Watershed

October 2020

Mississippi River – Lake Pepin Stressor Identification Report (Cycle 2)

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

Authors

Joe Magee (MPCA)

Contributors/acknowledgements

Tiffany Schauls (MPCA)
Jen Ender (MPCA)
Ashley Ignatius (MPCA)
Kristen Dieterman (MPCA)
Justin Watkins (MPCA)
Jeff Jasperson (MPCA)
Jesse Anderson (MPCA)
John Genet (MPCA)
Marco Graziani (MPCA)
Cole Weaver (MPCA)
Henry Cole (MPCA)
Brian Dean (MPCA)
David DePaz (DNR)
Beau Kennedy (Goodhue SWCD)

Editing and graphic design

PIO staff
Graphic design staff
Administrative staff

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

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Executive summary

The Minnesota Pollution Control Agency (MPCA) utilizes biological monitoring and assessment as a means to determine and report the condition of the state's rivers and streams. This basic approach is to examine fish and aquatic macroinvertebrate communities and related habitat conditions at multiple sites throughout a major watershed. From these data, an Index of Biological Integrity (IBI) score can be calculated, which provides a measure of overall community health. If biological impairments are found, stressors to the aquatic community are identified.

Stressor identification (SID) is a formal and rigorous process that identifies stressors causing biological impairment of aquatic ecosystems and provides a structure for organizing the scientific evidence supporting the conclusions (Cormier et al. 2000). In simpler terms, it is the process of identifying the major factors causing harm to aquatic life. SID is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act. Cycle 1 SID for Mississippi River – Lake Pepin (MRLP) was completed in 2013 (MPCA 2013).

This report summarizes Cycle 2 SID work in MRLP Watershed. Cycle 2 assessment identified zero biological impairments; fish and macroinvertebrate communities in the MRLP Watershed are healthy and meeting standards. Since no biological impairments were identified, no stressors were identified. However, current chemical and physical conditions were summarized, potential stressors and pollutant sources were investigated, and protection measures were identified. Overall, the biggest threats to fish and macroinvertebrates in the MRLP Watershed are excess sediment, increased stream flows (flow alteration), and habitat degradation. Prioritizing protection strategies to address these concerns is a good approach to maintain healthy aquatic life in the watershed.

1. Introduction

Please refer to previous MRLP reports (Monitoring and Assessment, SID, WRAPS, etc.) and/or the MRLP homepage for background information regarding the watershed and monitoring processes.

2. Overview

2.1. Background

The purpose of Cycle 2 SID work is to perform SID in a way that supports Cycle 2 watershed restoration and protection efforts, with an emphasis on meeting local partner needs, protection of biotic integrity, and identifying changes in biotic condition. A review of Cycle 1 SID work identified several areas where efficiencies could be incorporated without sacrificing the quality and integrity of the science. Cycle 2 SID work will implement these efficiencies and provide sharper focus in adding value to local partner implementation planning efforts. SID staff will seek to strengthen local partnerships and provide scientific analyses and recommendations in a format and timeframe that is most useful to local partners.

Goals for Cycle 2 SID work in MRLP Watershed included:

- Summarize current chemical, biological, and physical conditions and identify changes between Cycle 1 and Cycle 2.
- Identify potential stressors, pollutant sources, etc. that threaten future biological condition; goal is to keep fish and macroinvertebrates healthy and free of impairment.
- Identify any “hot spots” or areas contributing a disproportionate amount of a pollutant.
- Identify and prioritize protection areas.
- Provide value to local planning efforts.

2.2. Monitoring

Cycle 2 biological monitoring for fish and macroinvertebrates in the MRLP Watershed occurred in 2018 and 2019 (Figure 1). Detailed information regarding the biological monitoring process and impairment decisions can be found in the MRLP Watershed Monitoring and Assessment Report.

Figure 1: Biology and chemistry monitoring stations in the MRLP Watershed.

2.3. Biological Impairments

There were zero biological impairments identified during the Cycle 2 assessment process; the previous fish impairment on Gilbert Creek (Cycle 1) is recommended for de-listing based on new data. The pattern of increasing FIBI scores at the downstream station (08LM130), prevalence of sensitive taxa, and high scoring sample from 2018 indicate the fish community is meeting the coldwater general use aquatic life standard (MPCA CARL 2020).

2.4. Cycle 1 Stressors

Lack of habitat and bedded sediment were identified as stressors to the fish community in Gilbert Creek in Cycle 1. Habitat was limited with few riffles, deep pools, and cover for fish in the lower part of the watershed. The stream channel was over widened with diminishing gradient near Lake Pepin, resulting in sediment deposition and poor habitat. Gilbert Creek had the only biological impairment in Cycle 1; for more information regarding Cycle 1 stressors see the MRLP Tributaries Biotic SID Report (MPCA 2013).

3. Cycle 2 SID

Mississippi River – Lake Pepin (8-digit HUC)

This section summarizes SID work from Cycle 2 in the MRLP Watershed (8-digit HUC). There are no biotic impairments in the watershed. All AUIDs were assessed as coldwater (2A) and general use; the upper end of Gilbert Creek is recommended for exceptional use based on Cycle 2 fish and macroinvertebrate scores.

Biological communities

Fish and macroinvertebrate communities in the MRLP Watershed are healthy and meeting standards (Table 1). In general, fish IBI scores (FIBI) increased in Cycle 2 while macroinvertebrate IBI scores (MIBI) were mixed (some increased and some decreased). All stations assessed in Cycle 2 are Southern Coldwater with thresholds of 50 (fish) and 43 (macroinvertebrates), and all IBI scores were above thresholds except MIBI scores at stations 04LM138 (42.1) and 18LM032 (15.1). Station 04LM138 was just below the threshold and within the confidence interval, and station 18LM032 was deemed unrepresentative of overall condition in the upper end of Wells Creek. Common and abundant fish species across the watershed included brook trout, brown trout, white sucker, longnose dace, and slimy sculpin and macroinvertebrates included *Baetis* (mayfly), *Gammarus* (amphipod), *Brachycentrus* (caddisfly), and *Simulium* (black flies).

Table 1: Fish and macroinvertebrate IBI scores across the MRLP Watershed; Cycle 2 scores are bolded.

Station	Year	Waterbody	FIBI
08LM129	2008	Bullard Creek	77.9
08LM129	**2018**	**Bullard Creek**	**81.0**
08LM130	2008	Gilbert Creek	42.3
08LM130	2012	Gilbert Creek	49.5
08LM130	**2018**	**Gilbert Creek**	**65.2**
08LM138	2008	Gilbert Creek	52.4
08LM138	2012	Gilbert Creek	93.7
08LM138	**2018**	**Gilbert Creek**	**87.5**
18LM031	**2018**	**Gilbert Creek**	**80.3**
04LM138	2004	Handshaw Coulee	76.9
04LM138	**2018**	**Handshaw Coulee**	**88.9**
04LM132	2004	Hay Creek	61.6
04LM132	**2019**	**Hay Creek**	**78.8**
08LM133	2008	Hay Creek	61.9
08LM133	**2019**	**Hay Creek**	**89.8**
18LM030	**2019**	**Hay Creek**	**66.4**
08LM131	2008	Miller Creek	62.0
08LM131	**2018**	**Miller Creek**	**76.6**
04LM007	2004	Wells Creek	63.5
04LM007	**2018**	**Wells Creek**	**71.5**
08LM136	2008	Wells Creek	55.0
08LM136	**2018**	**Wells Creek**	**57.6**
18LM032	**2018**	**Wells Creek**	**78.8**

Station	Year	Waterbody	MIBI
08LM129	2008	Bullard Creek	53.3
08LM129	**2018**	**Bullard Creek**	**77.7**
08LM130	2008	Gilbert Creek	53.9
08LM130	**2018**	**Gilbert Creek**	**70.4**
08LM138	2008	Gilbert Creek	61.8
08LM138	**2018**	**Gilbert Creek**	**77.0**
18LM031	**2018**	**Gilbert Creek**	**81.2**
04LM138	2004	Handshaw Coulee	82.4
04LM138	2004	Handshaw Coulee	61.7
04LM138	**2018**	**Handshaw Coulee**	**42.1**
04LM132	2004	Hay Creek	79.0
04LM132	**2018**	**Hay Creek**	**67.3**
08LM133	2008	Hay Creek	46.4
08LM133	**2018**	**Hay Creek**	**52.2**
18LM030	**2018**	**Hay Creek**	**43.9**
08LM131	2008	Miller Creek	56.5
08LM131	**2018**	**Miller Creek**	**70.0**
04LM007	2004	Wells Creek	74.2
04LM007	**2018**	**Wells Creek**	**59.1**
08LM136	2008	Wells Creek	52.6
08LM136	**2018**	**Wells Creek**	**47.0**
18LM032	**2018**	**Wells Creek**	**15.1**

Temperature

Stream temperatures ranged from 11.1°C to 23.1°C across the watershed during sonde deployments in June and July of 2018 (Figure 2). Overall, temperatures were suitable for coldwater biota, but three stations (S004-863, S004-859, and S002-449) did have brief periods where temperatures exceeded 22 °C. Brown trout may be physiologically stressed from 19 to 22 °C (Bell 2006), and brook trout can briefly tolerate temperatures near 22.2 °C but temperatures of 23.8 °C for a few hours are generally lethal (MPCA 2019, Flick 1991). There were also several instantaneous (point) measurements collected throughout the watershed over the last decade (2010 through 2019), and 63 (4%) were above 22 °C; most of these occurred near the mouth of Wells Creek on a small warmwater AUID.

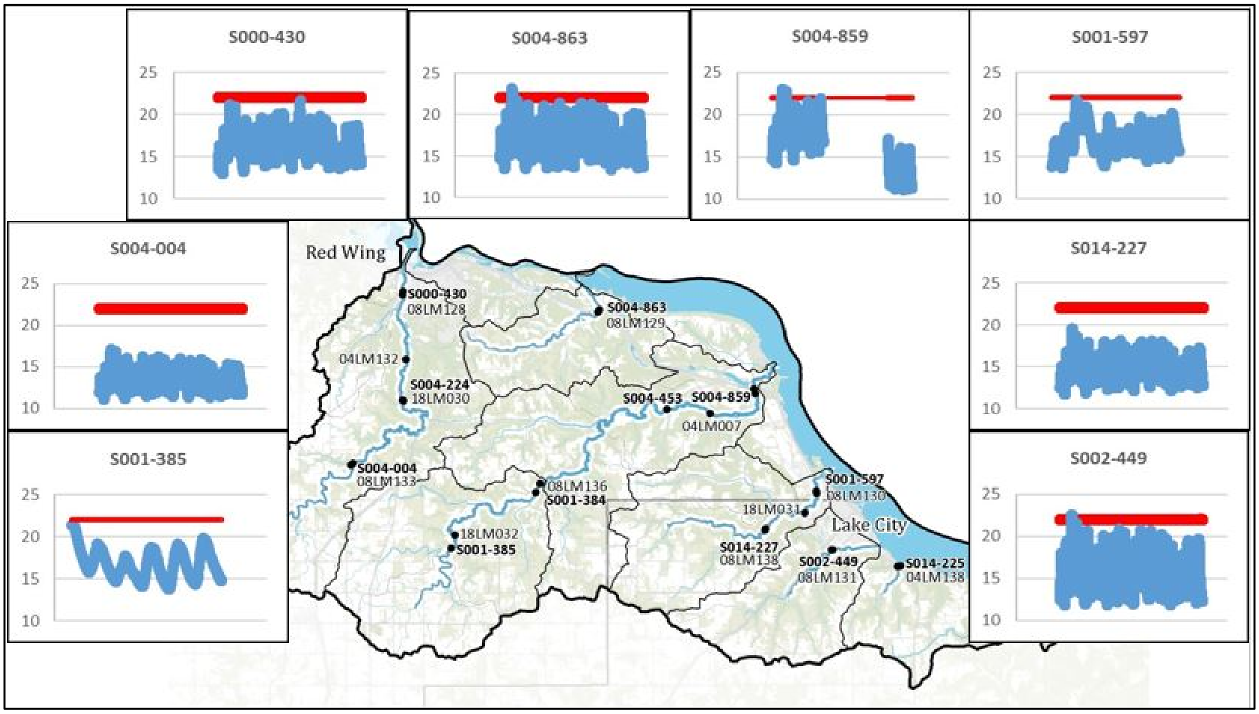


Figure 2: Temperature conditions during sonde deployments across the MRLP Watershed in 2018. The red line represents 22 °C, a general stress point for brown trout.

In general, temperature related fish metrics improved between Cycle 1 and Cycle 2; most stations had increases in relative abundance of coldwater/coolwater species and coldwater native/sensitive species (Figure 3). It should be noted that although most stations improved, many are still below the Southern Coldwater Streams statewide median of stations meeting the FIBI threshold (ColdPct – 72.9%, ColdCoolPct – 80.6%, NativeColdPct – 11.7%, and CWSensitivePct – 74.9%). Macroinvertebrate CBI (Coldwater Biotic Index) scores, which are based on coldwater tolerance values derived from Minnesota taxa and temperature data, were generally above the average metric score needed to meet the MIBI threshold (Figure 4). A majority of CBI scores increased between Cycle 1 and Cycle 2. Fish and macroinvertebrate communities are healthy across the MRLP Watershed with cold stream temperatures supporting these conditions.

