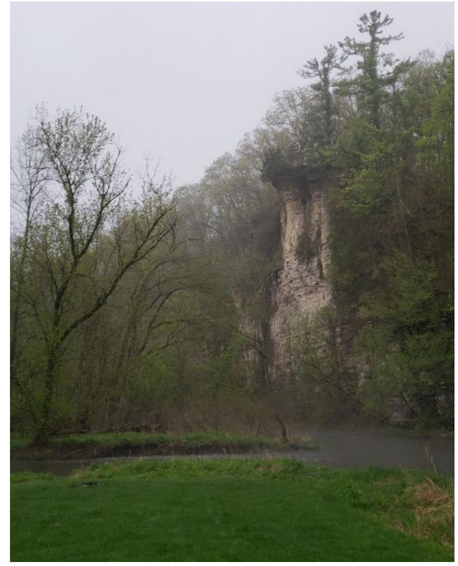


Root River Watershed

Root River Basin

Why is it important?

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 Minnesota Pollution Control Agency (MPCA) and local partners conduct an intensive exam of major lakes and streams in each of the state's 80 watersheds every 10 years to detect any changes in water quality. This intensive exam looks at fish and bug communities as well as water chemistry to gauge water quality. The partners use the data to see which waters are healthy and need protection and which are polluted and need restoration.

Long considered a gem of Minnesota, the Root River Watershed is multifaceted with stunning trout streams, scenic bluffs, and small farms and towns tucked in valleys. Crops and rangeland make up a large percentage of this watershed, and a lot of work is going to find innovative practices both healthy farms and waterways. Recreational visitors come to enjoy the fishing, winding bike paths, and small town charms. In a birds eye view of the watershed one could see the higher flat topography on the outer edges. Moving eastward and into the heart of the watershed, the topography and geology changes to bluff and Karst lands. The flat glacial till, bluff lands and Karst come together to make water quality a challenging puzzle. Each of these geological differences requires new and innovative approaches to monitor and understand water quality. With the complexities of this watershed, water monitoring has an important role in understanding how to maintain and improve water quality for generations to come.

Is the water quality improving?

Scientists use a tool called the Index of Biological Integrity (IBI) to assess the biological condition of aquatic communities. High IBI scores indicate healthy fish or macroinvertebrates communities, and a healthy community typically reflects healthy water quality, habitat, and hydrology. Often this is relatable to natural conditions that are undisturbed by human activities. 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. Overall, IBI scores for fish and macroinvertebrate communities averaged higher in 2018/2019 than in 2008. Macroinvertebrates had a more positive change than fish. Four reaches were delisted for macroinvertebrates and one was delisted for fish on Silver Creek. Full understanding for invertebrate IBI improvements are unknown. The progress for fish on Silver Creek is talked about in more detail below. In addition, two invertebrate listing were removed due to updated criteria and additional information. Though in many places we saw higher scores, many biological impairments were re-affirmed and two streams moved from deferred to impaired (Jordan and Bloody Run Creeks). Jordan Creek was only listed for macroinvertebrates, Bloody Run Creek was listed for both fish and macroinvertebrates. An additional impairment was added on Corey Creek for fish likely from culvert issues.

Chemistry results showed little change from the first assessment period ten years ago. Dissolved oxygen (DO) concentrations still appear supportive of the fish and macroinvertebrate communities. Elevated concentrations of total suspended solids (TSS) and bacteria (*E. coli*) still persist throughout the watershed. Thompson, Riceford, Rice and Trout Run Creeks are vulnerable to future TSS listings according to current data, and they should all be given high protection considerations to help prevent higher sediment loads. Elevated nitrate concentrations in streams are an increasing concern in the central and western portions of the watershed. All of these issues are reflective of the agricultural practices that dominate the upland land uses.

