Watershed assessment and trends update

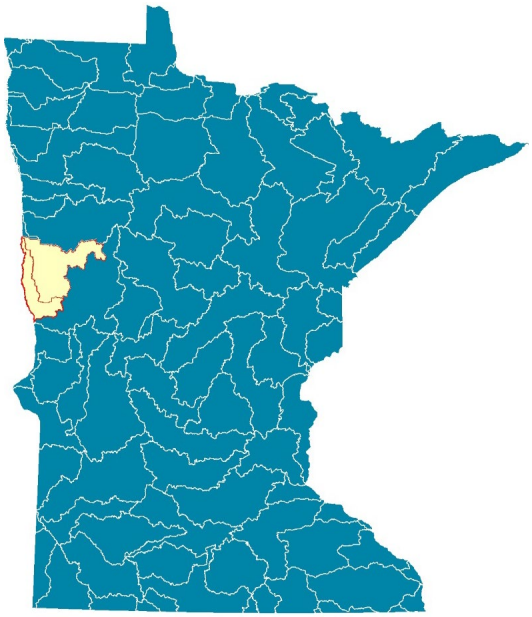
Buffalo River and Upper Red River of the North Watersheds

Red River Basin

Why is it important?

Water monitoring is essential in determining whether lakes and streams meet water quality standards designed for protecting beneficial uses like fishing and swimming. Regional and local water-stewardship groups, along with some state and federal agencies, continually monitor their respective watersheds.

Once every 10-years, the Minnesota Pollution Control Agency (MPCA) joins local partners and the Minnesota Department of Natural Resources (MN DNR) in conducting intensive monitoring of the lakes and streams in each of the state's 80 watersheds. This intensive monitoring looks at fish (all species) and macroinvertebrate communities as a measure of aquatic life health, in addition to water chemistry, to evaluate water quality. 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.



Agency staff and local stakeholders collaborate to review the data gathered, which helps to identify healthy (or stressed) waters in need of protection, and impaired waters in need of restoration. This data review and assessment helps to focus future watershed funding and on-the-groundwork.

Due to proximity to each other as well as the smaller data set for the Upper Red River of the North Watershed, the Buffalo River and Upper Red River of the North Watersheds were assessed together and will be reported on as such. They also share similar local interests and are both managed by the Buffalo-Red River Watershed District (BRRWD).

Is the water quality improving?

Over the past decade, scientists observed little change in water quality in the Buffalo River and Upper Red River of the North Watersheds. While the biological condition in individual streams may have improved or declined between 2008 and 2020, the overall health of fish and macroinvertebrate communities did not change over this period. Land use, development, and altered hydrology in the region appear to contribute to the poor quality of the surface water resources.

The main resource concerns within the watershed are wetland management, surface water quality, flood damage reduction, wildlife habitat, and soil erosion from wind and water. Land use modifications such as minimal use of buffers, tiling, and development result in increased sediment and pollutant loading to surface waters. In addition, hydrologic alteration, including groundwater withdrawal, may be contributing factors to the observed poor water quality conditions.

- Flows in the mainstem Buffalo River near Hawley and in the Red River of the North near Kragnes are increasing, however, the smaller tributaries are very flashy, where hydrologic peaks occur quickly after rainfall.
- Trend analysis for all Watershed Pollutant Load Monitoring Network (WPLMN) parameters was found to be not statistically significant for either watershed, meaning there's currently not enough evidence to determine if pollutant concentrations are increasing or decreasing in this area.
- Three impairments have been removed from the 2022 Impaired Waters List, including aquatic macroinvertebrate impairments on the Buffalo River (from Buffalo Lake to Unnamed Ditch northeast of Stinking Lake) and Whiskey Creek (from Highway 9 to Red River of the North), and a turbidity impairment on the Buffalo River, South Branch (from Highway 9 to Deerhorn Creek).

