French and Mazaska lakes were assessed as having inconclusive information but vulnerable to impairment, Upper Sakatah had insufficient survey information for assessment, and the remaining 12 lakes were assessed as not supporting aquatic life use (impaired). The primary stressors that are likely influencing these fish communities include shoreline development, watershed disturbance, and aquatic habitat loss.

Figure 3. Assessment results for aquatic life and aquatic recreation on rivers, streams, and lakes.



Trends

A key objective of the 2022 monitoring effort was to evaluate if and how water quality has changed since the initial monitoring. If water quality has improved, it is important to understand to what extent human actions may be responsible for the change. 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 was analyzed to provide as robust a picture as possible of what is happening in the Cannon River watershed:

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

Figure 4. Average TSS flow weighted mean concentration by major

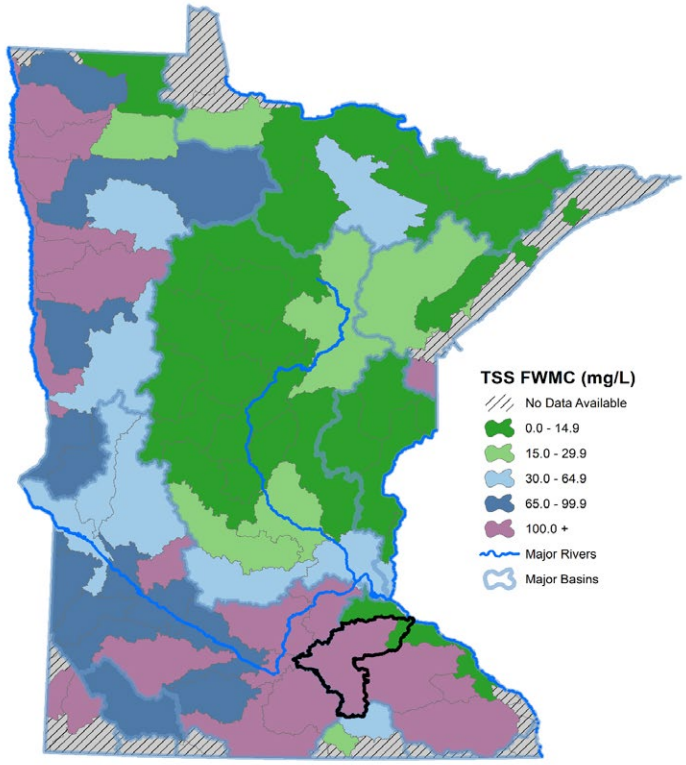
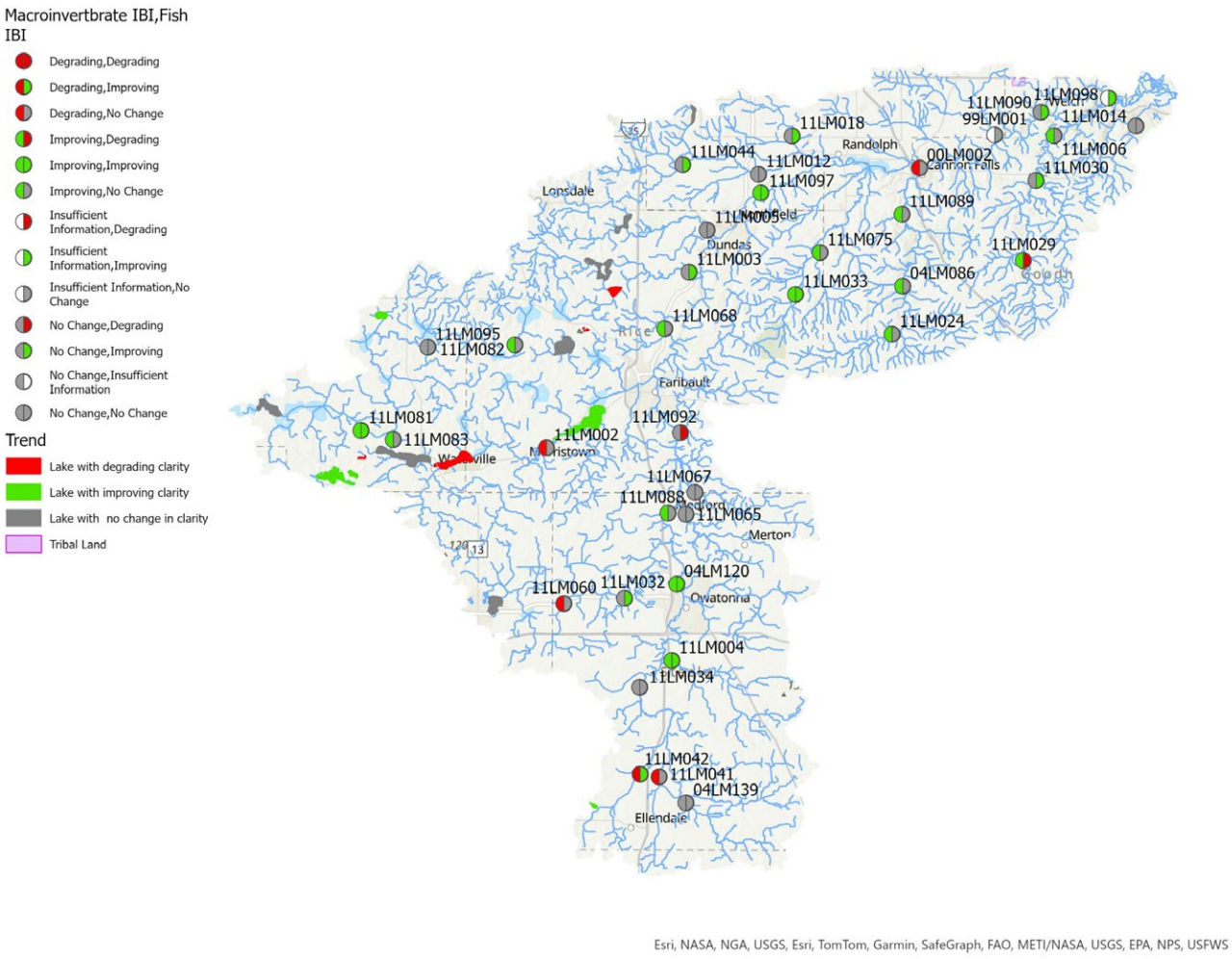