Highlights of monitoring

- In cycle two 4992 trout were counted, 4681 of those were Brown Trout, 257 Brook Trout, 53 Rainbow Trout, and 1 Tiger Trout.
- 69 streams had biological data for assessments.
- Elevated nitrate concentrations indicate new Drinking Water Use impairments are needed on 10 stream segments, four of which are on tributaries to Watson Creek.
- Citizen Stream Monitoring Program (CSMP) transparency measurements were crucial for delisting parts of the Root River and discovers turbidity problems on Bear Creek.

Success story

Silver Creek

Figure 1. Silver Creek sampling photos from 2008 and 2019

September 2008 | **August 2019**

In 2007, the Silver Creek watershed experienced a massive rain event that resulted in a devastating flood. Biological monitoring was conducted the following summer in 2008. While the stream had a year to recover before being sampled, the unstable stream banks and abundant sediment supply were so greatly impacted by the flood that the entire stream reach was still completely filled in with sand. Both fish and invertebrate communities were listed as impaired. Though there have been large rain events since that time, the stream has started on a path to recovery. A follow up visit in 2011 showed a significantly recovered channel and a much better fish score. Over time habitat and channel morphology have improved, and with it the fish community. The 2018 fish sample was high enough to result in a delisting for fish impairment. The macroinvertebrate community scored relatively similar in 2018 as the 2011 sample. As a result, there is still an aquatic life impairment, but overall this stream is noticeably improving. Additional monitoring would be useful to see if the macroinvertebrate community improves.

Citizen science

Citizen science is an important source of data collection during the 'in-between years' where MPCA is not intensively monitoring the watershed. These volunteers can help us to identify trends or changes in water quality by simply taking a transparency tube reading every one or two weeks throughout the summers. Long-term transparency records are very useful in areas with TSS issues, like the Root River and its many cold water tributaries.

Watershed results

Figure 1 overviews the aquatic life and recreation assessments. Most of the aquatic life assessments are being driven by biological assessments for macroinvertebrates at 67 sites and fish at 64 sites. Over half of the locations, 36, were supporting aquatic life uses and 31 showed impairment for macroinvertebrates. Only 12 sites were non-supporting for fish communities, with three near impairment. Many biological assessments found in cycle one were re-affirmed in cycle two. Sections of Pine Creek, South Branch Root River, and two sections on the Middle Branch Root River were delisted for macroinvertebrates. Two macroinvertebrate listing were removed due to updated criteria and data from additional monitoring. Silver Creek was delisted for fish.

There were 10 new or updated aquatic life impairments, including one non-pollutant impairment. Bear Creek, Wadden Valley, and South Branch Root River all have new data that brought on new impairments. Wadden Valley Creek saw a fish score drop nearly in half from 2008. In the 2018 fish visit, samplers noted that the stream seemed unstable with points of heavy erosion and sediment filling in the stream. Comparing habitat scores there were increases in erosion and reduction in riffle amounts. Looking at the fish captured, there were not many fish at either visit. However, the 2008 sample included some sensitive species including one brown trout that were missing in the 2018 sample.

There were several sites that had data collected in 2008 but were differed due to channelization. Streams like Jordan and Bloody Run Creeks had were not assessable until TALU criteria was adopted into Minnesota's water quality standards. This framework allows channelized streams, to be assessed against reasonable aquatic life goals as long as they were legally altered prior to the start of the Clean Water Act. If a stream is modified and currently showing a habitat-limiting condition it is compared to a modified expectation. Jordan and Bloody Run Creeks are considered altered but not habitat limiting. Whereas the Tributary to Deer Creek, County Ditch 8, North Fork Bear Creek, Riceford Creek, and the Headwaters of the South Branch Root River are altered and habitat limited. Corey Creek had been sighted as having culvert issues impacting fish passage. A non-pollutant impairment was added because of evidence from other biological samples on Corey Creek with passing fish communities upstream of the culverts.

