

Priority Watershed Water Quality Evaluation for the Lower Little Wolf River Watershed, Waupaca County, Wisconsin

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David Bolha-Water Quality Biologist-Oshkosh



Purpose

This project evaluated water quality improvements made in the Lower Little Wolf River Watershed from Best Management Practices installed in the watershed from 1997 through 2008 as part of the Lower Little Wolf River Priority Watershed Project. The Lower Little Wolf Watershed was identified as the drainage area downstream of Big Falls to the Little Wolf River confluence with the South Branch of the Little Wolf River near Royalton (Map 1-2). This project determined if the goals of the Priority Watershed Project to protect and improve the watershed water quality were met by collecting fish, aquatic macroinvertebrate, habitat, temperature, and inorganic chemistry information throughout the watershed.

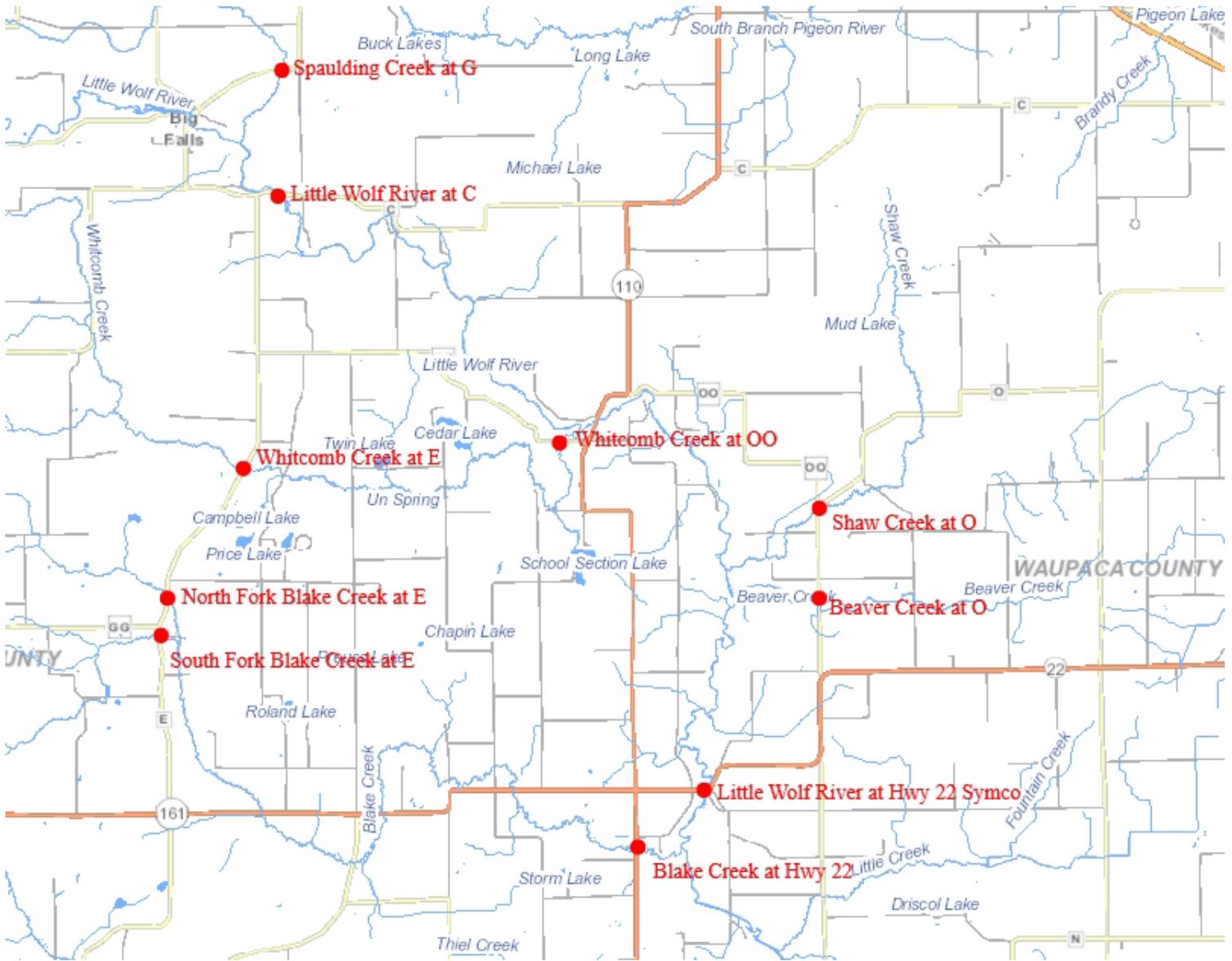
Methods

During the growing season of 2015, Total Phosphorus (TP) samples were collected at 12 locations once per month from May through October (Table 1, Map 1-2). In addition to the TP samples, Total Dissolved

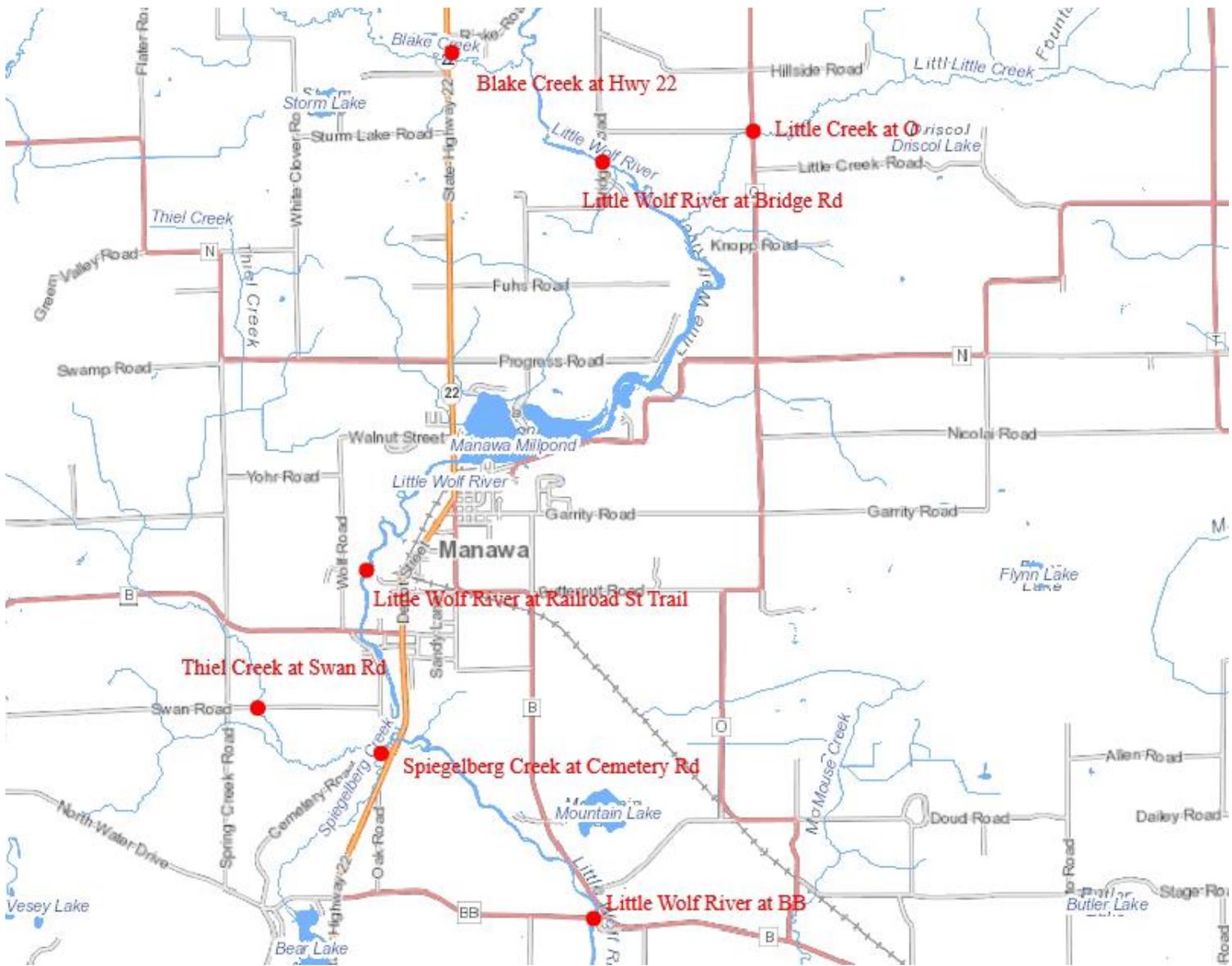
Phosphorus (TDP) samples were collected in August through October 2015 at 10 of the 12 locations in Table 1. Thirdly, Dissolved Nitrates + Nitrites as Nitrogen (NO₃+NO₂ as N) samples were collected in June and August 2015 at 12 locations in the Lower Little Wolf River Watershed (Table 1). Finally, Total Suspended Solids (TSS) samples were collected in May through October 2015 at 10 of the 12 locations in Table 1. All samples were collected using the standard WDNR grab sampling method for a total of 159 samples (WDNR 2014). Neither baseflow nor storm or snowmelt event sampling were targeted during this project, following the protocol of Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2014). However, the June sampling was conducted following a rain event based upon the National Oceanic and Atmospheric Administration (NOAA) historical precipitation data (NOAA 2016). Additionally, the August and October samples were collected during baseflow conditions (NOAA 2016). All nutrient samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the WDNR Surface Water Integrated Monitoring System (SWIMS) database.

SWIMS Station ID	Site Name	Surface Water WBIC
10030800	Beaver Creek – 280 ft downstream CTH O	283000
693129	Blake Creek at SH 22	280900
693145	Little Creek at Cth O	280700
693141	Little Wolf River at Cth BB	272400
693151	Little Wolf River at Cth C	272400
10043199	Little Wolf River at Railroad St Trail-Manawa	272400
693163	Lower Little Wolf River at Bridge Rd	272400
693131	Shaw Creek at Cth O	283100
693130	Spaulding Creek at Cth G	284900
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	279600
693143	Thiel Creek at Swan Rd	280100
10016223	Whitcomb Creek – Cth OO	283400

Table 1: Inorganic Chemistry Monitoring Sites Sampled in the Lower Little Wolf River Watershed May Through October 2015.



Map 1: Northern Half of Lower Little Wolf River Watershed Sample Locations in 2015.



Map 2: Southern Half of Lower Little Wolf River Watershed Sample Locations in 2015.

Eleven creek and river locations were sampled for aquatic macroinvertebrates in October 2015 (Map 1-2, Table 2). Blake Creek and its South Fork were sampled in May 2016 for macroinvertebrates to fill out the dataset (Map 1, Table 2). All sites were sampled using the WDNR *Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams* (2000). A D-shaped kicknet with 600 micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then overhanging vegetation, woody debris, or other vegetation would be sampled. This was done by jabbing the net into the vegetation to free the invertebrates. For a representative sample of the aquatic macroinvertebrate community, a minimum of 100 aquatic macroinvertebrates collected in each sample was targeted. The aquatic macroinvertebrates were preserved in a 70-80% ethanol solution inside quart “Mason” jars. If necessary, multiple “Mason” jars were used per sample depending upon how much sediment and organic material was collected with the aquatic macroinvertebrates. Within the next 24 hours, the samples were re-preserved with another 70-80% ethanol solution. Samples were taken to the UWSP Aquatic Entomology Laboratory (AEL) for lowest possible taxonomic identification. Staff at the AEL entered the data into the SWIMS database in 2016.

SWIMS Station ID	Site Name	Surface Water WBIC
10030800	Beaver Creek – 280 ft downstream CTH O	283000
10013573	South Fork Blake Creek US Cth E	282100
10016782	Blake Creek at Cth K	280900
693129	Blake Creek at SH 22	280900
693145	Little Creek at Cth O	280700
693141	Little Wolf River at Cth BB	272400
693151	Little Wolf River at Cth C	272400
693147	Little Wolf River at Hwy 22 Near Symco	272400
693131	Shaw Creek at Cth O	283100
693130	Spaulding Creek at Cth G	284900
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	279600
693143	Thiel Creek at Swan Rd	280100
10016223	Whitcomb Creek – Cth OO	283400

Table 2: Aquatic Macroinvertebrate Monitoring Locations Sampled in the Lower Little Wolf River Watershed in 2015 and 2016.

Between July and September 2015, wadable fish surveys were conducted at 13 sites (Map 1-2, Table 3). Wadable fish surveys were conducted at 10 of the 11 sites listed in Table 2. Beaver Creek at County Hwy O was dry during the scheduled sampling event period; therefore, no survey was conducted. The 13 wadable fish surveys were conducted following the WDNR *Guidelines for Assessing Fish Communities of Wadable Streams in Wisconsin* (2001). All 13 wadable sites were surveyed in July through September 2015 during the guidance-recommended summer time survey period. Stream flow and water chemistry data was recorded at each wadable site prior to conducting the fish survey. The wadable fish survey stations were a minimum of 35 times the mean stream width (overall minimum of 100 meters, overall maximum of 400 meters). An otter sled stream shocker with a 4000 Peak Watt generator was used for 6 of the 13 wadable sites with appropriate stream width and/or depth. A 12 Volt, 18 Amp Hour battery-powered backpack shocker was used for 7 of the 13 sites based upon the streams' smaller width and depth. Catch per effort sampling procedures were used for this project (no particular species was targeted, all captured). A single upstream pass was made using 0.125 inch mesh nets to collect the fish. At the end of the station, captured fish were identified and counted and all game fish were measured for length. Once all data was collected, the fish were returned to the creek. Fish survey data was entered into the WDNR Fisheries and Habitat Management Database (FHMD) by WDNR Water Resources staff.

SWIMS Station ID	Site Name	Surface Water WBIC
693151	Little Wolf River at Cth C	272400
693147	Little Wolf River at Hwy 22 Near Symco	272400
693141	Little Wolf River at Cth BB	272400
693128	Whitcomb Creek – US Cth E	283400
10016223	Whitcomb Creek – Cth OO	283400
693154	North Fork Blake Creek – US Cth E	281500
10013573	South Fork Blake Creek – US Cth E	282100
693129	Blake Creek at SH 22	280900
693143	Thiel Creek at Swan Rd	280100
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	279600
693130	Spaulding Creek at Cth G	284900
693145	Little Creek at Cth O	280700
693131	Shaw Creek at Cth O	283100

Table 3: Wadable Fish Survey Locations Sampled in the Lower Little Wolf River Watershed between July and September 2015.

