Watershed assessment and trends update

Bois De Sioux River Watershed

Red River of the North Basin

Summary

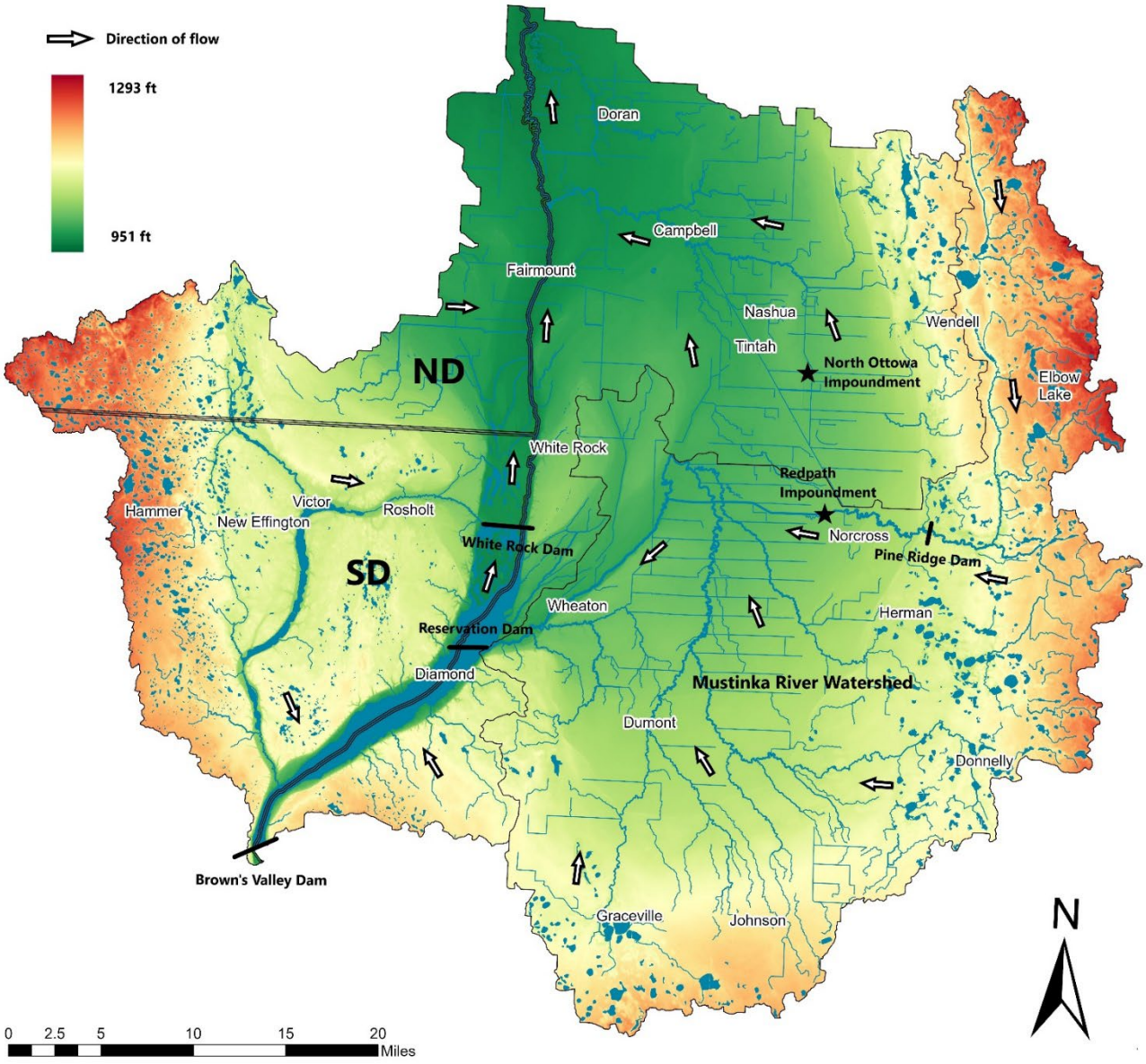
The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (MNDNR), and partners have completed a study of the Bois de Sioux River Watershed, which spans across portions of North Dakota, South Dakota, and Minnesota. While each of these three states contribute to water quality conditions within the watershed, this study focuses solely on the portion of the watershed within Minnesota. The Bois de Sioux River Watershed, within Minnesota, includes 754 miles of watercourses (streams, rivers, and ditches) along with 62 lakes, and 35 wetlands greater than ten acres in size within Grant, Otter Tail, Traverse, and Wilkin Counties (Figure 1).

The Bois de Sioux River Watershed begins at Lake Traverse where the Mustinka River as well as several smaller tributaries on both the South Dakota and Minnesota sides of the lake form the headwaters of the Bois de Sioux River. Flow from Lake Traverse is controlled by the Reservation Dam above Mud Lake and the White Rock Dam below Mud Lake. Below the White Rock Dam, the Bois de Sioux River flows north where it meets the Rabbit River north of Fairmount. At Wahpeton and Breckenridge, the Bois de Sioux River meets the Otter Tail River which combine to form the Red River of the North.

The Bois de Sioux River Watershed contains some of the most agriculturally productive land in the world, but due to the extremely flat topography of the Lake Agassiz Plain and the Rivers northward direction of flow, much of the watershed is prone to extensive flooding, particularly during spring snowmelt events. Since the arrival of white settlers to the area in the area in the mid to late 1800's, there have been a series of efforts to manage the landscape for agricultural production and mitigate flood risk. In 1883, the Minnesota legislature authorized county commissioners to construct public drainage ditches and an extensive campaign of ditching was undertaken in this watershed during the first half of the 1900's. More recently, subsurface tiling has become widespread in the watershed. Presently, 74% of the watercourses within this watershed have been ditched/channelized and 83% of the land area has been developed for agricultural use. While this extensive alteration of the watershed's hydrology has reduced flood risk, and allowed for greater agricultural development, it has dramatic impacts on water quality. Nearly all the waterbodies assessed for aquatic life and/or aquatic recreation use in this study were found to be impaired with no improving or declining trend at the watershed scale.

This study relies on both chemical testing of the water and surveys of fish and macroinvertebrate (bug) communities living in the water. These multiple lines of evidence offer a more comprehensive understanding of the watershed's health over time. The assessment, which is funded by Minnesota's Clean Water Land and Legacy Amendment, also uses data collected by volunteer water quality monitors. Details in this report will shape decisions on watershed management and pollution reduction measures for years to come.