Thirteen previous listings for turbidity were confirmed with new TSS or Secchi tube data. Six new listings for TSS will be added to streams that already have at least one impaired biological community (Figure 2). High bacteria concentrations continue to be an issue. Fourteen previous listings for bacteria and one new listing (South Fork Root River) were confirmed with new *E. coli* data (15 total this assessment cycle; Figure 2). The distribution of impaired streams suggests that elevated bacteria concentrations are likely a problem watershed-wide.

Figure 2. Watershed assessment results for 2020- Aquatic Life and Aquatic Recreation percentages on assessed streams.

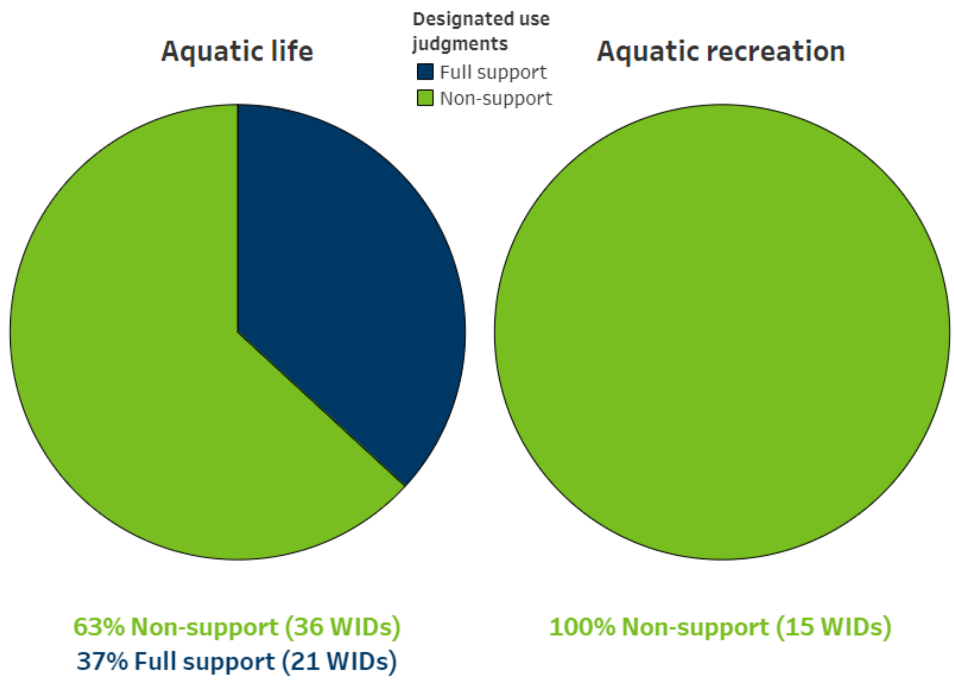
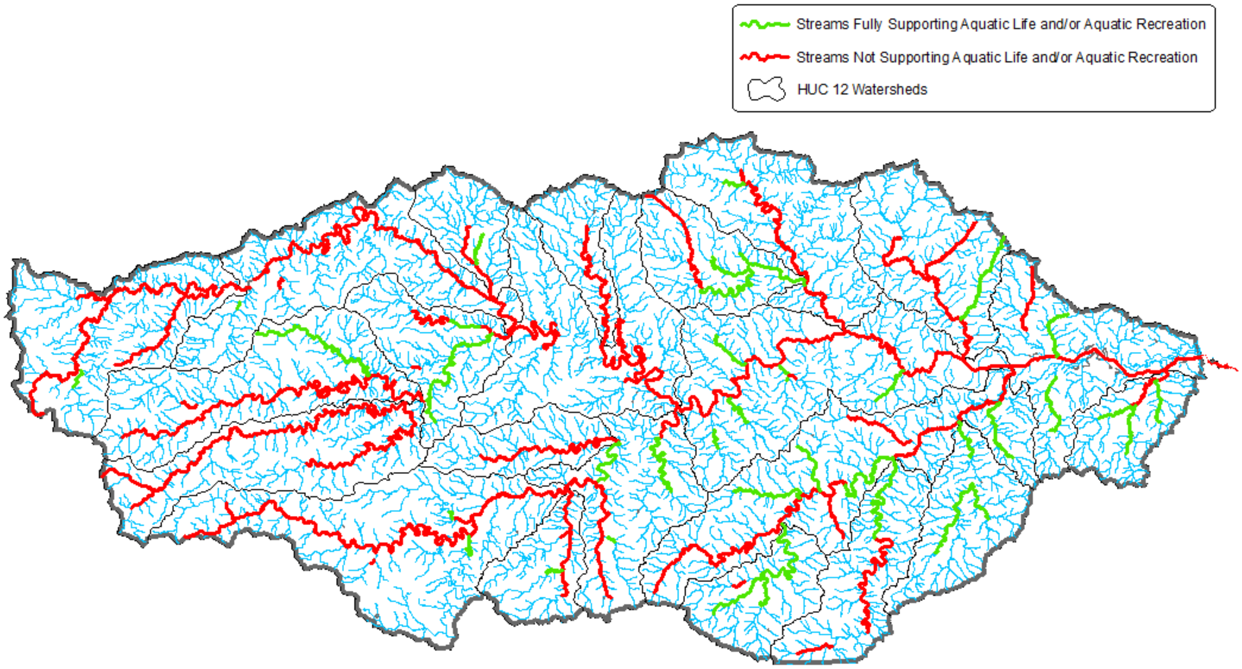