Onset Hobo Pendant thermistors were deployed to collect temperature data from May through October at 14 locations in the Lower Little Wolf River Watershed (Table 4, Map 1-2). Temperature measurements were taken once per hour at each location from May through October or November. Temperature measurements were taken with an Onset Hobo Pendant thermistor attached to a fence post driven into the stream bed of the creek or river. The thermistor was attached to the fence post in such a manner as to suspend the thermistor in the water column low enough to stay under water in low flow conditions and high enough to not get buried in bottom substrate (~ 6 inches above the bottom). The thermistor was placed in a shaded location when possible. Temperature data were uploaded into the SWIMS database by WDNR Water Resources staff.

SWIMS Station ID	Site Name	Surface Water WBIC
693151	Little Wolf River at County Hwy C	272400
693147	Little Wolf River at Hwy 22 Near Symco	272400
10043199	Little Wolf River at Railroad St Trail	272400
693128	Whitcomb Creek – US Cth E	283400
10016223	Whitcomb Creek – Cth OO	283400
693154	North Fork Blake Creek – US Cth E	281500
10013573	South Fork Blake Creek – US Cth E	282100
693129	Blake Creek at SH 22	280900
693143	Thiel Creek at Swan Rd	280100
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	279600
693130	Spaulding Creek at Cth G	284900
693131	Shaw Creek at Cth O	283100
10030800	Beaver Creek – 280 ft downstream CTH O	283000
693145	Little Creek at Cth O	280700

Table 4: Temperature Monitoring Locations in the Lower Little Wolf River Watershed Sampled From May through October 2015.

Quantitative habitat surveys were conducted at 10 locations in the Lower Little Wolf River Watershed in October 2015 (Table 5, Map 1-2). In May 2016, a quantitative habitat survey was conducted in Little Creek at County O (Table 5, Map 2). All sites were surveyed following the WDNR *Guidelines for Evaluating Habitat of Wadable Streams* (2002). Each quantitative habitat survey station length was 35 times the mean stream width of the survey station. Following the determination of station length, the station was divided into 12 transects. At each transect, substrate, sedimentation, erosion, water depth, and riparian land use data were collected. WDNR Water Resources staff entered the quantitative habitat data into the FHMD.

SWIMS Station ID	Site Name	Surface Water WBIC
693151	Little Wolf River at Cth C	272400
693147	Little Wolf River at Hwy 22 Near Symco	272400
693141	Little Wolf River at County Hwy BB	272400
10016223	Whitcomb Creek – Cth OO	283400
10013573	South Fork Blake Creek – US Cth E	282100
693129	Blake Creek at SH 22	280900
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	279600
693143	Thiel Creek at Swan Rd	280100
693130	Spaulding Creek at Cth G	284900
693145	Little Creek at Cth O	280700
693131	Shaw Creek at Cth O	283100

Table 5: Quantitative Habitat Survey Locations in the Lower Little Wolf River Watershed Conducted in October 2015 and May 2016.

Results

The 2015 TP sample analysis results in the Lower Little Wolf River Watershed ranged from 0.0172 mg/L at Spaulding Creek in May to 0.749 mg/L at Thiel Creek in July (Table 7, Chart 2). The TP sample analysis results in the Little Wolf River Mainstem ranged from 0.0182 mg/L at County Hwy C in October to 0.209 mg/L at County Hwy BB in June (Table 6, Chart 1). Four of the 12 locations in this project had an average TP concentration (mg/L) exceeding the Wisconsin Administrative Code ch. NR 102.06(3)(b) water quality criteria (WQC) for creeks and rivers at 0.075 mg/L (Table 6-7, Chart 1-2). Eight of the 12 locations had average TP concentrations less than the WQC (Table 6-7, Chart 1-2). The average TP concentrations for the 12 sites in this project ranged from 0.0376 mg/L in the Little Wolf River at County Hwy C to 0.2958 mg/L in Thiel Creek at Swan Road (Table 6-7, Chart 1-2).

Month of Sampling Event	Little Wolf River at Hwy C (mg/L)	Little Wolf River at Bridge Road (mg/L)	Little Wolf River at Railroad St Trail (mg/L)	Little Wolf River at Hwy BB (mg/L)
May	0.0211	0.0466	0.0363	0.0307
June	0.0818	0.163	0.207	0.209
July	0.0354	0.0407	0.0782	0.0613
August	0.032	0.0317	0.051	0.0464
September	0.037	0.0492	0.066	0.0682
October	0.0182	0.0206	0.032	0.0287
Average	0.0376	0.0586	0.0784	0.0741

Table 6: Total Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem from Upstream to Downstream in 2015.

Total Phosphorus Concentrations and Averages in the Lower Little Wolf River Mainstem in 2015

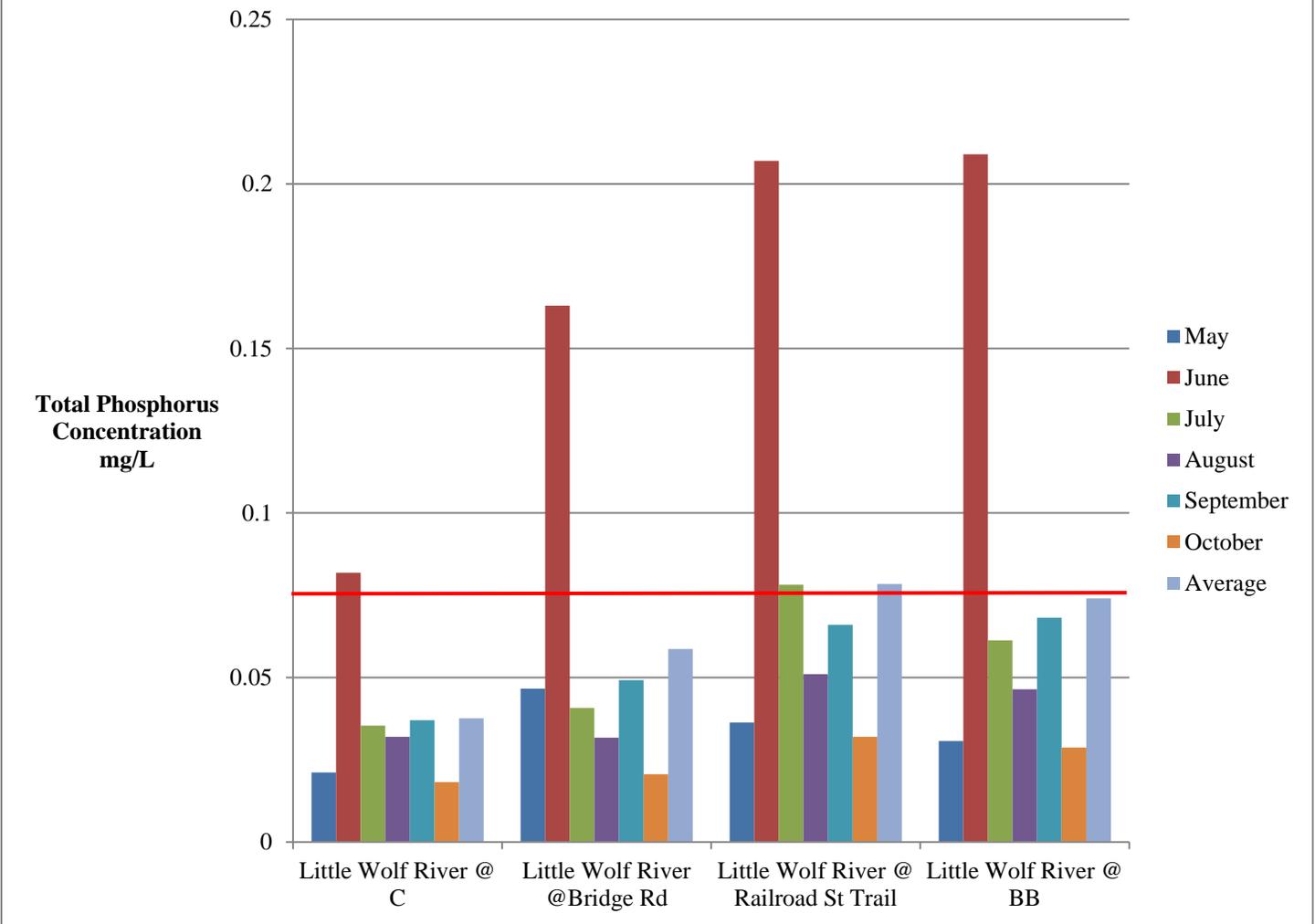


Chart 1: Total Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem from Upstream to Downstream in 2015 (with 0.075 mg/L WQC red line).

Sample Event Month	Whitcomb Creek at Hwy OO (mg/L)	Blake Creek at Hwy 22 (mg/L)	Thiel Creek at Swan Rd (mg/L)	Spiegelberg Creek at Cemetery Rd (mg/L)	Spaulding Creek at Hwy G (mg/L)	Shaw Creek at Hwy O (mg/L)	Beaver Creek at Hwy O (mg/L)	Little Creek at Hwy O (mg/L)
May	0.0271	0.0296	0.169	0.0357	0.0172	0.0738	0.204	0.25
Jun	0.103	0.203	0.373	0.0546	0.0682	0.133	0.209	0.231
Jul	0.0364	0.07	0.749	0.0466	0.0517	0.073	0.667	0.284
Aug	0.0318	0.0462	0.155	0.0518	0.0413	0.0665	N/A	0.192
Sep	0.0347	0.0533	0.222	0.047	0.0371	0.0582	0.128	0.21
Oct	0.0232	0.0326	0.107	0.0262	0.0207	0.0375	0.0893	0.107
Ave	0.0427	0.0725	0.2958	0.0437	0.0394	0.07367	0.2595	0.2123

Table 7: Total Phosphorus Concentrations and Averages of Samples Collected in the Tributaries of the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015)

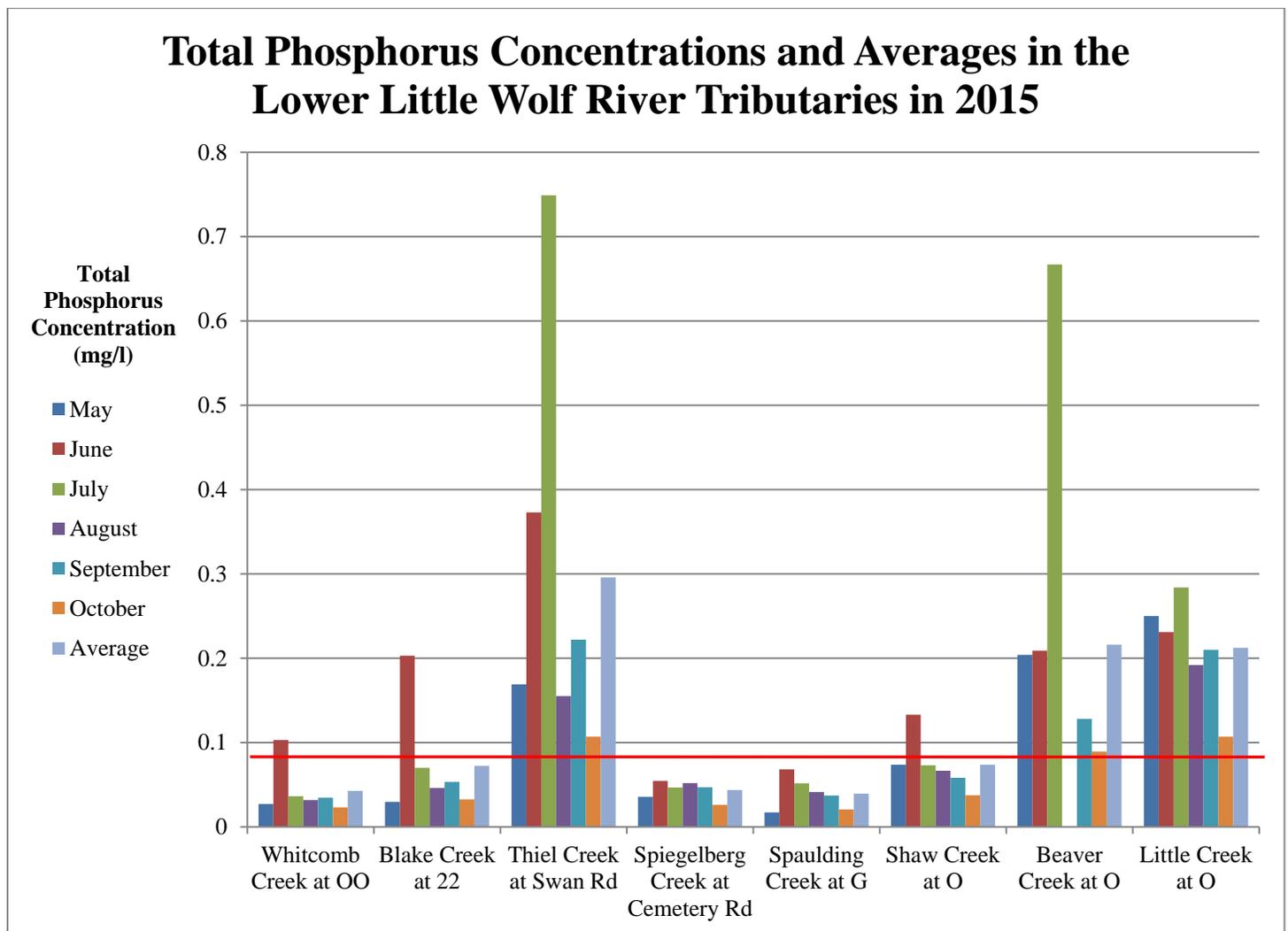


Chart 2: Total Phosphorus Concentrations and Averages of Samples Collected in the Tributaries of the Lower Little Wolf River Watershed in 2015 (with 0.075 mg/L WQC red line). (Beaver Creek was dry in August 2015)

At 10 of the 12 TP sample locations, TDP analysis was conducted on samples collected in August, September, and October 2015. The 2015 TDP concentrations in the Lower Little Wolf River Mainstem ranged from 0.0138 mg/L at County Hwy C in October to 0.0556 mg/L at Railroad St Trail in September (Table 8, Chart 3). The 2015 TDP concentrations in the Tributaries of the Lower Little Wolf River ranged from 0.0137 mg/L in Spiegelberg Creek in September to 0.172 mg/L in Little Creek in September (Table 9, Chart 4).

Month of Sampling Event	Little Wolf River at Hwy C (mg/L)	Little Wolf River at Bridge Road (mg/L)	Little Wolf River at Railroad St Trail (mg/L)	Little Wolf River at Hwy BB (mg/L)
August	0.0218	0.0216	0.0437	0.0395
September	0.0292	0.0337	0.0556	0.0522
October	0.0138	0.0177	0.0251	0.0229
Average	0.0216	0.0243	0.0418	0.0382

Table 8: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem in 2015.