Figure 1. The Bois de Sioux River Watershed spans across Minnesota, North Dakota, and South Dakota. Flow proceeds from the elevated moraine deposits at the periphery of the watershed (red and yellow) to the flat Lake Agassiz Plain (green) where the Bois de Sioux River flows north to meet the Ottertail River in Wahpeton/Breckenridge. This report covers the Minnesota portion of the watershed, excluding the Mustinka River and its tributaries.



Watershed study

Water monitoring is essential to determining whether waterbodies (lakes, streams, and ditches) meet water quality standards. While local partners and state agencies monitor water quality on an ongoing basis, the MPCA and local partners conduct an intensive survey of lakes and streams in each of the state's 80 watersheds every ten years to detect any changes in water quality. In the Bois de Sioux River Watershed, the MPCA and local partners conducted this intensive monitoring in 2010-2011. The second round of intensive monitoring took place in 2021-2022, with biological sampling delayed in 2020 due to the COVID-19 pandemic and further delayed in 2021 due to severe drought conditions. Chemistry data collected by local partners between 2014 and 2023 were also used for assessment. The monitoring strategy focused on whether waterbodies met water quality standards that support aquatic life, recreation, and/or consumption use. Waters which fail to meet these use standards and were assessed as not supporting aquatic life, recreation, and/or consumption are considered impaired. The overall goal of these assessments is to determine which waters are healthy and may need protection or are polluted and require restoration. For more information on the MPCA's approach to water quality monitoring see the following links: Watershed Approach to Water Quality, Minnesota's water quality Monitoring Strategy 2021 to 2031

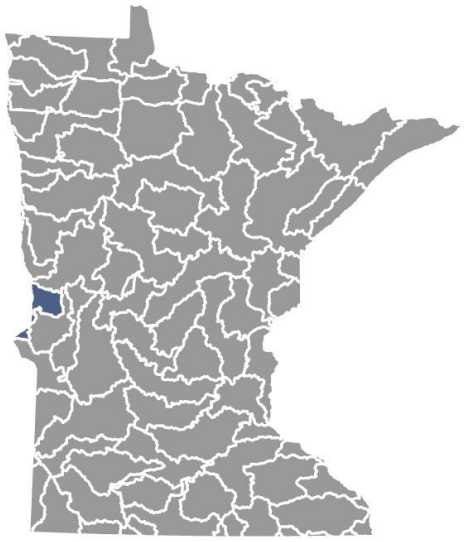
Changes in water quality

Over the past decade, scientists observed little change in water quality in the Bois de Sioux River Watershed. While the biological condition of individual streams may have improved or declined between 2010 and 2022, the overall biological condition of assessed fish and macroinvertebrate communities on a watershed scale did not change over this period. Continued water quality findings include excess bacteria levels, excess sediment (turbidity), low dissolved oxygen levels, and barriers to fish passage. Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable.

While there is some routine water monitoring in the Bois de Sioux River Watershed that occurs every year, the MPCA and local partners conduct an intensive survey of lakes and streams in the watershed every ten years.

To detect changes in water quality, this intensive survey looks at fish and macroinvertebrate communities as well as water chemistry. The MPCA uses the data to determine which waters are healthy and may need protection, and which are polluted and need restoration.

Figure 2. The Bois de Sioux River Watershed is one of 80 major watersheds within Minnesota.



- There was no significant change detected in the in the health of assessed fish and macroinvertebrate communities on a watershed-wide scale (Figure 6).
- Several aquatic life use impairments, resulting from low fish Index of biological integrity (IBI) and low macroinvertebrate IBI scores, have been added to the Bois de Sioux River. The entirety of the Bois de Sioux River is now impaired for aquatic life use due to low fish and macroinvertebrate IBI scores (Figure 5).

- Judicial Ditch 2, downstream of the primary outlet of the North Ottawa Project, remains impaired for aquatic life use due to excess total suspended solids (TSS) and low fish and macroinvertebrate IBI scores.
- Since the mid-1990's, streamflows at the White Rock Dam have shown an increasing trend relative to the 30-year moving average (Figure 7).
- The Bois de Sioux River Watershed now receives on average 1.8 additional inches of rain from the historical average (1895-2018). Air temperatures in the watershed have increased by about 1.1°F during the spring and fall over this period.
- Sample pollutant concentration of total phosphorus declined at a statistically significant rate from 2001-2020 at the watershed pollutant monitoring station on the Bois de Sioux River west of Doran. Sample pollutant concentrations of total suspended solids and nitrate + nitrite nitrogen do not show statistically significant change over the same interval.
- The Bois de Sioux River directly below the White Rock Dam exhibits a declining water clarity trend. The rest of the Bois de Sioux River shows no water clarity trend.
- Ash Lake, Mud Lake, and Upper Lightning Lake were assessed as impaired for aquatic recreation use in 2014 due to a combination of excess phosphorus, and the exceedance of a eutrophication response parameter (low water clarity via Secchi disk or high chlorophyll-a concentration). Limited samples collected from these lakes since 2014, continue to support the existing aquatic recreation use impairment (Figure 5). Total phosphorus measurements exceeded the impairment threshold for Lake Traverse, but response variables (Chlorophyl-a and Secchi disk measurements), met thresholds. Due to these conflicting results, MPCA staff consider Lake Traverse vulnerable to aquatic recreation use impairment.

Highlights of monitoring

- Nearly all the waterbodies assessed for aquatic life or aquatic recreation use within the watershed were found to be impaired (Figure 5).
- The macroinvertebrate communities collected in Grant County Ditch 5 and Traverse County Ditch 52 support aquatic life use. Both communities showed little change in community composition between 2010 and 2022.
- New aquatic life use impairments, resulting from low fish and macroinvertebrate IBI scores, were added at an unnamed tributary to Lake Traverse 21RD013 (Figure 4) and Traverse County Ditch 53. Both waterbodies were monitored for biology for the first time in 2022.
- Several species of game fish have consistently been collected from sites within the lower reaches of the Bois de Sioux River including Walleye, Sauger, White Bass, Northern Pike, Channel Catfish, and Smallmouth Bass.

The Rabbit River directly upstream of Campbell, MN and the confluence with the Rabbit River, South Fork. Channel incision, bank sloughing, and excess nutrient load are water quality concerns at this site.

