Watershed assessment and trends update

Zumbro River Watershed

Lower Mississippi River Basin

Summary

The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (DNR), and partners have completed a study of the Zumbro River Watershed, which includes the Zumbro River, its many tributaries, and 17 lakes. Monitoring was initially done in 2012 and 2013, and scientists returned 10 years later to see how things had changed in the watershed. In the Zumbro River Watershed there were found to be improvements (biological health, water clarity, and aquatic recreation use) leading to proposed removals from the impaired waters list. Stressors are still found and additionally impairments were added through the most recent assessments for aquatic recreation use (Escherichia coli [*E. coli*] bacteria), and aquatic life use (sediment and aquatic macroinvertebrates (bugs).

Instead of relying solely on chemical testing of the water, scientists also monitored fish and aquatic macroinvertebrate communities that live in the water. Macroinvertebrates refer to animals that lack a backbone that are large enough to be seen with the naked eye, i.e. aquatic insects, snails, bivalves, and crayfish. Evaluating chemical and biological components 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. Details in the full report will shape decisions on watershed management and pollution reduction measures for years to come.

Watershed Study

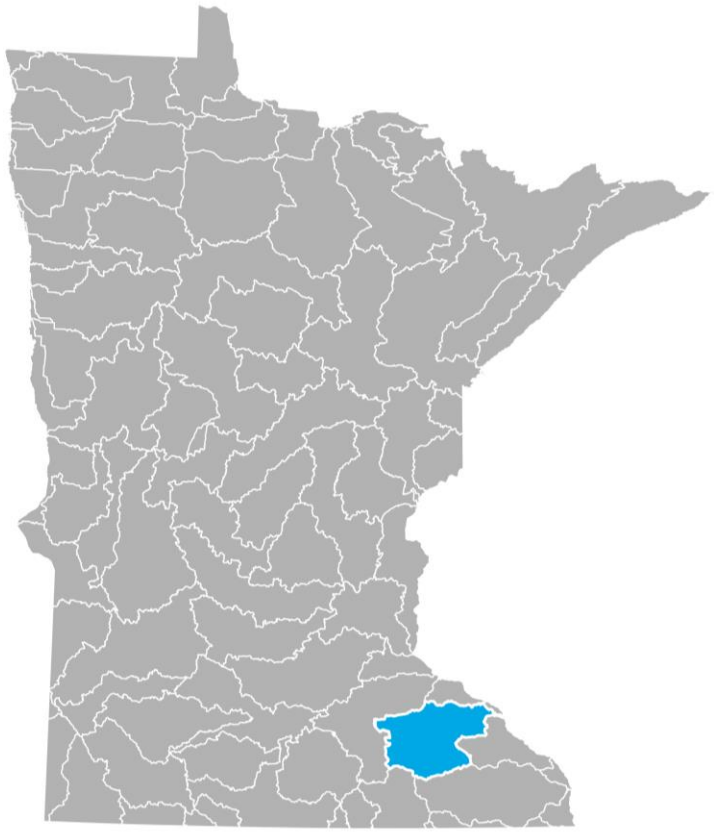
Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable. While local partners and state agencies monitor water quality on an ongoing basis, the MPCA and local partners conduct an intensive exam of major 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 (bug) communities as well as water chemistry to gauge water quality. The MPCA and its partners use the data to see which waters are able to support fishing and recreation, and which waters are impaired. Waters are considered impaired if they fail to meet water quality standards. Water quality conditions in the Zumbro River Watershed were intensively monitored in 2012-2013 and again in 2023-2024. Chemistry data collected by local partners between 2015 and 2024 were used for the most recent assessment. The data used to assess the condition of Minnesota water bodies focus on whether they are meeting water quality standards for aquatic life, recreation, and consumption.

Changes in water quality

To detect any changes in water quality, this recurring exam looks at fish and macroinvertebrate communities as well as water chemistry. Scientists use a tool called the Index of Biological Integrity (IBI) to assess the health of biological communities in lakes, rivers, streams, and wetlands. High IBI scores indicate a healthy aquatic community, which can only be attained when water quality, habitat, and hydrology are minimally disturbed by human activities. These data allow scientists to determine which waters are healthy and warrant continued protection; and which waters are polluted and/or are unable to support healthy fish and invertebrate communities; therefore, require restoration.

While the biological condition in individual streams may have improved or declined between 2012 and 2024, the overall health of fish and macroinvertebrate communities showed improvement over this period.

Figure 1. Location of the Zumbro River Watershed in Minnesota.



- Across the watershed, there was an increase in the health of biological communities over the last 10 years for fish and macroinvertebrates, this change was statistically significant for macroinvertebrates.
- No new fish impairments were identified in the Zumbro River Watershed. A section of Trout Brook is proposed for removal from the 2026 impaired waters list for fish as recent sampling has demonstrated a healthy coldwater fish community.
- Three stream segments are being proposed for removal from the 2026 Impaired Waters List for previous macroinvertebrate impairments since we have seen improvements in these communities.