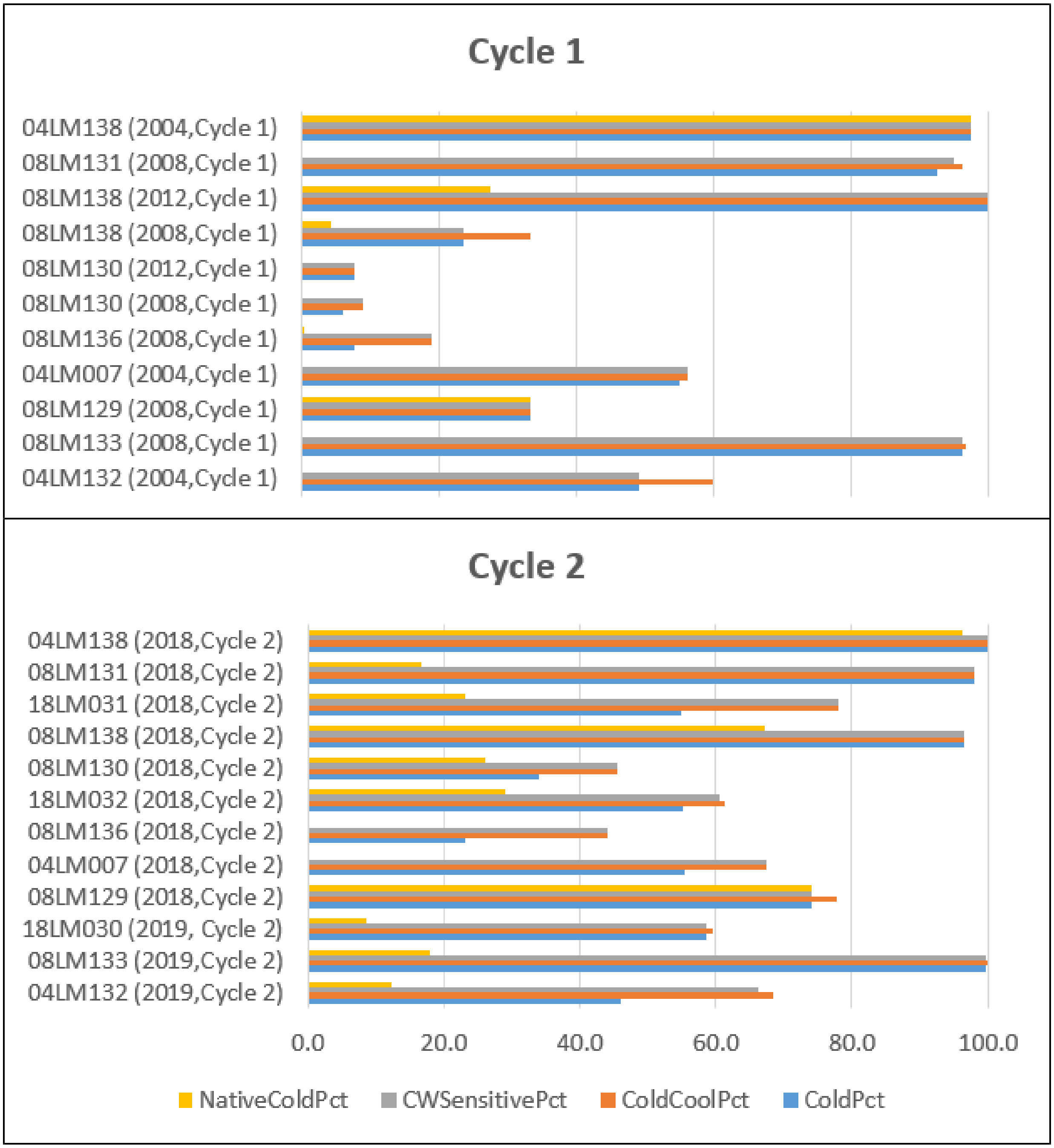


Figure 3: Temperature related fish metrics from Cycle 1 and Cycle 2 in the MRLP Watershed; relative abundance (%) of individuals that are native coldwater species (NativeColdPct), coldwater sensitive (CWSensitivePct), coldwater and coolwater species (ColdCoolPct), and coldwater species (ColdPct).

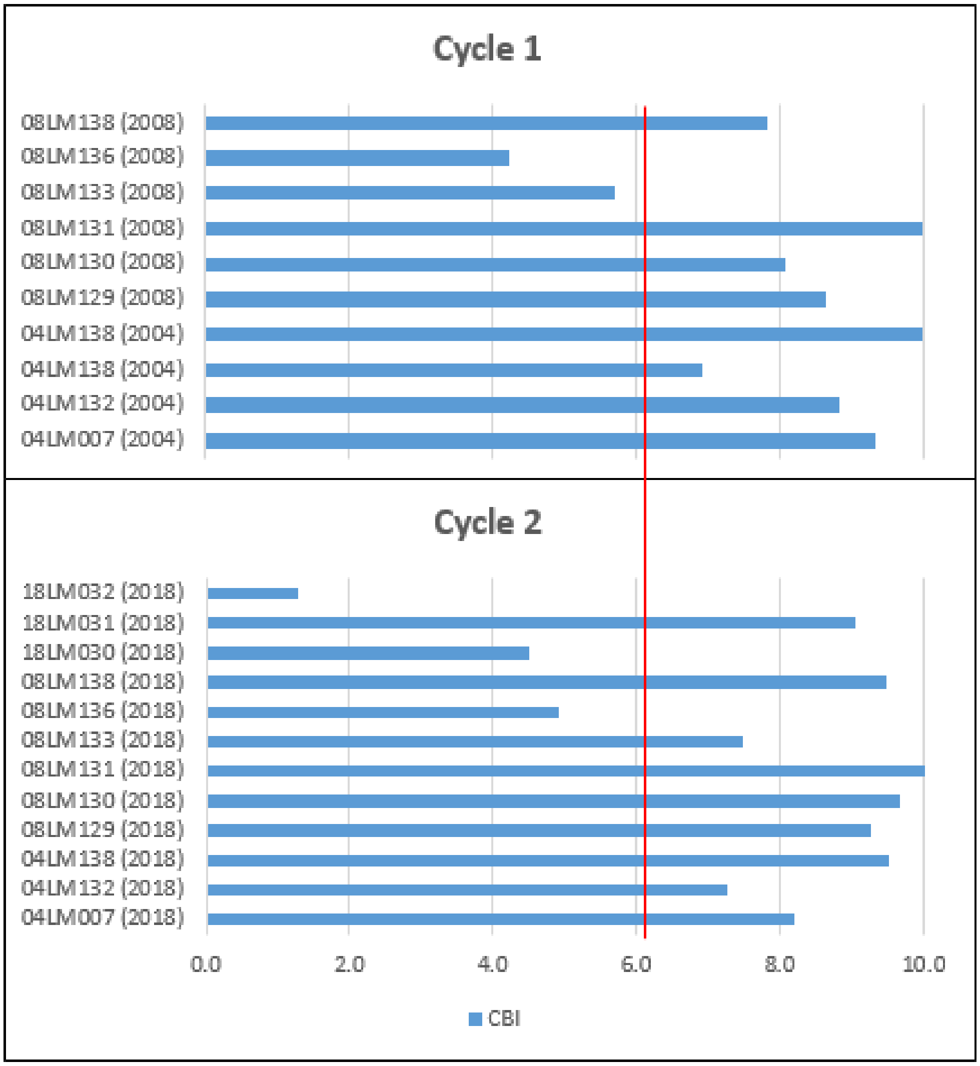


Figure 4: Macroinvertebrate CBI (Coldwater Biotic Index) scores from Cycle 1 and Cycle 2 in the MRLP Watershed. CBI scores are based on coldwater tolerance values derived from Minnesota taxa and temperature data. The red line represents the average metric score (6.1) needed to meet the MIBI threshold.

Nitrate

Nitrate concentrations during fish sampling in 2018 and 2019 ranged from 2.1 – 5.6 mg/L. Additional samples were collected across the watershed as part of SID in 2018, with a goal to sample various flow conditions and establish a range of nitrate concentrations (Figure 5). Concentrations ranged from 1.4 – 6.1 mg/L (average of 3.6 mg/L), and zero of the eighty-five samples were above 10 mg/L. Nitrate concentrations were low to moderate across the watershed, with the highest concentrations observed in the upper end of Hay Creek and Wells Creek. Primary factors controlling nitrate concentrations in the watershed include land use and hydrogeologic setting. The MRLP Watershed has fewer cropland acres (36%, MPCA 2012) than other watersheds in the region, and springs that originate from regionally sourced (nitrate poor) deep aquifers; both have significant influence on magnitude and variability of nitrate concentrations (Watkins 2011, MGS 2013).

Nitrate concentrations across the watershed over the last decade (2010 through 2019) ranged from 0.5 to 9.6 mg/L (average of 3.5 mg/L, 537 samples). The lower end of Wells Creek (station S004-859) was the only station sampled routinely over this time period; concentrations ranged from 0.5 to 9.6 mg/L (average of 3.2 mg/L, 209 samples). Recent increases in stream flow and precipitation have contributed to increases in nutrients and sediment, although not as pronounced with nitrate. In general, the average nitrate concentration (as well as median July through October stream flow and annual precipitation) was lower from 2010 through 2015 (3.17 mg/L) and increased from 2016 through 2019 (3.28 mg/L) (Figure 6). More information regarding stream flows and precipitation over the last decade can be found in the Flow Alteration and Conclusion sections.

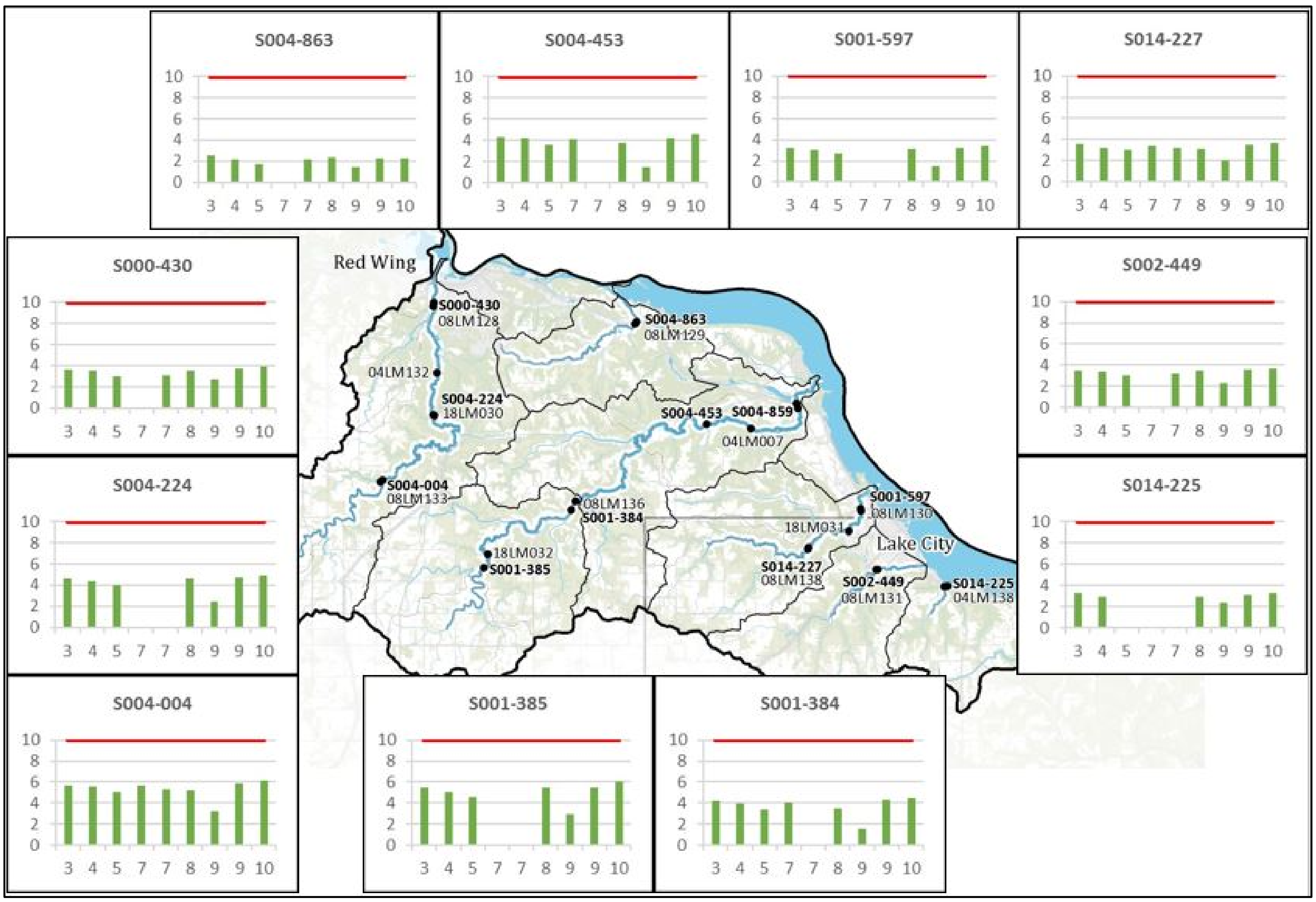


Figure 5: Nitrate concentrations (mg/L) across the MRLP Watershed in 2018. Samples were collected during all seasons with a majority during baseflow conditions. The red line (10 mg/L) indicates the drinking water standard, and numbers along the x-axis represent the month in which the sample was collected.

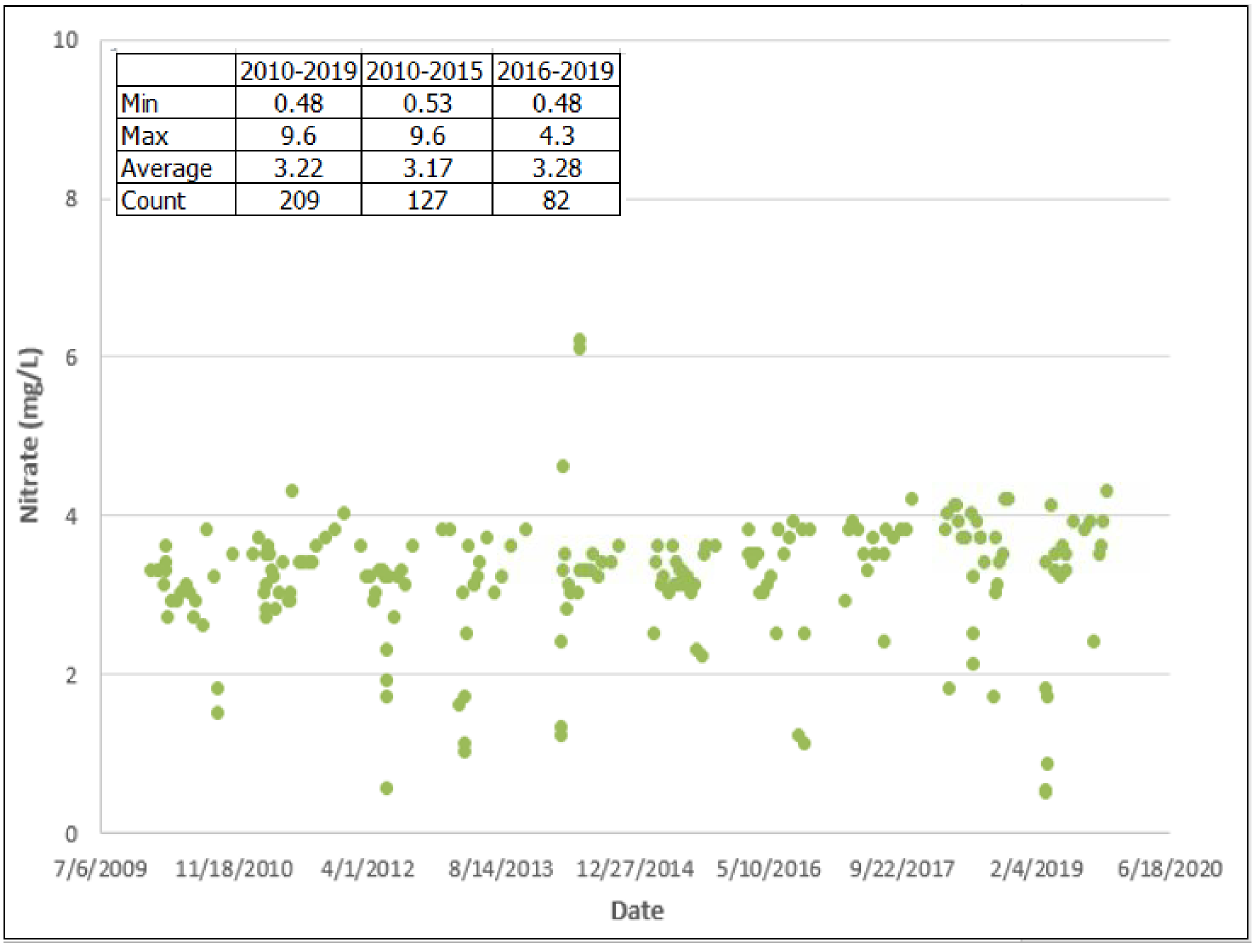


Figure 6: Nitrate concentrations from 2010 – 2019 in the lower end of Wells Creek (station S004-859); note the average concentration increase in recent years (2016 – 2019).