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

- The BRRWD, County Soil and Water Conservation Districts (SWCDs), and landowners have partnered to install over 2,200 best management practices to improve water quality across both watersheds since 2011 with federal, state, and local spending to implement those practices exceeding $69 million. Additionally, a number of large-scale restoration or pollutant reduction capital improvement projects have been completed, are underway, or are currently being planned in the watersheds, including those on the Buffalo River, Buffalo River South Branch, Wolverton Creek, Whiskey Creek, and more. Sufficient time may be needed for some of these practices to show significant results, while some improvements, including those mentioned above, have already been noted.

Highlights of monitoring

- Elevated flows hampered biological sampling efforts in 2019. Six stations were not sampled for fish and macroinvertebrates. Sampling at these locations was postponed until 2020 due to persistent high flows. However, only macroinvertebrates were sampled in 2020 due to the COVID-19 pandemic. The missing fish samples were collected in 2021, but assessment decisions have not been completed as of this report.
- The dobsonfly genus *Nigronia* was collected in a 2019 sample on Stony Creek. This long-lived taxon is intolerant to pollution as well as habitat disturbance and is rarely collected in the western half of Minnesota.
- One fish sample collected at the Lawndale Creek Remeandering Project scores nearly 30 points above the current impairment threshold, however due to conflicting biological results on this system, a formal assessment has not been completed, and will follow once more data has been collected.
- Little Sugar Bush Lake was found to have an exceptional fish community.
- The Upper Red River of the North Watershed has higher pollutant concentrations for all parameters when compared to the Buffalo River Watershed. Pollutant concentrations also tend to increase in the farther downstream portions of both watersheds.

Success story

The region has many streams that don't meet water quality standards due to excess sediment, soil, and other particles in the water that erode from streambanks and nearby fields. These products of runoff and erosion can be harmful to fish and aquatic insect ecosystems.

Despite concerns with sediment loading across these watersheds, the South Branch of the Buffalo River is clearing up, thanks to work of several organizations in the area. The BRRWD worked with the Wilkin and West Otter Tail County SWCD and the MN DNR to implement a number of projects that reduced sediment in the stream and led to a recommendation that a portion of the South Branch, from near State Highway 9 south of Barnesville to Deerhorn Creek, be removed from Minnesota's impaired waters list.

These efforts and projects included expanding vegetated buffers along this portion of the South Branch and enrolling almost 2,000 erosion-prone acres into permanent prairie and wetland conservation easements within the South Branch's Subwatershed. Additionally, the MN DNR's restoration of Lawndale Creek across the Atherton Wildlife Management Area (WMA) recreated almost two miles of natural creek across the WMA while eliminating that portion of State Ditch 14 which previously cut through the WMA. Prior to that restoration, a county ditch along the south and west sides of the WMA was repaired, eliminating gully erosion and sediment loading to the South Branch. Finally, work to restore wetland storage capacity within the Manston WMA aimed to reduce flooding and sediment loading to the South Branch.

Lawndale Creek receives water from a natural spring located in Rothsay WMA.

The BRRWD and partners are planning additional restoration work along the South Branch, with construction work expected to start in 2022 and resume through fall 2026. This work, as well as other ongoing and future projects can be reviewed at: https://www.brrwd.org/projects-programs.

Watershed assessment results

The MPCA and partners monitored water quality conditions in 2008-2010 and again in 2019-2020. Chemistry data collected by local partners between 2009 and 2020 were used for assessment. The data used to assess the condition of Minnesota waterbodies focus on whether or not they are meeting water quality standards for aquatic life, recreation, and consumption. The overall goal of these assessments is to ultimately determine which waters are healthy and in need of protection, or are polluted and require restoration.