- There is only one new impairment for macroinvertebrates, which is at Willow Creek.
- Lake Zumbro is proposed to be removed from the impaired waters list due to reductions in nutrients, which has led to improvements in water quality. Several best management practices (BMPs) made this possible. More details can be found below in the “Success Story” section.

Figure 2. The MPCA scientists monitored the fish and bugs, along with several water quality parameters, in the Zumbro River Watershed as part of the statewide effort to gauge the health of major lakes and rivers.

Highlights of monitoring

- One MPCA long-term biological monitoring station is located within the Zumbro River Watershed, helped provide context for the watershed and an in-depth evaluation over time of aquatic communities and their habitat within a tributary to the South Fork Zumbro River
- Spring Creek, east of West Albany, had the highest macroinvertebrate IBI score of 85.6, an increase of over 34 points since the sample in 2012. Improved habitat at the site likely led to the healthy coldwater community including saddle-case maker caddisfly larvae (Glossosomatidae) seen in 2023.
- Cold Creek had the highest fish IBI score of 99.6, which puts this creek above the exceptional use threshold for fish. The community is dominated by brook trout (*Salvelinus fontinalis*) and slimy sculpin (*Cottus cognatus*), which are both coldwater sensitive fish species.
- Cold Creek also supports a naturally reproducing brook trout population, and many young of year and adult brook trout were present when sampling.
- A crystal darter (*Crystallaria asprella*), which is an endangered species in the state of Minnesota was sampled in the Zumbro River north of Oakwood in 2023.

Figure 3. Long-term biological monitoring station at Trib. To the Zumbro River, South Fork

- The black redhorse (*Moxostoma duquesnei*), Ozark minnow (*Miniellus nubilus*), and the redside dace (*Clinostomus elongatus*), all species of special concern in Minnesota, were also sampled in the watershed in 2023.
- In 2025, two sites in the Continuous Nitrate Sensor Network (CNSN) were established within the watershed: Zumbro River at Kellogg (41043001) and Middle Fork Zumbro River near Oronoco (41071003). The CNSN is a network of monitoring sites with sensors installed at sites where high nitrogen loading has been historically measured. The MPCA has partnered with MDA, DNR, and U.S. Geological Survey to provide publicly available, real-time NOx-N concentration and load data across watersheds in southern Minnesota. For more information visit 24-Hour Nitrate Network | Minnesota Pollution Control Agency.

Figure 4. A brook trout sampled by MPCA biologists in 2023 at Dry Run Creek.

Figure 5. A redside dace sampled from the North Fork of the Zumbro River.

Success story

Lake Zumbro was placed on the impaired waters list for high nutrients in 2002 as part of initial lake eutrophication assessments in Minnesota. Since then, the Lake Zumbro Lake Association, local government units, farmers, and partners have implemented more than 1,100 watershed BMPs that targeted sediment and nutrient reductions on over 64,000 acres of land within the watershed. These projects have ultimately improved Lake Zumbro's nutrient levels and hence trophic state, over the past 25 years, and now Lake Zumbro is proposed for removal from the impaired waters list.

Figure 6. A photo of Lake Zumbro, courtesy of the lake association's webpage (lakezumbro.org).

Total phosphorus (TP) loads from wastewater effluent have decreased by about 4,600 lbs since the early 2000s. Sediment dredging took place in the lake between 2018 and 2019. About 450,000 cubic yards of sediment were removed, restoring 4 ft to 4.5 ft depths in certain portions of the lake. Not only did the dredging project improve recreation on the lake, it increased sediment storage capacity, removed phosphorus-rich surface sediment, increase settling and decrease sediment resuspension, and improve and restore aquatic habitat. Additionally, many nonpoint source BMPs targeting sediment and nutrients in the Zumbro River Watershed were implemented to help with Lake Zumbro's water quality. Examples of these nonpoint source BMPs include improvements to local farming practices (buffers, additions of conservation cover crops and perennials, crop rotation, no-till/reduced-till, and nutrient management on crops) as well as streambank stabilization and shoreline protection.