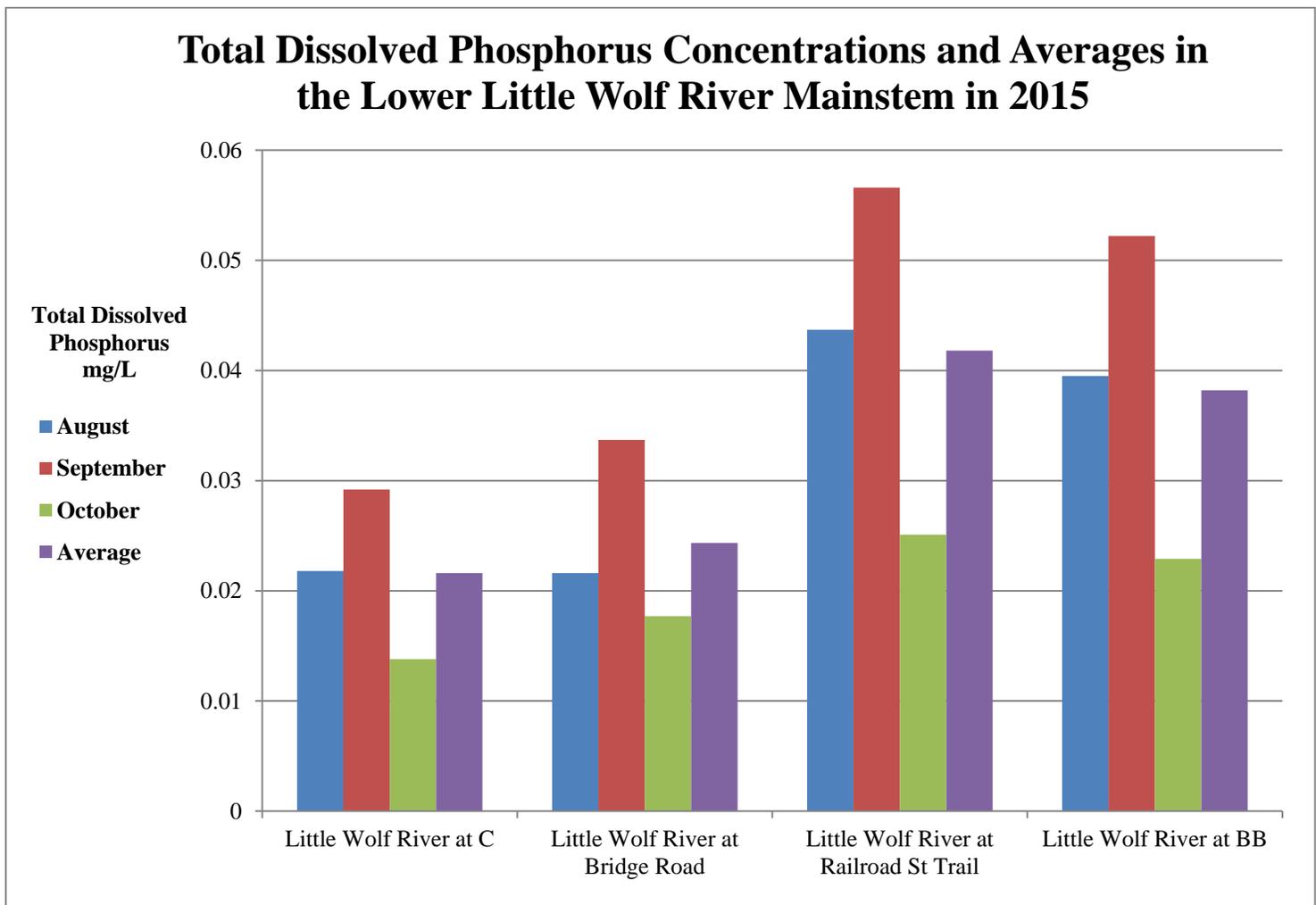


Chart 3: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem in 2015.

Sample Event Month	Whitcomb Creek at Hwy OO (mg/L)	Blake Creek at Hwy 22 (mg/L)	Thiel Creek at Swan Rd (mg/L)	Spiegelberg Creek at Cemetery Rd (mg/L)	Spaulding Creek at Hwy G (mg/L)	Shaw Creek at Hwy O (mg/L)	Beaver Creek at Hwy O (mg/L)	Little Creek at Hwy O (mg/L)
Aug	0.0245	0.0353	0.0951	0.0312	0.0309	0.054	N/A	0.152
Sep	0.0265	0.0369	0.201	0.0137	0.0296	0.0453	0.0849	0.172
Oct	0.018	0.0253	0.0894	0.0212	0.0201	0.0304	0.0443	0.0971
Ave	0.023	0.0325	0.1285	0.022	0.0269	0.0432	0.0646	0.1404

Table 9: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in Tributaries of the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015)

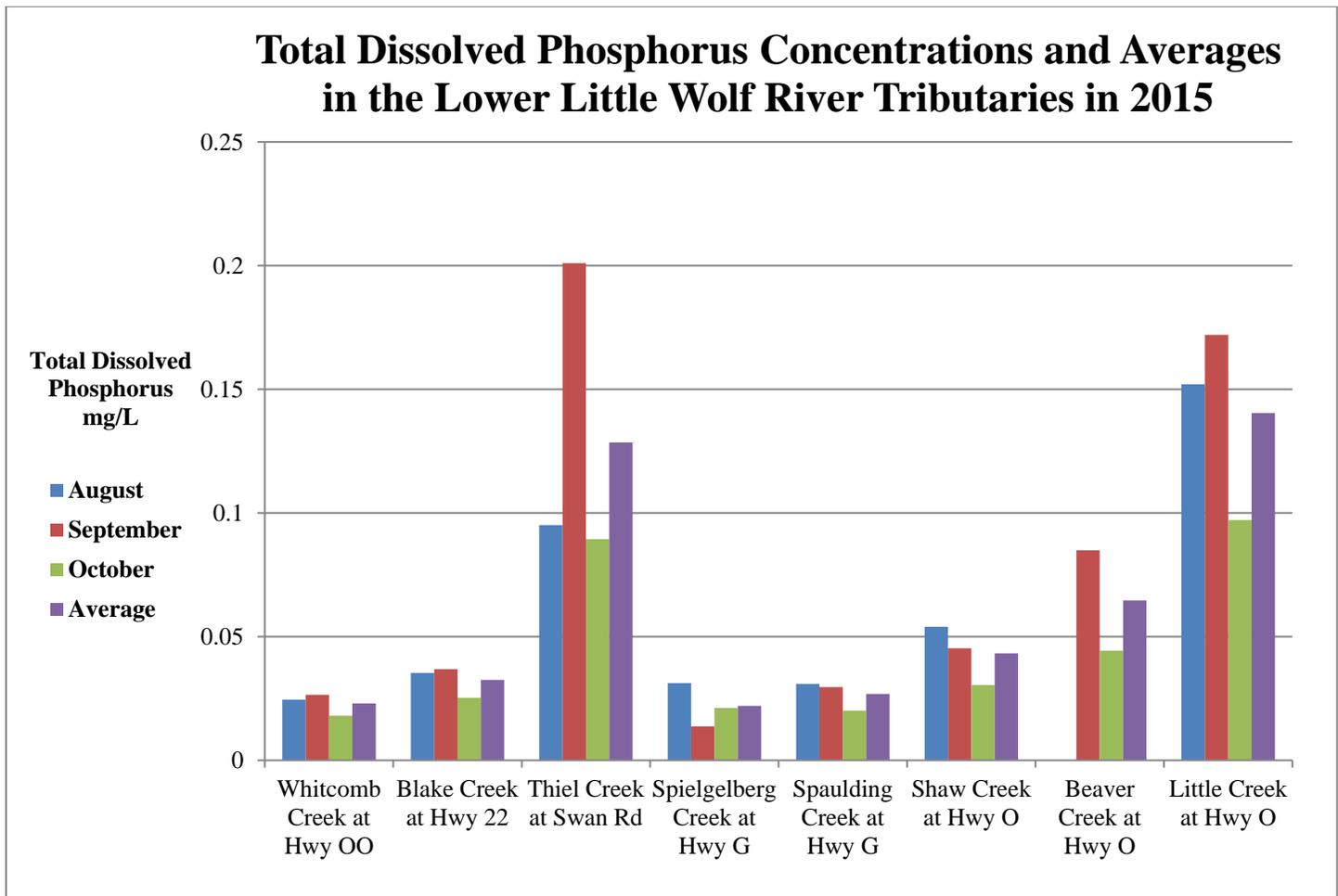


Chart 4: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in Tributaries of the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015)

At the 12 locations in Table 1, NO₃+NO₂ as N analysis was conducted on samples collected in June and August 2015 (Table 10, Chart 5). The 2 samples at County Hwy C had the lowest and highest NO₃+NO₂ as N concentrations in the Lower Little Wolf River Mainstem, 0.863 mg/L in June and 2.24 mg/L in August 2015, respectively (Table 10). The 2015 NO₃+NO₂ as N concentrations of the Tributaries of the Lower Little Wolf River Watershed ranged from 0.0785 mg/L in June in Whitcomb Creek to 2.01 mg/L in August in Little Creek (Table 10, Chart 5).

Sample Location	June	August
Little Wolf River at Hwy C	0.863	2.24
Little Wolf River at Bridge Road	1.27	1.26
Little Wolf River at Railroad St Trail	1	1.88
Little Wolf River at Hwy BB	1.14	1.19
Beaver Creek at Hwy O	0.474	N/A
Blake Creek at Hwy 22	0.861	1.27
Little Creek at Hwy O	1.67	2.01
Shaw Creek at Hwy O	1.71	0.143
Spaulding Creek at Hwy G	0.052	0.473
Spiegelberg Creek at Cemetery Rd	0.177	1.22
Thiel Creek at Swan Rd	0.853	0.868
Whitcomb Creek at Hwy OO	0.079	1.3

Table 10: Dissolved Nitrates + Nitrites as Nitrogen Concentrations (mg/L) of Samples Collected in the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015)

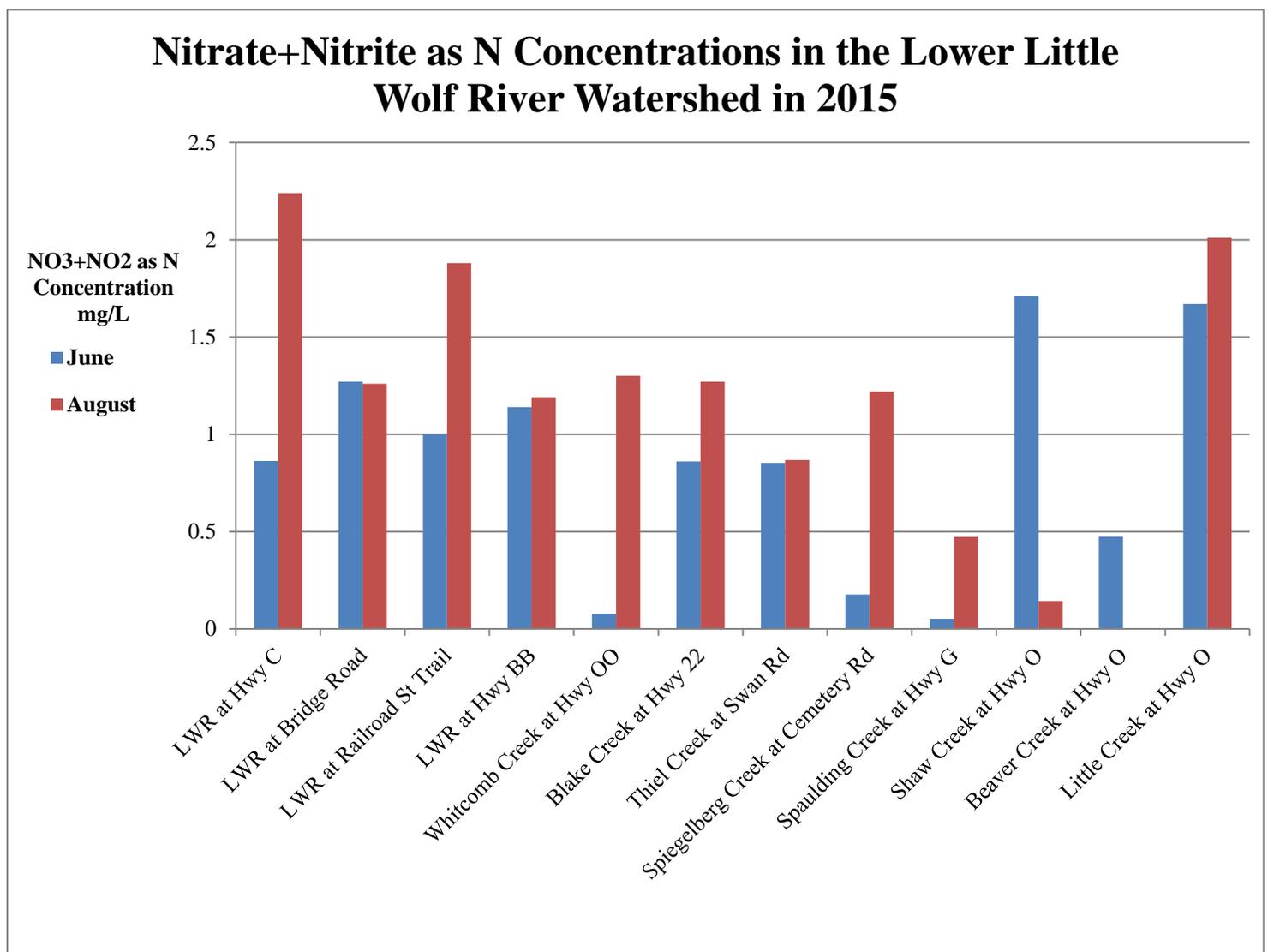


Chart 5: Dissolved Nitrates + Nitrites as Nitrogen Concentrations (mg/L) of Samples Collected in the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015)

TSS analysis was conducted on samples collected at 10 of the 12 Lower Little Wolf River Watershed project locations during the same sampling events as TP in 2015. TSS samples were collected once per month from May through October (Table 11-12, Chart 6). Wisconsin does not have a water quality standard for TSS; however, this data provides useful information about the watershed, background information for future comparison, and additional support for adding these systems to the CWA 303d list for habitat degradation. The TSS concentration of the Lower Little Wolf River Mainstem ranged from No Detection (ND), which is <2.0 mg/L, to 33.5 mg/L in June at County Hwy BB (Table 11, Chart 6). The TSS concentrations of the Tributaries in the Lower Little Wolf River Watershed ranged from ND to 67.4 mg/L in July in Shaw Creek at County Hwy O (Table 12, Chart 6).