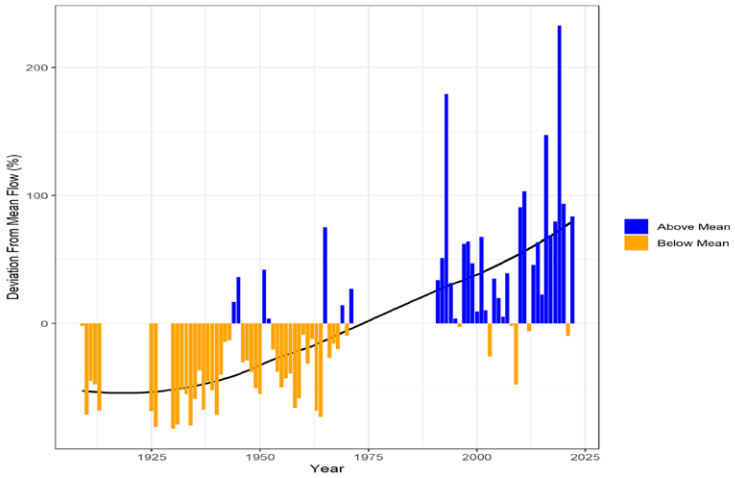
Figure 5. Change in water quality in the Cannon River Watershed.



Streamflow and pollutant concentrations

The Cannon River has seen an increase in average annual stream flow (Figure 6) over 113 years at the stream flow gage at Welch, MN (USGS 05355200). This gage is located just upstream of the Cannon River pour point into the Mississippi River and shows only six out of thirty-two years since 1991 have been below the mean average flow. This increasing trend is due to many factors, but is likely primarily due to increased precipitation with the watershed receiving an additional 3.8" annually. Increasing annual flow can lead to increased total pollutant loads, increased erosion, and larger flooding events.

Figure 6. ***Percent deviation from normal flow over time at the Cannon River outlet station. The changing yearly average flow (black line) is calculated using LOESS (locally estimated scatterplot smoothing) with the yellow and blue bars showing each years' deviation as above or below the average (721cfs).***



The Cannon River Watershed has four sites in the Watershed Pollution Load Monitoring Network (WPLMN) that are intensively sampled across a range of flows and conditions by the MPCA and Metropolitan Council Environmental Services (MCES). With streamflow contributions from the United State Geological Survey (USGS) and MNDNR, total annual pollutant loads can be estimated for each of these four sites. These annual loads are used to compare watersheds throughout the state and how they are changing over time. A trend analysis conducted by MCES showed a significant reduction in TSS, Total Phosphorus (TP), and Nitrate-Nitrite. Total Suspended Solid trends were calculated for two periods, 1999-2012 and 2012-2021. Both periods showed a significant decrease in TSS with '99-'12 decreasing by 30.9 percent and '13-'21 decreasing by 55.7 percent. For TP and Nitrate-Nitrite, there were also significant decreases throughout a singular period, 1999-2021, with TP decreasing by 45.7 percent and Nitrate-Nitrite decreasing by 28.3 percent.