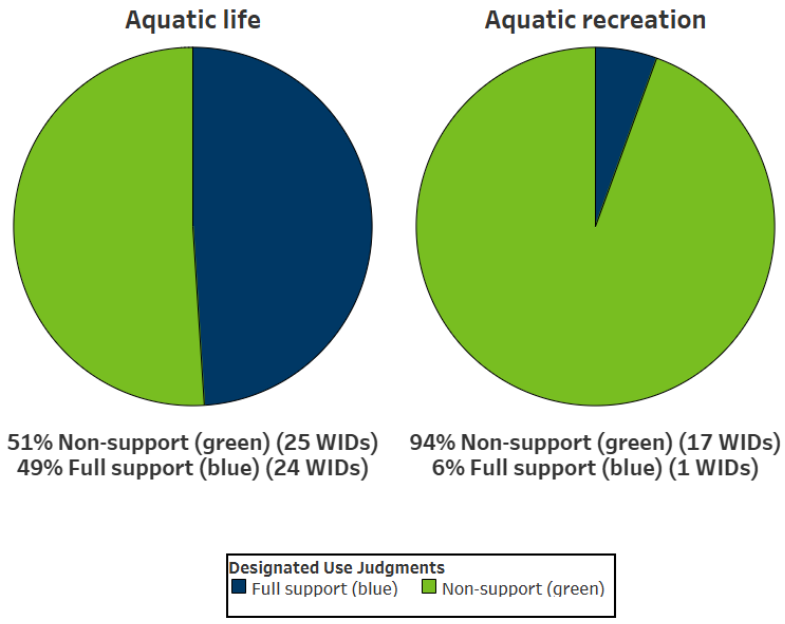
Given the uniqueness of Lake Zumbro compared to other lakes throughout the state, site-specific standards were adopted for Lake Zumbro in 2017. Lake Zumbro was still found to be impaired for aquatic recreation under the newly adopted standards in 2017. However continued implementation of BMPs led in-lake phosphorus concentrations to improve by ~35% during the most recent monitoring period (2017-2023) compared to the early 2000s (2000-2008), when the lake was first designated as impaired. These reductions have resulted in attainment of Lake Zumbro's site-specific standards. Additionally, summer low-flows are the critical period for elevated phosphorus concentrations and algae growth in Lake Zumbro. Phosphorus loading to Lake Zumbro during summer low-flows has decreased significantly over the last 25 years, primarily due to reductions in point source loads and internal loading from the 2018-2019 dredging project. Lake Zumbro is an excellent example of how water quality can be improved when locals work together to implement a variety of BMPs.

Watershed assessment results

Streams and rivers

Overall, roughly half of the stream reaches pass for aquatic life uses (Figure 7) in the Zumbro River Watershed. Stream reaches that meet aquatic life use standards have biological communities indicative of good water quality and suitable habitat. Bear Creek is narrowly supportive of aquatic life as indicated by fish community health and is therefore considered to be vulnerable. During this past cycle of monitoring, there are several systems where improvements in aquatic life were observed. Three stream reaches on the South Fork of the Zumbro River, Salem Creek, and Dodge Center Creek are being proposed for removal from the impaired waters list due to improvements in macroinvertebrate communities in these water bodies. Trout Brook is also being proposed for removal from the impaired waters list due to observed improvements in the fish community. Trout Brook now supports more brook trout and other species indicative of coldwater streams. Additionally, three segments on two streams: Trout Brook and Dry Run Creek, which were previously considered warmwater were recently designated as coldwater streams. Trout Brook was designated as a trout stream prior to 1954, and although it likely supported a native brook trout population, it was stocked from 1946 – 1952. By 1957, the creek was "in very poor condition..." and the trout stream designation was removed. However, without planned restoration efforts the stream improved enough to stock brook trout fingerlings in August of 2000 to try to re-establish a trout fishery. Both reaches of Trout Brook that were previously designated as warmwater use are being re-designated as coldwater use after surveys have found brook trout of various age classes, and macroinvertebrate coldwater indicator taxa. Stream temperature data from these segments of Trout Brook also indicate that the coldwater use designation is warranted.

Figure 7. Watershed assessment results for aquatic life and aquatic recreation in streams by water body identification (WID), assessment year 2025.



