Watershed assessment and trends update

North Fork Crow River

Upper Mississippi River Basin

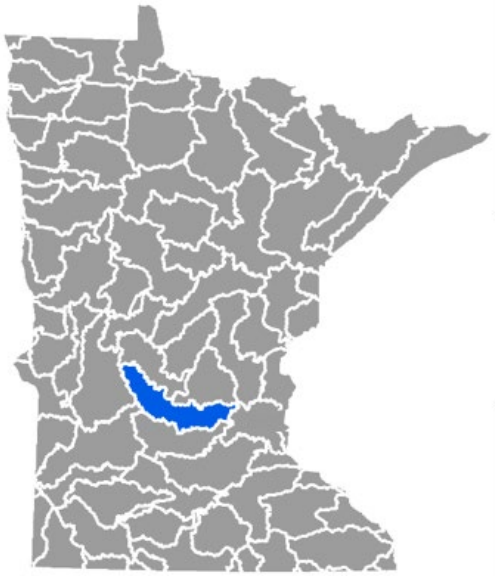
Why is it important?

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 (DNR) in conducting intensive monitoring of the lakes and streams in each of the state's 80 watersheds. This intensive monitoring looks at fish and aquatic insect (macroinvertebrate) communities as a measure of aquatic life health, in addition to water chemistry, to evaluate water quality. Agency staff and local stakeholder partners 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-ground work.

Waters in the North Fork Crow Watershed are an important resource for economic and recreational uses like fishing, swimming, hunting and other leisure.

Is the water quality improving?

Overall, scientists observed some change in water quality in the North Fork Crow River Watershed over the past decade. In general, the health of aquatic communities in the streams and rivers within the North Fork Crow River watershed have improved a small but noticeable amount since 2007. In the streams and rivers of the watershed, modest improvement within the biology was observed. As for water chemistry, little change was observed throughout the watershed, but phosphorus was decreasing at the mouth of the Crow River. Lakes within the watershed appear to be trending in a positive direction for clarity, as more lakes had increasing clarity than lakes with decreasing clarity. Although some parameters are showing a positive trend, continued problems include high nitrate and phosphorus levels, and low dissolved oxygen levels. Overall water quality is poor for aquatic life and recreation.



The North Fork Crow Watershed is in central Minnesota.

There is good news for the North Fork Crow River watershed as the assessment process has been effective in helping to identify sensitive areas in the watershed:

- The MPCA, DNR, and partners identified several lakes that support aquatic recreation, and healthy fish communities. Thirteen lakes were identified as a high priority for protection, Rattail, Spencer, Koronis, Martha, Uhl, and Sullivan lakes due to phosphorus, and Manuella, Minne-Bell, Rice, Charlotte, and Emma lakes due to vulnerable fish communities, while Nest and Ripley lakes vulnerable to phosphorus and fish communities are showing signs of stress.
- Grove Lake, the headwaters of the North Fork of the Crow River, has shown improvements in both fish Index of Biological Integrity (IBI) scores (>20 point increase in IBI from to 2012-2017) and nutrient reductions. A trend line of the historical phosphorous data suggests a decrease in concentrations over the last two decades, but data are noticeably lower and less variable starting in 2013.
- The fish community in Nest Lake is vulnerable to future aquatic life impairment based on the Fish Index of Biological Integrity (FIBI) for lakes, and although the lake is impaired for nutrients, new seasonal means are near the standard.
- The North Fork Crow River upstream of Paynesville, in photo at right, supports high-quality fish and insect communities, including several fish species that are intolerant of pollution (e.g. smallmouth bass). This long river stretch should be protected so the communities can continue to thrive.
- Jewitts Creek, in photo at right, was once impaired by ammonia, which is toxic to aquatic life, but improvements in wasterwater treatment methods significantly decreased the ammonia level, resulting in the creek now meeting the water quality standard for ammonia. Although the improvements have reduced ammonia levels, the aquatic life in the creek has not yet fully recovered, as this will take time.

The North Fork Crow upstream of Paynesville needs protection to sustain high-quality populations of fish and bugs.

Jewitts Creek now meets the ammonia standards thanks to improvements in wastewater treatment.

Highlights of monitoring

- Flows in the North Fork Crow River and tributaries are increasing as a result of both artificial drainage and increased rainfall. Increasing streamflow has implications for stream channel conditions and pollutant loading, namely more channel/bank erosion and risk of increased pollutant loading, even if pollutant concentrations are stable.
- Over half of the fish communities within the lakes did not meet standards designed to protect aquatic life, and most of the fish communities in the streams and rivers did not meet standards. Aquatic insects show moderate signs of stress when averaged over the entire watershed.