- The North Ottawa Project was completed in 2016. It's three-square mile series of impoundments collect water from a 74 square mile drainage including Judicial Ditch 12 and

Grant County Ditch 22, east of Tintah. Levees divide the impoundment into nine pools which can be flooded, planted for agricultural production, or managed for migratory bird habitat. Profits from the agricultural land within the impoundments are used to fund its operation and maintenance. At full capacity, the impoundment offers 18,210 acre feet of flood storage which greatly reduces flooding risk locally and helps to reduce peak flows to the Bois de Sioux River. Since its construction, the impoundment has become a popular destination for birders. Over 200 species of birds have been observed at the impoundment, some of which are rarely observed elsewhere in Minnesota. For more information on the North Ottawa Project see the Bois de Sioux River Watershed District website.

- In 2022, the Bois de Sioux River Watershed District began construction of the Redpath Flood Impoundment & Mustinka River Rehabilitation Project, in the neighboring Mustinka River Watershed. This project will create 23,000-acre feet of storage which can be used to reduce the potential for overland flooding from the Mustinka River to the Rabbit River Basin during high flow events. A reduction in overland flooding to the Rabbit River Basin is likely to reduce peak flows within the Rabbit River and Bois de Sioux River and help improve conditions for aquatic life. For more information on the Redpath Project see the Bois de Sioux River Watershed District website.

Success story

Traverse County Ditch 52 (TCD 52) was created in 1951 and connected a network of ditches and tributaries that drain 30 square miles of land on the east side of Lake Traverse. Flow from this expanded ditch network, when funneled through an undersized channel, rendered this system susceptible to severe erosion and a particularly dramatic precipitation event in the late 1950's dramatically destabilized the newly created ditch. Over time, erosion from TCD 52 has resulted in a sediment delta where it meets Lake Traverse and may contribute to the nutrient-related aquatic recreation use impairment on Mud Lake. In total, sediment loss from TCD 52 is estimated at more than four million cubic feet.

Left: Sediment plume is visible where TCD 52 meets Lake Traverse. Right: The TCD 52 above Highway 27 has been widened and armored to reduce erosion and stabilize the stream banks.

In the spring of 2020, the Bois de Sioux River Watershed District and Moore Engineering began work on the Lake Traverse Water Quality Improvement Project. This project was focused on reducing erosion on TCD 52 and sediment deposition in Lake Traverse. The first phase of this project in 2020 -2022 stabilized the failing banks and eroding channel bottom along the portion of TCD 52 below Highway 27. In 2023, streambanks upstream of the ravine and County Road 18 were stabilized. The channel has been re-graded, widened, and rock riffles were installed in both sections to provide greater habitat complexity.

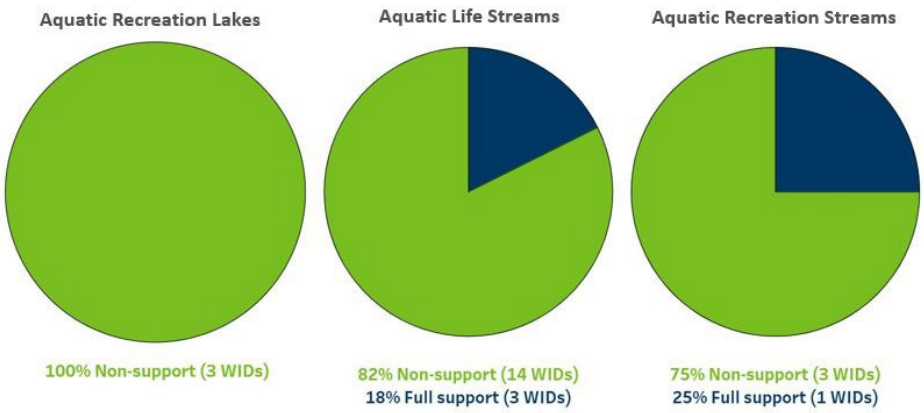
In the summer of 2022, the MPCA sampled fish and macroinvertebrate communities within the TCD 52 Subwatershed. Below Highway 27 the fish community supported aquatic life use. Numerous species including Channel Catfish, Creek Chub, Hornyhead Chub, and White Suckers were collected at this location suggesting that fish passage from Highway 27 to Lake Traverse is intact. Above Highway 27, fish and macroinvertebrate communities continue to indicate impairment of aquatic life use. For more information on this project, including video, see the project summary provided by Moore Engineering: https://www.mooreengineeringinc.com/projects/lake-traverse-water-quality-improvements-tcd-52/ and https://www.mooreengineeringinc.com/lake-traverse-environmental-success/

Watershed assessment results

Streams and rivers

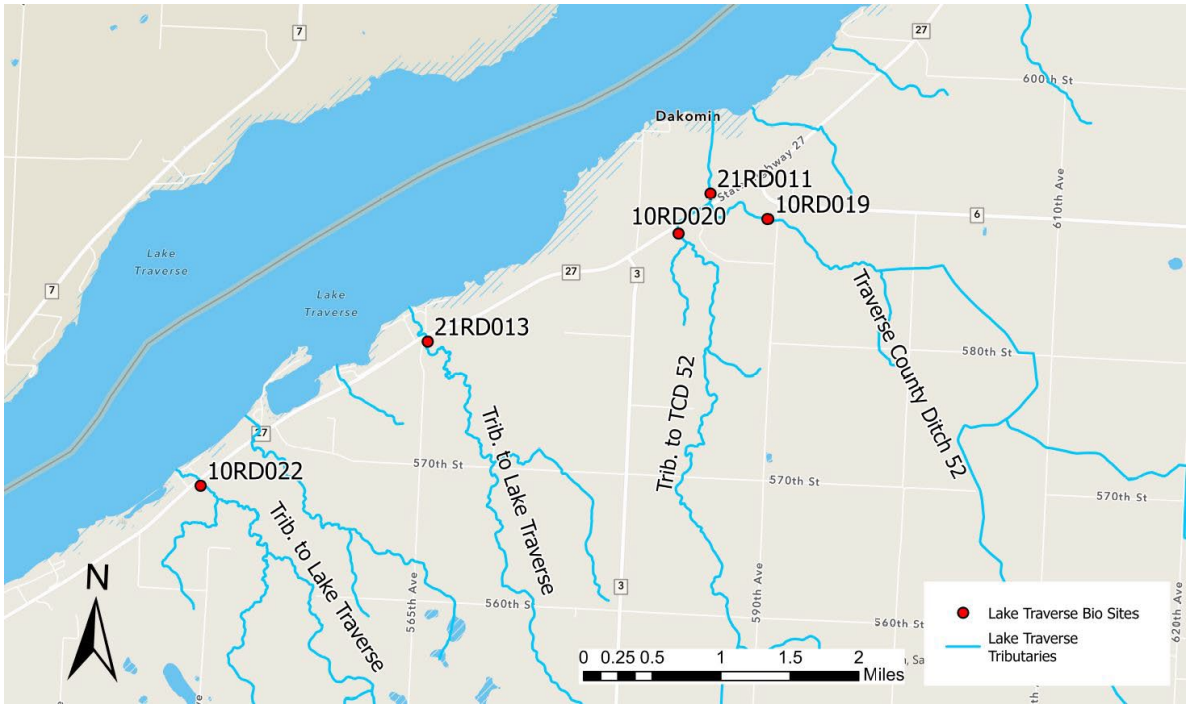
The MPCA determined that 82% of the stream reaches in the Bois de Sioux River Watershed that were assessed for aquatic life are impaired (Figure 3). Aquatic life use impairments caused by excess TSS, turbidity, nutrients and low dissolved oxygen levels are widespread, and fish and macroinvertebrate communities are significantly degraded, with few exceptions. Of the four stream reaches assessed for aquatic recreation use, three are impaired (Figure 3).