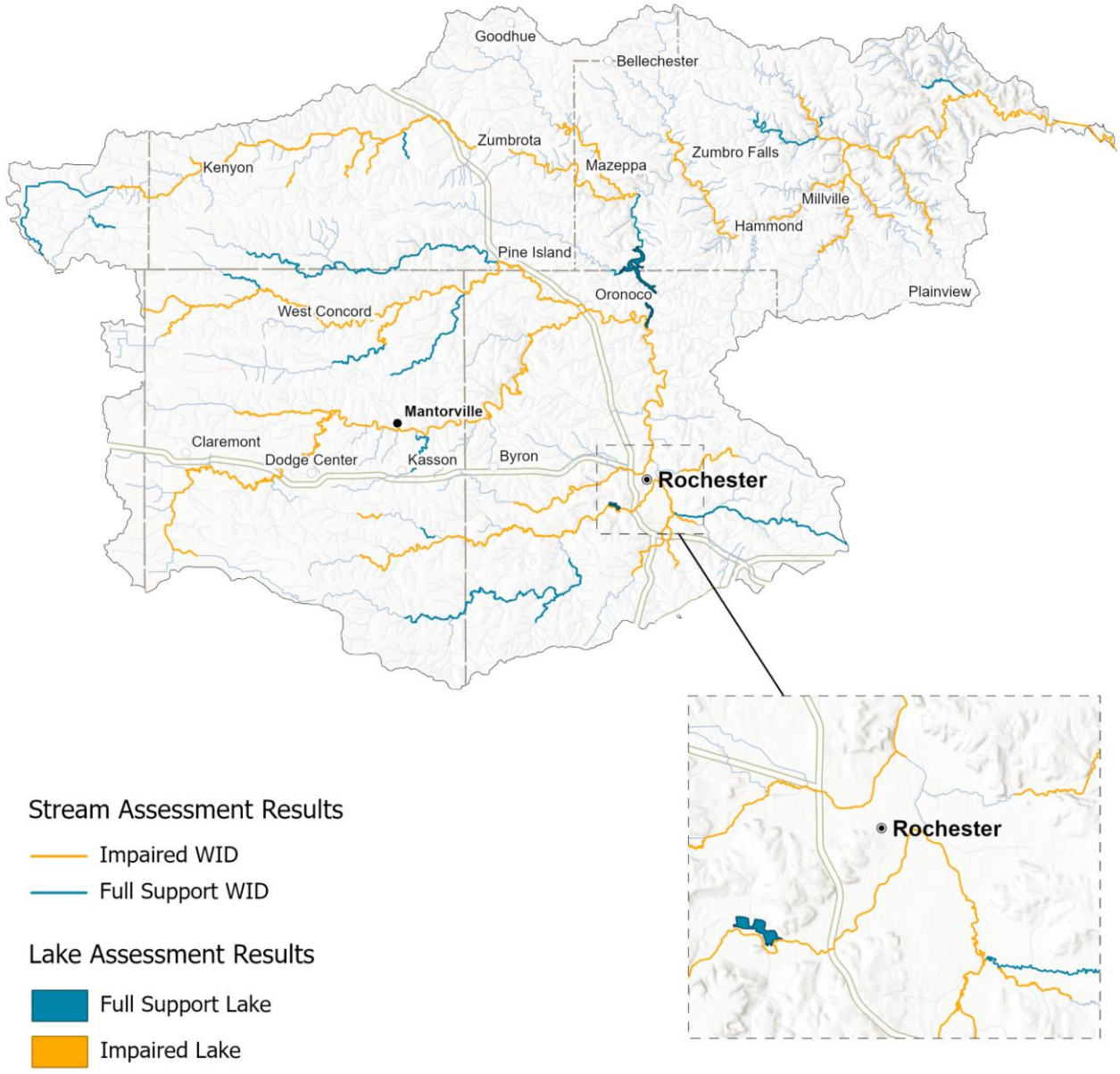
Milliken Creek and Cascade Creek are proposed to be removed from the impaired waters list for improved aquatic life health related to decreased sediment, which has led to an increase in water clarity. Both are still listed as impaired for aquatic recreation due to elevated *E. coli* levels. Despite fish and macroinvertebrates doing well in the watershed, only one stream reach fully supports aquatic recreation, pointing to other stressors in the watershed (Figure 7).

There are eight new impairments to rivers and streams regarding bacteria and excess sediment. Dry Run Creek, Cascade Creek, and Silver Creek were found to not support aquatic recreation due to *E. coli* bacteria. Aquatic life was found to be impaired due to excess sediment (total suspended solids, TSS) on Spring Creek, the Middle Fork of the Zumbro River, two portions of the South Branch of the Middle Fork of the Zumbro River, and West Indian Creek. The North Fork of the Zumbro River is impaired for both bacteria and excess sediment. Twenty-six stream segments are listed as impaired for aquatic recreation, aquatic life or both. Fecal coliform, *E. coli*, turbidity and TSS are the main parameters listed for these impairments. Cold Creek, and the lower ~48 miles of the Zumbro River have been noted to be vulnerable to poor recreational water quality due to bacterial pollution.

Lakes

Lake Zumbro was proposed to be removed from the impaired waters list for nutrients in June 2025 after 25 years of implementing many BMPs in the watershed. Of the six lakes assessed, two were found to be fully supporting aquatic recreation use (Zumbro and Bamber), while the other four had insufficient data sets to make an assessment. The floods in September of 2010 destroyed the dam creating Shady Lake. The decision to remove the dam and replace with rock arch rapids was favored. Additionally, reconstruction and restoration of the backwater wetland led to the restoration of the Middle Fork Zumbro River back to a meandering stream.

Figure 8. Assessment results for aquatic life and aquatic recreation on rivers, streams, and lakes.