Sediment building up in Kandiyohi Ditch 37 is degrading habitat for fish, leading to a sharp decrease in fish species.

- Kandiyohi County Ditch 37, in photo at right, showed a decline in biological condition between 2007 and 2017. Half of the fish species captured within the 2007 sample were absent in 2017. Habitat has degraded due to sediment buildup in the stream. Pools that were found within County Ditch 37 in 2007 are now nearly absent, a result of the extra sediment.

Success story: Waverly Lake

Waverly Lake was once impaired due to excess phosphorus, which causes algae blooms and reduced opportunities for recreation. A collaborative effort between the Waverly Lake Association, City of Waverly, the Wright Soil and Water Conservation District and area land owners lead to actions on the ground, which improved lake quality. Lake residents took on shore land improvements, area farmers installed projects to limit soil erosion, and the city restored shoreline at a city park. As a result, the lake is now meeting standards for recreation. For more information, see this story on the MPCA website: www.pca.state.mn.us/featured/farm-city-collaboration-helps-waverly-lake.

Lake residents, area farmers and other partners took action to reduce phosphorus and improve water quality in Waverly Lake.

About this study

The North Fork Crow River watershed is located in an ecological transition zone in Minnesota. Agriculture land uses dominate much of the watershed (particularly western regions), but transitions into suburban and even urbanized areas as you approach the Twin Cities Metropolitan Area to the east. The MPCA and local partners monitored water quality conditions in 2007-2008 and again 10 years later in 2017-2018. Additional chemistry data collected by local partners between 2008 and 2018 were also used for assessment. These data are used to assess the condition of Minnesota waterbodies, which is focused on whether or not waterbodies are meeting water chemistry, aquatic life, recreation, and consumption standards. The overall goal of these assessments is to ultimately determine which waters are healthy, are in need of protection, or are polluted and require restoration. In addition to the 10-year monitoring cycle, there are four Watershed Pollutant Load Monitoring Network (WPLMN) stations that operate every year on a long-term basis. One of these stations is located at the mouth of the North Fork Crow River; the others at upstream locations. The long-term nature of these stations is critical for trend analysis, measuring between-year differences in pollutant loading, and helping determine pollutant sources and their contributions.

The IBI is a tool that is used to measure a lake, stream, or river's health, utilizing aquatic communities. Fish and aquatic insect IBIs are used by the MPCA in streams and rivers. The DNR) uses a similar IBI tool for assessing aquatic life in lakes, using fish communities. Between the first and second rounds of biological monitoring in the North Fork Crow River watershed the MPCA adopted new rules to assess aquatic life in channelized streams and ditches (https://www.pca.state.mn.us/water/tiered-aquatic-life-uses-talu-framework).The new rules provide reasonable aquatic life protections for waterbodies that were legally altered prior to the advent of the Clean Water Act. As a consequence of the new rules, the most recent assessments include aquatic life use designations and assessment results for 17 legally altered streams segments.

In the North Fork Crow River watershed, fish communities generally do not meet standards designed to protect aquatic life. While stream reaches and lakes in the upper portion of the watershed have fish communities that are in good condition, in the lower portion the majority of

streams and lakes have fish communities that are severely degraded (Figure 1, Figure 2). In general, fish communities in the watershed exhibit signs of degradation characterized by a dominance of pollution tolerant species. Most of the lakes with poor fish communities exhibited high watershed disturbance rates, nutrient impairments for aquatic recreation, known infestations of aquatic invasive species, and low to moderate shoreline habitat quality. Lakes with healthy fish communities typically were not nutrient impaired, had lower rates of watershed disturbance, and moderate to high shoreline habitat quality.

Aquatic insect communities tended to be in better condition in the larger rivers but still exhibited significant signs of stress in the smaller streams and headwater reaches. Overall, aquatic insect communities exhibit moderate signs of stress when averaged over the entire watershed.

Although several new impairments have been identified within the North Fork Crow River watershed, for both fish and aquatic insect communities, some of the existing impairments are being corrected. Newer data collected in 2017 has indicated that the previous listings for aquatic insects within five stream reaches and one listing for fish were incorrect. This may have been a result of low water levels during the 2007 sampling or differences in aquatic insect habitat availability. The correction for the fish impairment is a result of improved standards, and the result of additional monitoring that indicated that these reaches met standards.