Month of Sampling Event	Little Wolf River at Hwy C	Little Wolf River at Hwy BB
May	ND	4.2
June	22.3	33.5
July	4.2	ND
August	3.2	ND
September	4.4	5.8
October	ND	ND
Average	5.27	8.25

Table 11: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Lower Little Wolf River Mainstem in 2015. (ND = No Detection) (Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

Sample Event Month	Whitcomb Creek at Hwy OO (mg/L)	Blake Creek at Hwy 22 (mg/L)	Thiel Creek at Swan Rd (mg/L)	Spiegelberg Creek at Cemetery Rd (mg/L)	Spaulding Creek at Hwy G (mg/L)	Shaw Creek at Hwy O (mg/L)	Beaver Creek at Hwy O (mg/L)	Little Creek at Hwy O (mg/L)
May	6	3.6	5.4	3.8	2.2	8.75	17.8	9
Jun	6.4	35.7	13.4	ND	4.4	11.3	2.4	8.25
Jul	5.4	11.2	7.4	9.2	8	67.4	4.4	10
Aug	3.2	2.8	5.4	6.4	2	5.4	N/A	4.6
Sep	5.4	6.4	3.8	12.4	3.2	6.67	15.7	7
Oct	2	ND	2.4	3.8	ND	ND	5.8	ND
Ave	4.733	10.283	6.3	7.12	3.633	16.92	9.22	6.808

Table 12: Total Suspended Solids Concentrations and Averages of Samples Collected in the Tributaries of the Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015) (ND = No Detection) (Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

Total Suspended Solids Concentrations and Averages in the Lower Little Wolf River Watershed in 2015

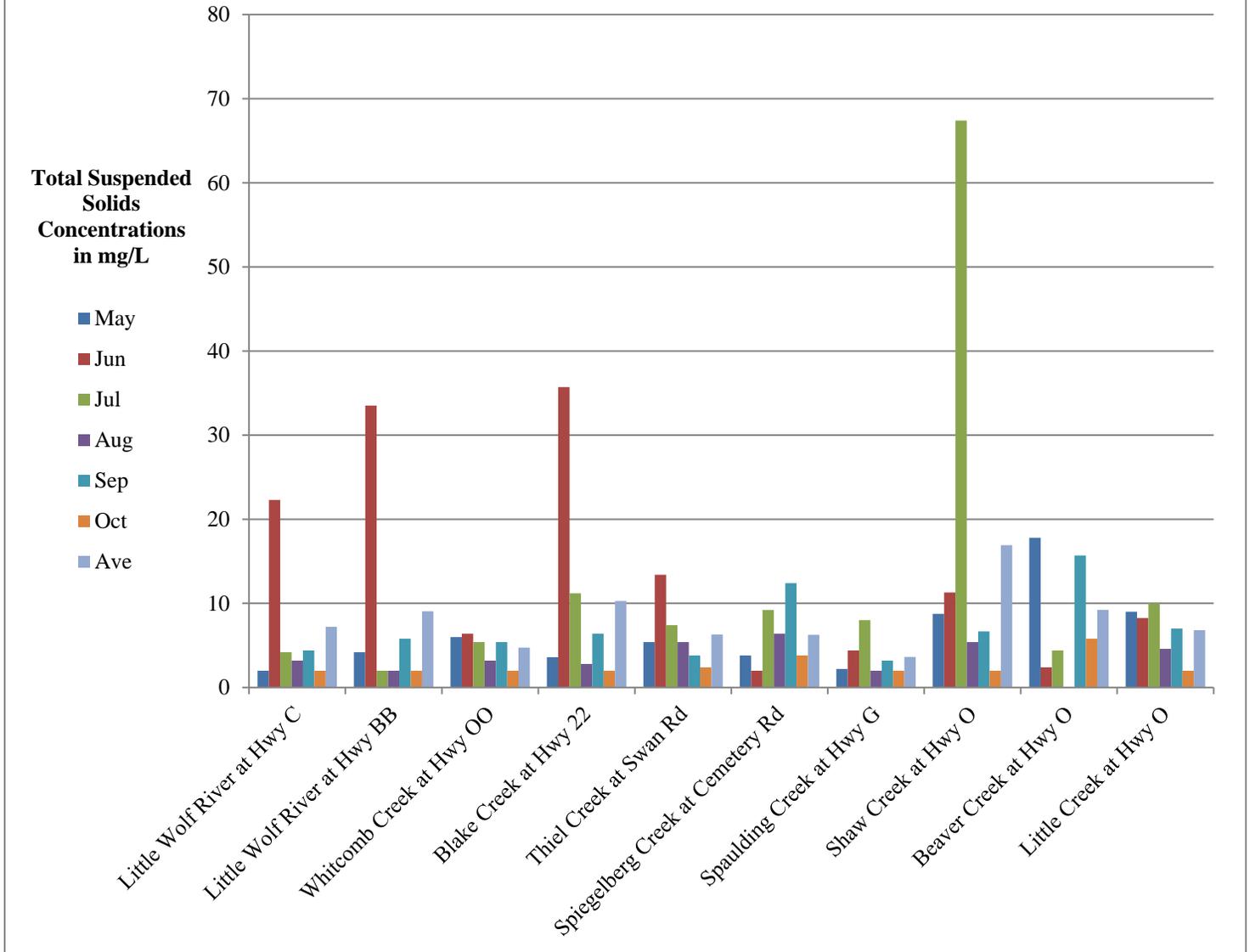


Chart 6: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Lower Little Wolf River Watershed in 2015. (Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

Aquatic macroinvertebrate communities were sampled at 11 locations in October 2015 (Table 2). In addition, macroinvertebrate samples were collected from Blake Creek at County K and its South Fork at County E in May 2016 (Table 2). Some aquatic macroinvertebrate species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate sample collected and their associated tolerance to environmental degradation, an Index of Biotic Integrity (MIBI) was calculated to indicate the water quality condition of the stream or river (Table 13, Chart 7). In general, the higher the MIBI score, the better the water quality rating for a waterbody. The MIBI scores ranged from 3.63 in Little Creek at County O to 8.3 in the Little Wolf River at County BB (Table 13,

Chart 7, Photo 1). The Condition Categories for the 13 sites ranged from Fair to Excellent. The 3 Little Wolf River Mainstem samples demonstrated a macroinvertebrate community that ranged from having some slight to no apparent impact from environmental degradation. The 10 tributary macroinvertebrate communities indicated significant to some slight impact from environmental degradation.

SWIMS Station ID	Stream Name and Location	Macroinvertebrate IBI Score	Condition Category
693151	Little Wolf River at Cth C	7.91	Excellent
693147	Little Wolf River at Hwy 22 Near Symco	7.18	Good
693141	Little Wolf River at Cth BB	8.3	Excellent
10016223	Whitcomb Creek – Cth OO	3.65	Fair
10013573	South Fork Blake Creek – US Cth E	6.05	Good
10016782	Blake Creek at Cth K	5.78	Good
693129	Blake Creek at SH 22	6.84	Good
693143	Thiel Creek at Swan Rd	4.83	Fair
693142	Spiegelberg Creek at Cemetery Rd	6.13	Good
693130	Spaulding Creek at Cth G	6.47	Good
693145	Little Creek at Cth O	3.63	Fair
693131	Shaw Creek at Cth O	4.73	Fair
10030800	Beaver Creek at Cth O	5.17	Good

Table 13: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Lower Little Wolf River Watershed in 2015 and 2016.

Wisconsin Wadable Macroinvertebrate Index of Biotic Integrity Scores and Condition Categories in 2015 and 2016

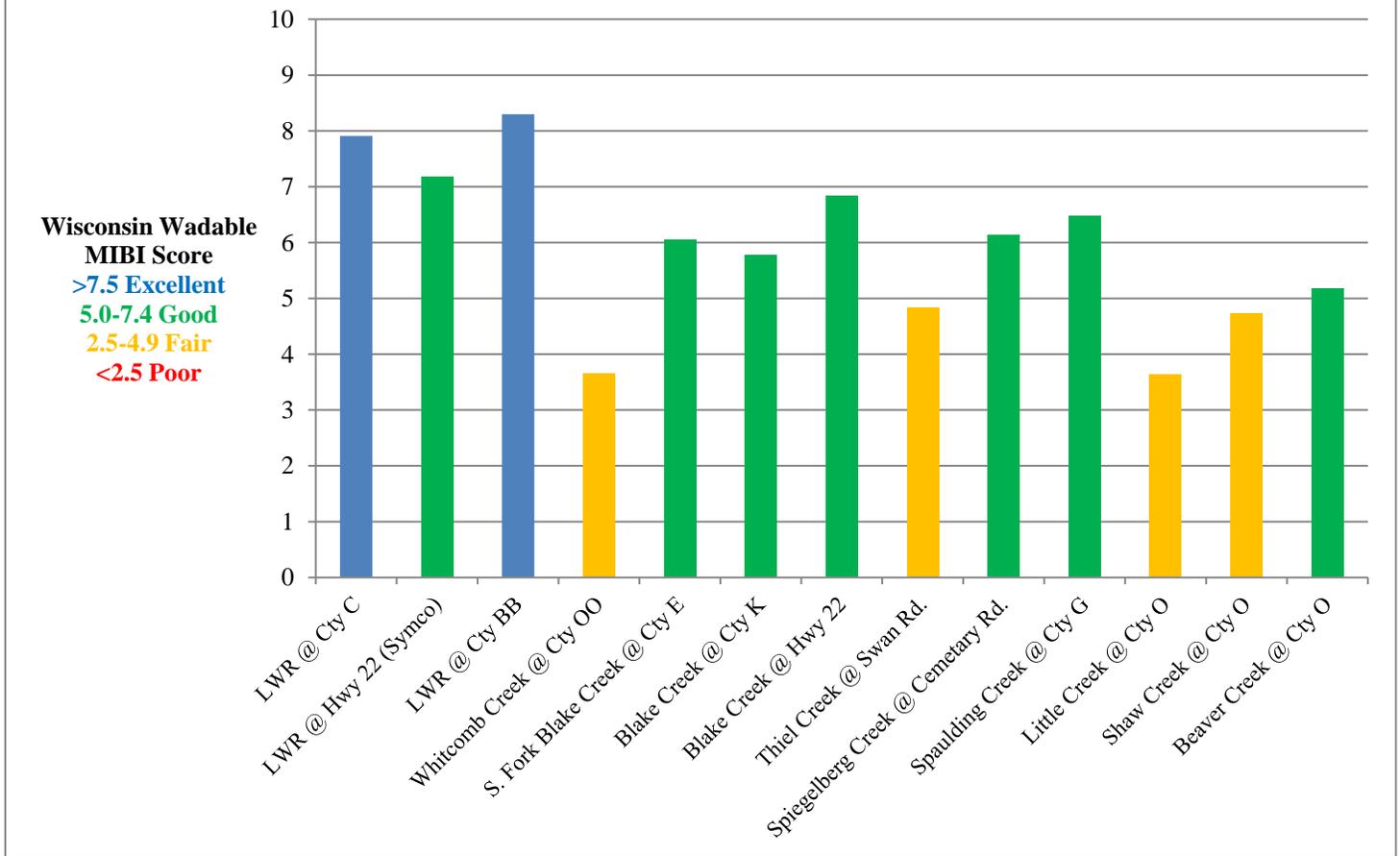


Chart 7: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Lower Little Wolf River Watershed in 2015 and 2016.



Photo 1: Little Wolf River at County BB facing downstream. Photo taken by D. Bolha on September 9th, 2015.

Between July and September 2015, 13 sites in the Lower Little Wolf River Watershed were surveyed for representative fish communities. Some fish species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative fish collected during the survey and their associated tolerance to environmental degradation, an Index of Biotic Integrity (FIBI) was calculated to indicate the water quality of each creek or river (Table 14, Chart 8). The FIBI scores ranged from 20 in Shaw, Thiel, and Little Creeks to 100 in the Little Wolf River at County Hwy C (Table 14, Chart 8). The Condition Category for the 13 sites ranged from Poor to Excellent. All 3 fish surveys in the Little Wolf River Mainstem indicate a Condition Category of Excellent, with the FIBI scores ranging from 90 to 100. Three of the remaining 10 tributary sites demonstrated a Condition Category of Excellent (Table 14, Chart 8). Two sites had a Condition Category of Good and 2 sites showed a Condition Category of Fair. The remaining 3 sites had a Condition Category of Poor based upon the fish surveys (Table 14, Chart 8).

Each fish community surveyed was used to verify or update the modeled Natural Community for that stream segment. The modeled Natural Community for the Little Wolf River was verified as Cool-Warm Mainstem from County Hwy C to County Hwy BB. Each of the 10 tributary streams' Natural Community was verified or changed based upon the fish caught in the survey (and any historical known surveys in that stream segment).

Verifying or changing the modeled Natural Community was important since the Natural Community determines which FIBI was used to determine the water quality of that stream segment. The results of the calculated FIBI calculations displayed in Table 14 and Chart 8 are based upon the verified or changed Natural Community.

SWIMS Station ID	Site Name	Fish IBI Score	Condition Category	Natural Community
693151	Little Wolf River at Cth C	100	Excellent	Cool-Warm Mainstem
693147	Little Wolf River at Hwy 22 Near Symco	90	Excellent	Cool-Warm Mainstem
693141	Little Wolf River at Cth BB	90	Excellent	Cool-Warm Mainstem
693128	Whitcomb Creek – US Cth E	70	Good	Coldwater
10016223	Whitcomb Creek – Cth OO	90	Excellent	Cool-Warm Mainstem
693154	North Fork Blake Creek – US Cth E	80	Good	Coldwater
10013573	South Fork Blake Creek – US Cth E	100	Excellent	Cool-Cold Mainstem
693129	Blake Creek at SH 22	90	Excellent	Cool-Warm Mainstem
693143	Thiel Creek at Swan Rd	20	Poor	Cool-Warm Mainstem
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	30	Fair	Cool-Warm Mainstem
693130	Spaulding Creek at Cth G	50	Fair	Coldwater
693145	Little Creek at Cth O	20	Poor	Cool-Warm Mainstem
693131	Shaw Creek at Cth O	20	Poor	Cool-Warm Mainstem

Table 14: Fish Survey Results in the Lower Little Wolf River Watershed Conducted in July through September 2015.