Figure 3. Bois de Sioux River Watershed assessment results for aquatic life use in streams and aquatic recreation use in streams and lakes. Aquatic life use was not assessed in any lakes within this watershed.



On the Minnesota side of Lake Traverse, a series of small streams flows from an elevated plateau created by a glacial moraine deposit. These streams are unique in the Bois de Sioux River Watershed as they take on significant gradient dropping from the moraine plateau to Lake Traverse. Agricultural development in the headwaters of these systems (ditching, tiling, wetland removal, loss of riparian buffering) has destabilized these systems creating deeply incised channels, unstable banks, and heavy bed loads. Fish passage barriers at Highway 27 also likely contribute to the fish IBI related aquatic life use impairments at 10RD022, 10RD020, and 10RD019 (Figure 4). Of the five Lake Traverse tributary sites assessed for aquatic life use, four are impaired due to low fish and/or macroinvertebrate IBI scores. Below Highway 27, TCD 52 is maintains fish passage to/from Lake Traverse, and supports aquatic life use due to the presence of several taxa which plausibly move between the lake and the tributary (Channel Catfish, Creek Chub, Hornyhead Chub, and White Suckers).

Figure 4. The MPCA collected water quality data from five locations on Lake Traverse tributary streams.



Downstream of White Rock Dam and upstream of its confluence with the Rabbit River, the Bois de Sioux River is impaired for aquatic life use due to low fish and macroinvertebrate IBI scores, low dissolved oxygen, excess turbidity, and excess nutrient levels. This stretch is also impaired for aquatic recreation use due to excess *E. coli* levels. Flows from the dam fluctuate drastically during the summer months. At times when flow from the dam is restricted, Big Slough, across the river in North Dakota, contributes most of the flow to this upstream stretch of the Bois de Sioux River. The entirety of this upstream stretch of the Bois de Sioux River is ditched, exhibits very limited depth variability, and generally limited habitat for aquatic life.

The Bois de Sioux River eight miles downstream of the White Rock Dam on August 3, 2022. Low depth variability and limited habitat complexity contribute to aquatic life use impairments on this channelized stretch of the Bois de Sioux River.

West of Campbell, the Bois de Sioux River meets the Rabbit River which, along with its tributaries, drains much of the Minnesota portion Bois de Sioux Watershed (Figure 1). The North Ottawa Impoundment collects flow from much of the headwaters of the Rabbit River via the Judicial Ditch 12 network and Grant County Ditch 22. Very little assessable data has been collected above the North Ottawa Project due to low flow conditions during the summer. Water from the North Ottawa Project can be released through two different outlets. On the west side of the impoundment, Judicial Ditch 12 is used in response to spring draw-downs and flood events. Judicial Ditch 2, on the north side of the impoundment, serves as the primary outlet and connects with the mainstem of the Rabbit River East of Nashua. Monitoring in 2021-22 corroborated existing aquatic life use impairments on Judicial Ditch 2 and Rabbit River, South Fork. The Rabbit River, South Fork is now impaired for aquatic life use based on low fish and macroinvertebrate IBI scores, low dissolved oxygen, and excess nutrient levels and turbidity. The Rabbit River itself is impaired for the same suite of aquatic life use parameters as well as aquatic recreation use due to excess E. coli levels. Both the South Fork and the mainstem of the Rabbit River are incised. Erosion along with excess nutrients from agricultural land use are major stressors for aquatic life in these systems. In 2022, the Bois de Sioux River Watershed District began construction of the Redpath Flood Impoundment & Mustinka River Rehabilitation Project in the neighboring Mustinka River Watershed. Once completed, these projects will create 23,000-acre feet of storage and reduce the frequency of overland flooding from the Mustinka River to the Rabbit River Basin. A reduction in overland flooding to the Rabbit River basin is likely to reduce peak flows within the Rabbit and Bois de Sioux Rivers, decrease sediment transport and help improve conditions for aquatic life. For more information on the Redpath Project see the Bois de Sioux River Watershed District website.