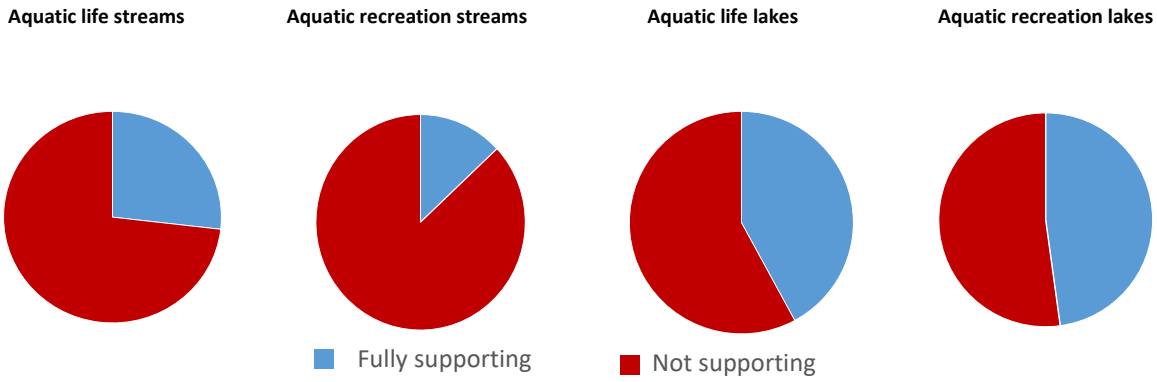


Figure 1. Watershed assessment results for aquatic life in streams and aquatic recreation in streams and lakes.

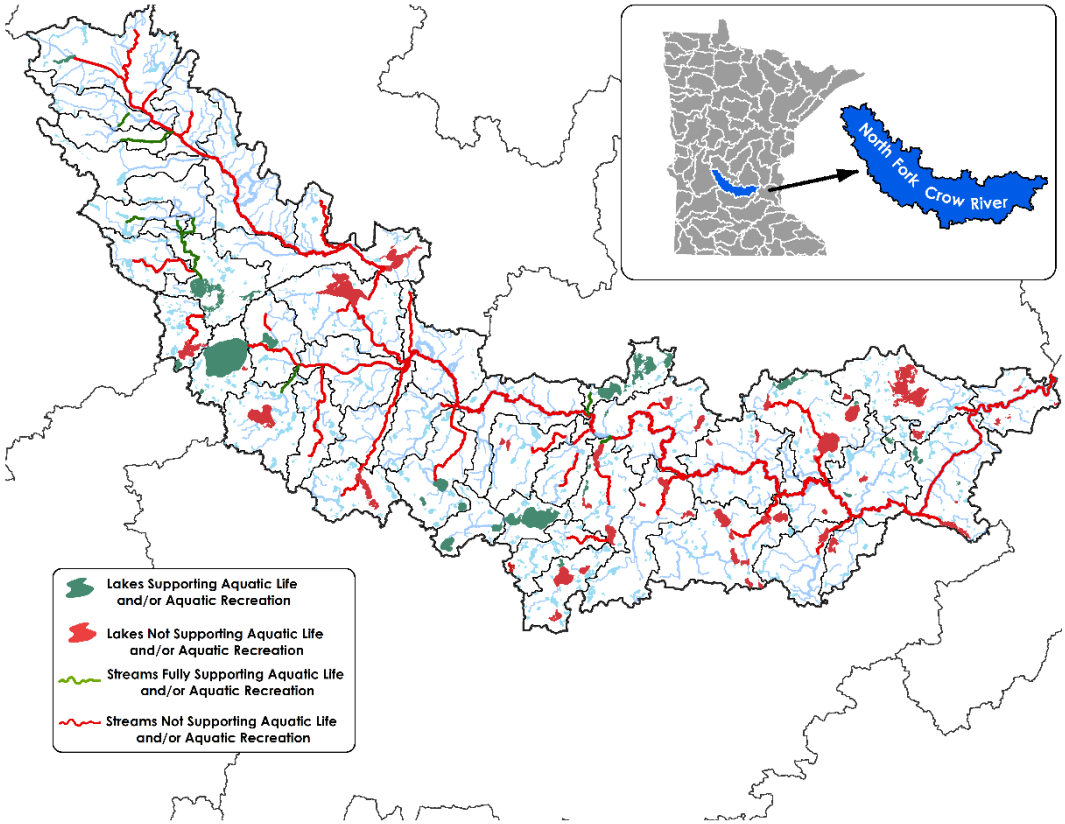


Figure 2. Assessment results for aquatic life and aquatic recreation on rivers, streams, and lakes.