Lower Little Wolf River Watershed 2015 Fish Index of Biotic Integrity Scores and Condition Categories

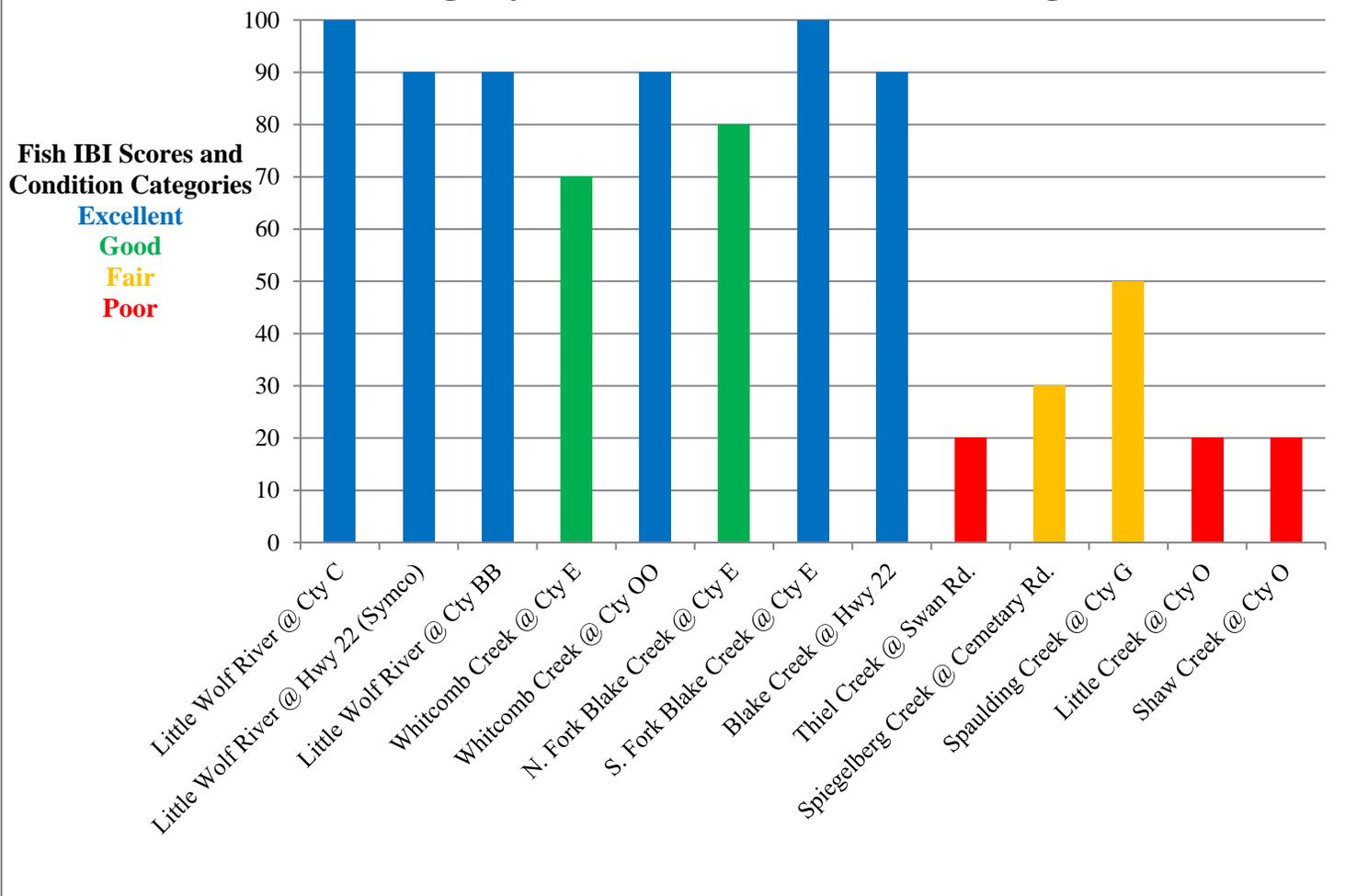


Chart 8: Fish Survey Results in the Lower Little Wolf River Watershed Conducted in July through September 2015.

Water temperature data was collected from May through October or November 2015 at 14 locations in the Little Wolf River Watershed (Table 4, Map 1-2). Monthly average temperatures were reported for months with complete data only. The water level in Beaver Creek became too low to accurately collect temperature data by mid-July 2015; therefore, only the average temperature for June 2015 was reported (Table 15, Chart 9). The hobo pendant deployed in the Little Wolf River at County Hwy C was vandalized during the summer; therefore, no temperature data was available for that location (SWIMS ID 693151). The temperatures at the sites monitored in 2015 during the time of deployment ranged from 32.2F in Whitcomb Creek at County Hwy E on 11/22/2015 to 84.7F in Spiegelberg Creek at Cemetery Rd on 8/14/2015. The average monthly temperatures ranged from 59.4F in the North Fork of Blake Creek at County Hwy E in June to 73.8F in the Little Wolf River at Railroad St Trail in July (Table 14, Chart 8). The Maximum Daily Averages (MDM) ranged from 66.1F in Shaw Creek to 78.1F in the Little Wolf River at Railroad St Trail (Table 15, Chart 9).

Location	June Average Temperature	July Average Temperature	August Average Temperature	September Average Temperature	Maximum Daily Average Temperature
Little Wolf River – Hwy 22 Symco	65.6	71.4	68.5	65.3	77.1
Little Wolf River - Railroad St Trail	67.6	73.8	71.1	67.1	78.1
Whitcomb Creek at County E	60.7	63.8	62.8	61.1	69.3
Whitcomb Creek at County OO	64.4	68	65.8	63.8	73.6
N Fork Blake Creek at County E	59.4	61.4	61.1	60.0	66.9
S Fork Blake Creek at County E	62.3	65.3	63.8	62.4	70.0
Blake Creek at Hwy 22	64.3	68.8	66.7	64.2	74.4
Thiel Creek at Swan Rd	63.2	64.6	62.7	62.1	68.6
Spiegelburg Creek at Cemetery Rd	69.2	71.9	68.0	68.4	77.2
Spaulding Creek at County G	60.3	64.4	63.5	61.6	70.5
Shaw Creek at County O	64.1	64.4	62.5	63.2	66.1
Beaver Creek at County O	64.8				
Little Creek at County O	65.0	67.2	63.9	63.2	71.5

Table 15: Monthly Average and Maximum Daily Average Temperatures in the Lower Little Wolf River Watershed in 2015. Beaver Creek water levels became too low in July 2015.

Average Monthly and Maximum Daily Average Temperatures of the Lower Little Wolf River Watershed in 2015

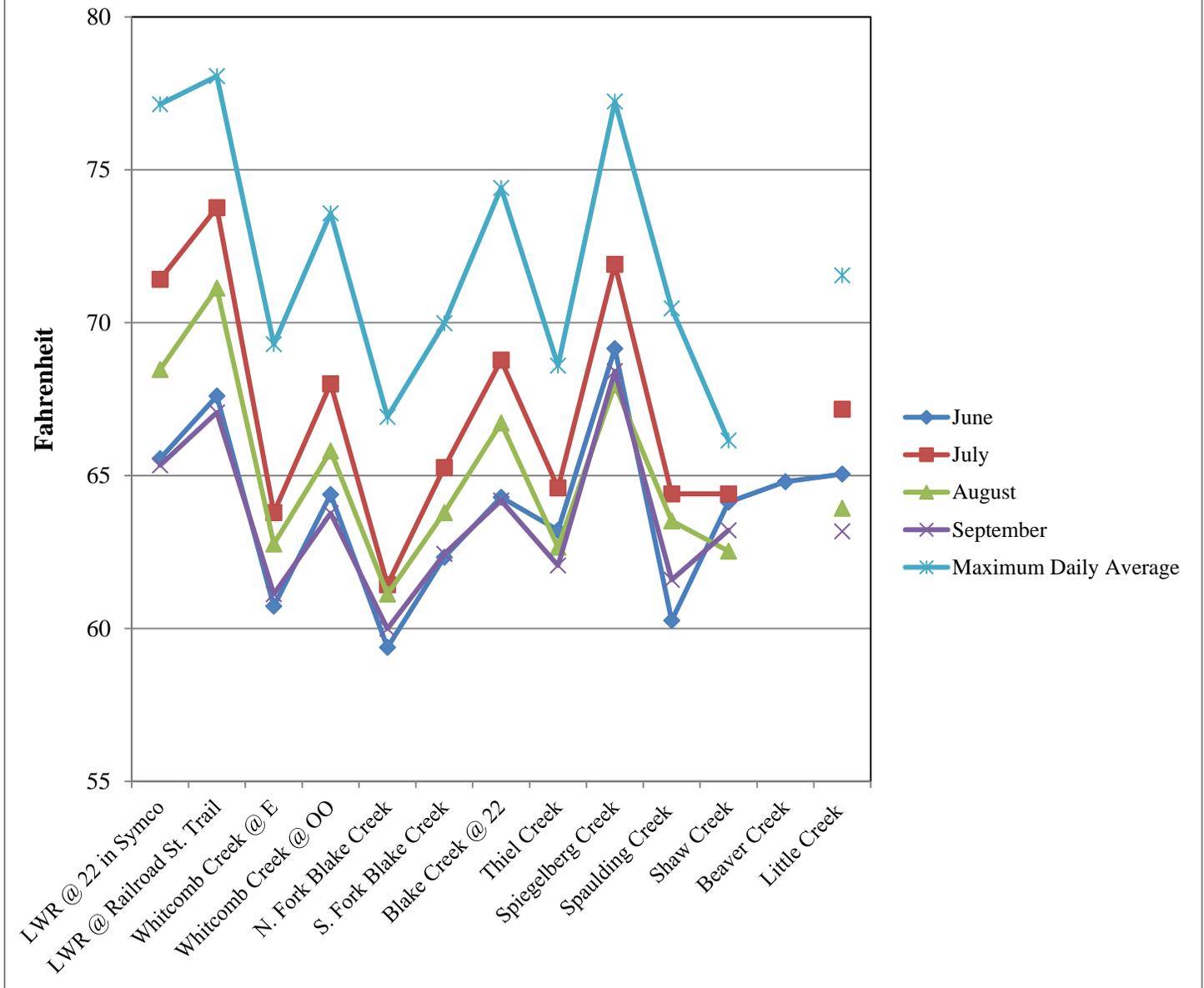


Chart 9: Monthly Average and Maximum Daily Average Temperatures in the Lower Little Wolf River Watershed in 2015. Beaver Creek water levels became too low in July.

In October 2015, quantitative habitat surveys were conducted at 10 locations in the Lower Little Wolf River Watershed (Table 16, Map1-2). A quantitative habitat survey was conducted at one location (Little Creek) in May 2016 (Table 16, Map 2). Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for game fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2015 and 2016 surveys, a habitat rating was calculated for the 11 locations (Table 16, Chart 10). The quantitative habitat scores ranged from 25 in Spiegelberg Creek at Cemetery Road to 82 in the Little Wolf River at County Hwy C (Table 16, Chart 10). The Little Wolf River at County Hwy C was the only location to have a habitat Condition Category of Excellent. Six of the 11 surveys demonstrated a habitat Condition Category of Good, with scores ranging from

55-70 (Table 16, Chart 10). Whitcomb Creek, Spaulding, Little and Shaw Creeks had a Fair Condition Category, with scores ranging from 25 to 48 (Table 16, Chart 10). None of the habitat surveys demonstrated Poor habitat.

SWIMS Station ID	Stream Name and Site Location	Quantitative Habitat Score	Condition Category
693151	LWR @ County Hwy C	82	Excellent
693147	LWR @ Hwy 22 (Symco)	69	Good
693141	LWR @ County Hwy BB	69	Good
10016223	Whitcomb Creek @ Cty OO	40	Fair
10013573	S. Fork Blake Creek @ Cty E	68	Good
693129	Blake Creek @ Hwy 22	58	Good
693143	Thiel Creek @ Swan Rd.	70	Good
693142	Spiegelberg Creek @ Cemetary Rd.	25	Fair
693130	Spaulding Creek @ Cty G	55	Good
693131	Shaw Creek @ Cty O	40	Fair
693145	Little Creek @ Cty O	48	Fair

Table 16: Quantitative Habitat Survey Scores and Condition Categories for the Lower Little Wolf River Watershed in 2015 and 2016.

Lower Little Wolf River 2015 and 2016 Quantitative Habitat Score and Condition Category

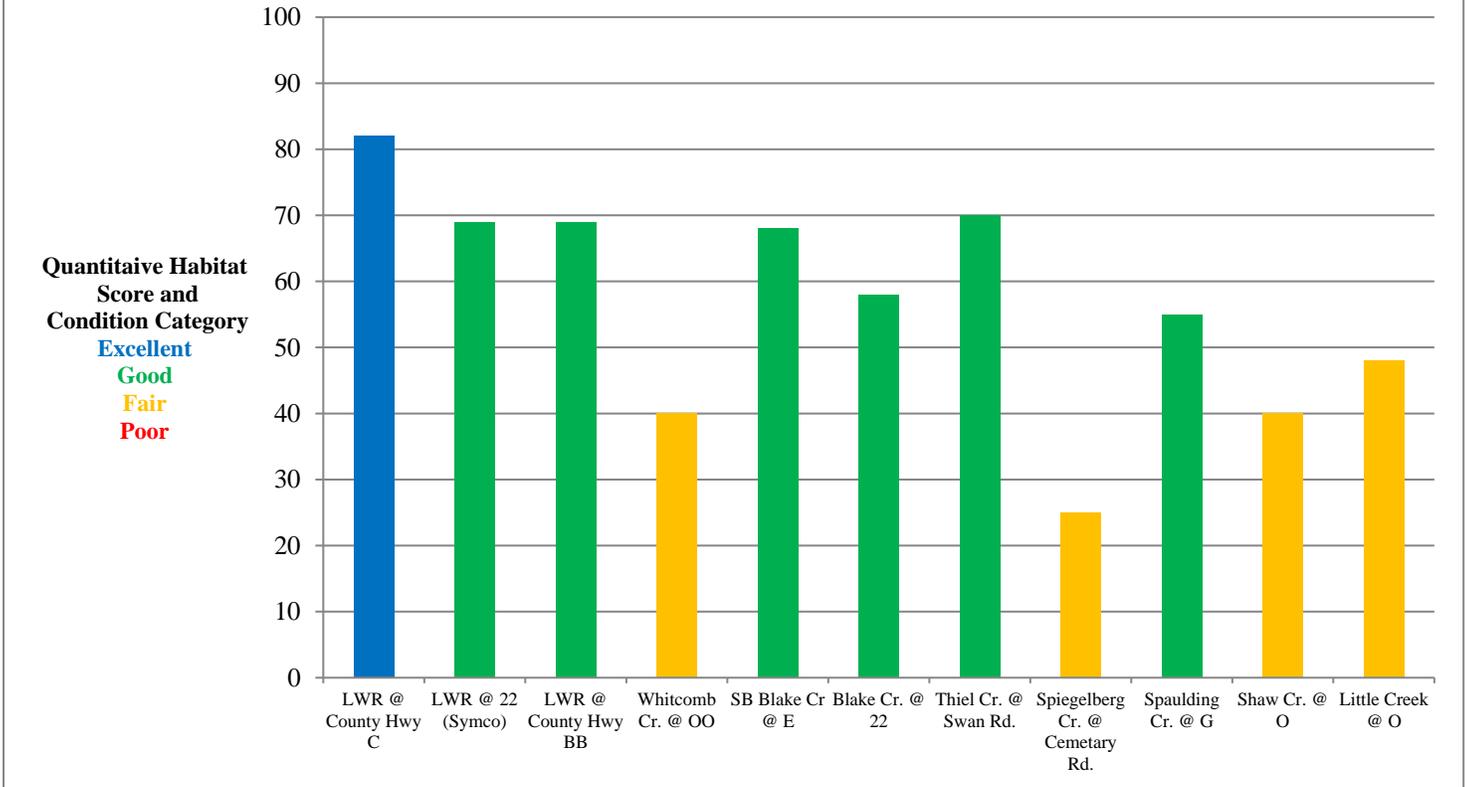


Chart 10: Quantitative Habitat Survey Scores and Condition Categories for the Lower Little Wolf River Watershed in 2015 and 2016.