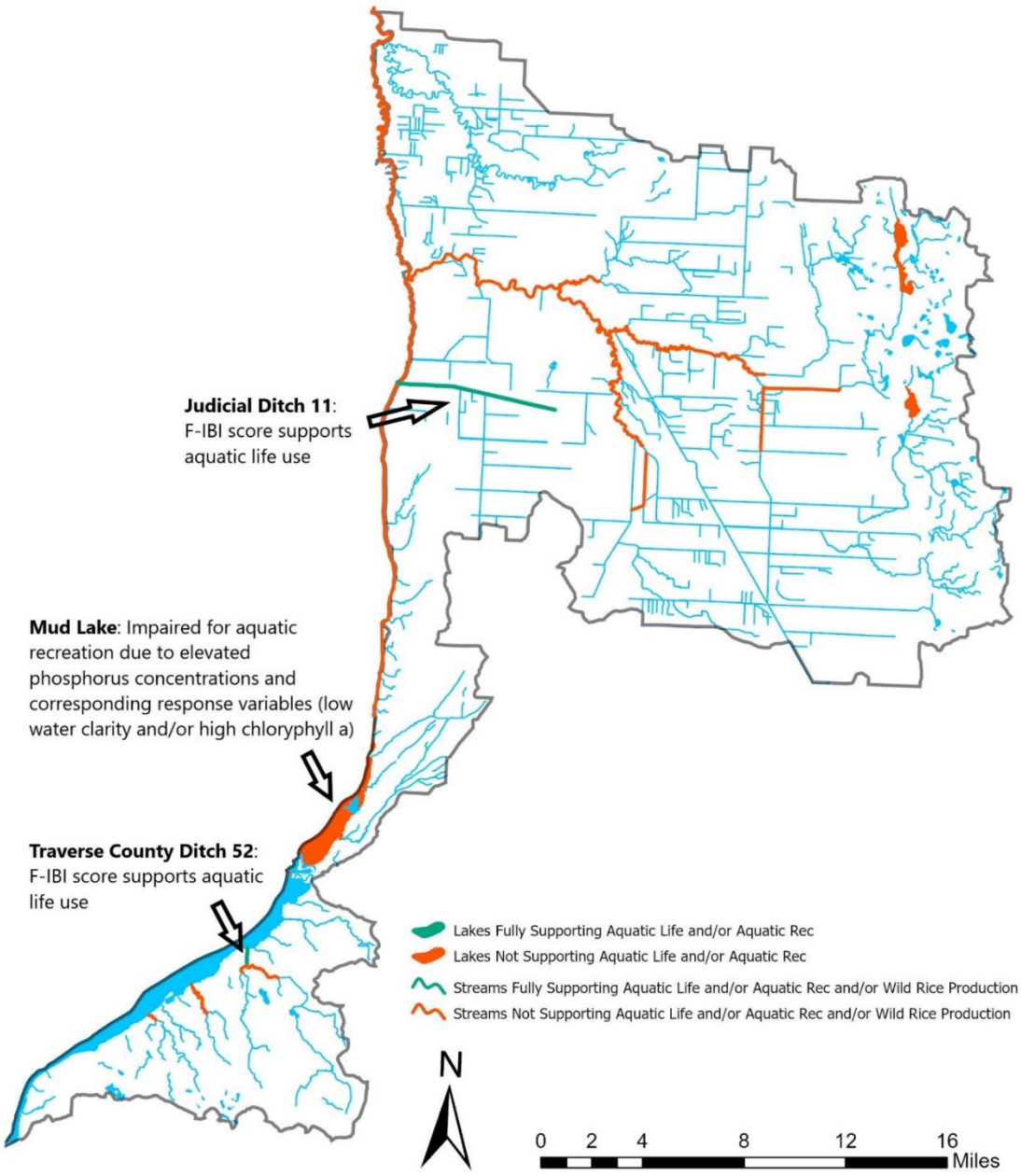
Downstream of its confluence with the Rabbit River, the Bois de Sioux River remains impaired for aquatic life use due to low fish and macroinvertebrate IBI scores, low dissolved oxygen, excess nutrients, and excess turbidity. It is also impaired for aquatic recreation use due to excess E. coli levels and aquatic consumption use due to excess mercury in fish tissue. Although water quality is impaired, the Bois de Sioux River retains its natural channel seven miles downstream of the confluence with the Rabbit River and in locations where water depth exhibits some variation and coarse substrates are present, fish and macroinvertebrate communities are comparatively more intact. Several species of sport fish have consistently been collected from sites within this section of the Bois de Sioux River including Walleye, Sauger, White Bass, Northern Pike, Channel Catfish, and Smallmouth Bass.

Lakes

Excess algal growth or a related loss of water clarity may impair the recreational suitability of a lake. For this reason, the MPCA relies on an ecoregion-based eutrophication standard to determine whether a lake meets its aquatic recreation use. Excessive nutrient concentrations, in particular total phosphorus (TP), may lead to increased algae blooms under certain conditions (i.e., sunlight, warm weather). If nutrient concentrations exceed parameter-level standards, the MPCA utilizes water clarity data (Secchi disk), and/or algal growth data (chlorophyll a) to determine if excess nutrients have resulted in a eutrophication response sufficient to trigger an aquatic recreation use impairment. The MNDNR assesses aquatic life use in lakes using a fish IBI tool; however, lakes within the Bois de Sioux River Watershed do not meet the tool criteria and were not assessed for aquatic life use.

Three lakes, Ash, Mud and Upper Lightning, are currently impaired for aquatic recreation use. Upper Lightning Lake is impaired due to excess total phosphorus levels and elevated chlorophyll a concentration. Ash Lake and Mud Lake are impaired due to excess phosphorus levels and both elevated chlorophyll-a and diminished water clarity measured using secchi disk readings (Figure 5). Limited data collected in 2015 corroborates the existing nutrient impairments on Ash Lake and Mud Lake. Within the last 10 years, only Lake Traverse, had sufficient data available for assessment. Total phosphorus exceeds the impairment threshold for Lake Traverse, but response variables chlorophyll-a and Secchi disk measurements, meet thresholds. Due to these conflicting results, Lake Traverse is considered vulnerable to impairment of its aquatic recreation use. The Lake Traverse Water Quality Improvement Project is targeted specifically at managing erosion within the TCD 52 Subwatershed to, at least in part, reduce sediment deposition and nutrient levels within Lake Traverse. Lake Traverse and Mud Lake will hopefully see the benefit of this work in years to come.

Figure 5. Assessment results for aquatic life and aquatic recreation use within the Bois de Sioux River Watershed.