In general, the macroinvertebrate communities across the watershed are healthy and meeting standards. However, many stations had increases in nitrate index scores and nitrate tolerant individuals between Cycle 1 and Cycle 2, and there were very few nitrate intolerant individuals in either cycle (Figure 7). The average increase in nitrate tolerant individuals between Cycle 1 and Cycle 2 was 13.3% (ranged from -3.5% to 53%), and most nitrate index scores were worse than the Southern Coldwater Streams statewide median (3.0) of stations meeting the MIBI threshold. As nitrate index scores increase, so does tolerance of the community. Although nitrate concentrations and biological health aren't currently alarming, minimizing future nitrogen loading is important to ensure concentrations don't increase and degrade biological communities. Signals of potential nitrate stress exist in the macroinvertebrate metrics, but not to the point of impairment.

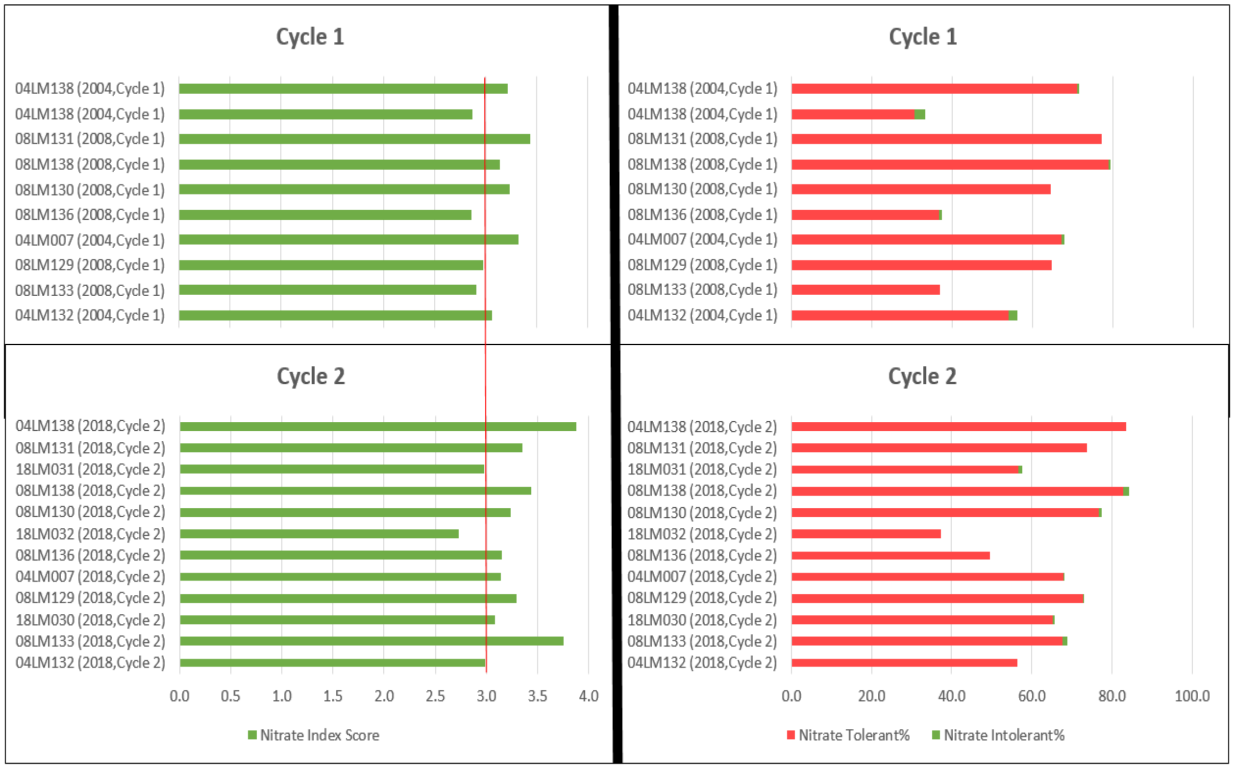


Figure 7: Macroinvertebrate nitrate index scores, nitrate tolerant individuals, and nitrate intolerant individuals from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (3.0) of stations meeting the MIBI threshold.

Eutrophication

Total phosphorus (TP) concentrations during fish sampling in 2018 and 2019 ranged from 0.05 to 0.135 mg/L. Additional samples were collected across the watershed as part of SID in 2018, with a goal to sample various flow conditions and establish a range of TP concentrations (Figure 8). Concentrations ranged from 0.027 to 1.84 mg/L (average of 0.168 mg/L), and 13 (15%) of the 85 samples exceeded the TP component of the river eutrophication standard for the Central Region (0.1 mg/L). All stations had at least 1 exceedance with most occurring during elevated flow conditions; concentrations were low during baseflow conditions. In general, TP concentrations were low across the watershed.

TP concentrations across the watershed over the last decade (2010 through 2019) ranged from 0.02 to 3.82 mg/L (average of 0.215 mg/L, 362 samples). The lower end of Wells Creek (station S004-859) was the only station sampled routinely over this time period; concentrations ranged from 0.03 to 3.82 mg/L (average of 0.302 mg/L, 174 samples). Recent increases in stream flow and precipitation have contributed to increases in nutrients and sediment. In general, the average TP concentration (as well as median July through October stream flow and annual precipitation) was lower from 2010 through 2015 (0.215 mg/L) and increased from 2016 through 2019 (0.400 mg/L) (Figure 9). More information regarding stream flows and precipitation over the last decade can be found in the Flow Alteration and Conclusion sections.

Chlorophyll–*a* (Chl-*a*), biochemical oxygen demand (BOD), dissolved oxygen (DO) flux, and pH flux are also considered when evaluating eutrophication stress. Chl-*a* and BOD samples were collected throughout the watershed at five sites in July 2018. Chl-*a* samples ranged from 2.0 to 2.5 µg/L, with zero exceedances of the Central Region standard (18 µg/L). BOD samples ranged from 0.9 to 1.2 mg/L, with zero exceedances of the Central Region standard (2 mg/L). Maximum daily DO flux concentrations ranged from 1.2 mg/L to 6.6 mg/L across the watershed in 2018 during sonde deployments; two of the eight sites exceeded the standard (3.5 mg/L). DO flux patterns varied (Figure 12) and are impacted by several factors such as aquatic vegetation, stream gradient, flow, habitat, etc. The pH values collected during sonde deployments across the watershed ranged from 7.5 to 8.4, all of which are within the standard. Maximum daily pH flux ranged from 0.1 to 0.6. Typical daily pH fluctuations are 0.2 to 0.3 (Heiskary et al. 2013); four of the eight sites had a daily flux greater than 0.3.

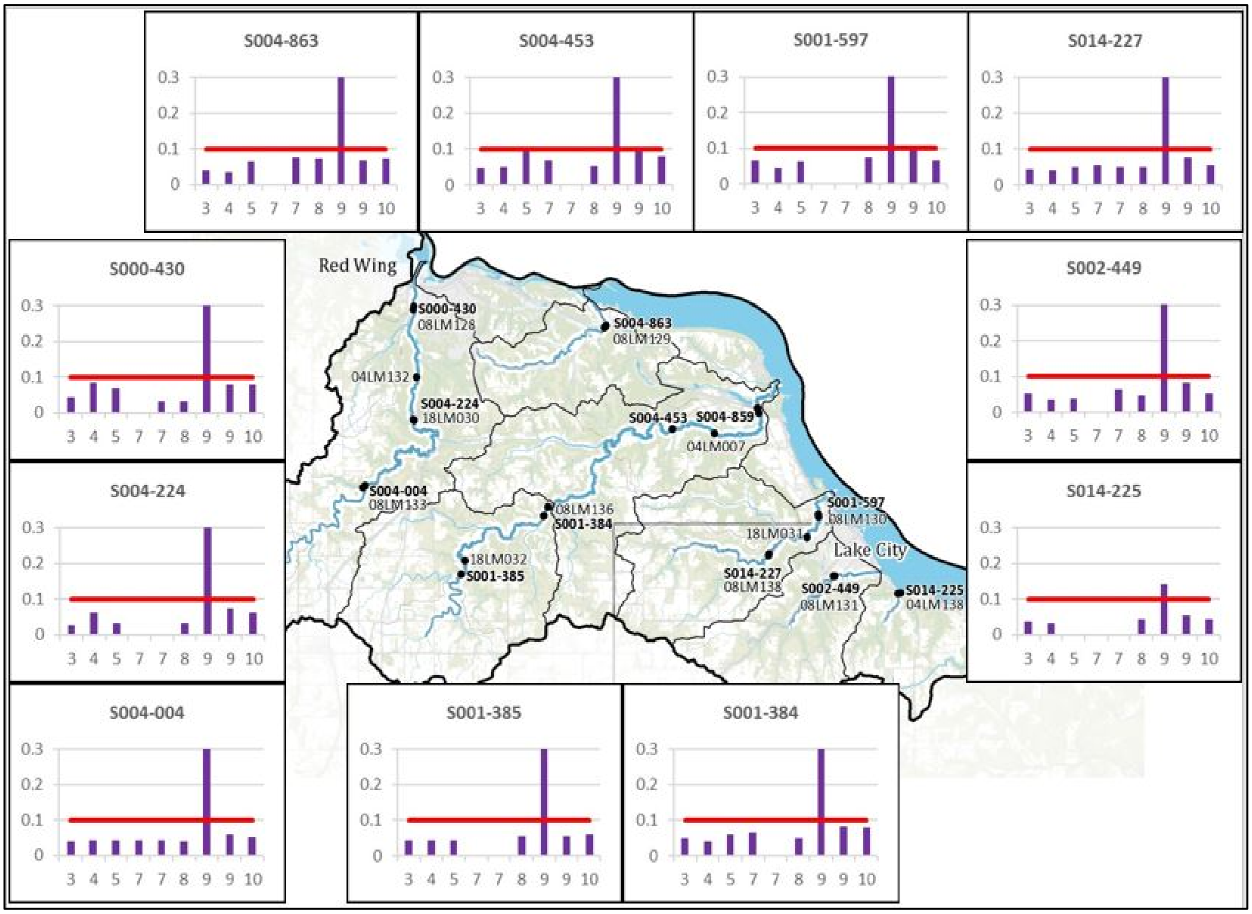


Figure 8: TP concentrations (mg/L) across the MRLP Watershed in 2018. Samples were collected during all seasons with a majority during baseflow conditions. The red line (0.1 mg/L) indicates the TP standard, and numbers along the x-axis represent the month in which the sample was collected. The first September sample was an event sample during which most stations exceeded 0.3 mg/L.