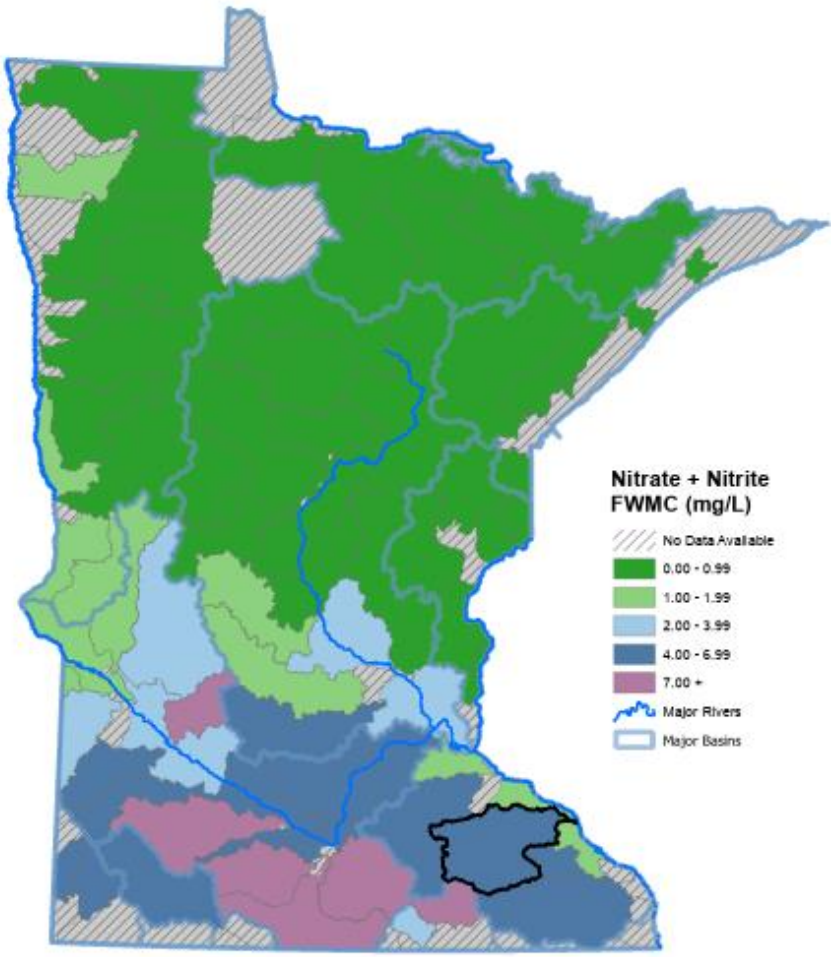
Trends

A key objective of the 2023-2024 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 were analyzed to provide as robust a picture as possible of what is happening in the Zumbro River Watershed:

1. Streamflow, sediment (TSS), TP, and nitrogen (nitrate)
2. Biological communities
3. Clarity of lakes
4. Climate

Figure 9. Nitrate and nitrite flow weighted mean concentration by major watershed, with the Zumbro River Watershed outlined in black.