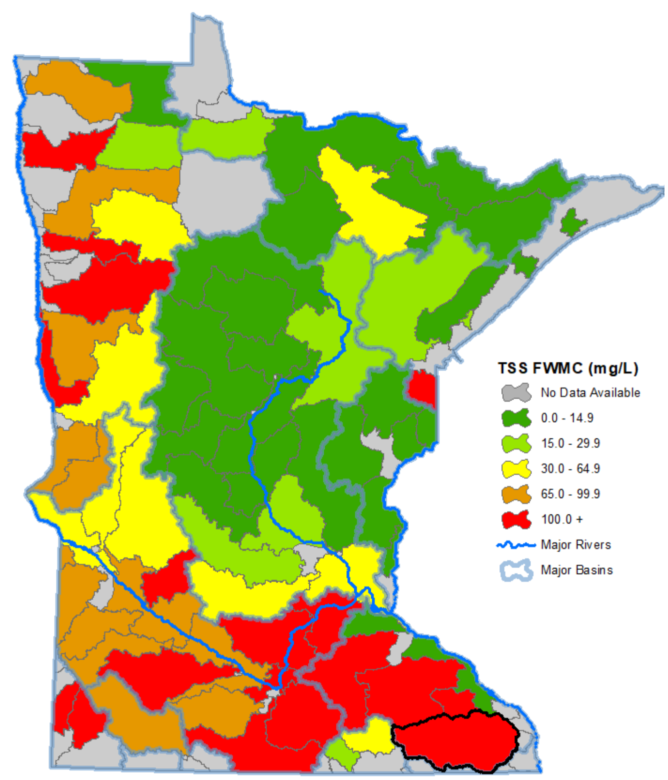
Figure 3 shows 2020 assessment results for both beneficial uses on one map. There are 21 stream segments that fully support aquatic life use (or about 150-rivermiles). Physical and biological impairments affecting aquatic life use were identified on 36 stream reaches, which brings the total up to 55 river/stream segments (or about 500-rivermiles). Impairments to recreational use are now listed on 22 stream segments (or roughly 250-rivermiles). An estimated 180-rivermiles have been assessed as impaired for both beneficial uses.