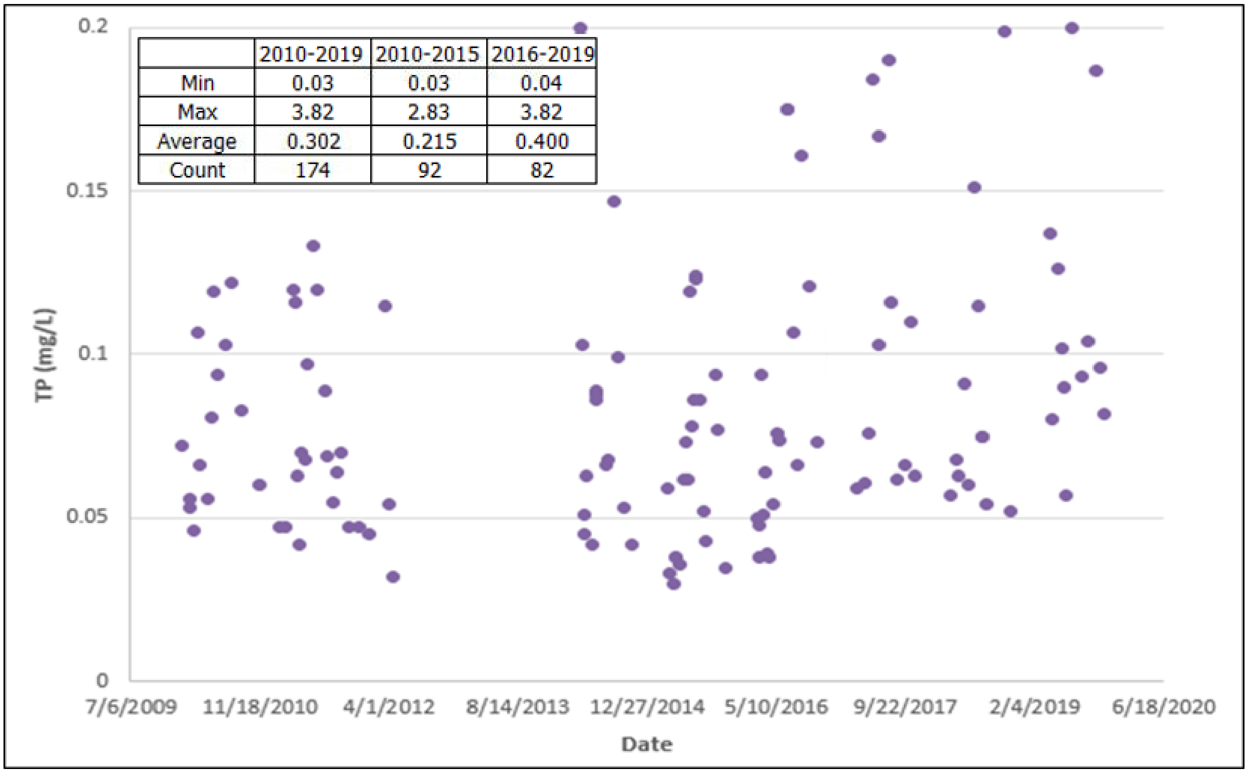
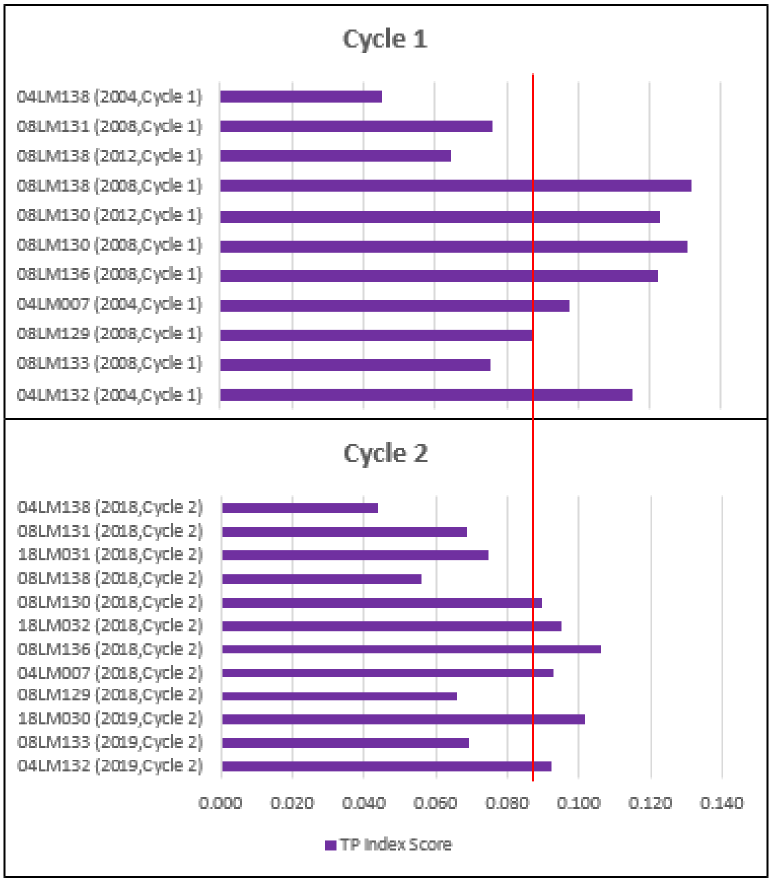


Figure 9: TP concentrations from 2010 – 2019 in the lower end of Wells Creek (station S004-859); note the average concentration increase in recent years (2016 – 2019).

Fish TP index scores decreased between Cycle 1 and Cycle 2; although index scores improved, many were still worse than the Southern Coldwater Streams statewide median (0.087) of stations meeting the FIBI threshold (Figure 10). In general, most macroinvertebrate TP index scores were better than the Southern Coldwater Streams statewide median (0.103) of stations meeting the MIBI threshold, with some scores increasing and some decreasing between Cycle 1 and Cycle 2 (Figure 11). As TP index scores decrease, so does tolerance of the community. Most stations had few TP intolerant and tolerant individuals; relative abundance of tolerant individuals decreased at all stations between Cycle 1 and Cycle 2. Overall, fish and macroinvertebrate communities are healthy across the MRLP Watershed with adequate nutrient dynamics helping support these biological conditions. Eutrophication is not an issue at this time, even though the watershed has experienced recent increases in TP concentrations. Although not currently driving impairment in MRLP streams the TP load from the watershed impacts downstream waters such as Lake Pepin; reducing TP loading is important for maintaining and improving conditions in MRLP Watershed and downstream waters.



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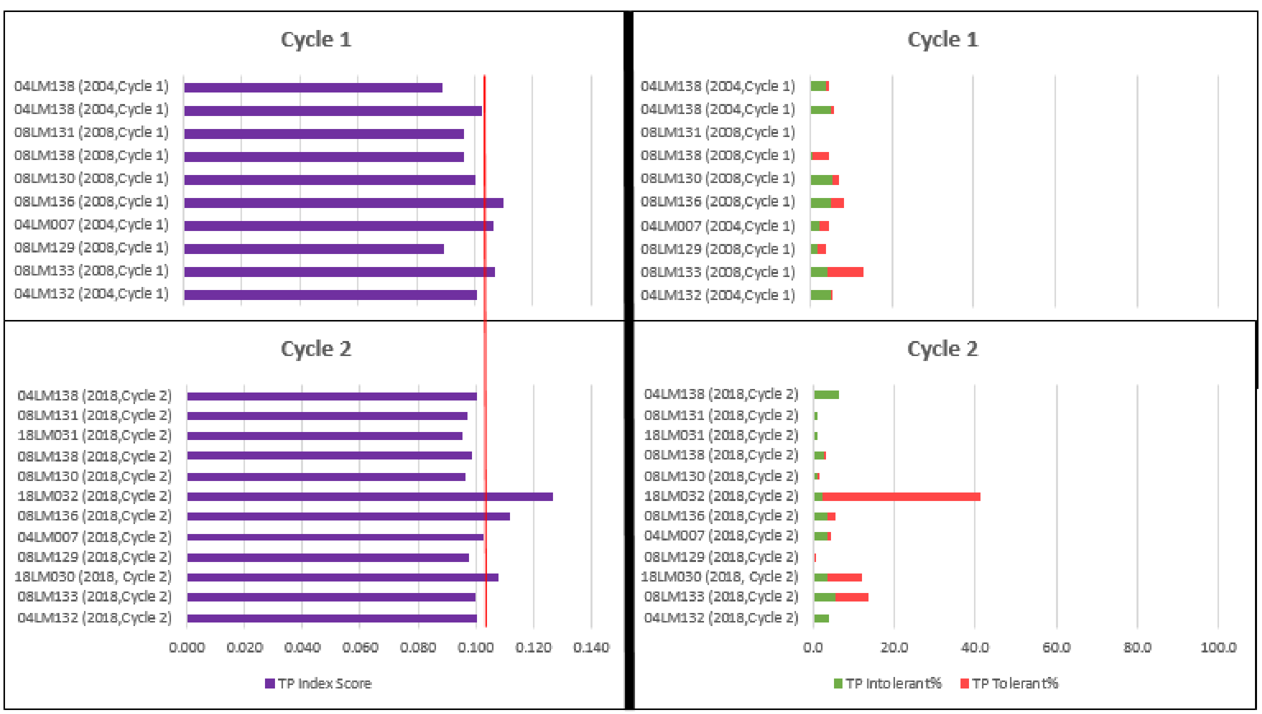


Figure 11: Macroinvertebrate TP index scores, TP tolerant individuals, and TP intolerant individuals from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (0.103) of stations meeting the MIBI threshold.

Dissolved Oxygen

DO ranged from 7.2 mg/L to 14.0 mg/L across the watershed during sonde deployments in June and July of 2018 (Figure 12). Overall, DO was suitable for coldwater biota and there were zero exceedances of the coldwater DO standard (7 mg/L). There were also several instantaneous (point) measurements collected throughout the watershed over the last decade (2010 through 2019), and three (<1%) were below 7 mg/L; all of which occurred in 2018 in the upper portion of Wells Creek.

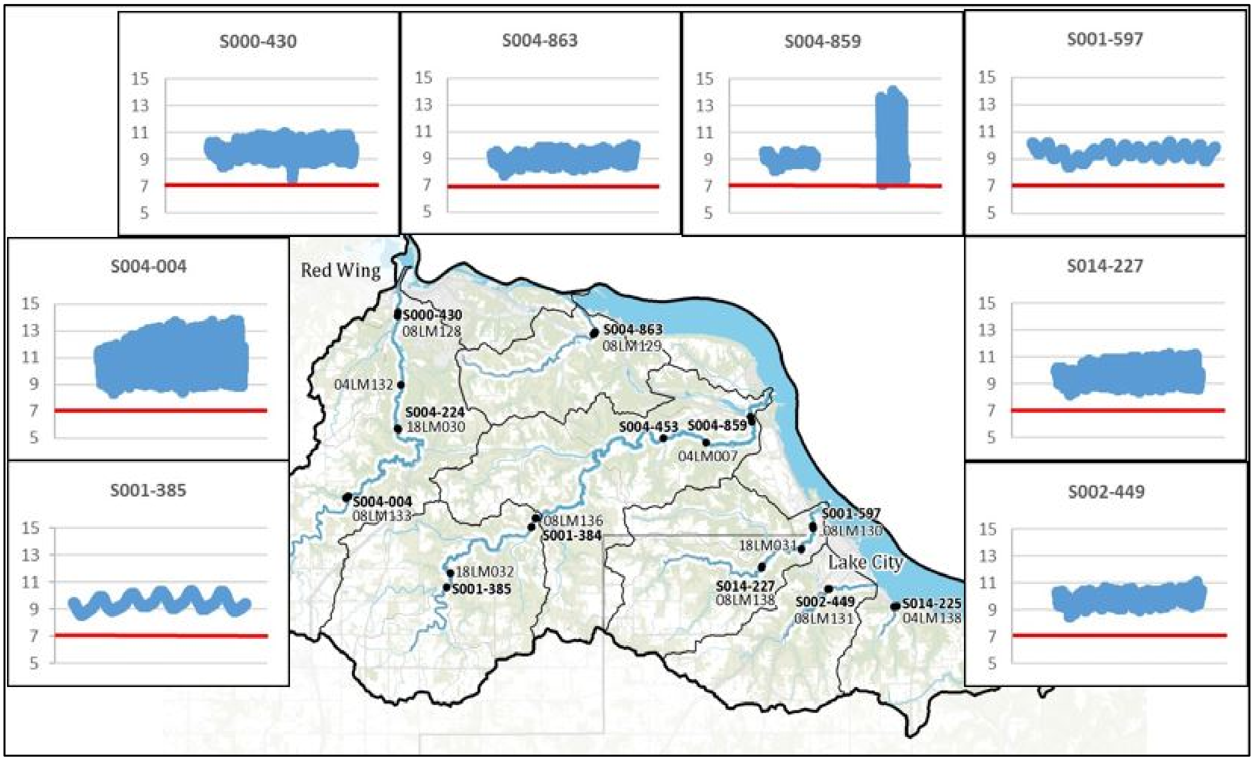


Figure 12: DO conditions during sonde deployments across the MRLP Watershed in 2018. The red line represents the coldwater DO standard (7 mg/L).

In general, most fish low DO index scores and probabilities of meeting the DO standard improved between Cycle 1 and Cycle 2; however, many low DO index scores were below the Southern Coldwater Streams statewide median (8.9) of stations meeting the FIBI threshold (Figure 13). Lower DO index scores indicate a more tolerant community. Most macroinvertebrate low DO index scores were better than the Southern Coldwater Streams statewide median (7.5) of stations meeting the MIBI threshold, with some scores increasing and some decreasing between Cycle 1 and Cycle 2 (Figure 14). Low DO intolerant individuals were abundant at most stations, and low DO tolerant individuals were limited. Overall, fish and macroinvertebrate communities are healthy across the MRLP Watershed with quality DO regimes helping support these biological conditions.

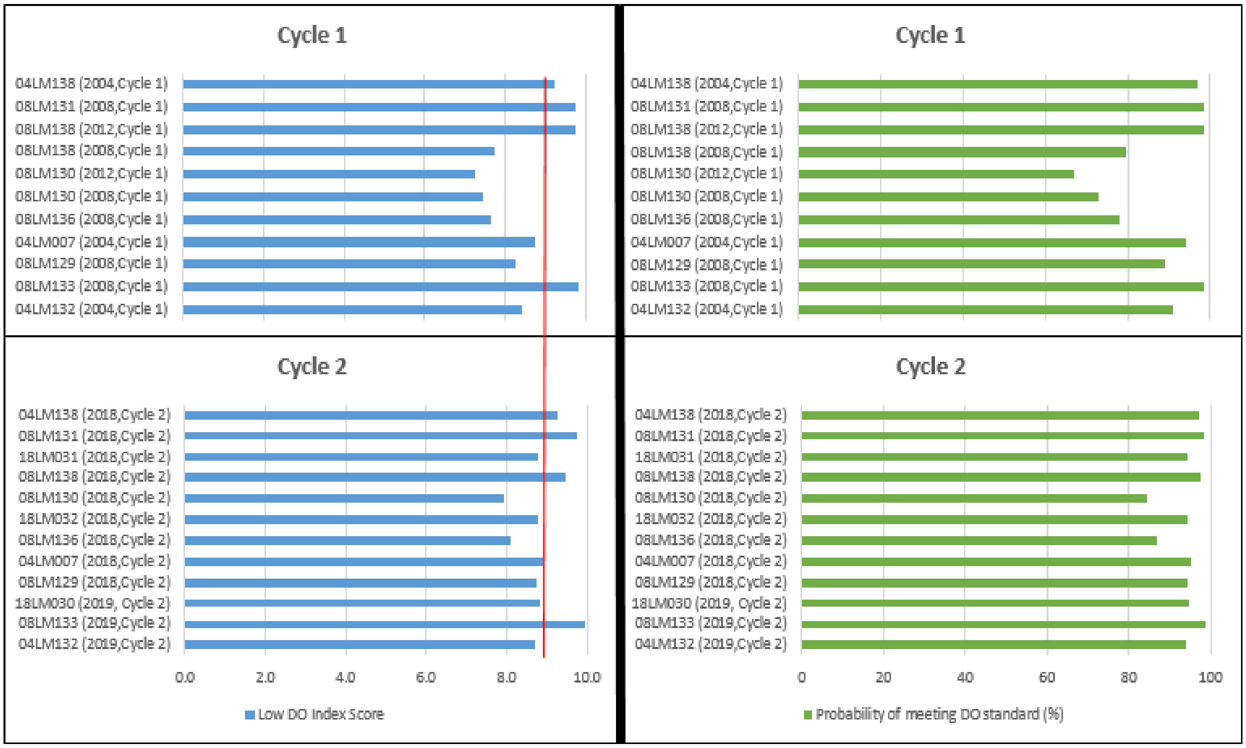


Figure 13: Fish low DO index scores and probability of meeting the DO standard from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (8.9) of stations meeting the FIBI threshold.