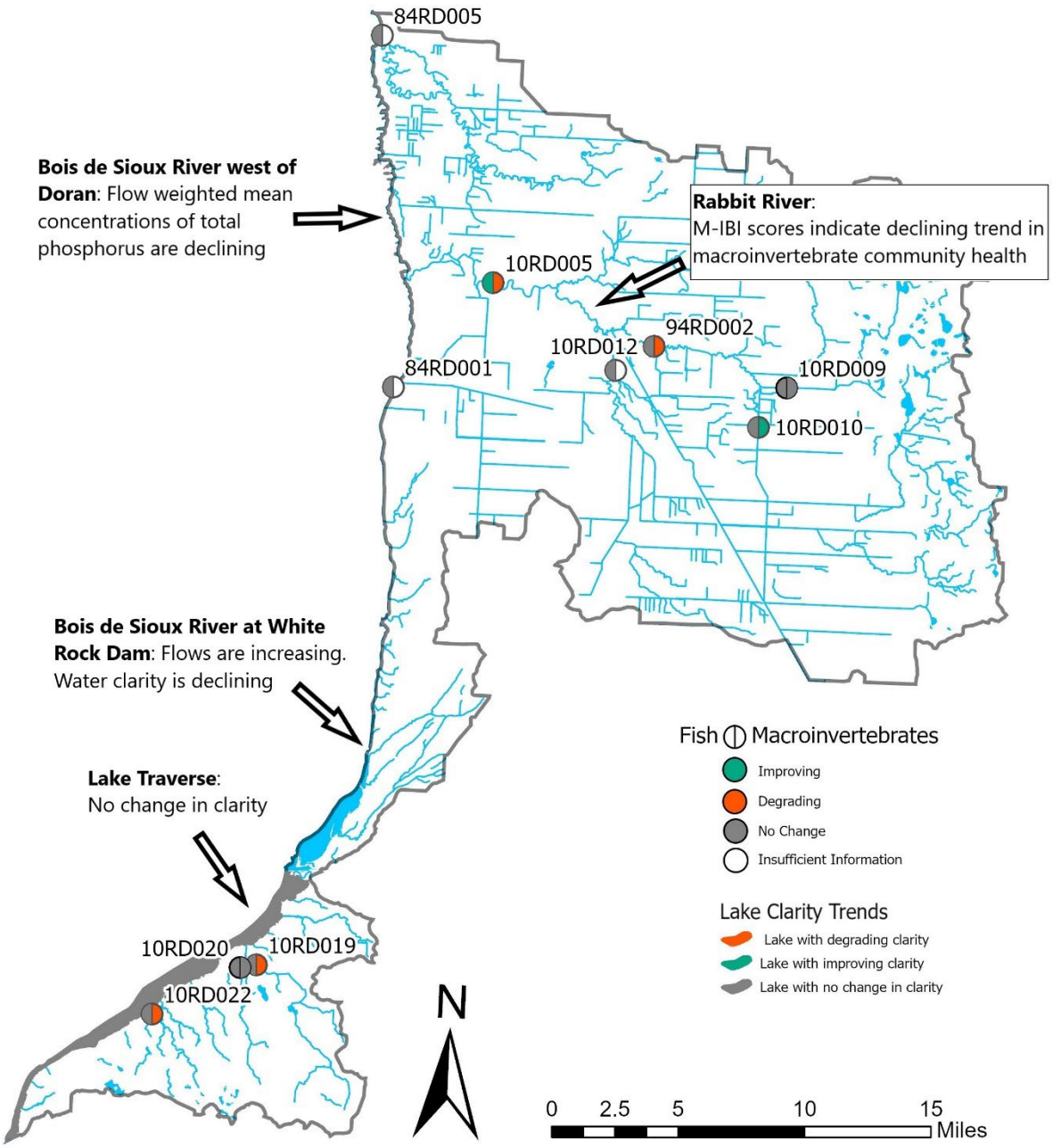
Trends

A key objective of the 2021-2022 monitoring effort was to evaluate if and how water quality has changed since 2010 (Figure 6). 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 for any improvement. It is equally important to understand if there is no change or a declining trend in water quality. Either way, the knowledge will help inform future water quality management activities.

Trends in four different aspects of water quality were analyzed to determine if environmental conditions are changing in the Bois de Sioux River Watershed:

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

Figure 6. Water quality parameter trends in the Bois de Sioux River Watershed. The right half of the symbols represent macroinvertebrate IBI trend, and the left half of the symbols represent fish IBI trend.



Streamflow and pollutant concentrations

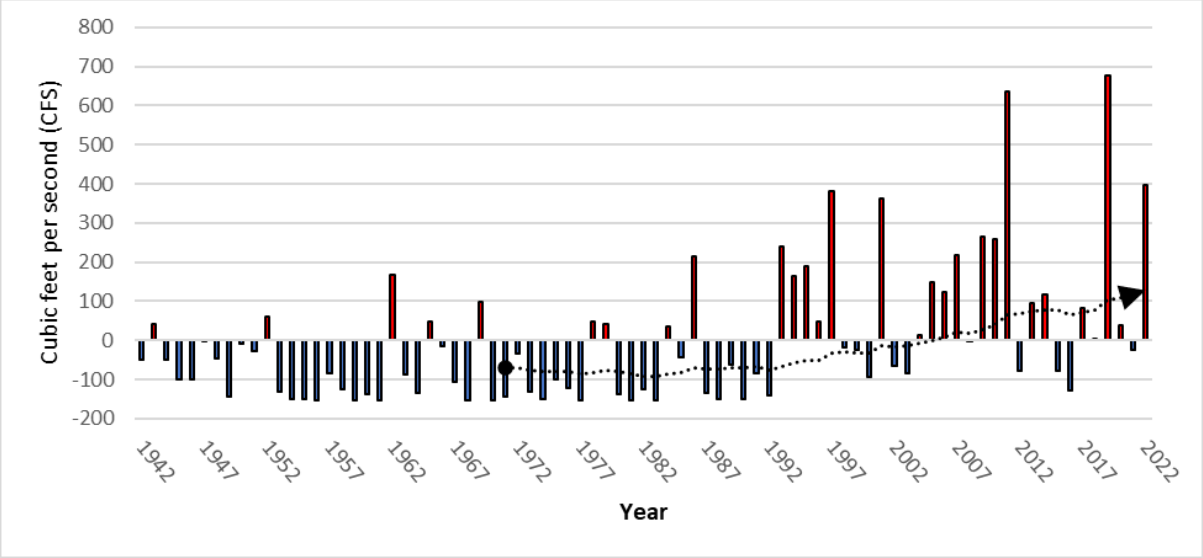
In addition to the intensive monitoring completed every ten years, approximately 200 Watershed Pollution Load Monitoring Network (WPLMN) sites are operational year-round across Minnesota. At these sites, streamflow data collected in collaboration with the United States Geological Survey (USGS) and the MNDNR is paired with water chemistry data collected by state and federal agencies, Metropolitan Council Environmental Services, state universities, and local partners. This combination of regular streamflow and pollutant monitoring is crucial for conducting trend analysis, assessing year-over-year variations, and identifying pollutant sources and their contributions. Three WPLMN sites are currently established in the Bois de Sioux River Watershed (Table 1. WPLMN sites within the Bois de Sioux River Watershed. Samples are collected by a local partner, the International Water Institute (IWI). Lab parameters are total suspended solids (TSS), total phosphorus (TP), nitrate + nitrite nitrogen (NOX), total Kjeldahl nitrogen (TKN), and dissolved orthophosphate phosphorus (DOP). *DOP was collected at other sites in the past but is currently only collected at Bois de Sioux River near Doran.).

