Watershed assessment and trends update

Sand Hill River Watershed

Red River Basin

Summary

The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (MNDNR), and partners have completed a study of the Sand Hill River Watershed, which includes the river itself along with tributaries and lakes. Being in the heart of the Red River basin, this watershed's land use is dominated by agriculture, however the study found several encouraging trends since the last assessment ten years ago. Fish communities improved in the Sand Hill River mainstem thanks to the removal of low head dams and improved fish passage. The improved fish communities resulted in the delisting of a fish bioassessment impairment for a portion of the river. There were a few new impairments identified in the watershed, but the quality of waterbodies generally remained similar between historic and more recent sampling efforts. A primary concern in this watershed is the impact of ditching on stream hydrology. Elevated levels of suspended sediment were found in the downstream sections of the Sand Hill River, and poor dissolved oxygen conditions persist in the middle and upper sections of the river.

Instead of relying on chemical testing of the water alone, scientists also 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. Data collected by volunteer water quality monitors also contributed to water quality assessments. This work is funded by Minnesota's Clean Water Land and Legacy Amendment. Details in this 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 examination 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. Data is then passed on to local partners to guide their work in the watershed.

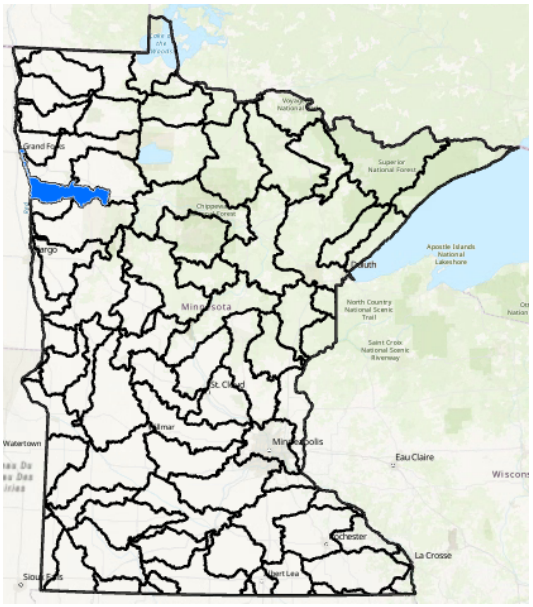
The MPCA and partners monitored water quality conditions in 2011-2012 (cycle I) and again in 2022-2023 (cycle II). Chemistry data collected by local partners between 2013 and 2023 were used for cycle II assessments. The data used to assess the condition of Minnesota waterbodies focuses on whether or not they are meeting water quality standards for aquatic life, recreation, and consumption. The overall goal of these assessments is to determine which waters are healthy and in need of protection or are polluted and require restoration.

Changes in water quality

Scientists use a tool called the Index of Biological Integrity (IBI) to assess the health of biological communities in lakes, rivers, streams, and wetlands. Different IBI classes and expectations are set to establish realistic goals for water quality in both ditches and natural systems. 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. Low IBI scores indicate impairment and highlight areas that restoration activities can be targeted to improve water quality.

Over the past decade, scientists observed little change in biological communities in streams throughout the Sand Hill River Watershed. While the biological condition in individual streams may have improved or declined between cycle I and cycle II, the overall health of fish and macroinvertebrate communities did not exhibit a statistically significant change over this period. Primary water quality issues in this watershed include elevated bacteria levels (*E. coli*), excess sedimentation (turbidity) and low dissolved oxygen levels.

Figure 1. The Sand Hill River Watershed is located in Northwest Minnesota flowing into the Red River between Fargo and Grand Forks.



County Soil and Water Conservation Districts (SWCDs), the Sand Hill River Watershed District, and other partners have used the data from cycle I to work with landowners to install hundreds of best management practices (BMPs) to improve water quality, but more are needed. It takes time for these practices to show results. Along with the cycle II watershed data, the Sand Hill River Watershed Comprehensive Watershed Management Plan was completed in January 2024, providing data, information, and a steady source of funding for local partners to target and prioritize opportunities for installing more BMPs and water-quality focused projects in the Sand Hill River Watershed in the future.