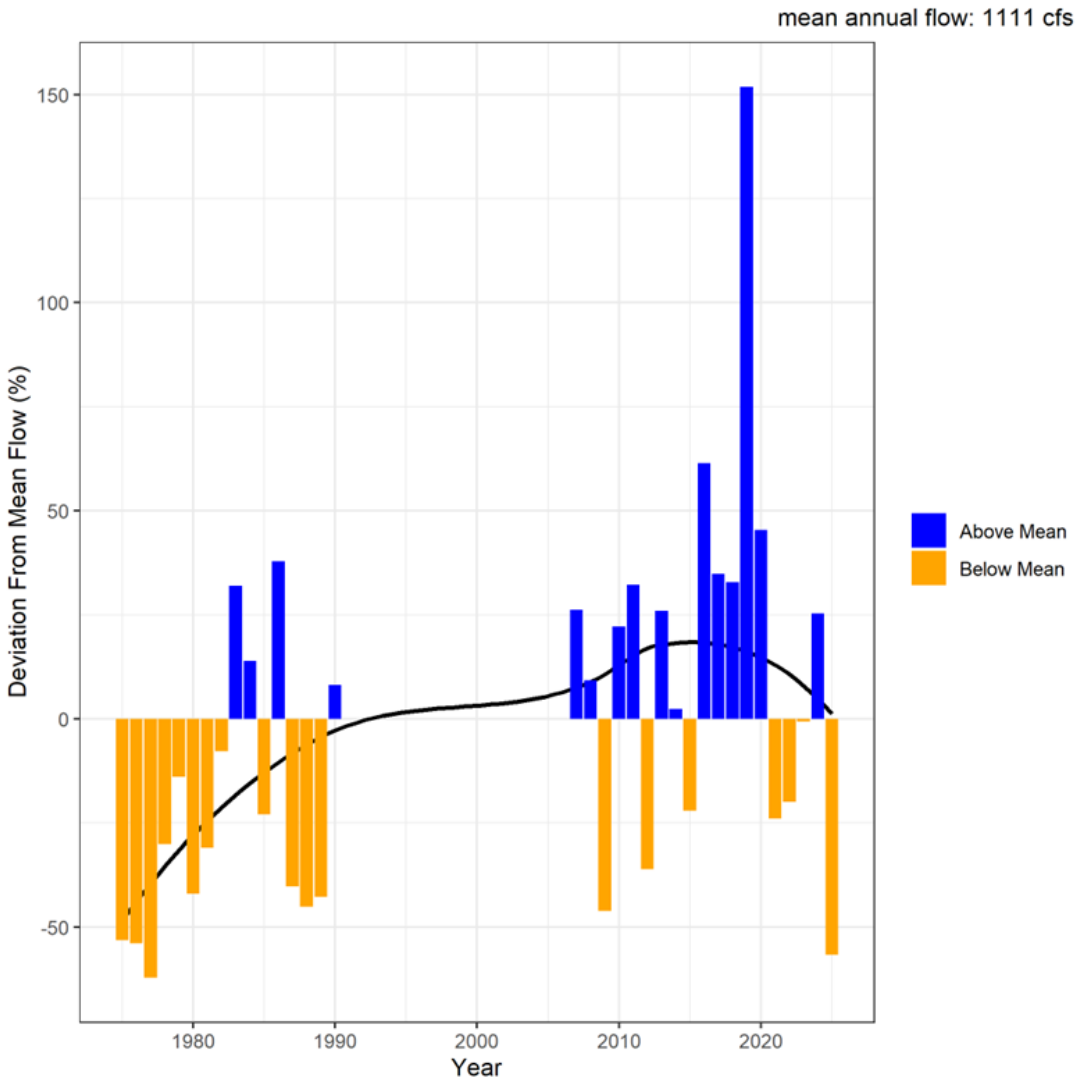
Streamflow and pollutant concentrations

The Zumbro River Watershed is located within an area of the state where concentrations of nitrate and nitrite are high but similar to surrounding watersheds (Figure 9). Many of these parameters are being focused on at the local level with project implementation and watershed planning efforts.

Long-term water quality and stream flow monitoring occur annually throughout Minnesota, with intensive sampling across a range of flow conditions. For more information about this sampling, please visit: https://www.pca.state.mn.us/wplmn.

Annual streamflow (discharge) data is available for the Zumbro River Watershed outlet since 1975. Figure 10 shows that there is an apparent increasing trend in flow on the Zumbro River. Since 2007 the Zumbro has shown double the number of wet years compared to dry. Water chemistry data is also available for the outlet since 2008.

Figure 10. Percent deviation from normal flow over time at the Zumbro River Watershed outlet station, 1975 - 2025. The changing yearly average flow (black line) is calculated using LOESS (locally estimated scatterplot smoothing) with the gold and blue bars showing each years' deviation as above or below the average (1111 cfs).



The increasing Zumbro River streamflow 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.

In addition to the outlet site near Kellogg, there are four subwatershed sites that have been monitored from 2013 to the present. These subwatershed sites: North Fork Zumbro River, Middle Fork Zumbro River, South Branch Middle Fork Zumbro River, and South Fork Zumbro River are all similar in concentrations between parameters with the South Fork Zumbro showing slightly better water quality. All watersheds share a similar landscape consisting of mainly agriculture with a large portion of the South Fork Zumbro being the town of Rochester, Minnesota.

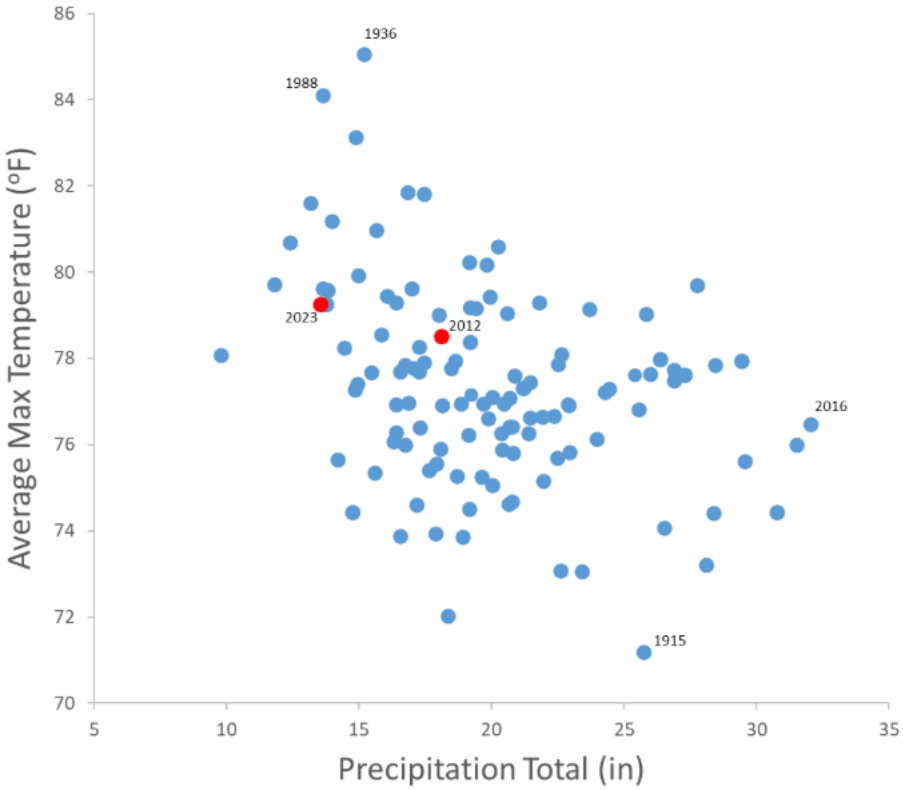
Seasonal trend tests on suspended sediment, phosphorus, and nitrate/nitrogen concentrations at the Zumbro River outlet were used to determine if changes over time were statistically significant from 2008-2023. No significant trend was evident for these parameters over the 16-year period.