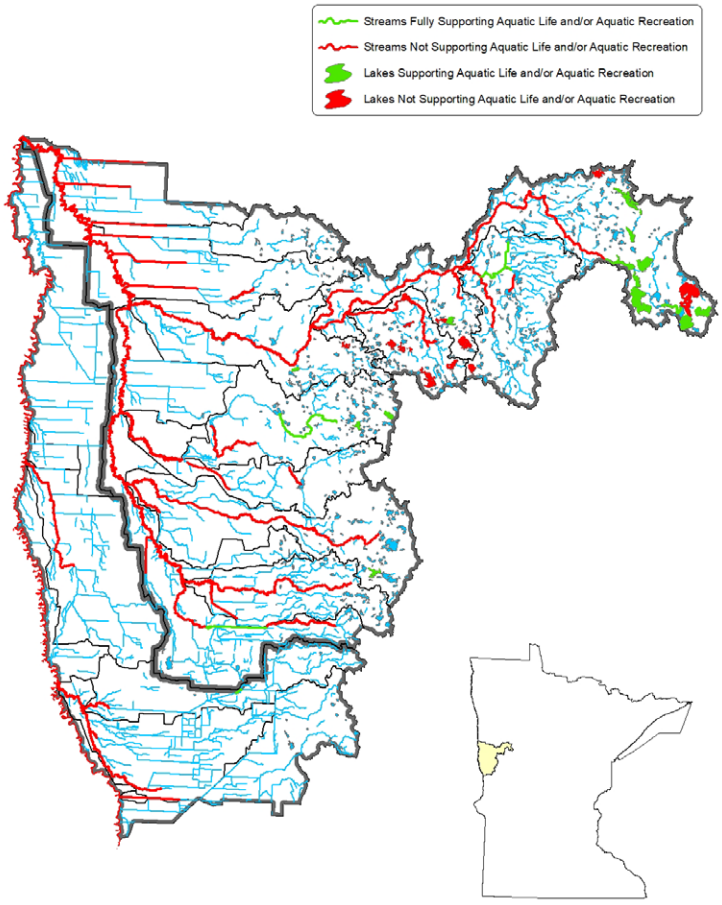
Streams and rivers

In the Buffalo River Watershed, elevated bacteria, suspended sediment, and low dissolved oxygen (DO) were prevalent across the watershed. Monitoring from the past decade uncovered a number of new impairments across the watershed. Low DO levels were discovered on three segments of the Buffalo River South Branch and County Ditch 10. New Escherichia coli (*E. coli*) bacteria impairments were also added on portions of Hay Creek, Unnamed Creek, and another portion of Whisky Creek. Lastly, two more impairments for total suspended solids (TSS) were added on two different segments of Hay Creek. In addition to these impairments, an additional 29 aquatic life impairments were added to the Impaired Waters List in 2020 and 2022. Several of these impairments were associated with data collected from channelized streams where formal

assessments had been deferred. A framework for assessing these channelized streams was implemented in 2018 allowing for the assessment of previously deferred data. These impairments indicate that fish or macroinvertebrate communities in the impaired streams are hampered by low DO or high suspended sediment, or by non-conventional pollutant stressors like decreased longitudinal connectivity or physical habitat.

Like in the Buffalo River Watershed, most streams/ditches that make up the Upper Red River of the North Watershed are still showing signs of stress. Two new impairments include low DO and high TSS in Wolverton Creek. New fish and macroinvertebrate impairments were also discovered on three unnamed streams and two segments of Wolverton Creek. Only one ditch had chemistry data meeting water quality standards (09020104-537; the unnamed ditch to the Red River, along 310 St. just north of Breckenridge, Minnesota).

Figure 1. Aquatic life and aquatic recreation support status of Buffalo River and Upper Red River of the North Watersheds