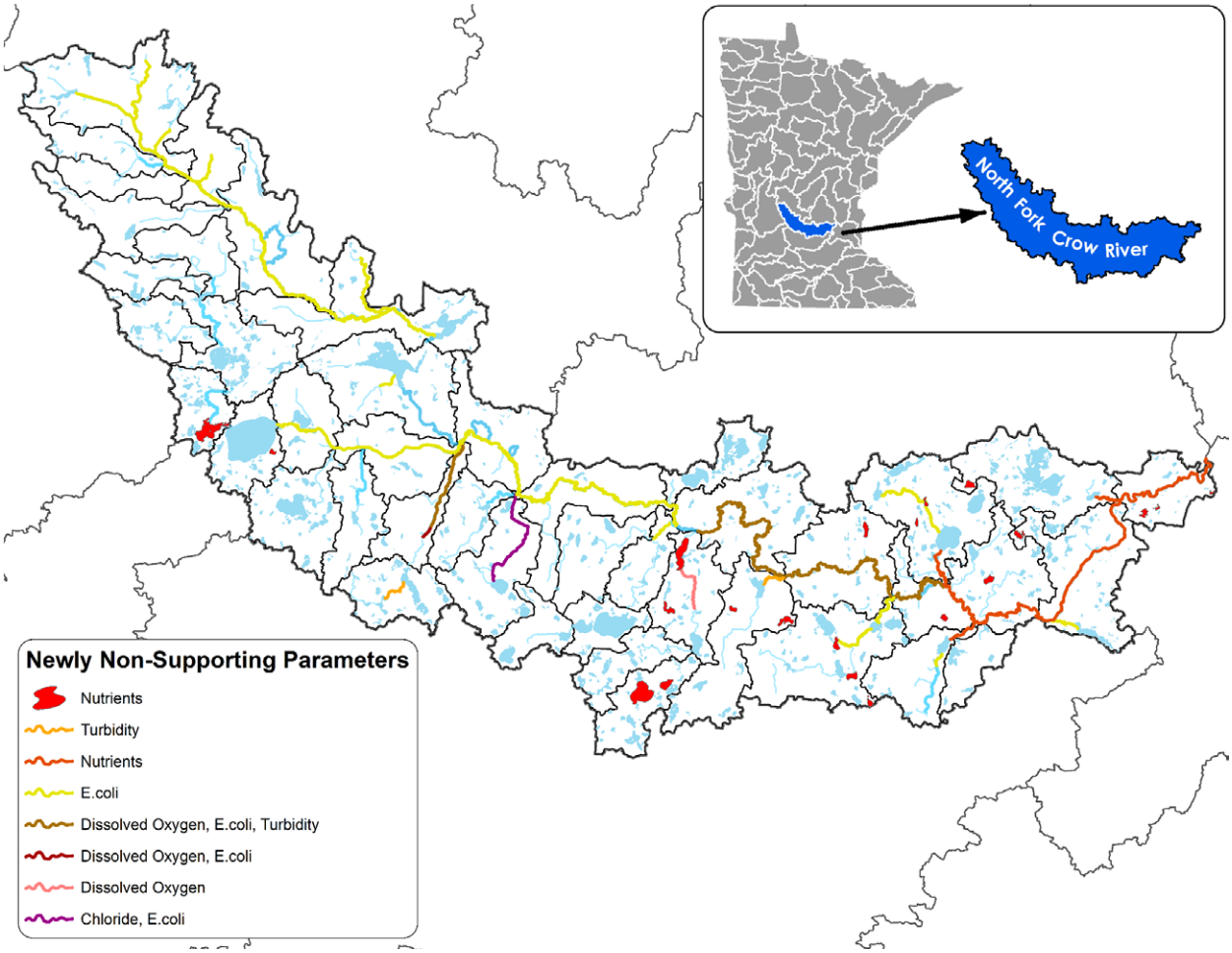


Figure 3. Newly non-supporting non-biological parameters within the North Fork Crow River watershed.

In the North Fork Crow River Watershed, elevated nutrients, bacteria, and low dissolved oxygen were prevalent across the watershed. New impairments for bacteria were added along nearly the entire extent of the North Fork Crow River and several tributaries. As a part of the statewide assessments for nutrients in 2015, impairments were added in the lower portion of the watershed. Mill Creek and the North Fork Crow River downstream of Mill Creek exceeded nutrient levels and had elevated algae in the river; an additional impairment for nutrients was Regal Creek in the most recent assessment.