Highlights of monitoring

- The lower section of the Sand Hill River, from east of Fertile to the Red River, supports healthy fish and aquatic macroinvertebrate communities. The Sand Hill mainstem near Winger to the Sand Hill Lake area has low dissolved oxygen levels and other stressors that appear to be limiting aquatic communities. This section has several aquatic life use impairments including both fish and macroinvertebrates. Portions of the headwaters of the Sand Hill River are ditched, which likely contributes to the existing impairments for dissolved oxygen and macroinvertebrates in the upstream most section of the river.

The upstream most biological monitoring location on the Sand Hill River, near Fosston.

- Kittleson Creek, which is the largest natural tributary stream in the watershed remains impairment free, with healthy biological communities and generally good water quality. However, Kittleson Creek is considered vulnerable to future impairment for aquatic recreation based on bacteria (*E. coli*) data collected in cycle II. Local partners have improved fish passage at the outlet of Kittleson Creek. Sections of this stream are ditched and it is an excellent candidate for natural stream channel restoration or re-meandering, particularly on the downstream most section where biological monitoring occurs.

- Lake fish IBI monitoring conducted by MNDNR identified Union Lake as impaired, and Lake Sarah as vulnerable to impairment. These lakes are connected, and Lake Sarah has had nuisance algal blooms reported to the MPCA the last several years. Additional water chemistry data will be collected on both lakes through 2025 by the East Polk SWCD to assess aquatic recreation use on both lakes.
- Across the watershed, there is no significant change in stream biological condition over the last 10 years for both fish and macroinvertebrates. However, some individual stream segments may exhibit degrading or improving biological condition, including the improving fish IBI scores in the Sand Hill River near Fertile, discussed more below in the success story.

Success story

The Sand Hill River Watershed District started investigating ways to restore the fish community on the Sand Hill River in 2003. Backed by a MNDNR grant, the first projects — a new road crossing west of Beltrami and box culverts west of Fertile — finished in 2007.

Ten years later, the U.S. Army Corps of Engineers (USACE) modified four failing drop structures that were built in the 1950s to control flooding. These drop structures were recently converted to rock arch rapid structures. The Clean Water Fund-supported work built upon a $7 million ecosystem restoration project, which drew from nearly $5 million in USACE dollars and $1.9 million in Outdoor Heritage Funds. The USACE designed and managed construction of the project; the watershed district assumed jurisdiction over operation and maintenance.

One of the riffle structures installed along the Sand Hill River. These structures replaced low head dams that previously inhibited migratory fish species from moving upstream.

A long-term biological monitoring site, just west of Fertile began to document the return of migratory species such as Redhorse in 2018. These species continue to be present in the River between Fertile and Rindal, resulting in higher fish IBI scores and subsequent removal of the fish bioassessment impairment from this portion of the river west of Fertile from the impaired waters list. The delisting will be reported to the Environmental Protection Agency (EPA) in 2026.

Remaining Outdoor Heritage Funds allowed the watershed district to work with the MNDNR to remove additional barriers to fish passage: a perched culvert on Kittleson Creek, a tributary west of Fertile; the Sand Hill Lake dam near Fosston, which was replaced with rock arch rapids in 2020; and the removal of the Poissant Bridge, which was on the verge of sliding into the river in 2021. Additionally, a total of 33 riffle structures to reduce channel erosion were installed within the project area.