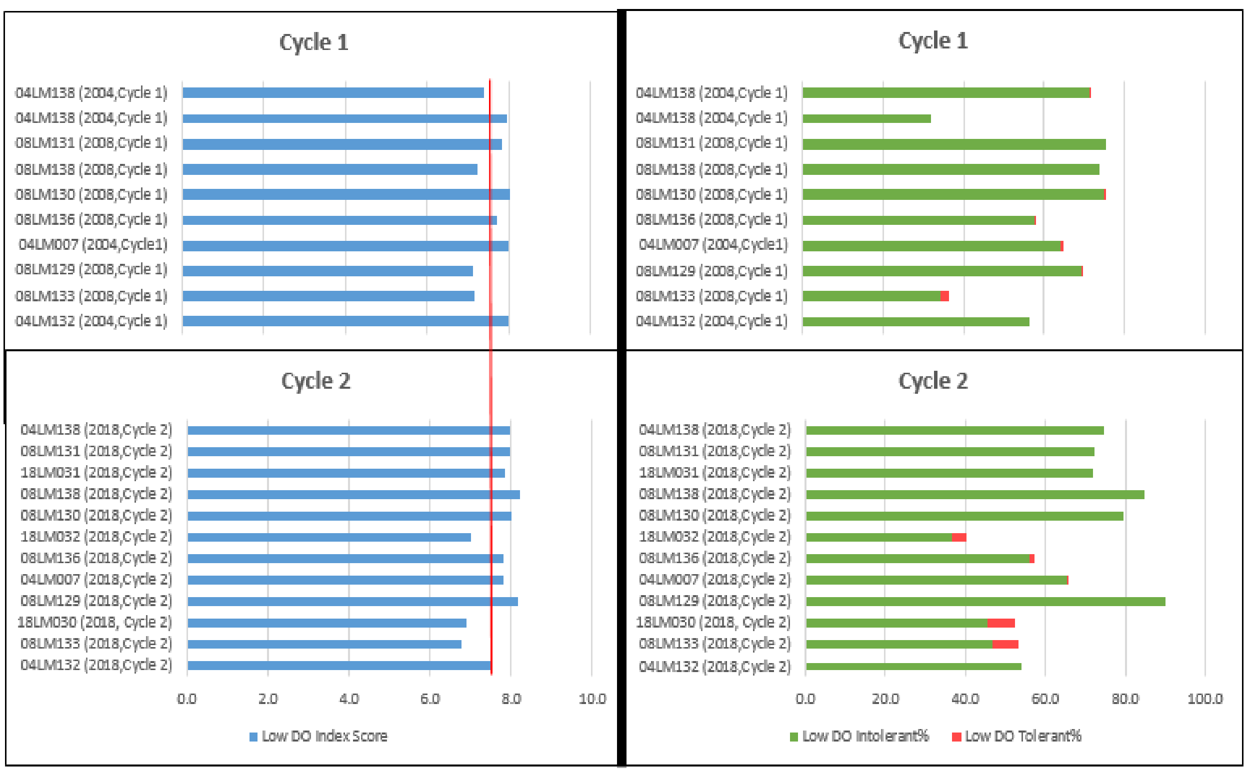


Figure 14: Macroinvertebrate low DO index scores, low DO tolerant individuals, and low DO intolerant individuals from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (7.5) of stations meeting the MIBI threshold.

TSS

Total suspended solids (TSS) concentrations during fish sampling in 2018 and 2019 ranged from 6.4 to 55 mg/L. Additional samples were collected across the watershed as part of SID in 2018, with a goal to sample various flow conditions and establish a range of TSS concentrations (Figure 15). Concentrations ranged from 2 to 790 mg/L (average of 49.4 mg/L), and 53 (62%) of the 85 samples exceeded the coldwater TSS standard (10 mg/L). Most stations had multiple exceedances; exceedances occurred during low and elevated flow conditions. In general, TSS concentrations often exceed the standard. Additional longitudinal sampling was conducted on Hay Creek in 2019 to further characterize sediment dynamics and identify areas that may be contributing a disproportionate amount of sediment (Figure 16). In general, TSS concentrations were below the standard in the upper part of the watershed and frequently exceeded the standard in the lower part of the watershed. Concentrations increased moving downstream, with changes in drainage area and stream gradient likely having significant influence. Station S004-004 is the most upstream station which has steeper gradient and a much smaller drainage area than the lower stations (S004-224, S015-283, S001-453, and S000-430). Trout Brook had minimal impact on TSS concentrations in Hay Creek; Trout Brook was generally clear with concentrations below the coldwater standard. Stream walks in 2019 identified large raw banks and a sand dominated stream bed in the lower end of Hay Creek, some of which can be seen in Figure 16.

TSS concentrations across the watershed over the last decade (2010 through 2019) ranged from 1 to 3,000 mg/L (average of 113.5 mg/L, 485 samples). The lower end of Wells Creek (station S004-859) was the only station sampled routinely over this time period; concentrations ranged from 9.6 to 3,000 mg/L (average of 195.2 mg/L, 215 samples). Recent increases in stream flow and precipitation have contributed to increases in nutrients and sediment. In general, the average TSS concentration (as well as median July to October stream flow and annual precipitation) was lower from 2010 through 2015 (162.3 mg/L) and increased from 2016 through 2019 (245.6 mg/L) (Figure 17). These higher flows during baseflow time periods have resulted in higher TSS concentrations (Figure 25), which is concerning as this increases the duration to which fish and macroinvertebrates are exposed to elevated TSS. More information regarding stream flows and precipitation over the last decade can be found in the Flow Alteration and Conclusion sections. Wells Creek has a proposed non-support aquatic life listing based on TSS data during the Cycle 2 assessment process.

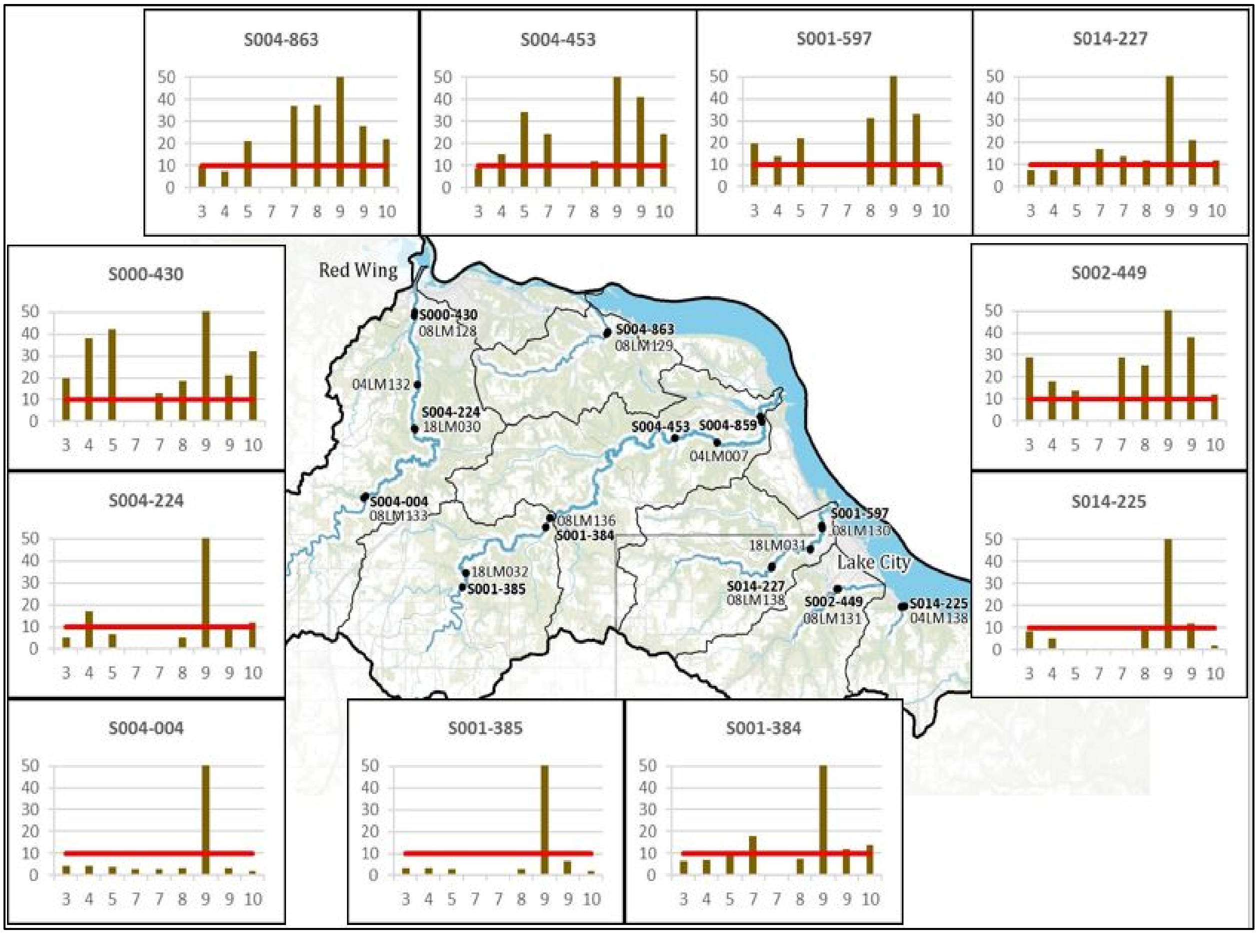


Figure 15: TSS concentrations (mg/L) across the MRLP Watershed in 2018. Samples were collected during all seasons with a majority during baseflow conditions. The red line (10 mg/L) indicates the coldwater TSS standard, and numbers along the x-axis represent the month in which the sample was collected. The first September sample was an event sample during which all stations exceeded 50 mg/L.

Figure 16: TSS concentrations, stream gradient, drainage area, and photos from Hay Creek. Red dots on the longitudinal profile represent chemistry stations at the top of the figure. The box and whisker plots illustrate TSS concentrations from Hay Creek longitudinal sampling in 2019; the red line indicates the coldwater TSS standard (10 mg/L) and stations are organized upstream to downstream (left to right). The yellow and green segments on the longitudinal profile highlight differences in stream gradient from upstream to downstream. The blue fill displays drainage area, and stream photos were included to illustrate differences in stream gradient, substrate, habitat, etc. along the profile.

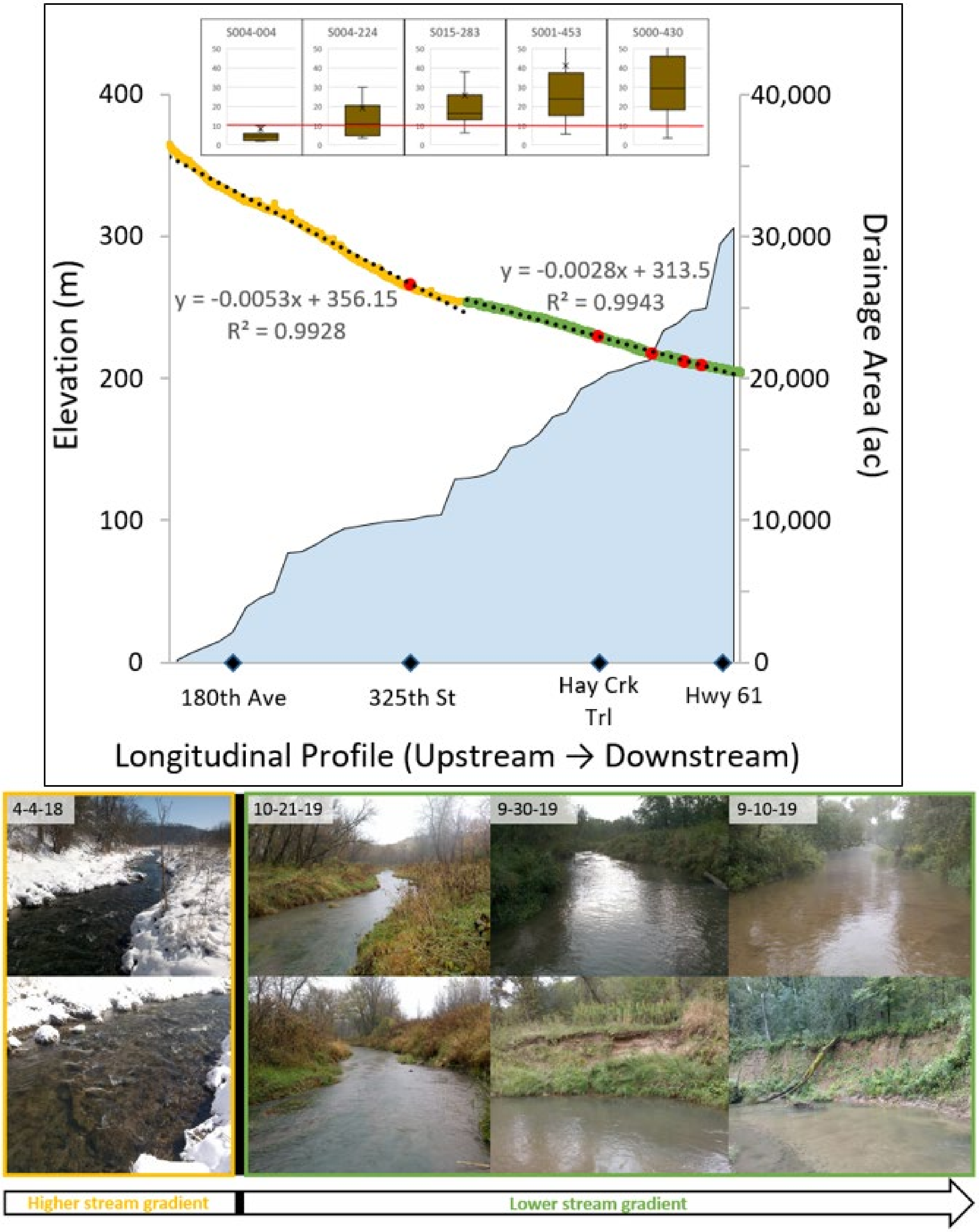
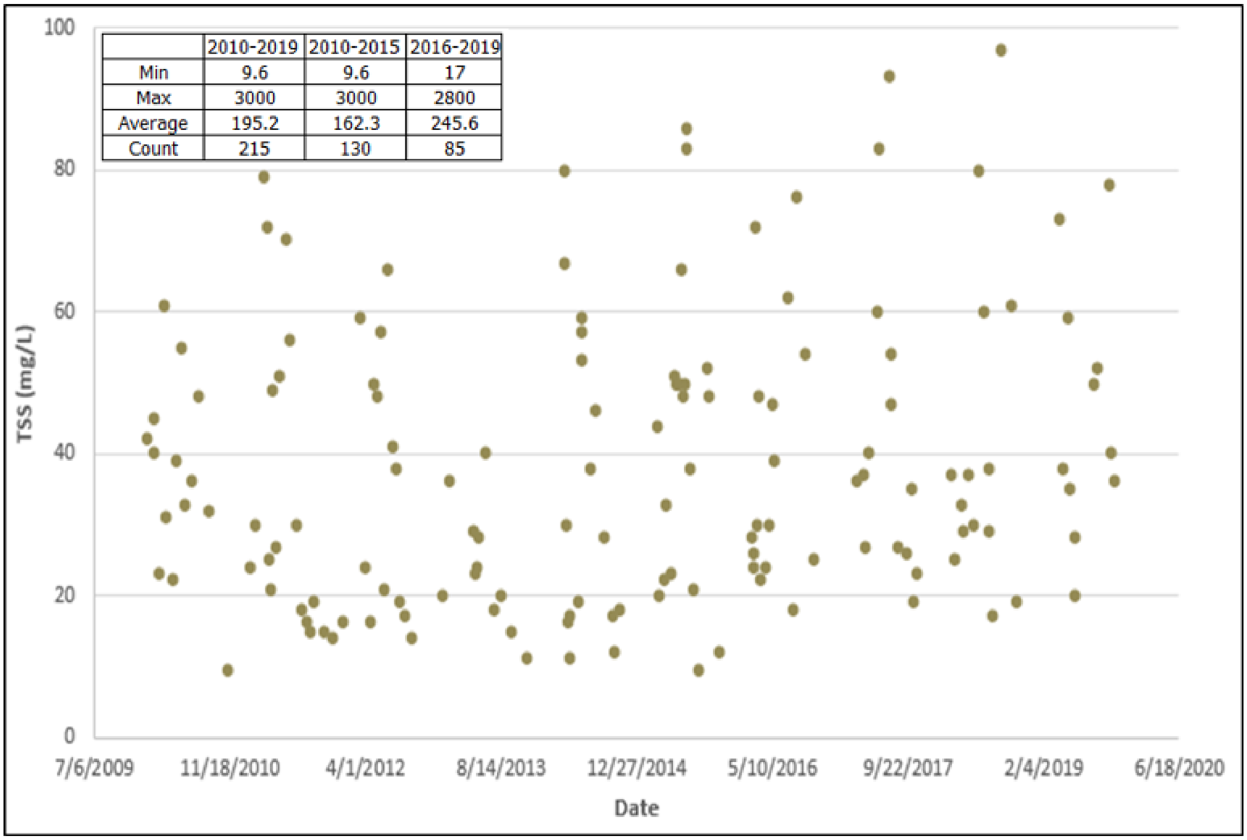