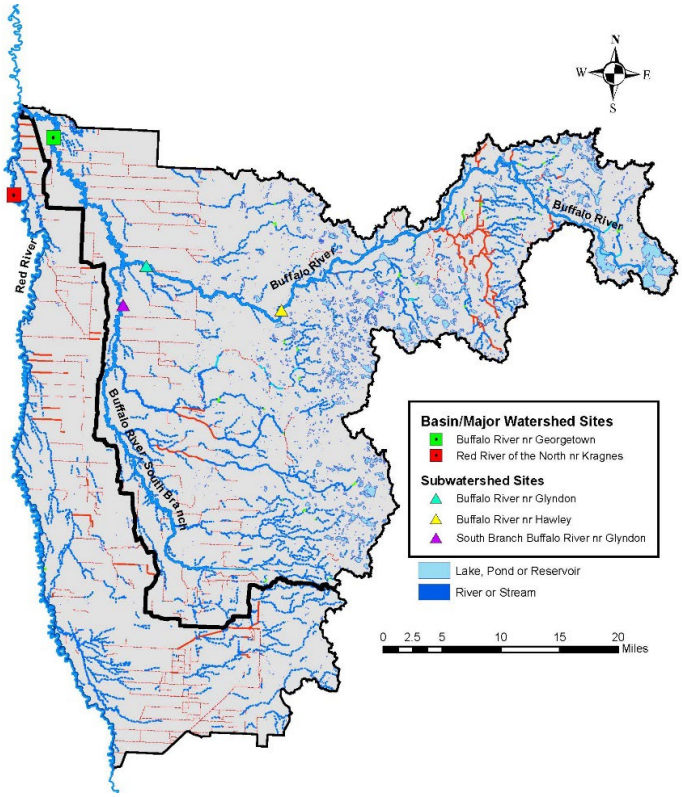


In addition to the 10-year monitoring cycle, there are WPLMN sites throughout Minnesota that operate every year on a long-term basis. The long-term nature of these sites is critical for trend analysis, measuring between-year differences in pollutant loading, and helping to determine pollutant sources and their contributions.

Pollutant concentration data is collected at every site by MPCA staff or local partners contracted through the state. Each site has a defined sampling period and sample analysis that is determined by the site type. Sample analysis is focused on parameters that are known to have an impact on water quality such as nitrogen, phosphorus, and sediment. The Buffalo River and Upper Red River

of the North Watersheds have five sites that are monitored by WPLMN throughout the year (Figure 2).

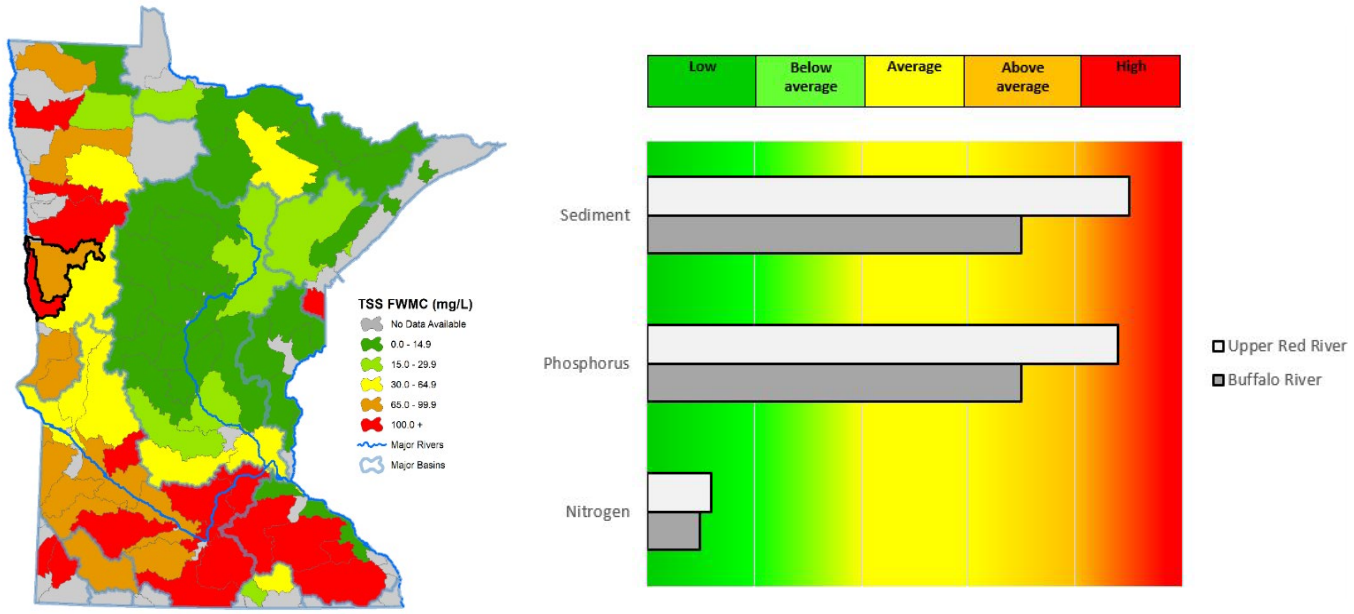
Figure 2. Locations of WPLMN sites in the Buffalo River and Upper Red River of the North Watersheds.