See the full story on the BWSR website:

https://bwsr.state.mn.us/sites/default/files/2023-12/snapshots_story_1_january_2024_sand_hill_river.pdf

Watershed assessment results

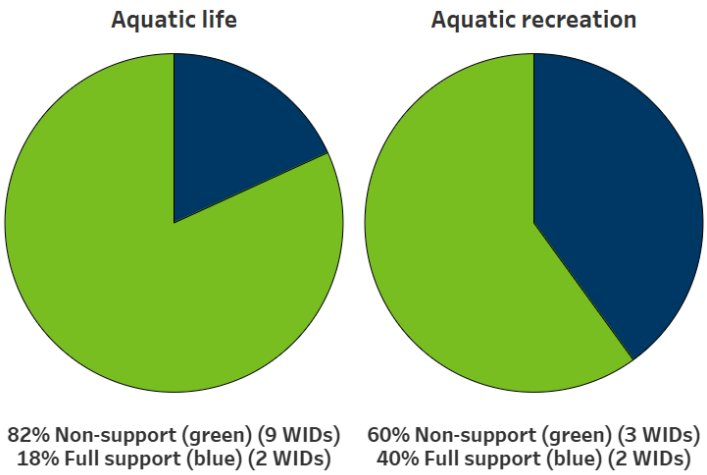
Streams and rivers

Overall, about one-fifth of the stream reaches that have been assessed in the Sand Hill River Watershed support aquatic life (Figure 2). The Sand Hill River from Fertile through Climax supports healthy fish and macroinvertebrate communities, but many other areas exhibit signs of degradation characterized by a dominance of pollution-tolerant species.

The headwaters of the Sand Hill River mainstem, near Fosston are ditched, which likely contributes to impairments for dissolved oxygen and macroinvertebrates. Moving downstream towards Winger and Rindal, there are additional impairments for elevated levels of bacteria (*E. coli*), increased sediment levels (turbidity), and for poor fish assemblages. The section of the Sand Hill River near Fertile has better water quality and is only listed as impaired for *E. coli* and suspended sediments. This is also the section of the Sand Hill River where improvements have been documented in the fish communities because of fish passage improvements. West of Fertile, the

Sand Hill River is ditched for 17 miles. This stretch is impaired for *E. coli* and Mercury (in fish tissue) and historically has had degraded water quality documented, including high turbidity and more recently, increased flooding and channel instability. The downstream most section of the Sand Hill River, near Climax is a natural channel with healthy biological communities, although turbidity, *E. coli*, and Mercury remain problematic in that stretch. Monitoring data from Kittleson Creek, several small tributaries to the Sand Hill River, and various ditch networks within the watershed is largely limited to biological monitoring for fish and macroinvertebrates. Results can be seen on figures 2 and 4.

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



Suspended sediments (TSS/turbidity), low dissolved oxygen, and elevated bacteria (E.coli) were the primary chemical impairments found throughout the watershed. Land use is predominantly row crop agriculture, which could be driving some of the sediment issues seen in the middle and downstream reaches of the Sand Hill River. Very slow flow and wetland conditions in the Winger area seem to be driving some of the dissolved oxygen problems observed in that section of the river. *E. coli* issues are sporadic in the upper half of the watershed but are more prevalent in the lower half.

Lakes

There were 12 lakes within the Sand Hill River Watershed that had some level of lake chemistry data collected as a part of cycle II monitoring. Four lakes fully support aquatic recreation (Sandhill, Union, Sarah, Kittleson) (Figure 3). This includes a delisting of a historic nutrient impairment on Kittleson Lake. There were no new aquatic recreation impairments on lakes in the watershed, although cycle II monitoring on Maltrud Lake confirms the existing aquatic recreation impairment for that system. Water chemistry monitoring also showed degrading conditions on Lake Sarah. There were seven lakes that had insufficient data to make an assessment for aquatic recreation. One lake of note in this category is Uff Lake. One year of assessed data (2023) is showing significantly improved conditions compared to cycle I. Additional data will be collected on this lake by the East Polk SWCD in 2024 and 2025 to conduct a full condition assessment to see if a delisting can be obtained.

New to this assessment cycle are aquatic life assessments based on fish communities in lakes. The development of a lake IBI along with the chemistry data provides a broader basis for examining overall lake health. Although this watershed contains numerous shallow lakes, only two lakes were eligible to be assessed for aquatic life based on fish IBI data. Other lakes in the basin were either

subject to natural winterkill events (e.g., Sand Hill) that adversely impacted fish, or were too small for the fish IBI to be appropriate. Of the two eligible lakes, Union Lake did not support aquatic life use (listed as impaired) and Lake Sarah was considered inconclusive, but vulnerable to future impairment. During the fish IBI surveys, 17 fish species were captured in Union Lake and 16 were captured in Lake Sarah. Among other metrics, the numbers of insectivore, vegetation dwelling, and intolerant species were below expectations when compared to similar healthy lakes. The primary stressors that are likely influencing these fish communities include shoreline development, aquatic habitat loss, and eutrophication.