Table 1. WPLMN sites within the Bois de Sioux River Watershed. Samples are collected by a local partner, the International Water Institute (IWI). Lab parameters are total suspended solids (TSS), total phosphorus (TP), nitrate + nitrite nitrogen (NOX), total Kjeldahl nitrogen (TKN), and dissolved orthophosphate phosphorus (DOP). *DOP was collected at other sites in the past but is currently only collected at Bois de Sioux River near Doran.

Site name (WISKI_ID)	Streamflow data available	Pollutant concentration data available	Sample collection	Lab parameters
Bois de Sioux River near White Rock (E54034001)	1942-current (USGS)	2014-current	20-25 samples collected per year from ice out to Oct.31. (IWI)	NOX, TKN, TSS, TP
Bois de Sioux River near Doran (E54018001)	1990-current (USGS)	2007-current	28-35 samples collected year-round. (IWI)	NOX, TKN, TSS, TP, DOP*
Rabbit River near Campbell (H54017001)	2006-current (MN DNR)	2012-current	20-25 samples collected per year from ice out to Oct.31. (IWI)	NOX, TKN, TSS, TP

There was a statistically significant streamflow increase in the Bois de Sioux River Watershed. Departure from the annual average flow of 154 cubic feet per second at the Bois de Sioux River near White Rock, shows the 30-year moving average increasing in the mid-1990s (Figure 7). The other WPLMN sites had similar increases but the data at these locations was limited. Streamflow increases have 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.

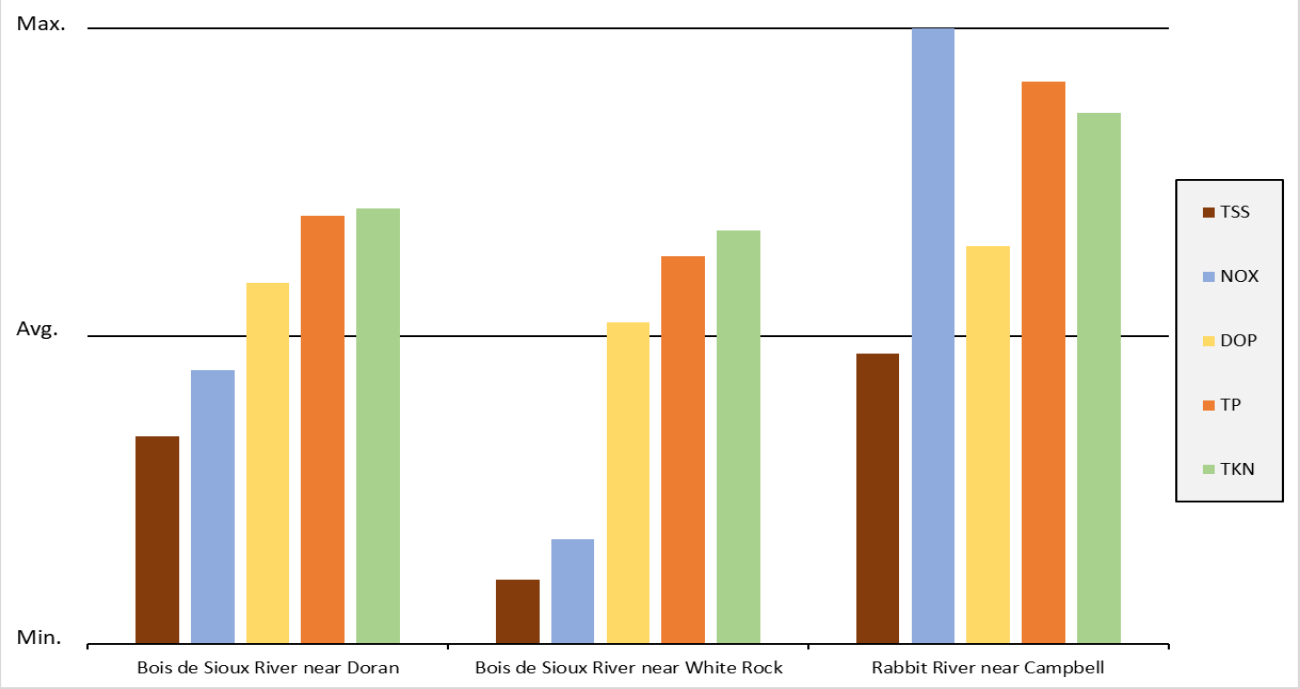
Figure 7. Annual mean discharge departure from overall average discharge (0=154 cfs). Red bars show higher than average flow and blue bars show below average flow. The 30-year moving average shows an increasing trend at the Bois de Sioux River near White Rock. It is notable that the last 30 years have many more years above the mean.



Water samples collected at WPLMN sites are analyzed for pollutants that are known to have an impact on water quality (Table 1). Combining sampled pollutant concentrations with streamflow data allows for the calculation of a flow-weighted mean concentration (FWMC) and total pollutant load. Loads represent the total amount of a pollutant moving through a system. FWMCs are important when considering the impact of pollutants on downstream resources such as the Red River of the North and Lake Winnipeg etc. where these pollutants may accumulate. These statistics can also be used to determine what the water quality is like on average, allowing for the equal comparison between watersheds differing in size or streamflow volume.

FWMCs in the Bois de Sioux River Watershed are varied across the different parameters when compared to other watersheds in the Red River Basin (Figure 8). Out of the three WPLMN sites in the Bois de Sioux River Watershed, the Rabbit River at Campbell has the highest average FWMC for all parameters, including some of the highest average TP and TKN of all WPLMN sites Minnesota. Averaged NOX at this site is also the highest of any site located in the Red River Basin but is low relative to other areas in the state, such as southern Minnesota. Averaged FWMCs in the Bois de Sioux River for most parameters are near or slightly above the basin average. NOX and TSS are the exceptions, with both being below average when compared with other WPLMN sites in the Red River Basin or near minimum concentrations when compared statewide. Averaged FWMCs increase for all parameters from White Rock to Doran, possibly due to the Rabbit River's contribution upstream of Doran.