Figure 17: TSS concentrations from 2010 – 2019 in the lower end of Wells Creek (station S004-859); note the average concentration increase in recent years (2016 – 2019).



All fish TSS index scores decreased between Cycle 1 and Cycle 2, and probability of meeting the TSS standard increased at all stations between Cycle 1 and Cycle 2 (Figure 18). As TSS index scores decrease, so does tolerance of the community. Although TSS index scores and probability of meeting the standard improved, many are still worse than the Southern Coldwater Streams statewide median (10.2 and 43% respectively) of stations meeting the FIBI threshold. In general, most macroinvertebrate TSS index scores were worse than the Southern Coldwater Streams statewide median (13.4) of stations meeting the MIBI threshold, with a majority increasing between Cycle 1 and Cycle 2 (Figure 19). All TSS index scores were at or above the statewide median in Cycle 2. Most stations had limited TSS intolerant and tolerant individuals, with some increasing and some decreasing between Cycle 1 and Cycle 2. Fish and macroinvertebrate communities are healthy across the MRLP Watershed, but elevated TSS concentrations pose a threat to future biological health. Signals of TSS stress exist within the biota, but not currently to the point of impairment. Reducing sediment loading in the MRLP Watershed is necessary to protect fish and macroinvertebrate communities from future impairment.

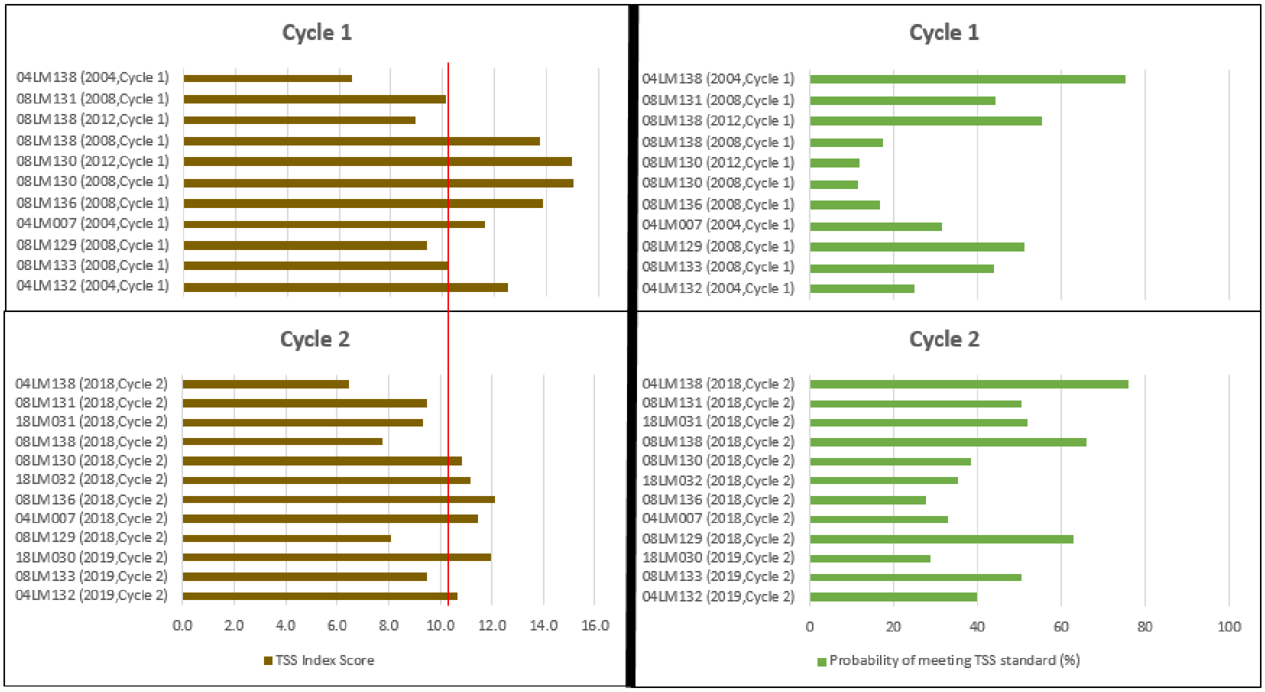


Figure 18: Fish TSS index scores and probability of meeting the TSS standard from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (10.2) of stations meeting the FIBI threshold.

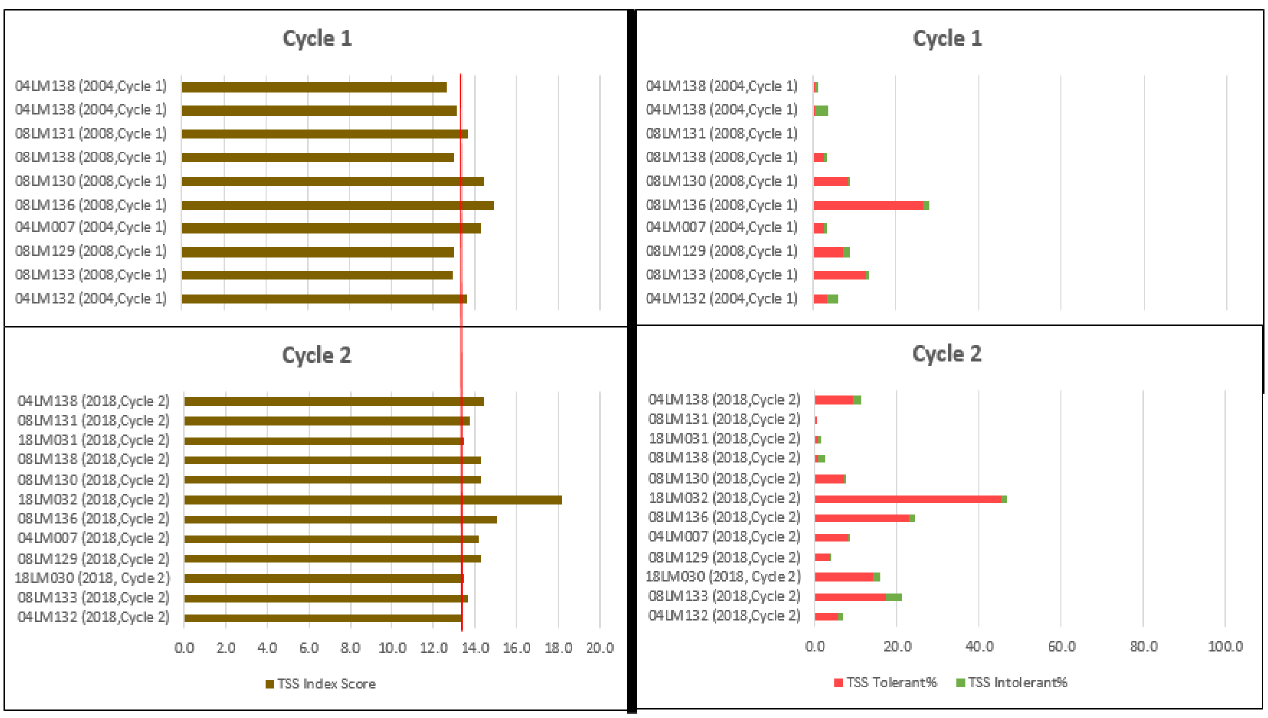


Figure 19: Macroinvertebrate TSS index scores, TSS tolerant individuals, and TSS intolerant individuals from Cycle 1 and Cycle 2 in the MRLP Watershed. The red line represents the Southern Coldwater Streams statewide median (13.4) of stations meeting the MIBI threshold.

Lack of Habitat

The MPCA Stream Habitat Assessment (MSHA) scores throughout the watershed range from 31.5 (“poor”) to 83.7 (“good”) (Figure 20). In general, MSHA scores decreased across the watershed from Cycle 1 to Cycle 2, with fewer “good” scores and more “fair” scores. The average sub-category scores (Land Use, Riparian, Substrate, Cover, and Channel Morphology) decreased in 2018 for all categories except cover which increased slightly. Habitat examples from biological monitoring in 2018 can be seen in Figure 21. Bank erosion and embeddedness increased or remained the same at most sites between Cycle 1 and Cycle 2 (Table 2). Geomorphology work completed by the DNR in Wells Creek identified *“aggradation and excess sediment supply as the processes most often identified as stability risks within catchments of Wells Creek. These processes can result in loss of habitat and channel instability issues, as measured by increases in width/depth ratios and accelerated bank erosion. Another common concern within multiple catchments is direct channel impacts, such as straightening, heavy grazing pressure, and crop encroachment, which negatively affects channel stability”* (DNR 2020).

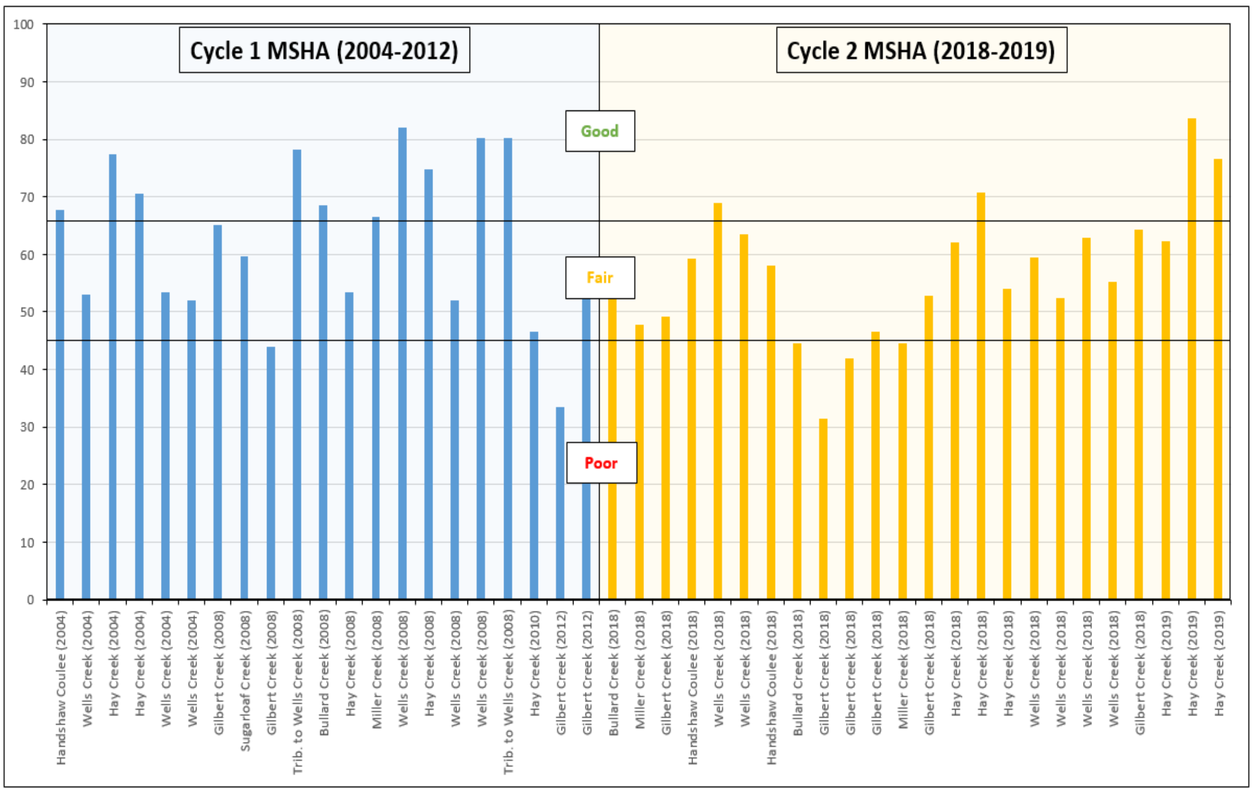


Figure 20: MSHA scores across the MRLP Watershed in Cycle 1 and Cycle 2.