Suspended sediment becomes problematic in the downstream portions of the watershed as well. Relative to other major watersheds in Minnesota, cumulative water quality conditions (i.e. as measured at the mouth of the North Fork Crow River) reflect the transitional nature of the watershed. Ten-year average water runoff and levels of the pollutants (suspended solids, phosphorus, and nitrate nitrogen) fall mid-way between those seen in other parts of the state. Figure 4 shows statewide monitoring results for total phosphorus (TP). Similar maps for other pollutants and supporting data can be found at https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring.

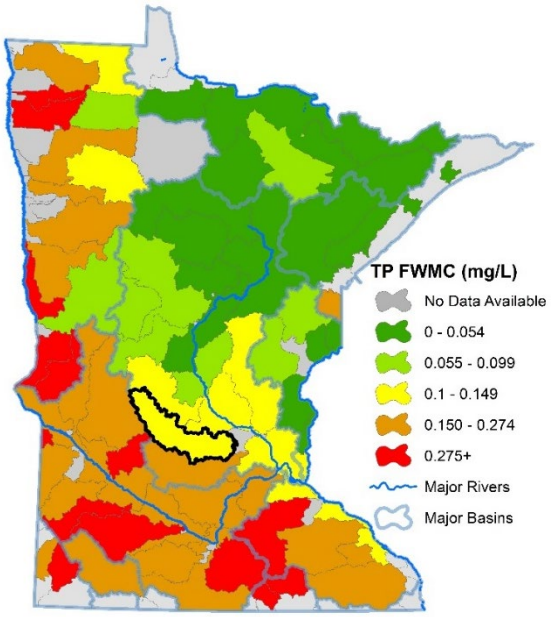


Figure 4. Average total phosphorus flow weighted mean concentrations (FWMC) by major watershed. The North Fork Crow watershed is outlined in black.

In addition to the WPLMN site at the mouth of the North Fork Crow River (that has been operating annually since 2009), there are three subwatershed-scale sites that have been operating since 2015. Based on results from these sites, we now understand that nitrate nitrogen concentrations are highest in waters draining the western part of the watershed, while total phosphorus and sediment concentrations increase from west to east across the watershed. Water quality impacts of the North Fork Crow River on the Upper Mississippi River basin is greatest for total phosphorus. The average phosphorus load from the North Fork Crow River is the equivalent of 5% of the average load measured at Lock and Dam 3. Lock and Dam 3 is the furthest downstream monitoring site on the Mississippi River above Lake Pepin (monitored by Metropolitan Council Environmental Services). Suspended sediment and nitrate nitrogen inputs from the watershed have a lesser impact with both pollutants the equivalent of 1% of the average load measured at Lock and Dam 3.

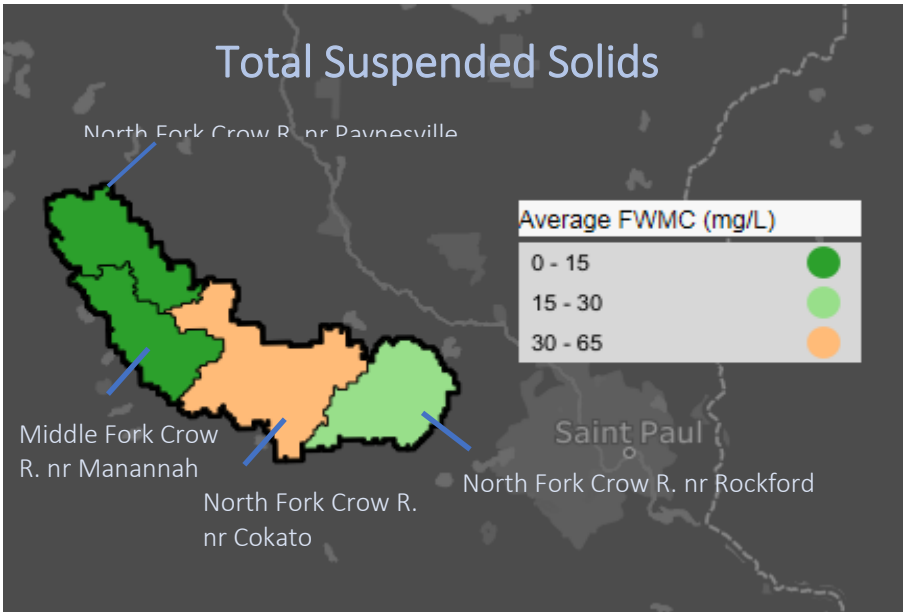


Figure 5. Average total suspended solids flow weighted mean concentration for the North Fork Crow River subwatersheds.