Figure 3. Watershed assessment results for aquatic life and aquatic recreation in lakes.

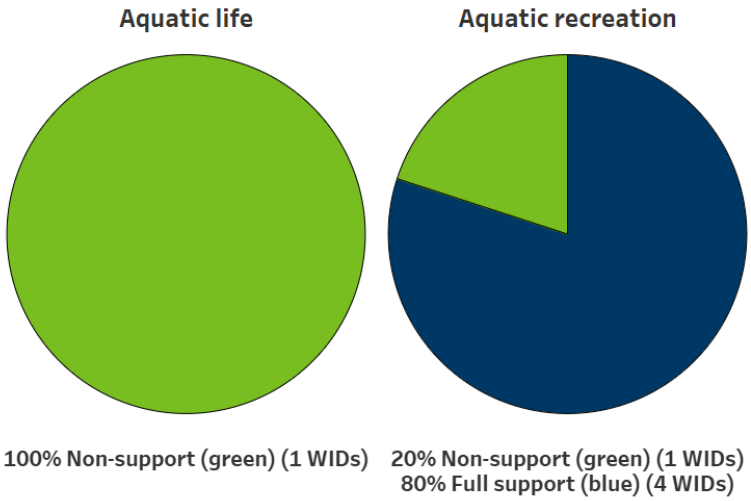
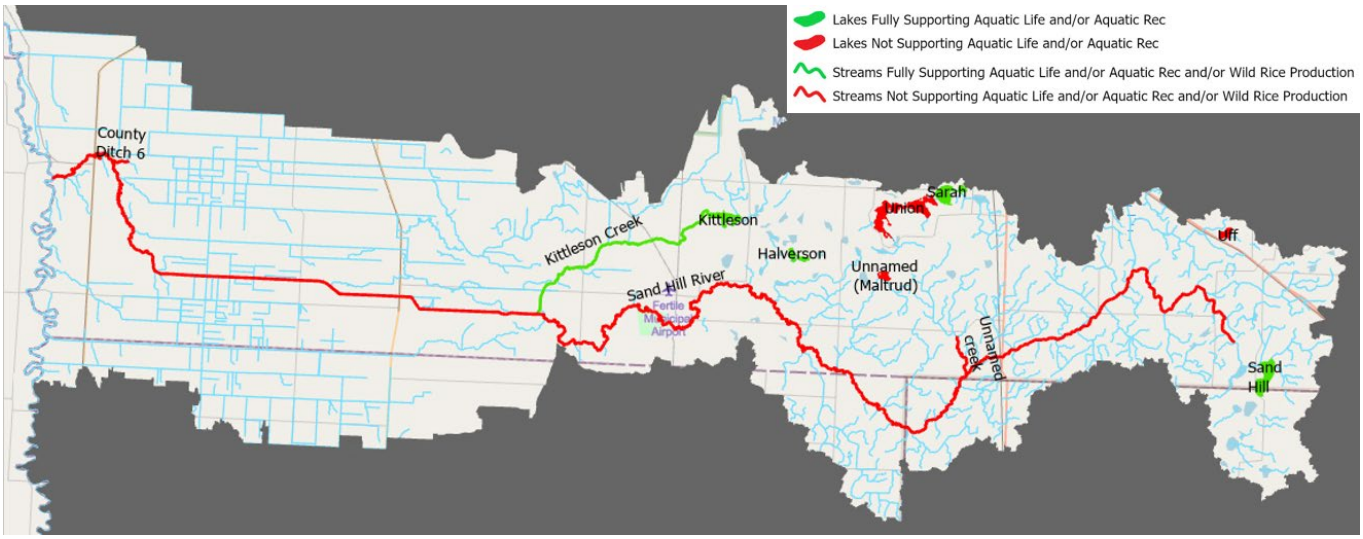


Figure 4. Assessment results for aquatic life and aquatic recreation on rivers, streams, and lakes.