Discussion

The purpose of this project was to evaluate water quality improvements made in the Little Wolf River Watershed from Best Management Practices installed in the watershed from 1997 through 2008 and determine if the goals of the Lower Little Wolf River Priority Watershed Project were met. The overall goal for the Priority Watershed Project was to enhance and protect the water quality of the surface waters of the sub-watersheds to ultimately improve the water quality of the Lower Little Wolf River. Nutrient and suspended solids samples, aquatic biological community evaluations, and habitat assessments were conducted to determine the water quality of the Lower Little Wolf River Watershed. The total phosphorus, aquatic macroinvertebrate, and fish monitoring in this project demonstrated that the water quality in the Lower Little Wolf River Watershed is between poor and excellent condition.

The Lower Little Wolf River Watershed drains a 152 square-mile watershed before discharging into the Wolf River near Royalton, Wisconsin. The Lower Little Wolf River Watershed is located entirely within Waupaca County. The Lower Little Wolf River begins at the downstream side of the Big Falls hydroelectric dam and continues downstream roughly 27 miles until its confluence with the South Branch of the Little Wolf River (Map 1-2). There are 189 named and unnamed stream miles in the watershed. The watershed is dominated by agricultural land use at 52%, while 22% is wooded. Less than 5% is considered developed. Typically, as increases in agricultural land use occur, there is a correlating increase in TP and TN concentrations in creeks in

the watersheds in Wisconsin. Water clarity (secchi depths) decreases and chlorophyll a concentration (which is an indication of algae populations) increases as TP and TDP increases. Water clarity and chlorophyll a concentration are indicators of water quality in Wisconsin lakes (WisCALM 2014).

Between September 1995 and September 1996, biological, physical and chemistry monitoring was conducted by the WDNR to summarize the existing conditions of the Lower Little Wolf River Watershed prior to the implementation of the Priority Watershed Project. In early 1997, the “Lower Little Wolf River Priority Watershed Surface Water Resources Appraisal Report” was prepared by WDNR staff Bradley Johnson (WDNR 1997). In addition, water quality monitoring was conducted in 2001 by staff at the University of Stevens Point Center for Watershed Science and Education (CWS) throughout the Lower Little Wolf River to target which sub-watersheds have the greatest need for Best Management Practices (BMPs) to reduce non-point sediment and nutrients from reaching the Little Wolf River. In 2003, a “Water Quality Assessment of the Lower Little Wolf River Watershed” was prepared by CWS staff (Turyk, et. al. 2003). A comparison of the 1995-2001 data to the data that was collected in 2015 can provide some indication of water quality changes over time as a result of the Priority Watershed Project.

The 1995-1996 nutrient and suspended solids concentration data were mainly collected during runoff events, with a few baseflow conditions monitored (WDNR 1997) (Table 17-20, Chart 11-14). In 2001, both runoff events and baseflow conditions were targeted for collecting nutrient samples, while only runoff events were sampled for suspended solids concentrations (Turyk et. al. 2003) (Table 17-20, Chart 11-14). In 2015, runoff event (June 2015) and baseflow nutrient and suspended solids conditions (August and October 2015) were monitored as part of this project. If multiple sampling events were conducted during baseflow or runoff conditions, then the average concentration was calculated for that set of monitoring results.

The concentrations of NO_3+NO_2 as N varied considerably from year to year and from location to location during baseflow conditions in the Lower Little Wolf River Watershed. The average baseflow NO_3+NO_2 as N concentrations in the Little Wolf River Mainstem at County Hwy C and County Hwy BB decreased from the 1995-1996 Watershed Appraisal concentrations to the 2015 concentrations in this project (Table 17, Chart 11). Baseflow NO_3+NO_2 as N concentrations in Blake, Spaulding, and Whitcomb Creeks maintained relatively similar concentrations from pre-existing and 2001 monitoring results to the 2015 baseflow concentrations. The 2015 baseflow NO_3+NO_2 as N concentrations were higher in Little, Spiegelberg, and Thiel Creeks than previous baseflow concentrations. Shaw Creek had the lowest baseflow NO_3+NO_2 as N concentration of any of the Lower Little Wolf River tributaries in 2015. The NO_3+NO_2 as N baseflow concentration in Shaw Creek of 0.05 mg/L in 2015 was considerably lower than 1995-1996 and 2001, 0.5725 mg/L and 3.0 mg/L respectively (Table 17, Chart 11). The lower NO_3+NO_2 as N in baseflow in the Mainstem suggests that the groundwater influx to the Mainstem and its tributaries has overall decreased in NO_3+NO_2 as N concentration following the Priority Watershed Project.

Location	1995-1996 (Pre) Baseflow NO ₂ + NO ₃ (N)	2001 (Mid) Baseflow NO ₂ + NO ₃ (N)	August (Post) Baseflow 2015 NO ₂ + NO ₃ (N)
LWR @ C	2.6	2.7	2.2
LWR @Bridge Rd			1.3
LWR @ Railroad St Trail			1.9
LWR @ BB	2.08	1.75	1.2
Beaver Creek at O		0.15	
Blake Creek at 22		1.3	1.3
Little Creek at O	0.365	1.1	2
Shaw Creek at O	0.5725	3	0.05
Spaulding Creek at G	0.499	0.6	0.5
Spiegelberg Creek at Cemetery Rd		0.2	1.2
Thiel Creek at Swan Rd		0.04	0.9
Whitcomb Creek at OO		1	1.3

Table 17: Pre-existing, Mid, and Post Priority Watershed Project NO₂ + NO₃ as N Concentrations during Baseflow Conditions in the Lower Little Wolf River Watershed.

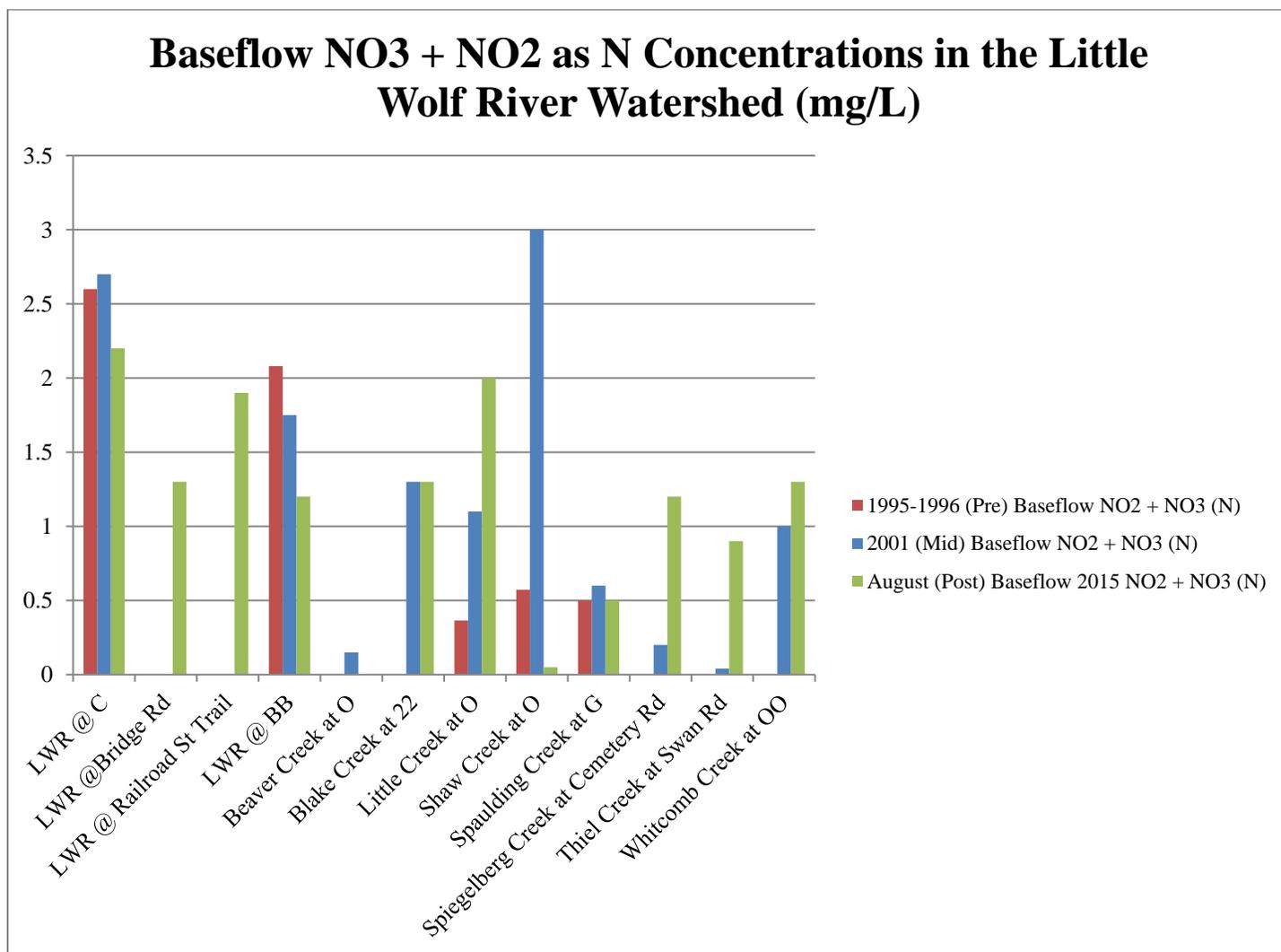


Chart 11: Pre-existing, Mid, and Post Priority Watershed Project NO₂ + NO₃ as N Concentrations during Baseflow Conditions in the Lower Little Wolf River Watershed.

The runoff event monitoring NO₃+NO₂ as N results were consistently lower than the baseflow concentrations in the Lower Little Wolf River and its tributaries. This was likely due to the dilution effect of snowmelt and rain to the NO₃+NO₂ as N concentrations in groundwater. When comparing the monitoring results from 1995, 1996, and 2001 to the 2015 runoff event results, the Little Wolf River Mainstem NO₃+NO₂ as N concentrations were relatively similar. The Little Wolf River at County Hwy C demonstrated the largest difference with a decrease from 1.7mg/L event average in 2001 to 0.9mg/L event average in 2015 (Table 18, Chart 12). Beaver, Blake, Spaulding, Spiegelberg, Thiel and Whitcomb Creeks runoff concentrations either remained relatively similar or showed some slight decrease in NO₃+NO₂ as N concentration. Runoff events in Little and Shaw Creeks increased in NO₃+NO₂ as N concentration from 2001 to 2015.

Location	Event 1995-1996 NO ₂ + NO ₃ (N)	Event 2001 NO ₂ + NO ₃ (N)	Event 2015 NO ₂ + NO ₃ (N)
LWR @ C		1.7	0.9
LWR @Bridge Rd	1.3		1.3
LWR @ Railroad St Trail			1.0
LWR @ BB		1	1.1
Beaver Creek at O		0.8	0.5
Blake Creek at 22	0.8	0.7	0.9
Little Creek at O		1.2	1.7
Shaw Creek at O	0.15	1.2	1.7
Spaulding Creek at G	0.2	0.5	0.1
Spiegelberg Creek at Cemetery Rd	0.5	0.1	0.2
Thiel Creek at Swan Rd	1.1	0.5	0.9
Whitcomb Creek at OO	0.3	0.5	0.1

Table 18: Pre-existing, Mid, and Post Priority Watershed Project NO₂ + NO₃ as N Concentrations during Runoff Event Conditions in the Lower Little Wolf River Watershed.

Runoff Event NO₃ + NO₂ as N Concentrations in the Little Wolf River Watershed (mg/L)

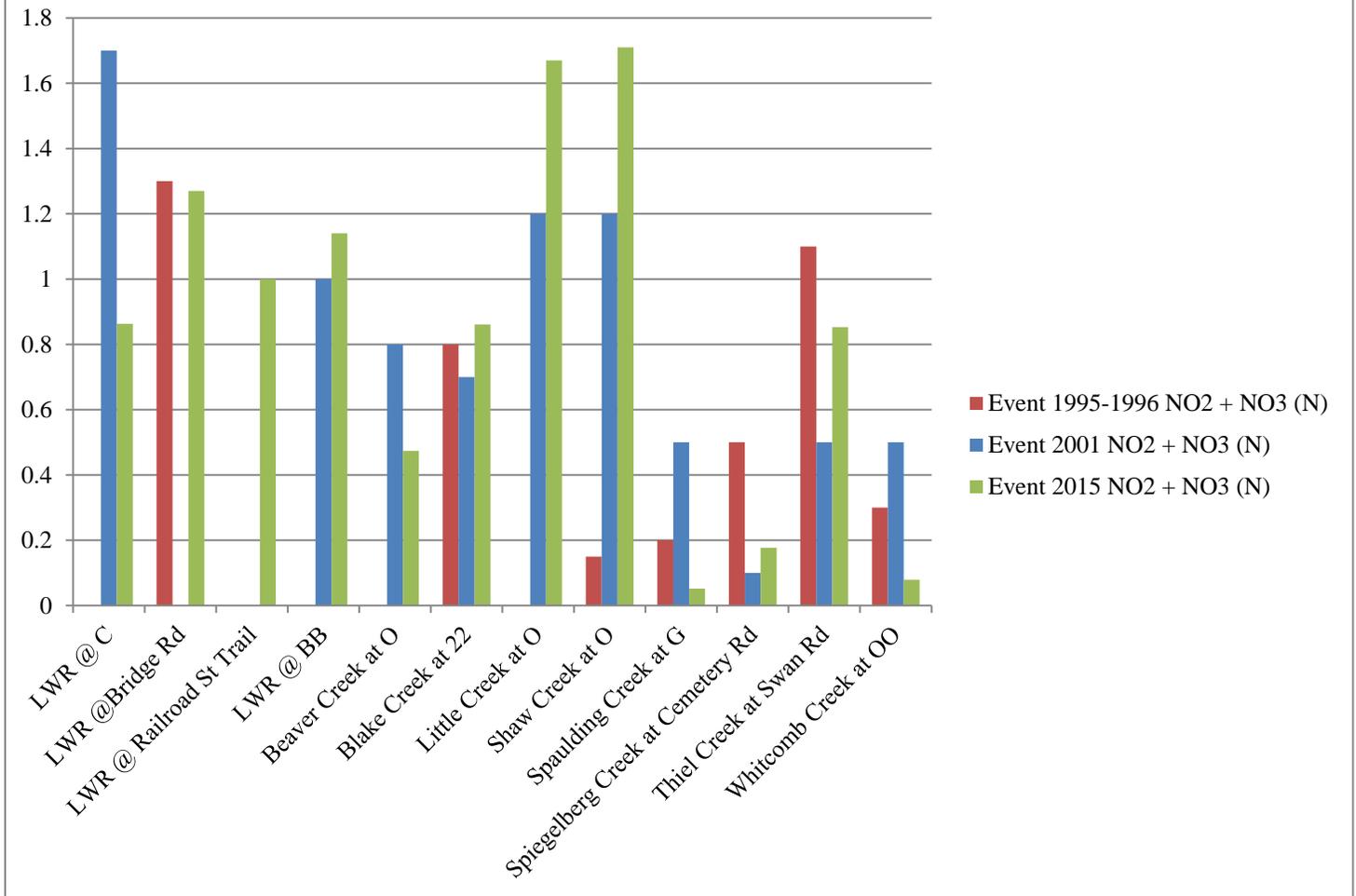


Chart 12: Pre-existing, Mid, and Post Priority Watershed Project NO₂ + NO₃ as N Concentrations during Runoff Event Conditions in the Lower Little Wolf River Watershed.