When compared with watersheds throughout the state, Figure 4 shows that the Cannon River has an elevated flow weighted mean concentration for TSS compared to other watersheds. This is consistent throughout much of the Southeastern portion of the state due to increased run-off ratio due to dense networks of agricultural drain tile. The other two pollutants, TP and Nitrate-Nitrite are also elevated when compared to the rest of the state but not to the same magnitude as TSS. The significant decreasing trend of all three pollutants in the Cannon River watershed is a testament to the efforts of local partners, landowners, and businesses, especially given the current trend of increasing flow and precipitation.

Streamflow in the Cannon River is increasing, which has implications for stream channel conditions and pollutant loading. This could mean more channel erosion and possibly 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 the Mississippi River, where these pollutants may accumulate.

Biological communities

Paired t-tests of 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 tests were performed on each community with 35 sites evaluated for macroinvertebrates and 37 sites evaluated for fish (i.e., sites that were sampled in both time periods). The average macroinvertebrate IBI score for the watershed increased by 6.4 points between 2011 and 2022, representing a statistically significant change. Similarly, fish IBI scores across the Cannon River watershed increased by 6.9 points, which was also statistically significant. While the overall health of fish and macroinvertebrate communities across the watersheds improved between time periods, biological condition at individual stream sites may have improved or degraded (Figure 5).

Context for the change analysis results is provided by a characterization of the conditions under which biological monitoring occurred in 2011 and 2022. In 2011, the Cannon River watershed experienced near normal rainfall (-1.7 inch departure from normal) and was abnormally cool (-1.2 °F) over the May to September time period (Figure 7). In comparison, the watershed had a moderate drought (-4.3 in) and normal temperatures (+0.1 °F) in 2022 during the May to September period. Overall, given the relatively dry conditions affecting the watershed in 2022 compared to the near normal conditions observed in 2011, there is a moderate likelihood that 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.

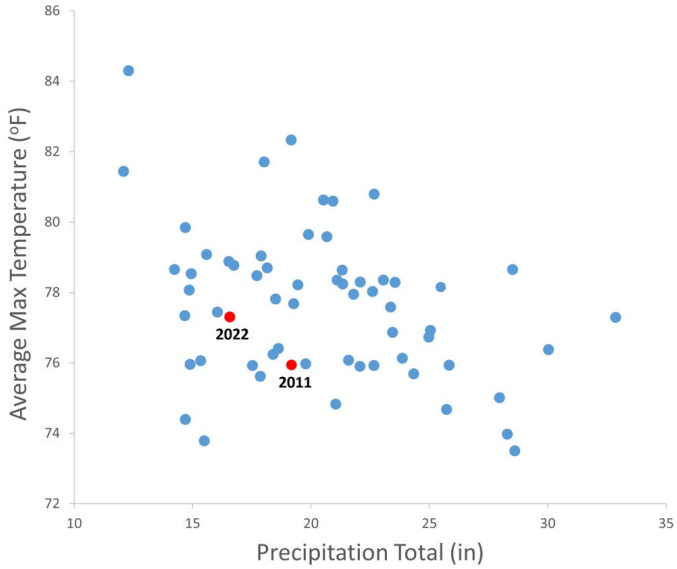
Clarity of lakes

Within the Cannon River Watershed, trend analysis was conducted on 27 lakes that met data requirements (50 Secchi measurements, eight years of data). Similar to statewide results, most lakes do not exhibit a significant trend. Four lakes had improving clarity; these include Rays, Frances, Beaver, and Volney Lakes. Four lakes also had declining clarity: Upper Sakatah, Fish, Dudley, and Fox. Eight lakes had no discernable change in clarity, indicating neither degrading nor improving conditions. Ten lakes had no noticeable trend in lake clarity over the analysis period, and many of those lakes were also assessed and not supporting aquatic recreation.

Climate

Increased rainfall and temperature can worsen existing water quality problems. More precipitation and reduced snow cover can increase soil erosion, pollutant runoff, and streamflow's. Increased streamflow's 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. DNR climate summary for the Cannon River watershed.

Figure 7. Characterization of air temperature and rainfall conditions for May-September period across historical record (1961-2023) for the Cannon River Watershed. Biological monitoring years for the watershed highlighted in red.



For more information

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

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