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 have changed between time periods. Independent tests were performed on each community with 38 sites evaluated for macroinvertebrates and 39 sites evaluated for fish (i.e., sites that were sampled in both time periods). The average macroinvertebrate IBI score for the watershed increased by 7.4 points between 2012 and 2023, a statistically significant increase in biological condition for the watershed (P =0.005; Figure 12). Similarly, fish IBI scores across the Zumbro River Watershed increased by 3.1 points; however, this does not represent a statistically significant increase in biological condition for the watershed (P=0.0824; Figure 12). While the overall health of fish and macroinvertebrate communities across the watersheds was positive, biological condition at individual stream sites may have improved or degraded (± 10 IBI points).

Across the historical record watershed-wide rainfall totals were estimated for May-September based on the gridded precipitation data set (State Climatology Office). Temperature was summarized for the May-September period by calculating the average maximum temperature at a monitoring station centrally located in the watershed that had a period of record sufficient to determine a normal value (*source:* Western Regional Climate Center, https://wrcc.dri.edu/summary/mnF.html). Rainfall and temperature normal values were determined by averaging each statistic over a 30-year period (1981-2010). Departure from normal values were calculated and used to characterize climatic conditions for each biological monitoring year (Table 1). This information was then used to estimate the likelihood (high, medium, or low) that climate/weather influenced biological condition in either biological monitoring cycle. For instance, if both time periods fall within the bounds of near normal conditions (i.e., lightest shade of gray in Table 1) then there would be a low likelihood that results in either time period are affected by climate/weather and thus any observed changes in condition are presumably driven by watershed scale factors.

Figure 11. Characterization of air temperature and rainfall conditions for May-Sept period across the historical record of climate data for the Zumbro River Watershed (1903-2024). Biological monitoring years for the watershed highlighted in red.



In 2012, the Zumbro River Watershed experienced less rainfall than normal (-3.2 in) and was abnormally hot (+1.4°F) during the May to September time period (Figure 11). The watershed had a severe rainfall deficit (-7.8 in) and was abnormally hot (+2.1°F) in 2023 over the May to September time period (Figure 11). Overall, given the relatively similar conditions experienced across the watershed in both years, there is a low likelihood that observed changes in biological condition at either the watershed or individual site scale are due to differences in climatic conditions between the two periods.

Figure 12. Change in IBI scores for fish and aquatic macroinvertebrates in the Zumbro River Watershed.