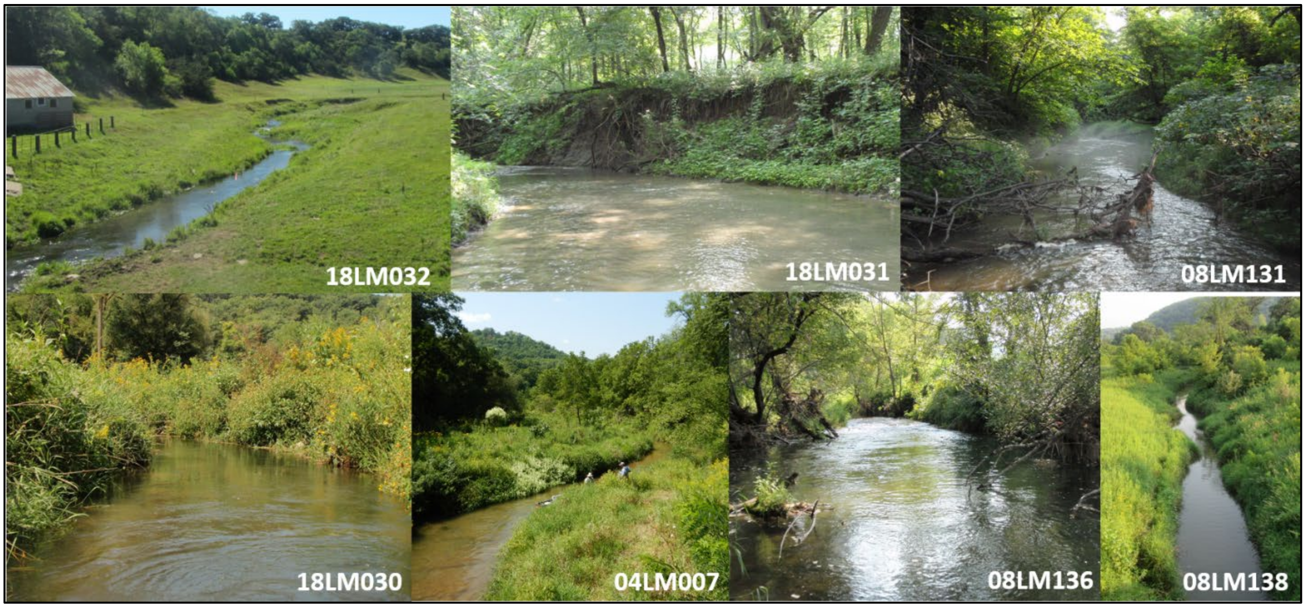


Figure 21: Habitat examples from biological monitoring stations in the MRLP Watershed in 2018.

Table 2: Bank erosion, embeddedness, and cover amount noted during MSHA analysis in the MRLP Watershed. Arrows indicate an increase or decrease between Cycle 1 and Cycle 2, and a dash indicates no change, mixed results, or no Cycle 1 visit.

Station (Year Sampled,Cycle)	Waterbody	Bank Erosion		Embeddedness		Cover Amount	
04LM132 (2004,Cycle 1)		None		Moderate		Sparse	
04LM132 (2018,Cycle 2)		Little-Heavy	↑	Light	↓	Extensive	↑
04LM132 (2019,Cycle 2)		Little-Moderate		Moderate		Moderate	
08LM133 (2008,Cycle 1)		None		Moderate		Moderate	
08LM133 (2018,Cycle 2)	Hay Creek	Little	↑	Moderate	↓	Extensive	↑
08LM133 (2019,Cycle 2)		None		Light		Extensive	
18LM030 (2018, Cycle 2)		Little-Moderate	-	Severe	-	Extensive	-
18LM030 (2019, Cycle 2)		None		Light		Extensive	
08LM129 (2008,Cycle 1)		Little		Moderate		Sparse	
08LM129 (2018,Cycle 2)	Bullard Creek	Little	↑	Moderate	↑	Sparse	-
08LM129 (2018,Cycle 2)		Little-Heavy		Severe		Sparse	
04LM007 (2004,Cycle1)		Little		Light		Sparse	
04LM007 (2018,Cycle 2)		Little	↑	Moderate	↑	Moderate	↑
04LM007 (2018,Cycle 2)		Moderate-Heavy		Severe		Moderate	
08LM136 (2008,Cycle 1)	Wells Creek	None-Little		Light		Moderate	
08LM136 (2018,Cycle 2)		Little	↑	Light	-	Moderate	-
08LM136 (2018,Cycle 2)		Little		Light		Moderate	
18LM032 (2018,Cycle 2)		Little	-	Light	-	Extensive	-
18LM032 (2018,Cycle 2)		Little		Light		Moderate	
08LM130 (2008,Cycle 1)		Little-Moderate		Severe		Nearly Absent	
08LM130 (2012,Cycle 1)		Moderate	↑	Severe	↑	Nearly Absent	↑
08LM130 (2018,Cycle 2)		Moderate		Severe		Moderate	
08LM130 (2018,Cycle 2)		Severe		No Coarse Substrate		Sparse	
08LM138 (2008,Cycle 1)		Little		Severe		Extensive	
08LM138 (2012,Cycle 1)	Gilbert Creek	Little	-	Severe	-	Moderate	↓
08LM138 (2018,Cycle 2)		Little		Moderate		Sparse	
08LM138 (2018,Cycle 2)		Little		No Coarse Substrate		Moderate	
18LM031 (2018,Cycle 2)		Moderate	-	Light	-	Moderate	-
18LM031 (2018,Cycle 2)		Severe		Severe		Sparse	
08LM131 (2008,Cycle 1)		None-Little		Light		Sparse	
08LM131 (2018,Cycle 2)	Miller Creek	Moderate	↑	Moderate	↑	Sparse	-
08LM131 (2018,Cycle 2)		Little-Heavy		Severe		Sparse	
04LM138 (2004,Cycle 1)		None-Little		Moderate		Extensive	
04LM138 (2018,Cycle 2)	Handshaw Coulee (Second Creek)	Little	↑	Moderate	-	Sparse	↓
04LM138 (2018,Cycle 2)		Moderate		Moderate		Moderate	

In general, a majority of habitat related fish metrics improved or remained the same between Cycle 1 and Cycle 2. Many stations had increases in relative abundance (%) of darter, sculpin, and round bodied sucker species (DarterSculpSuc%), non-tolerant benthic insectivore species (BenInsect-Tol%), and piscivore species (Piscivore%); these metrics are expected to decrease in response to stress (**Figure 22**). Relative abundance of simple lithophilic spawners (SLithop%), which is also expected to decrease with stress, decreased at most stations. Overall, fish metric values were mixed when compared to the Southern Coldwater Streams statewide median of stations meeting the FIBI threshold; approximately half were better than the statewide median and half were worse. Macroinvertebrate metrics related to habitat were mixed; some improved between Cycle 1 and Cycle 2 while others declined, and some were better than the Southern Coldwater Streams statewide median of stations meeting the MIBI threshold while others were worse (Figure 23) Most stations had limited burrowers (Burrower%) and legless (Legless%) individuals; both are expected to increase with stress as burrowers “burrow” in fine sediment and legless species are tolerant individuals that can withstand degraded habitat conditions. However, most stations also had limited climbers (Climber%); climbers require habitat such as overhanging vegetation or woody debris and are expected to decrease with stress. Many stations had increases in clingers (Clinger%), who attach to rock or woody debris and are expected to decrease with stress. Swimmers (Swimmer%) decreased significantly at all stations between Cycle 1 and Cycle 2; swimmers require low velocity water and their decline may be a result of recent increases in flow. Fish and macroinvertebrate communities are healthy across the MRLP Watershed with quality habitat supporting these conditions. Protecting stream habitat is critical for future biological health; increased flows and sediment loads are potential threats to habitat availability and quality.

Figure 22: Habitat related fish metrics from Cycle 1 and Cycle 2 in the MRLP Watershed; relative abundance (%) of individuals that are darter, sculpin, and round bodied sucker species (DarterSculpSuc%), riffle-dwelling species (Riffle%), non-tolerant benthic insectivore species (BenInsect-Tol%), simple lithophilic spawners (SLithop%), pioneer species (Pioneer%), and piscivore species (Piscivore%).

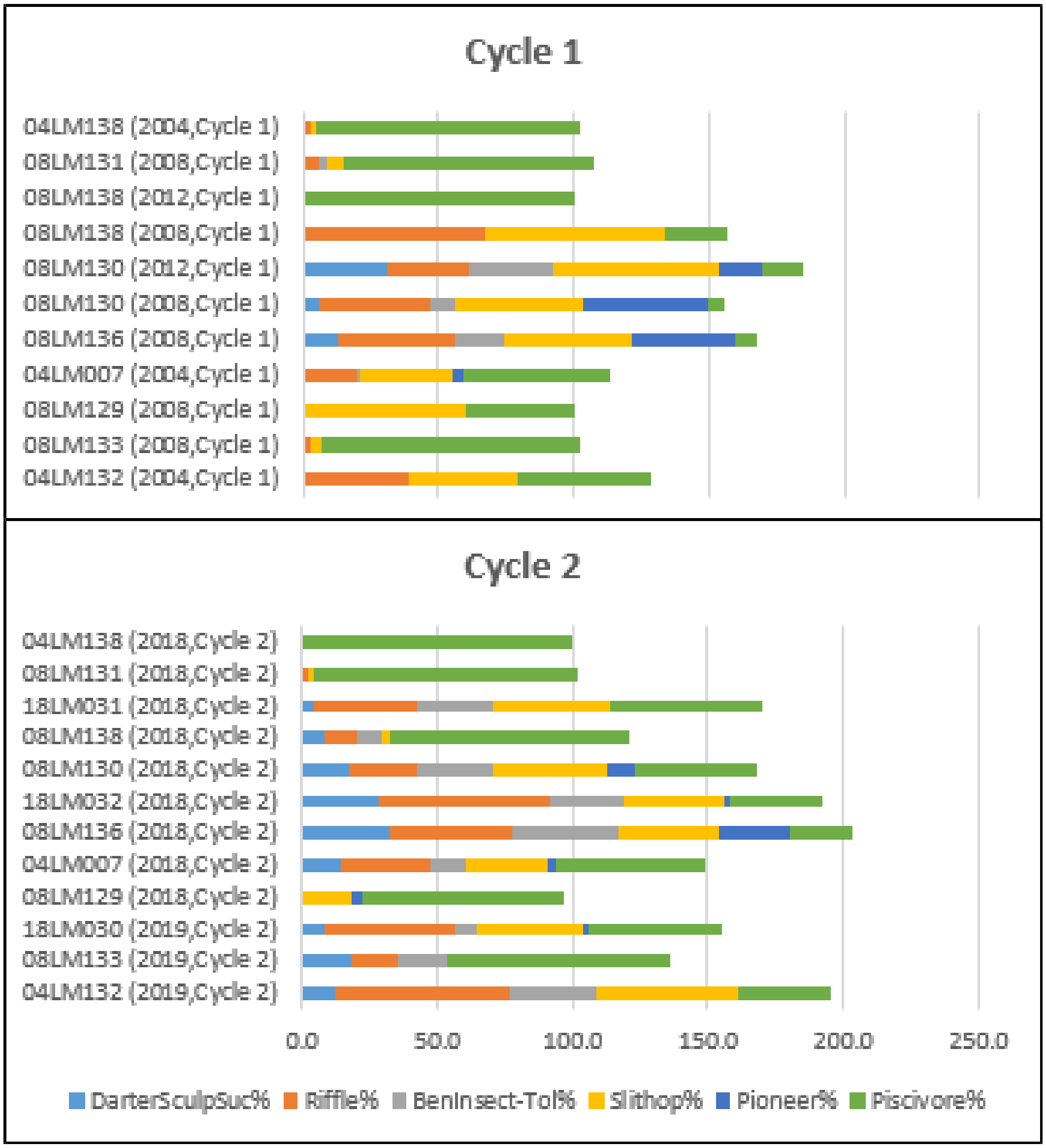
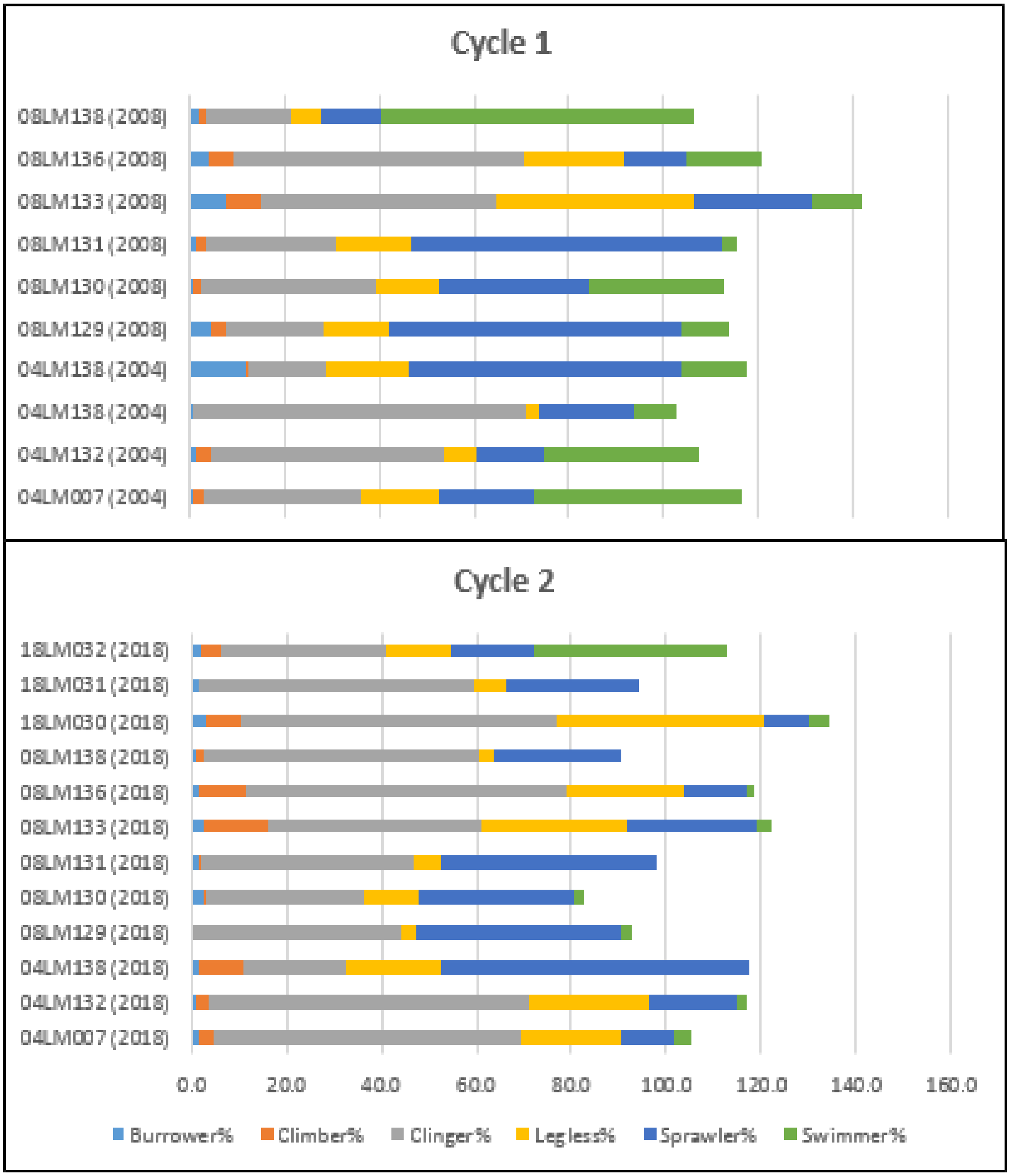


Figure 23: Habitat related macroinvertebrate metrics from Cycle 1 and Cycle 2 in the MRLP Watershed; relative abundance (%) of burrowers (Burrower%), climbers (Climber%), clingers (Clinger%), legless (Legless%), sprawlers (Sprawler%), and swimmers (Swimmer%).