Figure 3. Map of assessment results for Aquatic Life and Aquatic Recreation on streams



In the Root River watershed, the ten-year average water runoff as well as levels of the pollutants (suspended solids, phosphorus, and nitrate) fall mid-way between those seen in other parts of the state. Suspended sediment becomes problematic in the downstream portions of the watershed. Relative to other major watersheds in Minnesota, cumulative water quality conditions (i.e. as measured at the mouth of the Root River) reflect the karst geology of the watershed. Figure 4 shows statewide monitoring results for total suspended sediment (TSS). 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. Statewide TSS concentrations by watershed



In addition to the annual site at the mouth of the Root River (in operation since 2009), there are five seasonal monitoring sites that have been operating since 2013. Based on results from these sites, nitrate concentrations are highest in waters draining the western subwatersheds, while total phosphorus and sediment concentrations are relatively stable from west to east across the watershed. Water quality impacts of the Root River on the Lower Mississippi River basin is greatest for total suspended sediment (TSS).

There are three primary landscape settings within the Root River watershed. The western portion is composed primarily of glacial till. The central portion contains Karst geology and the eastern portion is considered bluffland Karst. There are distinct water quality differences between the areas and vary by water quality parameter. The western portion of the watershed yields high nitrate concentrations as compared to the rest. The central portion is karst geology and has considerable ground and surface water interaction. Due to the geologic nature of

Karst, nitrate provide greatest threat to groundwater contamination. Bluffland Karst yields the highest sediment loss per acre due to steeper slopes and soil types. It should also be noted that the glacial till landscape has the highest amounts of surface water runoff within the watershed thus carrying additional sediment and phosphorus into the waterways.

When compared to the rest of the state, the Root River's average flow weighted mean concentration (FWMC) is 164 mg/L of TSS. Typically, the FMWC is less than 100 mg/L in dry years. The relationship between rainfall and TSS concentrations are indicative of overland runoff sources. Overall, these numbers are in line with the rest of the agricultural region in MN.

Trends

A key objective of the 2018-2019 monitoring effort was to evaluate if and how water quality has changed since 2008. 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.

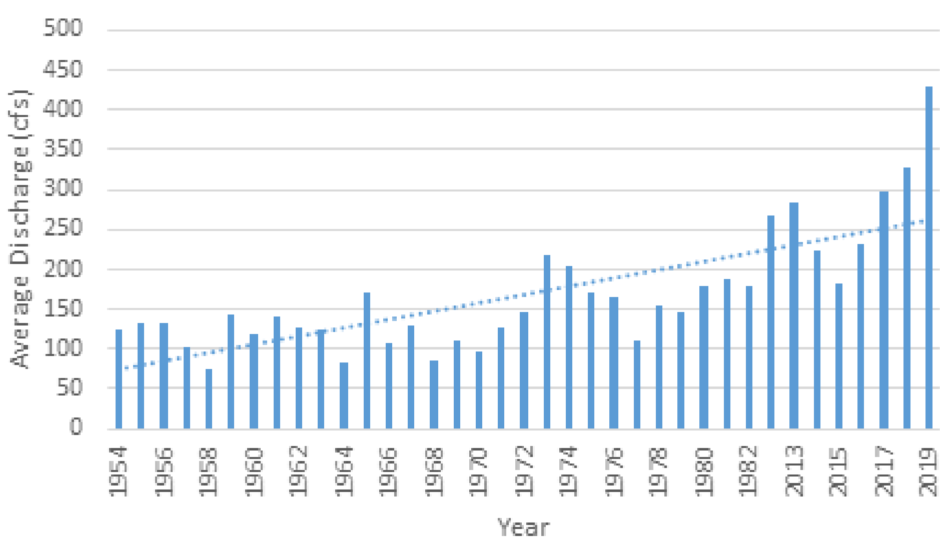
Trends in three different aspects of water quality was analyzed to provide as robust a picture as possible of what is happening in the Root River Watershed:

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

Streamflow, and the pollutants suspended solids, phosphorus, and nitrate

A trend analysis was performed for TSS, phosphorus, and nitrate concentrations, which was used to determine if changes over time are statistically significant. With limited data available, only a 10-year record was analyzed. TSS showed no significant change over the past ten years. However, phosphorous showed a decreasing trend. Nitrates showed no significant trend over 10 years but in the latter years it appears to be increasing. Average annual flow (Figure 5) has been increasing since 1954.