The watershed has approximately 80 publically accessible lakes. Over half of these lakes are considered impaired for nutrients, with excessive algae blooms in the summer months reducing recreation opportunities. Several of the lakes are large, flow-through lakes; Rice and Koronis lakes on the North Fork Crow River and Nest and Green lakes on the Middle Fork Crow River. In general, headwaters lakes, deep lakes, and those in smaller, more forested subwatersheds were meeting standards. Examples include Green Lake in Kandiyohi County, Lake Koronis in Stearns County, and Lake Charlotte in Wright County. Lakes with intensively developed watersheds, either agricultural or urban, and shallow lakes are more likely to be impaired, such as Jennie, Hope and Long lakes in Meeker County, and Howard and Buffalo lakes in Wright County.

Trends

A key objective of the 2017 monitoring effort was to evaluate if and how water quality has changed since 2007. 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. In any matter, this knowledge will help inform future activities in the watershed.

Trends in four different aspects of water quality were analyzed to provide as robust a picture as possible of what is happening in the North Fork Crow River watershed:

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

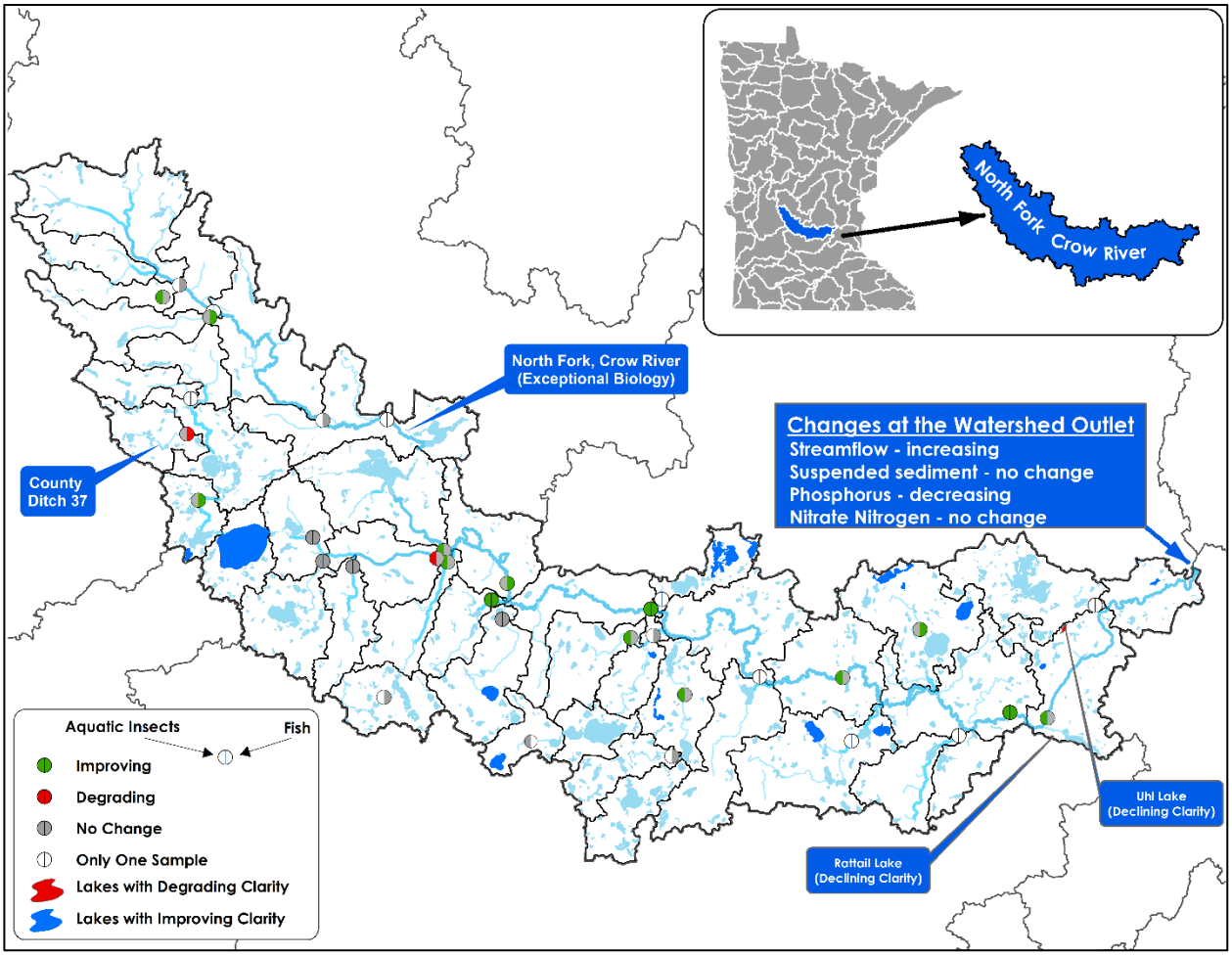


Figure 6. Water quality trends in the North Fork Crow River watershed.

Streamflow and pollutant concentrations

Annual streamflow (discharge) data is available for the North Fork Crow River watershed since 2009. In that time period, there is no clear trend; although 2016 and 2017 were the highest flow years since 2011. A much longer data record exists for the Crow River downstream of the confluence of the north and south forks. There is an increasing trend in flow on the Crow River; it is not possible to know which fork more strongly influences this trend (Figure 7).