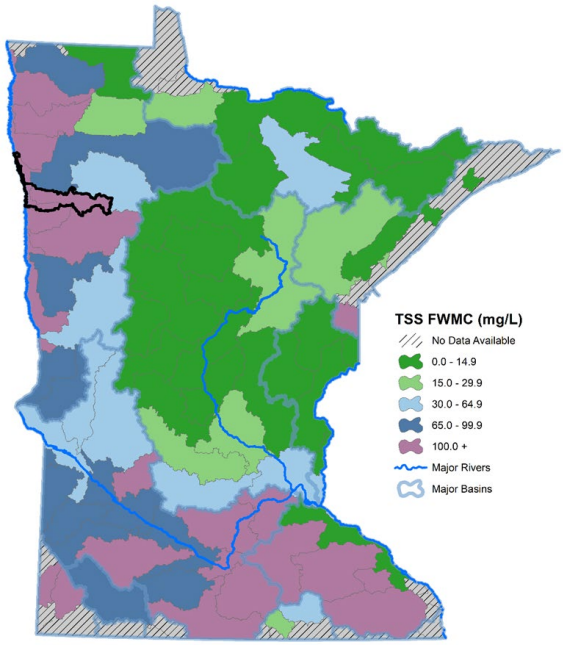
Trends

A key objective of the cycle II 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 a robust picture of what is happening in the Sand Hill River Watershed:

1) Streamflow, total suspended solids (TSS), total phosphorus (TP), and nitrate + nitrite nitrogen (NOX).
2) Biological communities
3) Clarity of lakes
4) Climate

Figure 5. Flow weighted mean concentrations (FWMC) for total suspended solids (TSS)



Streamflow and pollutant concentrations

In addition to the intensive monitoring completed every ten years, approximately 200 Watershed Pollutant Load Monitoring Network (WPLMN) sites are operational year-round across Minnesota. These sites are sampled intensively across a range of flow conditions for parameters that are known to affect water quality. There are currently two WPLMN sites located in the Sand Hill watershed. These sites are located on the Sand Hill River mainstem, near Fertile and in Climax. WPLMN sites allow for the calculation of flow weighted mean concentrations of various chemical pollutants. Suspended sediment concentrations throughout the watershed are quite high compared to other parts of the state (Figure 5). The value of +100 mg/L is among the highest values in the state. Similar maps for other pollutants and supporting data can be found at:

https://www.pca.state.mn.us/air-water-land-climate/watershed-pollutant-load-monitoring

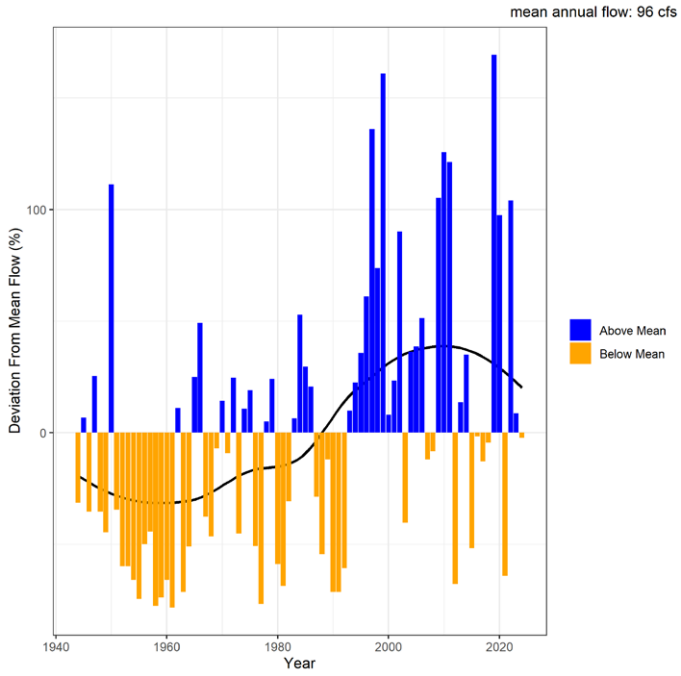
Annual streamflow (discharge) data is available for the Sand Hill River Watershed since 1943. There is an increasing trend in flow on the Sand Hill River (Figure 6).