The flux in concentrations of TP from year to year and from location to location during baseflow conditions was minimal to significant in the Lower Little Wolf River Watershed. The average baseflow TP concentrations in the Little Wolf River Mainstem at County Hwy C decreased slightly from the 2001 concentrations to the 2015 concentrations in this project (Table 19, Chart 13). At County Hwy BB, the average baseflow TP concentration increased from 2001 to 2015, 0.027mg/L to 0.0375mg/L, respectively. Baseflow TP concentrations in Blake, Shaw, Spaulding, Spiegelberg, and Whitcomb Creeks maintained relatively similar concentrations from 2001 monitoring results to the 2015 baseflow concentrations (Table 19, Chart 13). The 2015 baseflow TP concentrations were lower in Beaver, Little, and Thiel Creeks than the 2001 baseflow concentrations. Little Creek had the highest baseflow TP concentration of any of the Lower Little Wolf River tributaries in 2015.

In contrast to the runoff event NO₃+NO₂ as N monitoring results, the runoff event TP results were consistently higher than the baseflow concentrations in the Lower Little Wolf River and its tributaries. This was likely due to the increased phosphorus attached to sediments from the landscape and streambank erosion reaching the streams and river, amongst other contributing factors. When comparing the runoff event monitoring results from 1995, 1996, and 2001 to the 2015 runoff event results, the Little Wolf River Mainstem TP concentrations

were consistently higher in 2015. The Little Wolf River at County Hwy BB demonstrated the largest difference with an increase from 0.08mg/L event average in 2001 to 0.209mg/L event average in 2015 (Table 19, Chart 13). Beaver, Blake, Thiel, and Whitcomb Creeks runoff concentrations increased in TP concentration over that same time period. Runoff events in Little, Shaw, and Spiegelberg Creeks decreased in TP concentration from 1995, 1996, and 2001 to 2015.

Location	Baseflow 2001 TP	Baseflow 2015 TP	Event 1995-1996 TP	Event 2001 TP	Event 2015 TP
LWR @ C	0.028	0.0251		0.042	0.0818
LWR @ Bridge Rd		0.0265	0.094		0.163
LWR @ Railroad St Trail		0.0415			0.207
LWR @ BB	0.027	0.0375		0.08	0.209
Beaver Creek at O	0.279	0.0893		0.189	0.209
Blake Creek at 22	0.039	0.0395	0.168	0.098	0.203
Little Creek at O	0.219	0.1495		0.258	0.231
Shaw Creek at O	0.049	0.052	0.23	0.163	0.133
Spaulding Creek at G	0.019	0.031	0.03675	0.097	0.0682
Spiegelberg Creek at Cemetery Rd	0.034	0.039	0.128	0.188	0.0546
Thiel Creek at Swan Rd	0.743	0.131	0.203	0.249	0.373
Whitcomb Creek at OO	0.03	0.0275	0.057	0.074	0.103

Table 19: Pre-existing, Mid, and Post Priority Watershed Project Total Phosphorus Concentrations during Baseflow and Runoff Event Conditions in the Lower Little Wolf River Watershed.

Comparison of Baseflow and Runoff Event Total Phosphorus Concentrations in the Little Wolf River Watershed (mg/L)

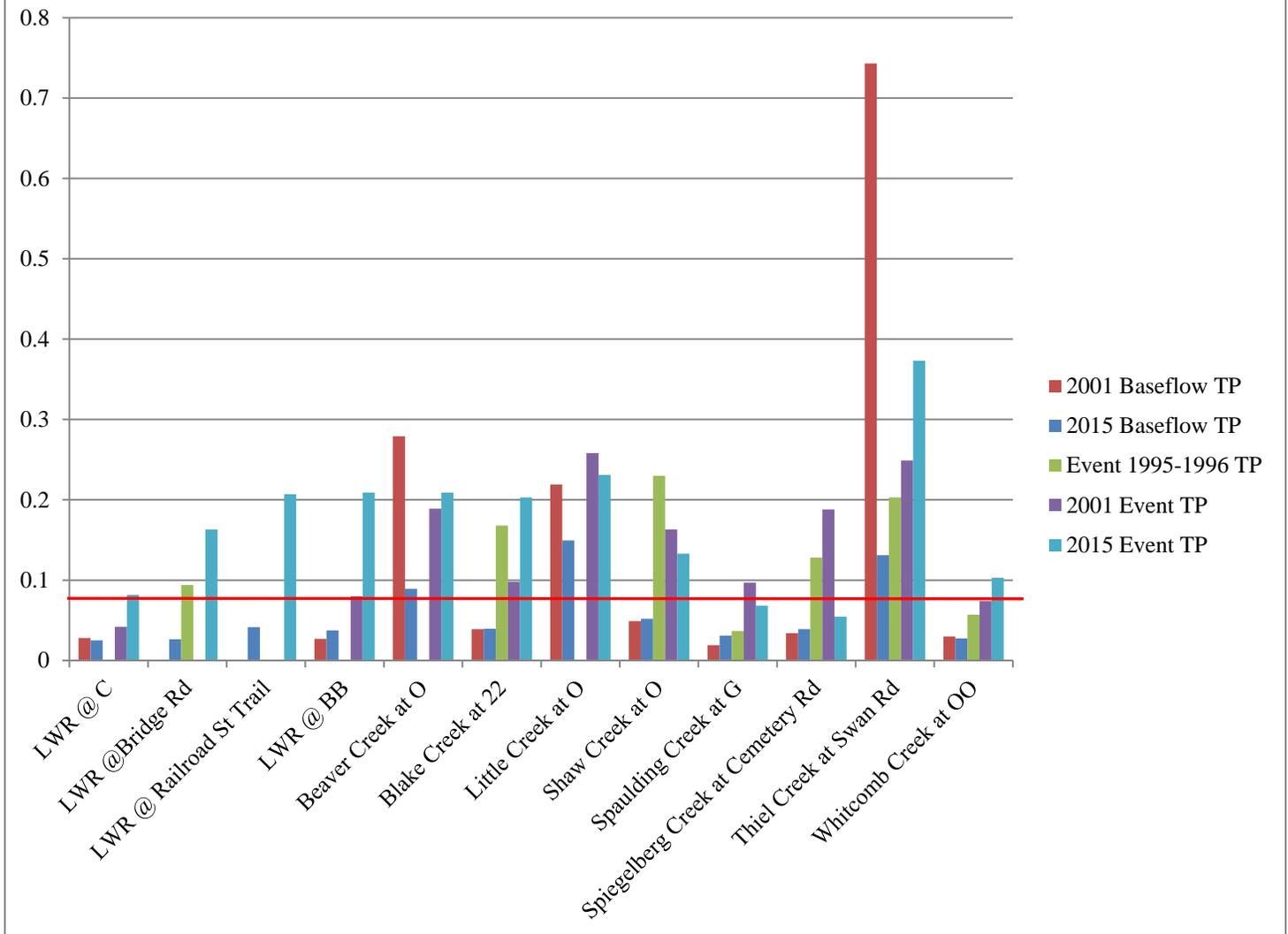


Chart 13: Pre-existing, Mid, and Post Priority Watershed Project Baseflow and Runoff Event Total Phosphorus Concentrations in the Little Wolf Watershed. Red line indicates NR 102 Water Quality Criteria for Total Phosphorus for the Lower Little Wolf River and its tributaries.

In addition to comparing the 2015 TP results to historic phosphorus data collected, an impairment assessment was conducted to verify whether the Lower Little Wolf River Watershed TP concentrations meet the Wisconsin Administrative Code ch. NR 102 WQC or if the waterbodies should be placed on the United States Environmental Protection Agency Clean Water Act Section 303d Impaired Waters List (CWA 303d IWL). The sampling requirements to demonstrate if WQC for TP were being met, clearly exceeded, or overwhelmingly exceeded were accomplished through this project. The impairment assessment protocol requires a parametric statistical approach to assess stream and river TP data against the applicable water quality criterion found in NR 102 (WisCALM 2014). This approach involves the calculation of a 90% confidence limit around the median of a TP sample dataset. If the lower 90% confidence limit (LCL) exceeds the criterion for TP, then that stream or river segment (assessment unit) is considered to be exceeding the criterion. The LCLs were calculated for each complete set of TP samples (Table 20). Beaver Creek was dry in August; therefore, the sampling requirements to assess whether or not the TP exceeded the WQC were not met. All of the Little

Wolf River Mainstem sample sets met the WQC of 0.075mg/L. Two of the seven tributary LCLs overwhelmingly exceeded (LCL of ≥ 0.15 mg/L) the water quality criterion for TP (Table 20, Chart 14). Little and Thiel Creeks will be recommended for the 2018 CWA 303d IWL due to the pollutant phosphorus.

Location	TP Lower 90% Confidence Limit
Little Wolf River @ C	0.024
Little Wolf River @ Bridge Rd	0.027
Little Wolf River @ Railroad St Trail	0.039
Little Wolf River @ BB	0.033
Blake Creek at 22	0.033
Little Creek at O	0.176
Shaw Creek at O	0.054
Spaulding Creek at G	0.028
Spiegelberg Creek at Cemetery Rd	0.037
Thiel Creek at Swan Rd	0.151
Whitcomb Creek at OO	0.025

Table 20: Total Phosphorus Lower 90% Confidence Limits in the Lower Little Wolf River Watershed in 2015.

Lower 90% Confidence Limit for Total Phosphorus Samples in the Lower Little Wolf River Watershed in 2015 (mg/L)

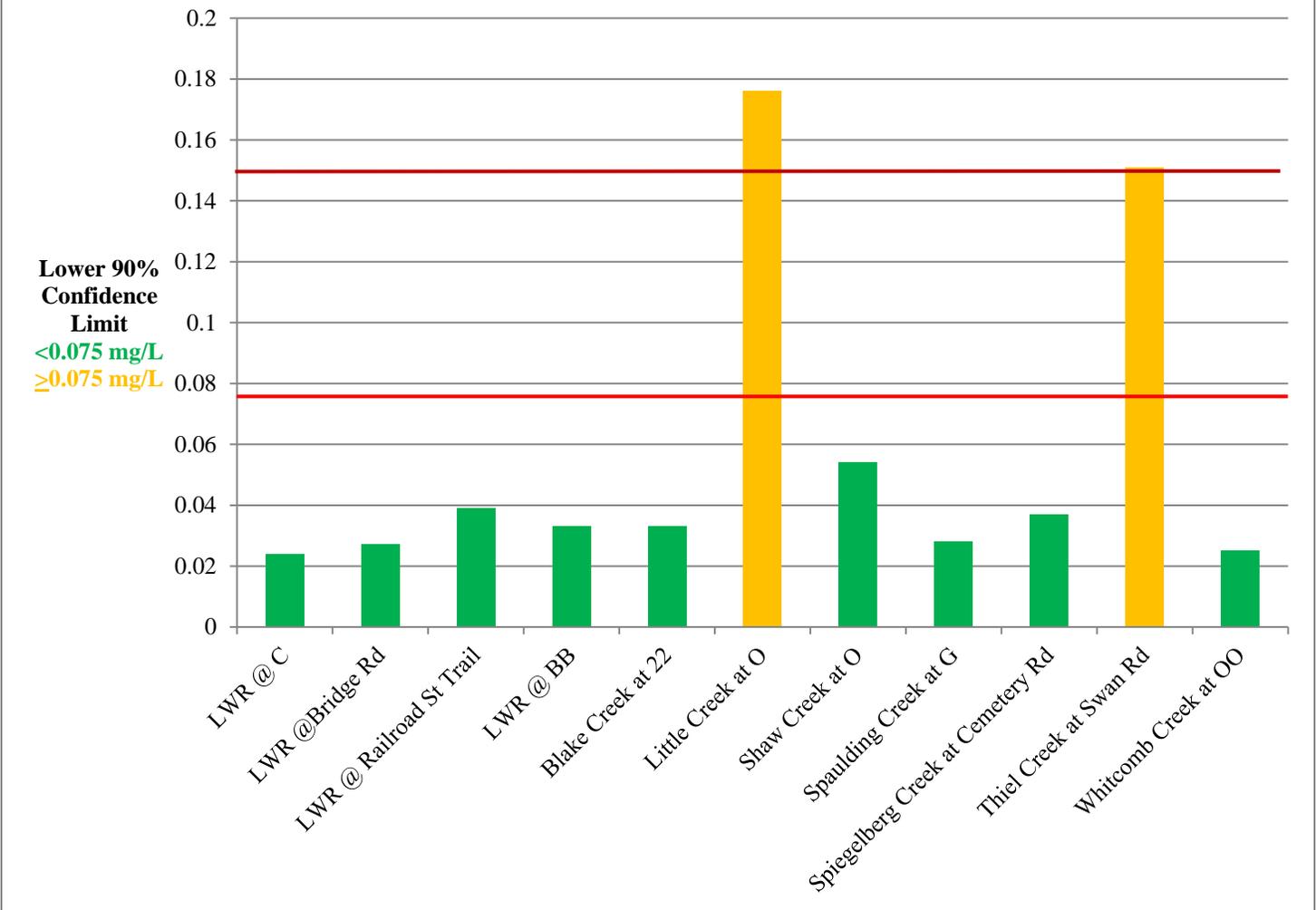


Chart 14: Total Phosphorus Lower 90% Confidence Limits in the Lower Little Wolf River Watershed in 2015. Red line indicates the NR 102 WQC for Total Phosphorus for the Lower Little Wolf River and its Tributaries. Maroon line indicates an Overwhelming Exceedance of NR 102 WQC for Total Phosphorus.