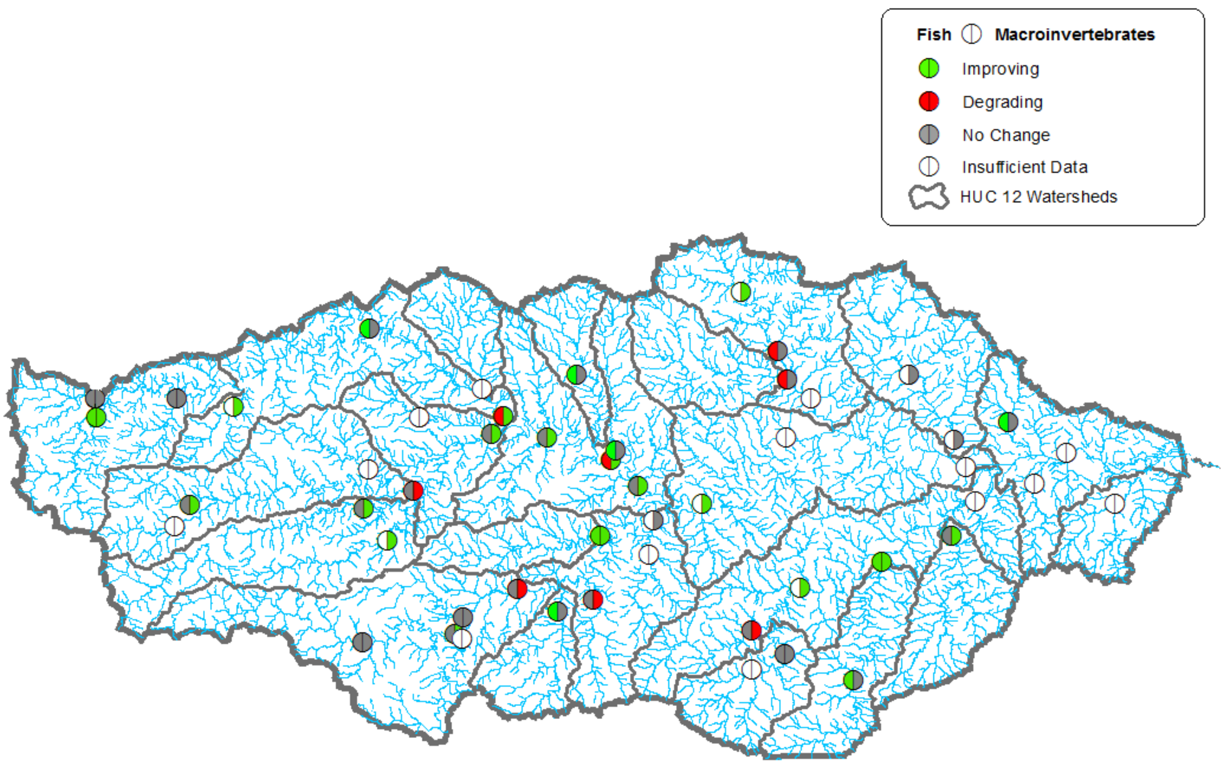
Figure 5. Average yearly discharge at the Root River



Fish and macroinvertebrate communities

Scientists used statistical testing methods, requiring site data from both 2008 and 2018-19, to detect changes for fish and macroinvertebrate communities. The average macroinvertebrate IBI score for the watershed increased by 6.1 points between 2008 and 2018-19, which is a significant difference. Similarly, fish IBI scores across the Root River watershed increased by 4.4 points, which was also a statistically significant difference. 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 or land use changes between the two periods. These difference can be seen in the map below (Figure 6), where each half circle is colored to indicate if IBI scores improved, degraded, no change, or we had insufficient data. Much of the insufficient data comes from the large rain events seen in 2018 and again in 2019. Most of these sites fell on larger waterbodies, which take more time to normalize after rain events. The improving and degrading colors mean there was a difference, but not that the samples are or are not impaired.