Pollutant concentration and streamflow data from WPLMN sites are combined using statistical models to estimate a pollutant load. Loads represent the total amount of a pollutant moving through a system, which is important to take into account when thinking about water quality for downstream resources such as the Red River or Lake Winnipeg, where these pollutants may accumulate. Load data can also be used for comparative analysis and long-term trends.

When comparing them to other watersheds in Minnesota, the Buffalo River and Upper Red River of the North Watersheds have higher sediment and phosphorus concentrations than most of Minnesota (Figure 3). By contrast, nitrogen levels for both watersheds are considered lower than most of the state. Similar maps and information regarding the WPLMN program can be found at: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring

Figure 3. Sediment and pollutant concentrations by watershed across Minnesota.



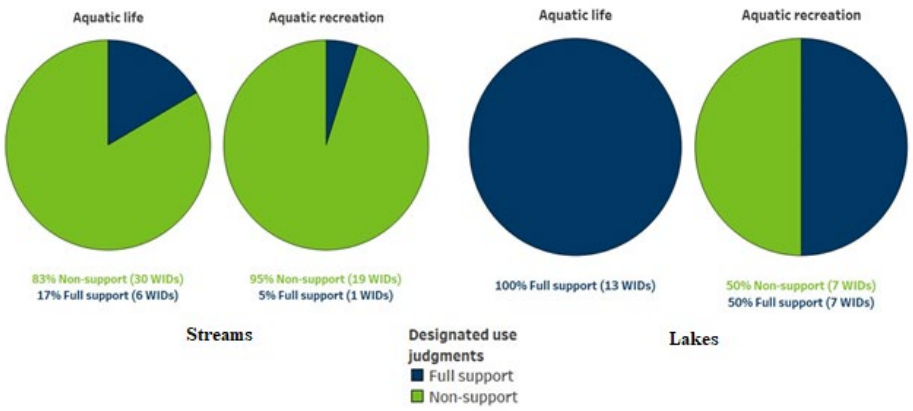
Lakes

In general, lakes in the headwaters of the Buffalo River Watershed and those with less anthropogenic (human) influence (i.e., more forest and prairie within their watershed) were meeting standards. Many of those lakes were also deep (more than 15 feet). Lakes with intensively developed (i.e., urban or agricultural) watersheds, flow-through lakes, and shallow lakes were more likely to be impaired. Internal loading (the recycling of phosphorus within a lake) will have to be addressed after watershed inputs of nutrients are controlled for shallow lakes in the watershed.

The watershed has approximately 168 publicly accessible lakes. Twelve lakes assessed as part of this study are considered impaired for nutrients, and as a result are more prone to excessive algae blooms in the summer months, reducing recreation opportunities. Of these lakes, Boyer was identified as being barely impaired, meaning it is very close to being in attainment of the standard. Continued efforts and monitoring on this lake should be prioritized in order to remove its impaired status. Additionally, seven lakes were found to have good water quality and support aquatic recreation.

Aquatic life assessments based on fish index of biological integrity (FIBI) data were completed for 13 lakes. North Tamarack, Rock, Big Sugar Bush, Little Sugar Bush, Boyer, Buffalo, Fifteen, East LaBelle, Turtle, Sand, and Marshall Lakes were found to have healthy fish communities. Meanwhile, Lee and Silver Lakes were found to have fish communities that are vulnerable to future impairments. West Olaf was not accessible during this sampling period due to high water level. Stressors that may influence fish communities in Lee and Silver Lakes include excess nutrient inputs from agricultural and urban land uses and degraded and/or developed shorelines. Both lakes have contributing watersheds that are greater than 50% cultivated. Despite generally high development and disturbance within the downstream (west) side of the watershed, the upstream (eastern) portion of the watershed has much more natural land, which is generally associated with higher FIBI scores. During FIBI sampling, a total of 30 fish species were captured in 13 lakes.