Flow Alteration

Recent increases in stream flow and precipitation have contributed to increases in nutrient and sediment concentrations in the MRLP Watershed (Figure 24). Median stream flows (July through October) near the mouth of Wells Creek have increased considerably since around 2016 and have remained elevated through 2019. While storm event flows have always resulted in flow peaks in the MRLP Watershed, the data indicate that in recent years baseflows during "calm" periods are elevated relative to the historical record. This is important because fish and bugs are subject to baseflow conditions for a majority of the year; changes in water quality during this chronic condition can have significant impacts on aquatic life. An example of how increased flows have impacted water quality in the MRLP Watershed can be seen in Figure 25. Flows in Wells Creek were lower in 2012 resulting in lower TSS concentrations during baseflow conditions, whereas flows in 2019 were higher resulting in higher TSS concentrations during baseflow conditions. Some laboratory work has suggested that brook trout will abandon overhead cover and look for other habitat after <200 hours of exposure to 4.5 mg/L SSC (a measurement similar to TSS) (Gradall & Swenson 1982). Above average precipitation has also been observed in the area over recent years. These recent increases in stream flow and precipitation also align with increases in nutrient and sediment concentrations; see the Nitrate, Eutrophication, and TSS sections for more information. Although fish and macroinvertebrate communities are healthy, protection strategies that reduce/capture overland flow, increase infiltration, and improve soil health are necessary to mitigate stream flows and sustain current biological conditions. Elevated stream flows can negatively impact variables such as in-stream habitat availability and quality, and nutrient/sediment loading.

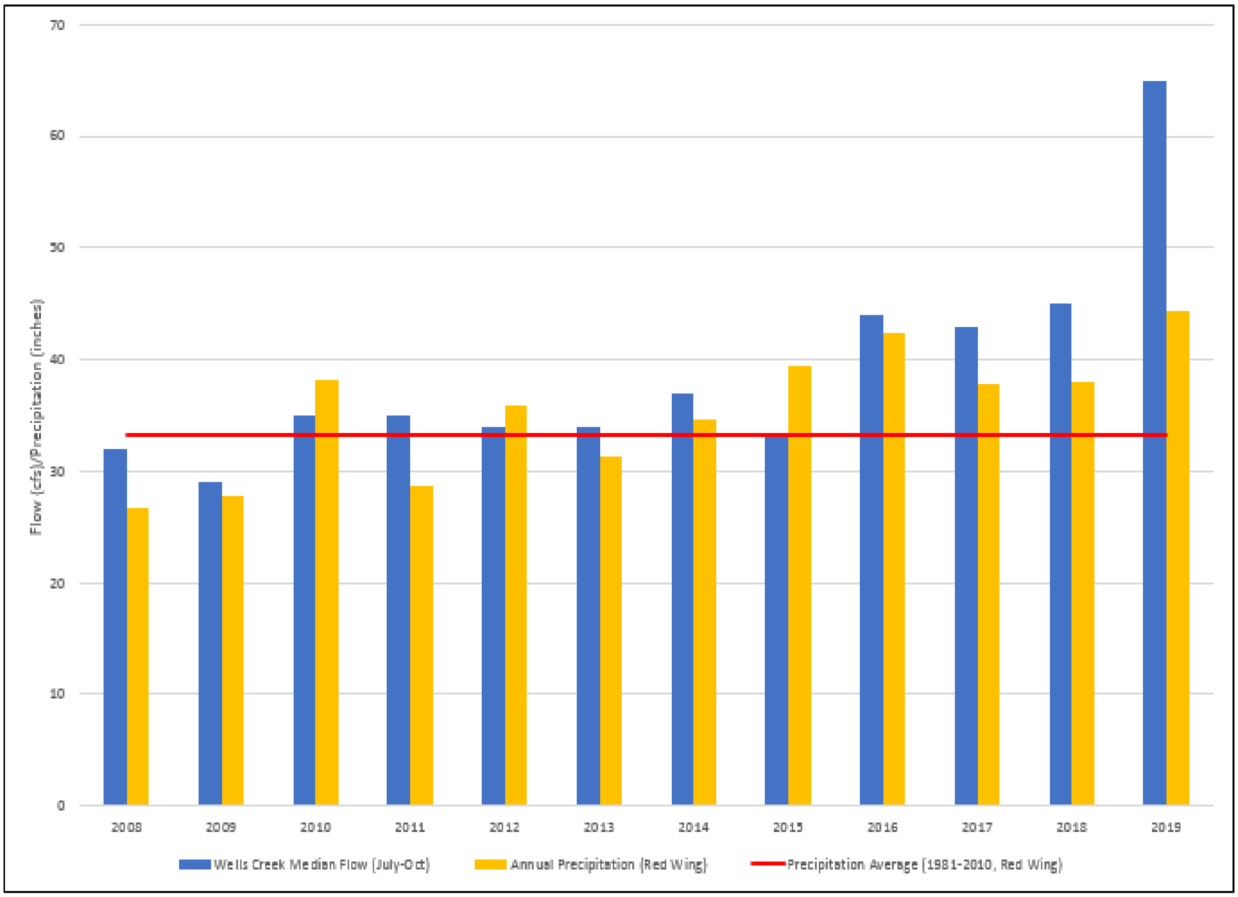


Figure 24: Wells Creek median stream flows (July – October) and annual precipitation (Red Wing, MN) from 2008 – 2019.

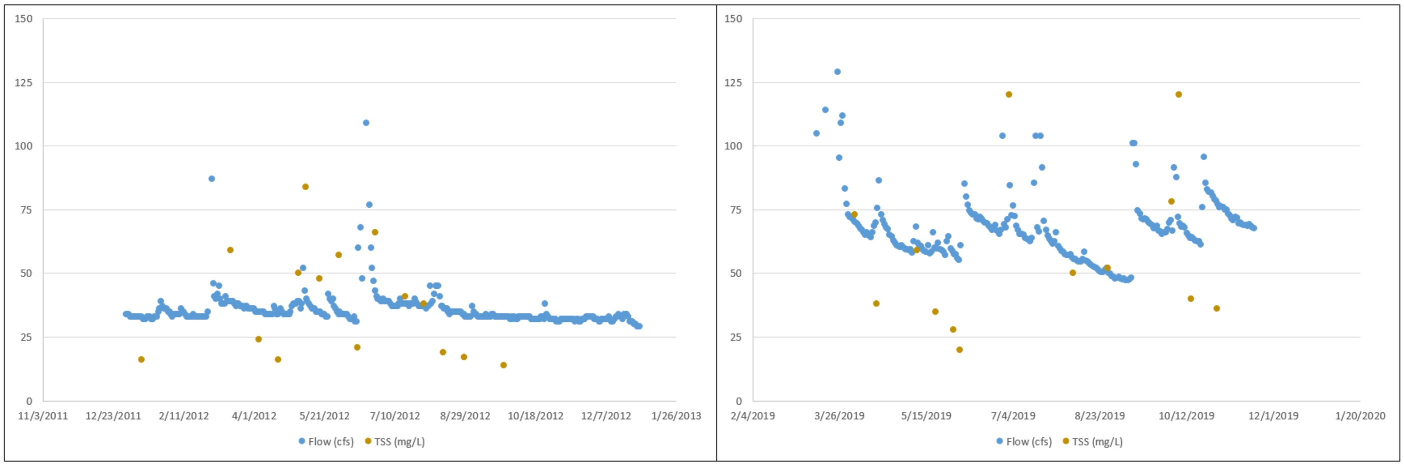


Figure 25: Flow (cfs) and TSS (mg/L) comparisons in Wells Creek (station S004-859) for 2012 (left) and 2019 (right). Note how sustained elevated flows in 2019 resulted in higher TSS concentrations during the latter part of the year which is typically a low flow and low TSS time period; 2012 had lower flows during this time period, which resulted in lower TSS concentrations.

Conclusion

Fish and macroinvertebrate communities in the MRLP Watershed are healthy and meeting standards; most fish IBI scores increased in Cycle 2 while macroinvertebrate IBI scores were mixed (some increased and some decreased). In general, nutrients (nitrate and phosphorus) are low and temperature, DO, and habitat are suitable to support coldwater communities. TSS often exceeds the coldwater standard (particularly in the downstream portions of each subwatershed), but at this time it's not degrading biological condition to the point of impairment; adequate nutrients and stream temperatures coupled with quality DO and habitat conditions are likely minimizing the elevated TSS impact. However, these elevated TSS concentrations are a threat to future biological health, and protection measures aimed at reducing sediment loading are a priority. Primary sediment sources include runoff from upland agricultural land, ravines, stream bank erosion, and re-suspension of in-stream fine substrate. The lower portion of Hay Creek has several large raw stream banks and a stream bed dominated with fine substrate (Figure 16). In addition to directly impacting biology, excess sediment can negatively affect variables such as temperature, DO, and habitat.

Recent increases in stream flow and precipitation (Figure 24) have contributed to increases in nutrient/sediment concentrations (Figure 6, Figure 9, and Figure 17) and bank erosion/embeddedness (Table 2). Protection strategies that reduce/capture overland flow, increase infiltration, and improve soil health are necessary to mitigate stream flows (and nutrient/sediment loading) and sustain current biological conditions. Elevated stream flows can negatively impact in-stream habitat (availability and quality), and nutrient/sediment loading.

Overall, the biggest threats to fish and macroinvertebrates in the MRLP Watershed are excess sediment, increased stream flows (flow alteration), and habitat degradation (Figure 26); prioritizing protection strategies to address these concerns is a necessary approach to maintain healthy aquatic life in the watershed. Hay Creek, Wells Creek, and Handshaw Coulee are high priority protection watersheds based on input from local partners, amount of recreational use, decreasing IBI scores, and/or IBI scores near threshold.

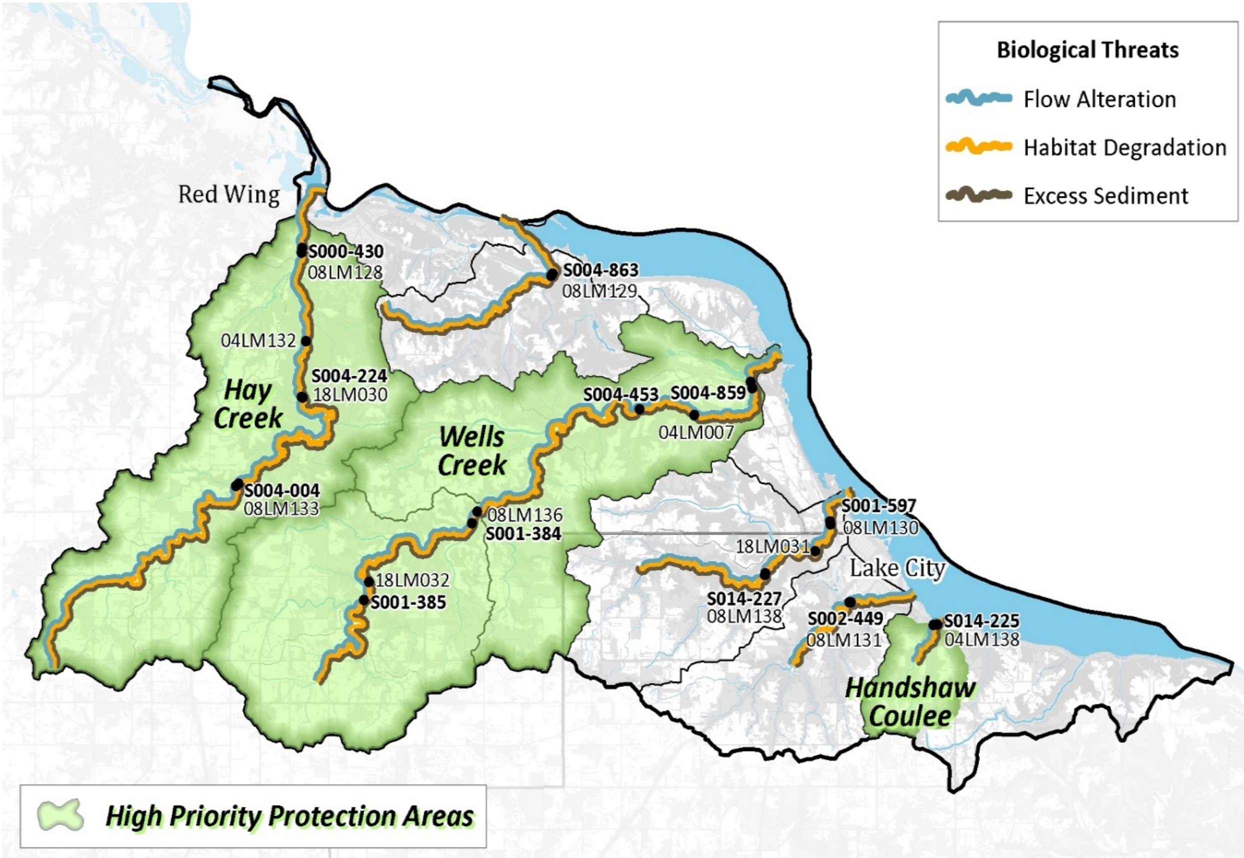


Figure 26: High priority protection areas and threats to biology in the MRLP Watershed.

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