Figure 6. Biological difference between scores in time one and time two



In the Root River watershed, extreme weather events occurring before or during each watershed-monitoring year had dramatic impacts on conditions. Specifically, climatic conditions can affect stream aquatic life in a variety of ways such as altered flow, increased temperatures, decreased dissolved oxygen, habitat degradation, and changes to connectivity. However, it is difficult to make predictions of the impact of climatic conditions/weather events on stream aquatic life due to the specificity of possible responses that are dependent on the timing, magnitude, frequency and duration of events as well as the type of stream or biological community.

In 2008, the Root River watershed experienced a moderate to severe rainfall deficit (-2.5 in) from May to September. Then in 2018, the watershed had extremely high rainfall (+9.9 in) from May to September. Disentangling the influence of climatic conditions on the aquatic life of flowing waters in this watershed is not as simple as summarizing the prevailing conditions during each year. The rain events seem to be the biggest difference as both years the temperature remained close to average through May to September. Though 2008 saw less rainfall, the biological condition of rivers and streams in 2008 was likely impacted by two severe flooding events that in August of 2007 and June of 2008. In fact, the precipitation total for August 2007 is the highest estimated monthly total for any month across the entire period of record (1890-2018) in the Root River watershed. That three-day rain from August 18th to the 20th stands as 'one of the most significant rainfall events in Minnesota's climate history' (MNDNR Climate Journal – Heavy Rains Fall on SE MN: August 18-20, 2007). The devastating floods that occurred in 2007 were worsened by additional flooding the following June. The result was severe erosion, streams forging new channels, becoming extremely over-widened, or becoming deeply entrenched. Even though there was a rainfall deficit in 2008, it is likely that biological communities in rivers and streams were more impacted by the extreme flooding than the 2018 cycle. The 2018 cycle was impacted by increased rainfall, but the precipitation was consistently throughout the summer and extreme events were relatively isolated, resulting in prolonged periods when rivers and streams in the watershed were too high to sample fish and macroinvertebrate communities. A total of 21 stations could not be sampled for fish due to prevalent high water levels throughout southern Minnesota. Invert monitoring was successfully conducted in 2018 at all but a handful of stations on the Root River main stem that were too high to sample. Given the extreme flooding impacting 2008 monitoring and the prolonged high water levels present in 2018-19, there is a high likelihood that any observed changes in biological condition are at least partially due to differences in climatic conditions between the two periods.

Climate

The Root River Watershed currently receives on average an additional 3.6 inches of rain annually compared to the historical average (1895-2018). Furthermore, climate scientists suggest that precipitation events are becoming more intense. Meanwhile, the average annual temperature across the watershed has increased by about 1°F, with a more pronounced increase (+2°F) observed during the winter (December-February). More precipitation and reduced snow cover can increase soil erosion, pollutant runoff, and stream flow. Increased stream flow in turn can lead to in-stream channel erosion and degraded habitat for aquatic life. Longer growing seasons with higher temperatures can lead to more algal blooms, especially in lakes. These changes will complicate efforts to protect and restore the aquatic resources in the watershed. For a more comprehensive analysis of climate trends for the Root River watershed, see: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/climate_summary_major_43.pdf

For more information

For more information, go to https://www.pca.state.mn.us/water/watersheds/root-river or search for "Root River" on the MPCA website.

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CLEAN WATER LAND & LEGACY AMENDMENT