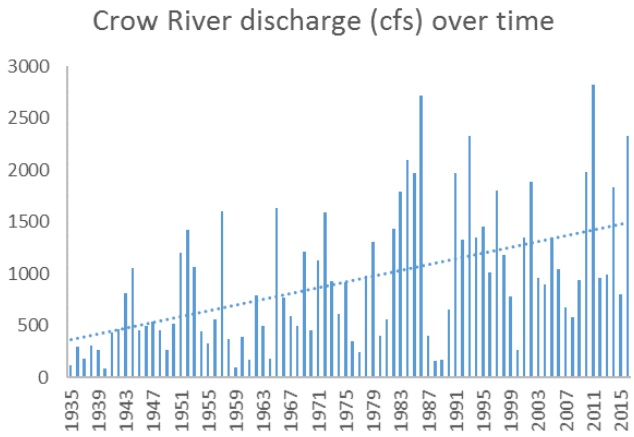


Figure 7. Crow River annual flow (cfs).

Seasonal Kendall trend tests on suspended sediment, phosphorus, and nitrate nitrogen concentrations at the North Fork Crow River outlet were used to determine if changes over time were statistically significant. Only total phosphorus showed a statistically significant change, decreasing about 4% each year. Suspended solids and nitrate nitrogen concentrations are neither increasing nor decreasing according to the test.

As noted previously, there is not a long-term streamflow record for the North Fork Crow River. However, streamflow is clearly increasing in the main stem Crow River, which suggests that flows are likely increasing in the North Fork as well. Increasing streamflow has implications for stream channel conditions and pollutant loading, namely 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 Lake Pepin and the Mississippi River, where these pollutants may accumulate.

Fish and aquatic insect communities

The overall change in the health of aquatic communities in rivers and streams was measured by studying the difference in fish and aquatic insect communities of the North Fork Crow River watershed index of biological integrity scores between time periods. Although waterbody assessments were monitored at 41 stations in 2007 and again in 2017, assessments were not conducted on channelized streams during the first assessment cycle. However, index of biotic integrity scores for channelized streams were calculated allowing for a direct comparison of channelized and unchannelized streams between time periods. In general, the stream biological communities of the North Fork Crow River watershed have improved a small amount since 2007.

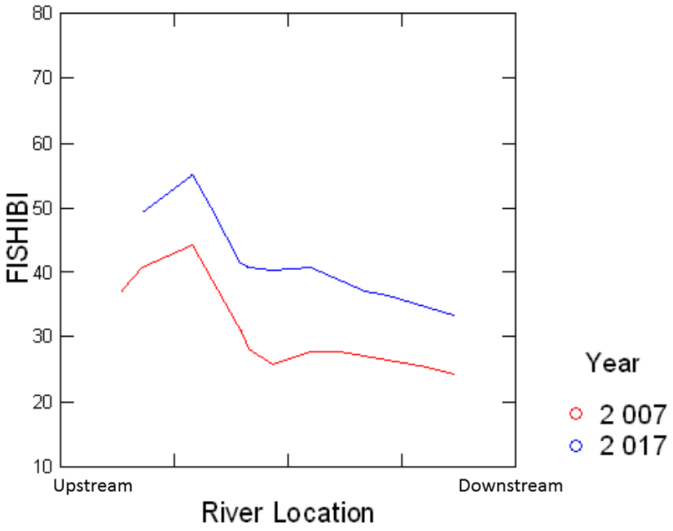


Figure 8. Fish index of biotic integrity scores on the Crow River, North Fork, 2007 vs. 2017. Lines were statistically smoothed (LOWESS) through the data from each year.