With increasing streamflow in the Sand Hill River Watershed, there may be implications for stream channel conditions and pollutant loading in the future. Higher stream flow 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 measure helps us to understand the condition of downstream resources such as the Red River of the North, where these pollutants may accumulate.

A Seasonal Kendall trend test on total suspended solids (TSS), total phosphorus (TP), and nitrate + nitrite-nitrogen (NOX) concentrations at the Sand Hill River outlet was used to determine if changes over time were statistically significant. Results indicate that there is no statistically significant trend for any of these parameters, meaning that concentrations for these parameters have remained relatively stable over this time period.

Although there are no significant trends in pollutant concentrations in the Sand Hill River, it's helpful to understand how concentrations compare to other rivers around the state. NOX levels in the Sand Hill River are among some of the lowest in the state while TP and TSS rank towards the top compared to the rest of the state.

Figure 6. The percent deviation from normal flow over time at the Sand Hill River at Climax. 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 (96 cfs).

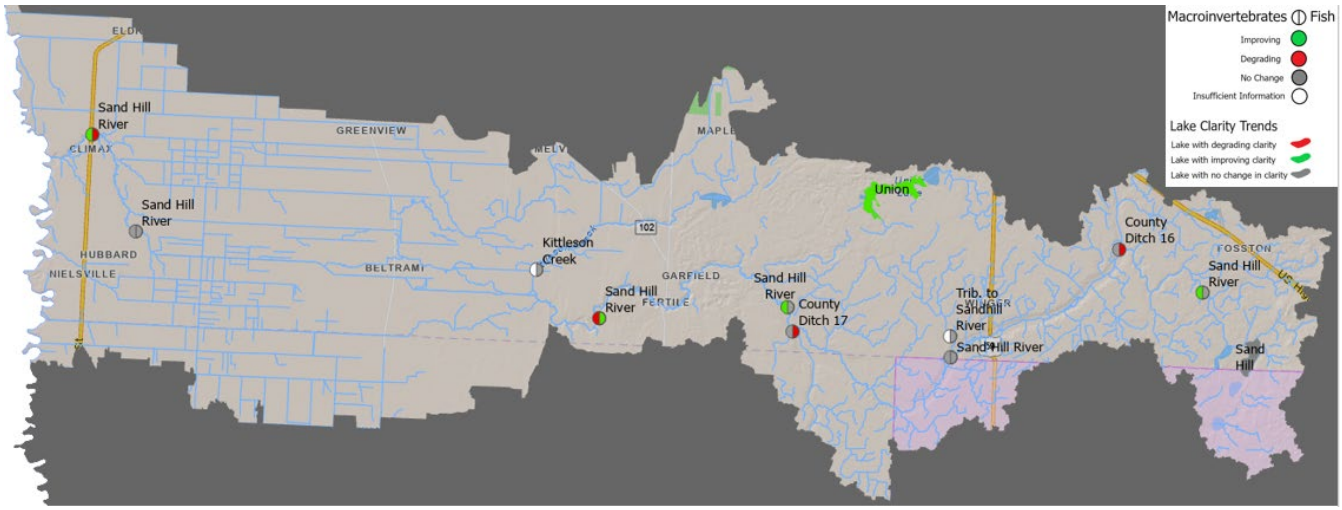


Biological communities

Paired t-tests of stream fish and macroinvertebrate IBI scores were used to evaluate if the biological condition of the watershed's rivers and streams has changed between time periods. Independent tests were performed on each community with eight sites evaluated for macroinvertebrates and 10 sites evaluated for fish (i.e., sites that were sampled in both time periods). The average macroinvertebrate IBI score for the watershed increased by 4.8 points between cycle I and cycle II, this however does not represent a statistically significant change. Fish IBI scores across the Sand Hill River Watershed decreased by 2.5 points, which was also not statistically significant. While the overall health of fish and macroinvertebrate communities across the watersheds did not change between time periods, biological condition at individual stream sites may have improved or degraded