Figure 4. Watershed assessment results for aquatic life and aquatic recreation in streams and lakes in both watersheds.



Trends

A key objective of the 2019/2020 monitoring effort was to evaluate if and how water clarity and biological communities have changed since 2008/2010 (**Figure 7**). 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 Buffalo River and Upper Red River of the North Watersheds:

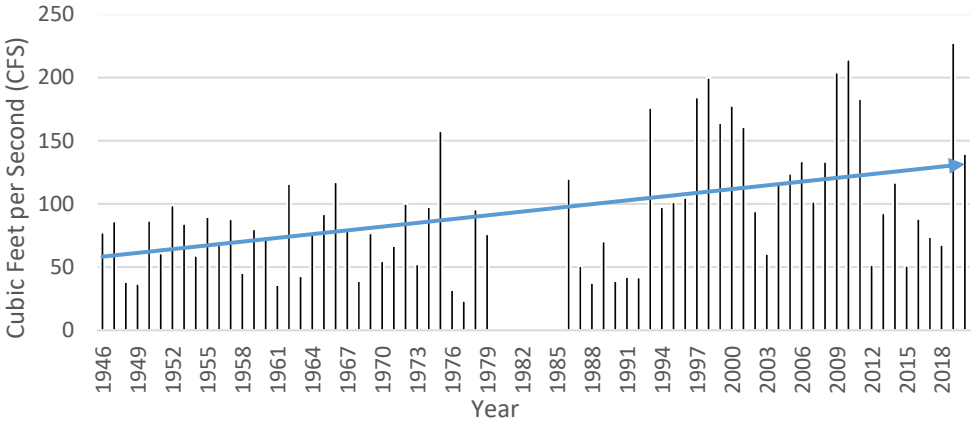
1) Streamflow
2) Biological communities
3) Clarity of lakes
4) Climate

Streamflow

One component needed for the WPLMN is streamflow data, which is collected by the MN DNR and United States Geological Survey (USGS) in cooperation with the MPCA. Streamflow is a very important factor when considering the overall health of watershed. Increasing 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. Other negative impacts include the degradation of habitat for river biology and flooding that threatens the property or safety of watershed residents. Trend analysis in both watersheds have provided evidence that increasing streamflow may be an issue in the area.

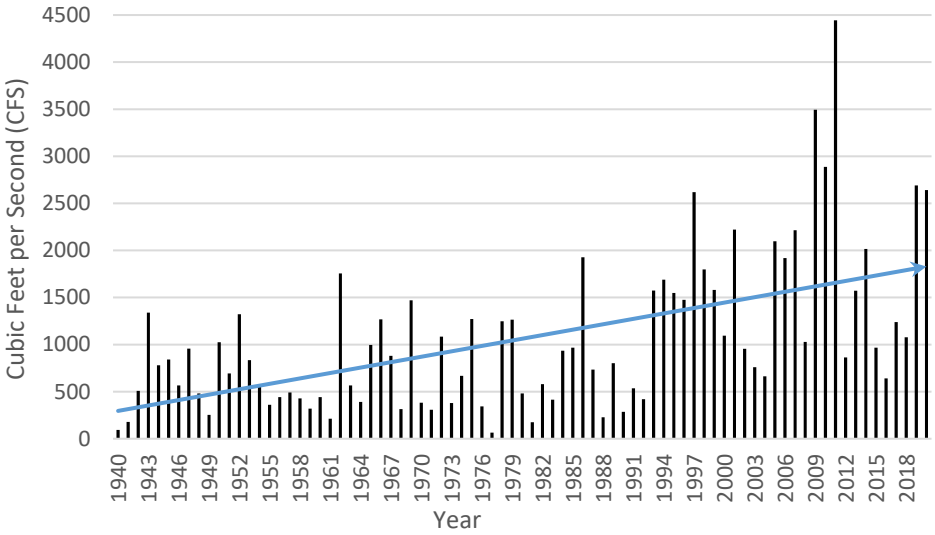
The Buffalo River has streamflow data starting in 1946. Average annual flows have increased 125%, and four out of the top six flows have occurred since 2009 (**Figure 5**). The top ten flows ever recorded have occurred since 1993.