The average aquatic insect index of biotic integrity score for the watershed increased by 8.0 points between 2007 and 2017. The average fish index of biological integrity score for the watershed increased by 5.8 points between 2007 and 2017. On the main stem North Fork Crow River, an increase in fish index of biotic integrity score from 2007 to 2017 is apparent (Figure 8).

Looking beyond index of biotic integrity scores to the underlying structure and function of biological communities, it is noteworthy that pollution-sensitive organisms (both fish and aquatic insects) have increased in these streams since 2007; this is a sign that water quality may be improving. In 2017, the average fish community of streams in the watershed included 13% sensitive fish species, an increase from 8% that was observed in 2007. However, the summer of 2007 was characterized by drought conditions; low streamflows, warm water temperatures, and poor dissolved oxygen conditions associated with the drought may also have contributed to the lower percentages of sensitive fish and aquatic insect species that were observed in 2007 (Figure 9). Droughts tend to have a larger impact on smaller tributary streams, and could explain the larger changes in IBI scores on the tributary streams within the North Fork Crow watershed.

Overall, stream health in the watershed has improved only a small amount since 2007. However, there did appear to be a consistent and significant improvement in the main stem of the North Fork Crow River.

Clarity of lakes

The North Fork Crow watershed has approximately 250 lakes, several of which are large, flow-through lakes on the river (e.g. Rice, Nest, Koronis, and Green). About half of the lakes have some level of water quality data, much of which come from volunteer monitors participating in the Citizen Lake Monitoring Program.

Trend analyses were conducted on 83 lakes in the watershed that had sufficient data (i.e. 50 Secchi measurements and a minimum of 8 years of data). Similar to statewide results, most lakes do not exhibit a trend, and more lakes are improving in clarity than declining. Two small, shallow lakes in the watershed, Rattail and Uhl, had decreasing clarity trends. Nineteen lakes had improving clarity, including Pulaski, Green, East and West Sylvia, Waverly, and Minne-Belle.

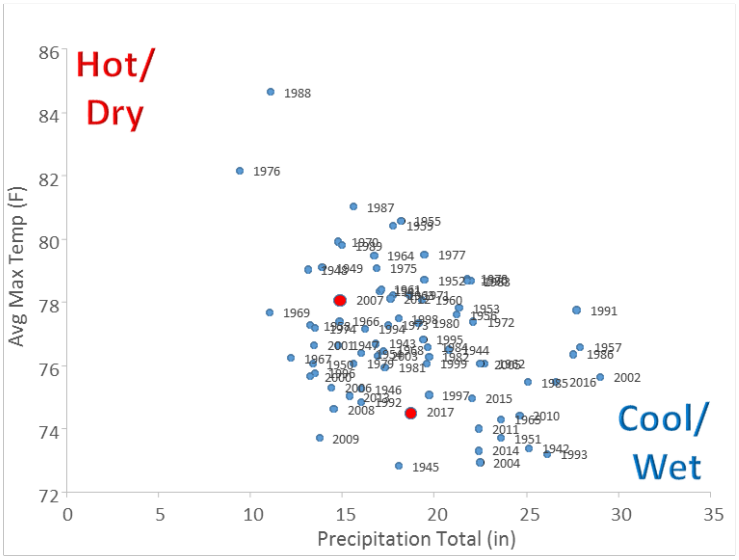


Figure 9. Characterization of air temperature and rainfall conditions for May-September period across the historical record for the North Fork Crow River watershed. IWM years highlighted in red. Temperature data from Litchfield Coop monitoring station (Source: https://wrcc.dri.edu/summary/mnF.html).

Climate

The North Fork Crow River watershed now receives on average three additional inches of rain in the northwest to two additional inches of rain in the east portion of the watershed from the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense. In addition, temperatures in the watershed have increased by 1.2 degrees 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 streamflows. Increased streamflows 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.
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/climate_summary_major_18.pdf

For more information

Stressor identification for new impairments and updates to the Watershed Restoration and Protection Strategy (WRAPS) follow the completion of monitoring and assessment. For more information, go to North Fork Crow River | Minnesota Pollution Control Agency (state.mn.us) or search for "North Fork Crow River Watershed" on the MPCA website.

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