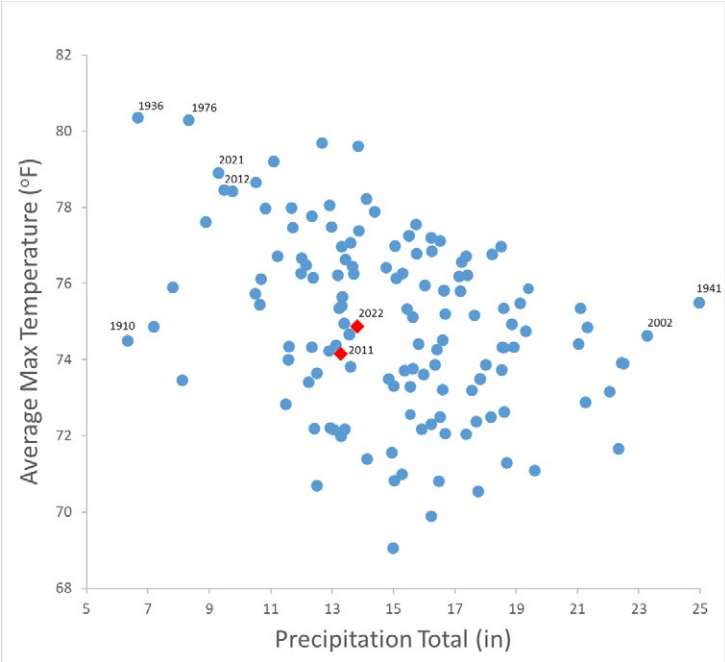
(± 10 IBI points)(Figure 7). A change analysis was not conducted for Lake fish IBI, as data was not collected in cycle I.

Figure 7. Change in water quality in the Sand Hill River Watershed.



Context for the change analysis results is provided by a characterization of the conditions under which biological monitoring occurred between monitoring cycles. In 2011, the Sand Hill River Watershed experienced a moderate rainfall deficit (-3.3 in) and had near normal temperatures (+0.1 ^{o}F) during the May to September time period (Figure 8). In comparison, the watershed also had a moderate rainfall deficit (-2.8 in) and near normal temperatures (+0.6 ^{o}F) in 2022 from May to September. Given the relatively similar conditions present during the summer months of each biological monitoring year, there is a low probability 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. It should be noted, however, that several stream biological community samples were collected in the summer of 2023, which experienced a significant drought with a rainfall deficit of ~6 inches and temperatures ~4.5 ^{o}F above normal from May to September of that year. Some of those samples were incorporated into the IBI change analysis for macroinvertebrates and fish.

Figure 8. Characterization of air temperature and rainfall conditions for May-September period across the historical record (1890-2023) of climate data for the Sand Hill River Watershed. Red diamonds = IWM years.



Clarity of lakes

The Sand Hill River Watershed has 11 lakes with some level of transparency data in cycle II. Trend analysis was conducted on two lakes that met data requirements (50 Secchi measurements, eight years of data). Union Lake showed increasing clarity, while Sarah Lake showed no significant trend in clarity.

Climate

The Sand Hill River Watershed now receives on average 1.1 additional inches of rain from the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense both statewide and in the Red River Basin. In addition, temperatures in the watershed have increased by about half a 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 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 Sand Hill River Watershed.

For more information

This study of the Sand Hill 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 report 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 Sand Hill 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 Sand Hill River webpage, or search for "Sand Hill River" on the MPCA website. For water quality data see MPCA's Surface Water Data program https://webapp.pca.state.mn.us/surface-water/search or the updated impaired waters list at https://www.pca.state.mn.us/air-water-land-climate/minnesotas-impaired-waters-list.

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