Figure 5. Annual mean flow (cubic feet per second) for the Buffalo River near Hawley from 1946-2020.



The Upper Red River of the North Watershed has streamflow data stretching back as far as 1940 at the Red River near Kragnes site. Average annual flows have increased even more on the Red River, with a substantial increase of 400% since 1940 (**Figure 6**). One of the main contributors to increased flow in the area is likely altered hydrology. Much of the landscape has been altered to aid in rapid water drainage for agricultural production and to alleviate recurring flooding issues. These factors contribute to streams within the watersheds being described as flashy. During these events, overland runoff carries higher amounts of pollutants into nearby rivers. Events like these offer MPCA staff a unique opportunity to collect pollutant concentration data across a broad range of streamflow, which helps with our understanding of pollution dynamics.

Figure 6. Annual mean flow (CFS) for the Red River near Kragnes from 1940-2021.



Biological communities

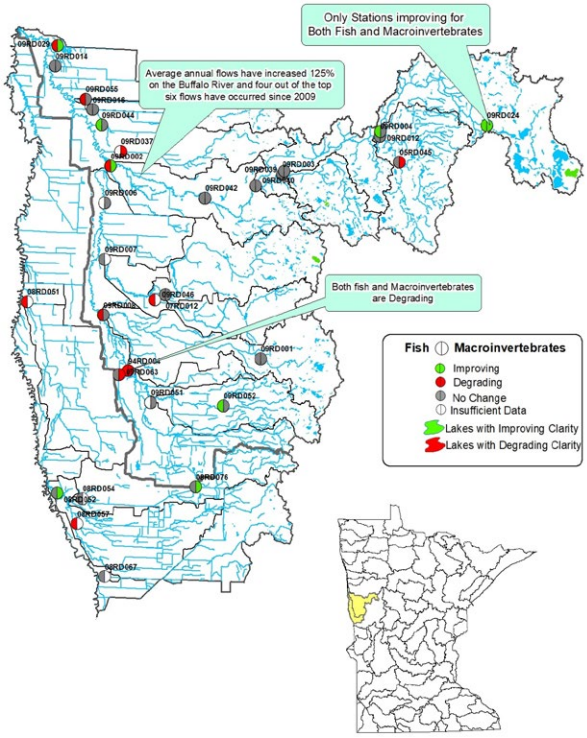
Paired t-tests of fish and macroinvertebrate IBI scores were used to evaluate if the biological condition of the watersheds' rivers and streams have changed between time periods. A similar change analysis was not completed for lakes because comparable fish community data had not been collected during the first time period. Independent tests were performed on each community with 25 sites evaluated for macroinvertebrates and 28 sites evaluated for fish (i.e., sites that were sampled in both time periods).

Fish IBI scores across the watersheds increased by 2.1 points, which was also not statistically significant. In the watersheds, of the 50 stream segments assessed for FIBI, 44% are currently considered impaired. Although FIBI scores declined at 16 of 28 stations between 2008 and 2019, most of these changes were minor (< 10 points). Climatic influence on these watersheds may explain some of the differences in IBI scores. The region received above average rainfall during the summer of 2019 (~+1.7 inches). As a result, we were not able to sample the larger rivers. There are data gaps in this change analysis from the larger systems that were unable to be sampled in 2019 due to these high flows. These larger systems were planned to be sampled during the summer of 2020, however, the COVID 19 pandemic did not allow electrofishing to take place. Sampling resumed the summer of 2021, however, the 2021 data was not included due to being collected outside the one-year window for our change analysis.

The average macroinvertebrate IBI score for the watershed increased by 4.4 points between 2008 and 2020, this however does not represent a statistically significant change. MIBI scores increased at 17 of the 25 stations sampled for macroinvertebrates in both time periods, but averaged across both watersheds, changes in MIBI scores were not statistically significant. Notably, IBI scores at all but one site on the mainstem of the Buffalo River increased so there are no longer any MIBI impairments on the main stem of the Buffalo River. Watershed-wide, of the 49 streams segments currently assessed with MIBI, 39% are currently considered impaired.