Figure 8. The graph compares normalized FWMC data from the 43 total WPLMN sites in the Red River Basin to the sites in the Bois de Sioux River Watershed. The y-axis is scaled in terms of maximum, average, and minimum for each lab parameter in the basin. For example, a maximum value would indicate that site has the highest FWMC in the Red River Basin.



To determine if sample pollutant concentrations (not FWMCs) in the Bois de Sioux River Watershed experienced statistically significant changes over time, a seasonal Mann-Kendall trend test was applied to TSS, TP, and NOX data at the furthest downstream WPLMN station in the watershed (Bois de Sioux River near Doran). Among these sample concentrations only TP displayed a statistically significant change from 2001-2020, indicating a decreasing trend. No trends were found from 2008-2020. More information regarding the WPLMN program can be found at: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring

Biological communities

Paired t-tests of fish and macroinvertebrate IBI scores were used to evaluate if the biological condition of the assessed watercourses within the Bois de Sioux River Watershed have changed between 2010 and 2021-22. Independent tests were performed on each community with seven sites evaluated for macroinvertebrates and ten sites evaluated for fish (sites that were sampled in both time periods). The average macroinvertebrate IBI score for the watershed decreased by 3.6 points between 2010 and 2021-22, this however does not represent a statistically significant change. Fish IBI scores in the Bois de Sioux River Watershed increased by 0.9 points, which was also not statistically significant.

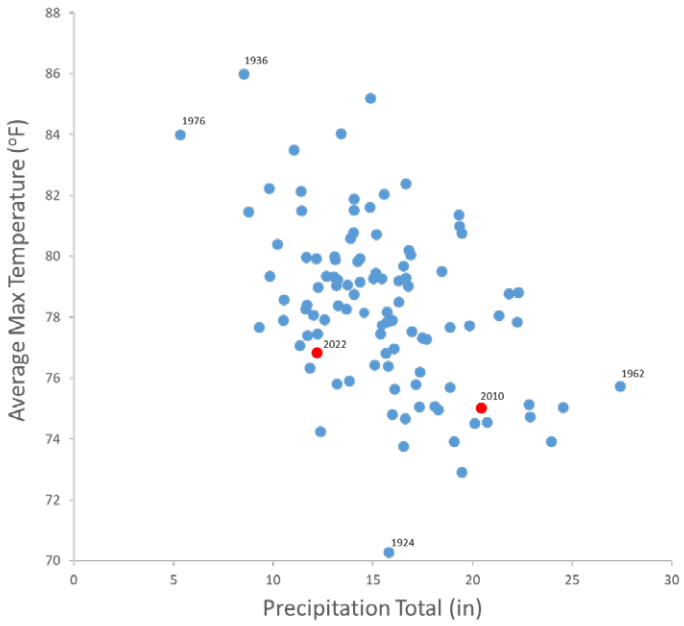
Despite the lack of a watershed-wide trend in the Bois de Sioux River Watershed, a few streams did see notable changes in fish or macroinvertebrate communities. Grant County Ditch 5 was one of only three streams where the macroinvertebrate community improved and, along with the tributary to Traverse County Ditch 52 (Figure 4, 10RD019), are the only sites in the Bois de Sioux River Watershed that are not impaired for aquatic life use due to low macroinvertebrate IBI scores. Both a tributary to Lake Traverse (Figure 4, 10RD022) and TCD 52 above Highway 27 saw significant (greater than ten IBI points) declines in macroinvertebrate community health which contributed to aquatic life use impairments (Figure 5).

Changes in IBI scores in streams within the Bois de Sioux River Watershed may reflect improvements in water quality and/or habitat conditions. However, it is also important to note that other factors may have contributed to these changes. For example, macroinvertebrate sampling methods changed slightly between monitoring cycles to account for differences in habitats at various monitoring locations. Also, differences in weather patterns between each sampling period may have led to changes in stream flow, water temperature, dissolved oxygen levels, habitat, and connectivity. In 2010, the Bois de Sioux River Watershed experienced above normal rainfall (+4.2 in) with abnormally cool temperatures (-2.7°F) during the time that the biological surveys were being conducted (May to September). In comparison, the watershed was in a moderate to severe drought for most of the summer in 2021, forcing biological monitoring activities to be suspended until the following summer. Stream flows during the summer of 2022 returned to near normal conditions primarily because of above normal winter precipitation, lessening the impacts of another summer with below normal rainfall (-4.0 in). Overall, given the wet/cool conditions affecting the watershed in 2010 and the drought conditions present during monitoring in 2021-22, there is a high likelihood that any 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

Lake Traverse is the only lake that met the data minimum requirements for lake clarity assessment (50 Secchi measurements, eight years of data). No significant trends in water clarity were found in Lake Traverse within the last ten years. Lake Traverse is not currently impaired for aquatic recreation use due to excess nutrients or turbidity although MPCA samplers noted an abundance of the cyanobacteria Aphanizomenon. Aphanizomenon often proliferate in water bodies with excess nutrient levels, where they form long blue green strands or clumps. The presence of large Aphanizomenon blooms during the warmest months of the summer suggests that both aquatic life and human health outcomes are vulnerable to further nutrient degradation in Lake Traverse. Mud Lake, directly downstream of Lake Traverse is impaired for aquatic recreation use due to excess nutrients.

Figure 9. Characterization of air temperature and rainfall conditions for May-September period across historical record for the Bois De Sioux River Watershed. Biological monitoring years for the watershed highlighted in red.



Climate

The Bois de Sioux River Watershed now receives on average 1.8 additional inches of rain from the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense. In addition, air temperatures in the watershed have increased by about 1.1°F during the spring and fall over this time period. Increased rainfall and temperature can worsen existing water quality problems. More precipitation as well as reduced snow cover can increase soil erosion, pollutant runoff, and streamflows. Increased streamflows 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. MNDNR climate summary for the Bois de Sioux River Watershed

For more information

This study of the Bois de Sioux 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 Bois de Sioux 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 on assessment decisions and reports, go to the MPCA Bois de Sioux River webpage, or search for "Bois de Sioux River" on the MPCA website.

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