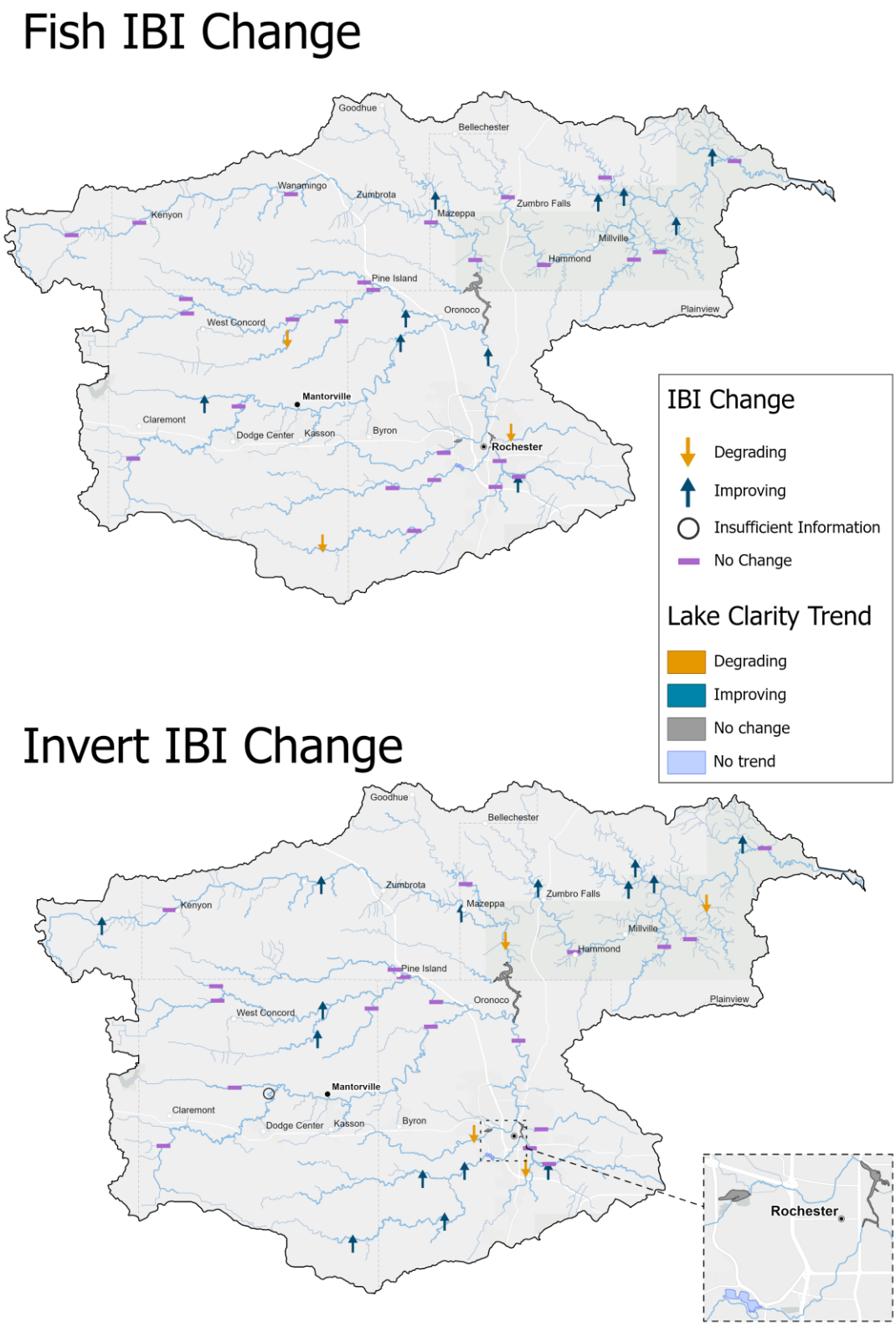


Table 1. Criteria used to characterize May-September rainfall and temperature conditions across the watershed. Likelihood of climate/weather influence on biological condition results: lightest gray = low; medium gray = medium; darkest gray = high.

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

Clarity of lakes

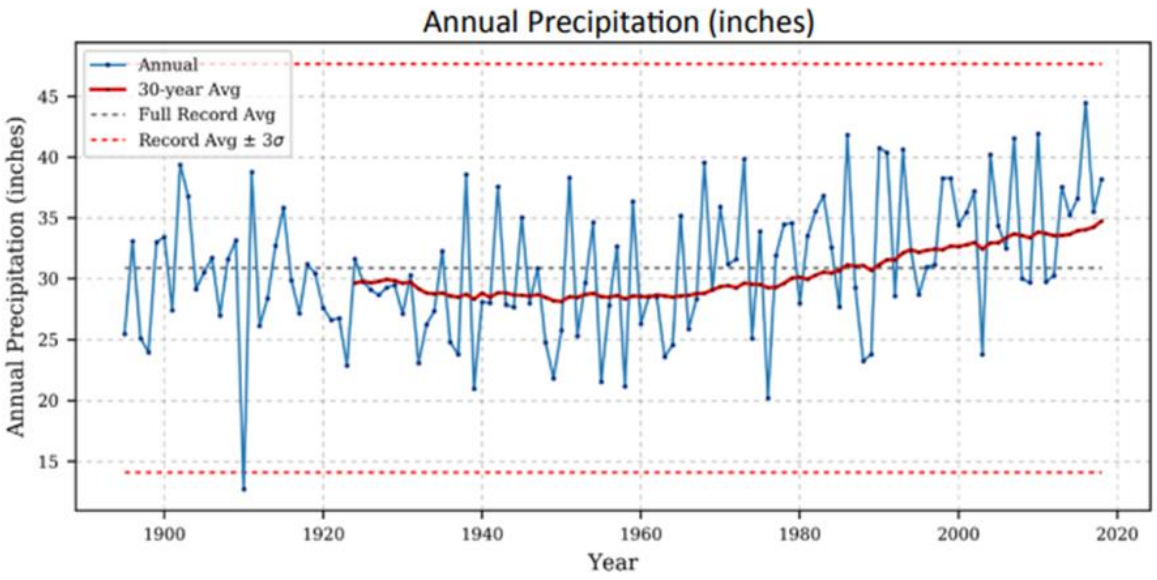
Water transparency is typically a good indicator of overall lake water quality. As water clarity increases, there is a greater likelihood that water quality standards are being met. Of the nine lakes/reservoirs that are monitored in the Zumbro River Watershed, three lakes (Zumbro, Silver, and Manor Woods Pond) have shown no change in clarity trends. Bamber Lake has had water clarity data collected since 2003, but no trend has been established. The remaining five lakes, North Central Pond/South Central Pond/Mayo Pond, Silver Creek Reservoir, Willow Reservoir 6A, Willow Reservoir 4, and Bear Creek Reservoir, have insufficient data to make a water clarity trend analysis.

Climate

The Zumbro River Watershed now receives on average 3.8 additional inches of rain from the historical average (1895-2018; Figure 11 and Figure 13). Furthermore, climate scientists suggest that precipitation events are becoming more intense. In addition, temperatures in the watershed have increased by about one degree when averaged across all seasons, with the greatest warming happening in the winter months (~2.3°F) 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. To learn more, check out the DNR climate summary for the Zumbro River Watershed.

Figure 13. Annual average values (solid blue line) alongside the 30-year running average for precipitation in inches (solid red line) and the overall record average precipitation in inches (dashed blue line).



For more information

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

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