Twelve (3 MIBI and 9 FIBI) new aquatic life impairments have been added to the Impaired Waters List as a result of cycle two monitoring.

Figure 7. Change in biological communities in the Buffalo River and Upper Red River of the North Watersheds.



Clarity of lakes

About 54 of the lakes in the Buffalo River Watershed have some level of transparency data, and only 10 of those lakes had sufficient data (50 Secchi measurements, eight years of data) to conduct a water clarity trend analysis. Much of the transparency data was collected by local volunteers through the MPCA's Volunteer Water Monitoring Program. Those data end up playing a large role

in statewide data analysis, which help inform water quality assessments and track trends over time. Similar to statewide results, most lakes do not exhibit a significant trend, and more lakes have improving clarity than declining. Three lakes had improving clarity, including Talac which is currently impaired. None of the lakes analyzed had decreasing clarity (**Figure 7**).

Climate

The Buffalo River and Upper Red River of the North Watersheds now receive on average 1.8 additional inches of rain from the historical average (1895-2018). Climate scientists suggest that precipitation events are becoming more intense. In addition, temperatures in the watershed have increased by about one degree 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.

Climate summary for watersheds, Buffalo River (state.mn.us).

Climate summary for watersheds, Upper Red River of the North (state.mn.us)

In 2009, the Buffalo River and Upper Red River of the North Watersheds experienced a moderate rainfall deficit (-2.5 inches) and was abnormally cool (-2.4 °F) between May and September. The watershed had slightly elevated precipitation (+1.7 inches) and was again abnormally cool (-2.0 °F) in 2019 over the May to September time period. Overall, given the relatively dry conditions affecting the watersheds in 2009 versus the slightly elevated conditions of 2019, there is a moderate likelihood that partially due to differences in climatic conditions between the two periods. any observed changes in 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.

Figure 8. Characterization of air temperature and rainfall conditions for May-September period across historical record for the Buffalo River and Upper Red River of the North Watersheds. Biological monitoring years for the watershed highlighted in red.

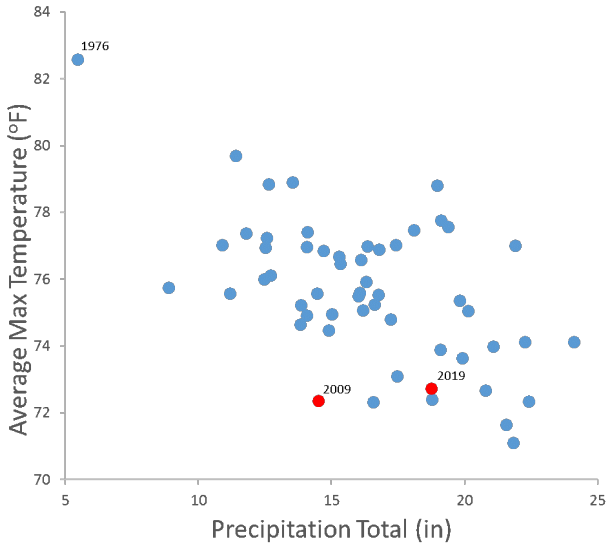


Table 1. Criteria used to characterize May-September rainfall and temperature conditions across the watershed. Likelihood of climate/weather influence on biological condition results: low medium high

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

For more information

This study of the Buffalo River and Upper Red River of the North Watersheds 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. 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 Buffalo/Upper Red River of the North Watersheds, 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 Buffalo River | Minnesota Pollution Control Agency (state.mn.us), Upper Red River of the North | Minnesota Pollution Control Agency (state.mn.us) or search for "Buffalo River" or "Upper Red River of the North" on the MPCA website.

CLEAN WATER LAND & LEGACY AMENDMENT

Contact

Andrew Frank: Andrew.frank@state.mn.us
218-316-3932
Minnesota Pollution Control Agency