In addition to TP and $\text{NO}_3 + \text{NO}_2$ as N, TSS was indicated as a pollutant of concern in the Priority Watershed Nonpoint Source Control Plan in 1997. In the Lower Little Wolf River Watershed in 1995-1996 and 2001, runoff event samples were collected for TSS analysis. When multiple runoff events were sampled, the average TSS concentration for those samples was calculated (Table 21, Chart 15). When comparing the monitoring results from 2001 to the 2015 runoff event results, the Little Wolf River Mainstem TSS concentrations increased at County Hwy C and BB. The event sample in June 2015 from Blake Creek at Hwy 22 was 35.7mg/L, which was considerably higher than the average event TSS concentrations in 1995-1996 and 2001 (Table 21, Chart 15). However, the maximum runoff event TSS concentration from 1996 (49mg/L) was higher than the 2001 and 2015 maximum TSS concentrations, 21mg/L and 35.7mg/L respectively, in Blake Creek. Beaver, Little, Spiegelberg and Whitcomb Creeks decreased in runoff TSS concentrations (Table 21, Chart 15).

Location	Event 1995-1996 TSS	Event 2001 TSS	Event 2015 TSS
Little Wolf River @ C		9.9	22.3
Little Wolf River @ Bridge Rd	16.9		
Little Wolf River @ BB		11	33.5
Beaver Creek at O		9	2.4
Blake Creek at 22	15.9	11.5	35.7
Little Creek at O		29.6	8.3
Shaw Creek at O	4.88	37.2	11.3
Spaulding Creek at G	ND	15.7	4.4
Spiegelberg Creek at Cemetery Rd	10	3.9	ND
Thiel Creek at Swan Rd	27.3	6.2	13.4
Whitcomb Creek at OO	13.3	11.4	6.4

Table 21: Pre-existing, Mid, and Post Priority Watershed Project Total Suspended Solids Concentrations during Runoff Event Conditions in the Lower Little Wolf River Watershed. ND indicates No Detection of TSS by the analysis method with the Limit of Detection at 4.4 mg/L in 1995 & 2.0 mg/L in 2015.

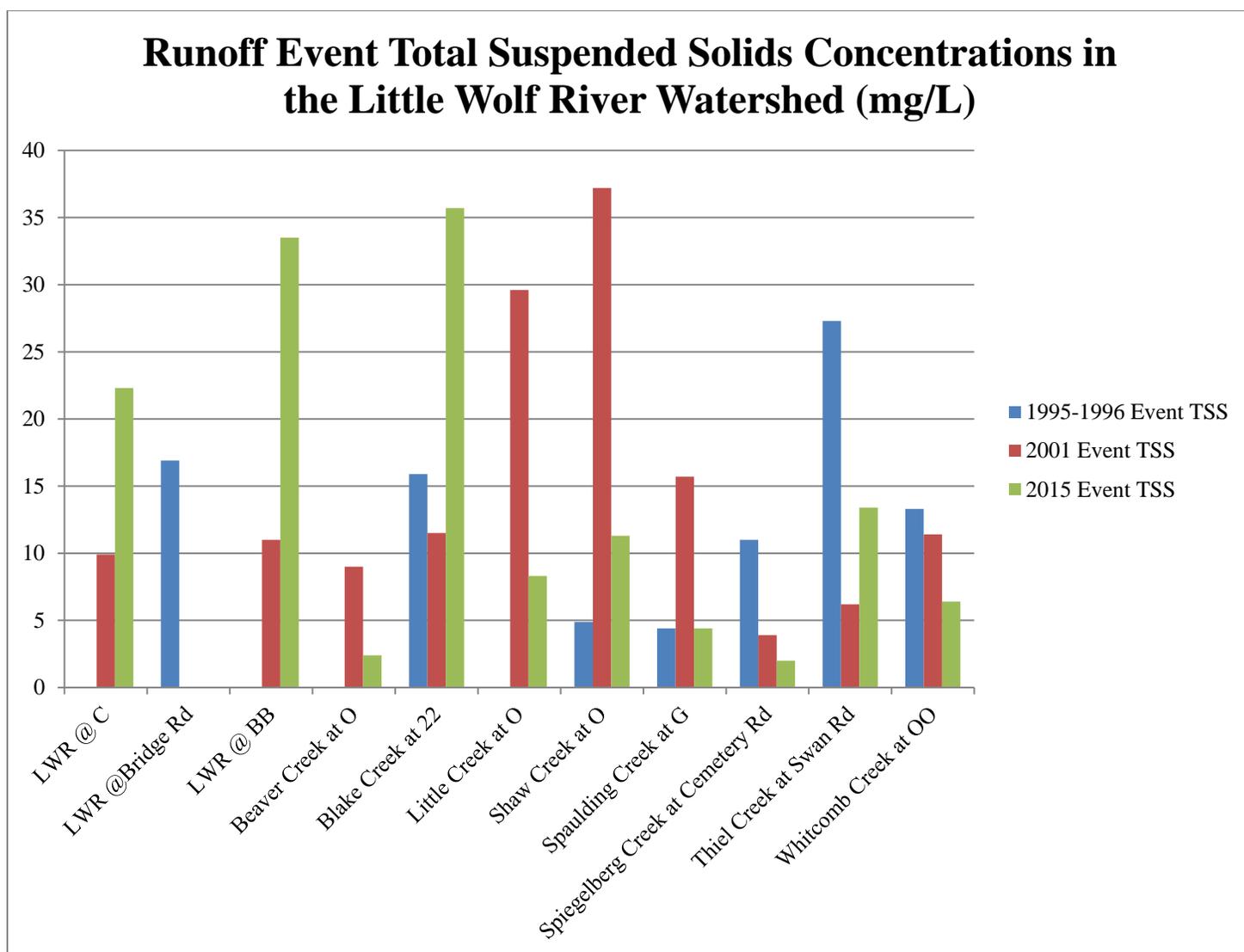


Chart 15: Pre-existing, Mid, and Post Priority Watershed Project Runoff Event Total Suspended Solids Concentrations in the Lower Little Wolf Watershed.

In October 1995, aquatic macroinvertebrate surveys were conducted at 8 locations in the Lower Little Wolf River Watershed (WDNR 1997). The WDNR MIBI protocol was followed during the surveys; thus, the MIBI scores from 1995 can be compared with the MIBI surveys conducted in 2015 as part of this project. All 8 locations surveyed in 1995 were close enough to the locations in this project for comparison to the 2015 surveys (Table 22, Chart 16). Four of the 8 2015 MIBI scores were similar ($\pm < 1$) when compared to the 1995 MIBI scores (Table 22, Chart 16). Thiel and Spiegelberg Creeks increased in MIBI score from 1995 to 2015 (Table 22, Chart 16). The samples collected from Whitcomb and Blake Creeks indicated decreases in MIBI score or lower water quality and decreased in Condition Category from 1995 to 2015.

Location	1995 MIBI Score	2015 MIBI Score	1995 Condition Category	2015 Condition Category
Little Wolf River @ Cty C	7.3	7.91	Good	Excellent
Little Wolf River @ Hwy 22 (Symco)	6.82	7.18	Good	Good
Little Wolf River @ Cty BB	9.28	8.3	Excellent	Excellent
Whitcomb Creek @ Cty OO	5.94	3.65	Good	Fair
S. Fork Blake Creek @ Cty E	6.1	6.05	Good	Good
Blake Creek @ Cty K	7.93	5.78	Excellent	Good
Thiel Creek @ Swan Rd.	3.23	4.83	Fair	Fair
Spiegelberg Creek @ Cemetary Rd.	3.48	6.13	Fair	Good

Table 22: Comparison of 1995 Wisconsin MIBI (Left Column) Scores to 2015 Wisconsin MIBI (Right Column) Scores at 8 Locations in the Lower Little Wolf River Watershed.

Historical and Current Macroinvertebrate IBI Scores in the Lower Little Wolf River Watershed

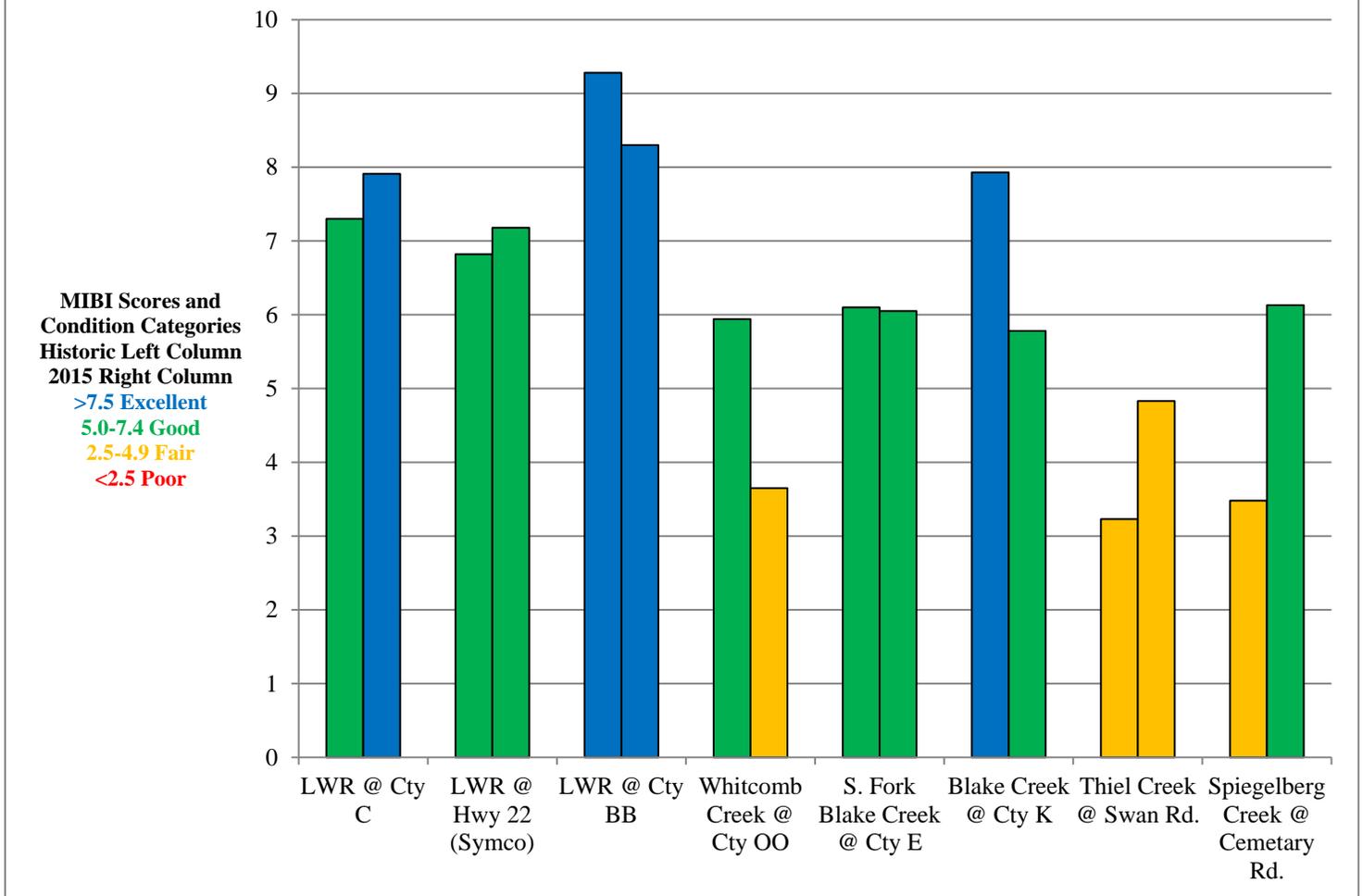


Chart 16: Comparison of 1995 Wisconsin MIBI (Left Column) Scores to 2015 Wisconsin MIBI (Right Column) Scores at 8 Locations in the Lower Little Wolf River Watershed.

In August 1996, fish surveys were conducted at 25 locations in the Lower Little Wolf River Watershed (WDNR 1997). FIBI protocol was followed during the surveys; thus, the FIBI scores from 1996 can be compared with the FIBI scores from 2015 as part of this project. Just as in 2015, the 1996 FIBI surveys were used to verify the Natural Community of the river or creek. The 1996 FIBI scores and Condition Category were based upon the verified Natural Community. None of the Natural Communities verified or changed in 2015 were changed based upon the 1996 FIBI surveys. Eleven of the 25 locations surveyed in 1996 were close enough for comparison to the 2015 surveys (Table 23, Chart 17). Nine of the 11 2015 FIBI scores were similar or increased when compared to the 1996 FIBI scores (Table 23, Chart 17). Thiel and Shaw Creek decreased in FIBI score and Condition Category from 1996 to 2015 (Table 23, Chart 17).

Monitoring Location	1996 FIBI Score	2015 FIBI Score	1996 Condition Category	2015 Condition Category
LWR @ Cty C	100	100	Excellent	Excellent
LWR @ Hwy 22 (Symco)	80	90	Excellent	Excellent
Whitcomb Creek @ Cty E	60	70	Good	Good
Whitcomb Creek @ Cty OO	60	90	Good	Excellent
N. Fork Blake Creek @ Cty E	50	80	Fair	Good
S. Fork Blake Creek @ Cty E	100	100	Excellent	Excellent
Blake Creek @ Hwy 22	90	90	Excellent	Excellent
Thiel Creek @ Swan Rd.	70	20	Excellent	Poor
Spaulding Creek @ Cty G	40	50	Fair	Fair
Little Creek @ Cty O	0	20	Very Poor	Poor
Shaw Creek @ Cty O	50	20	Good	Poor

Table 23: Historical and Current Fish Index of Biotic Integrity Scores and Condition Categories in the Lower Little Wolf River.

Historical and Current Fish IBI Scores in the Lower Little Wolf River Watershed

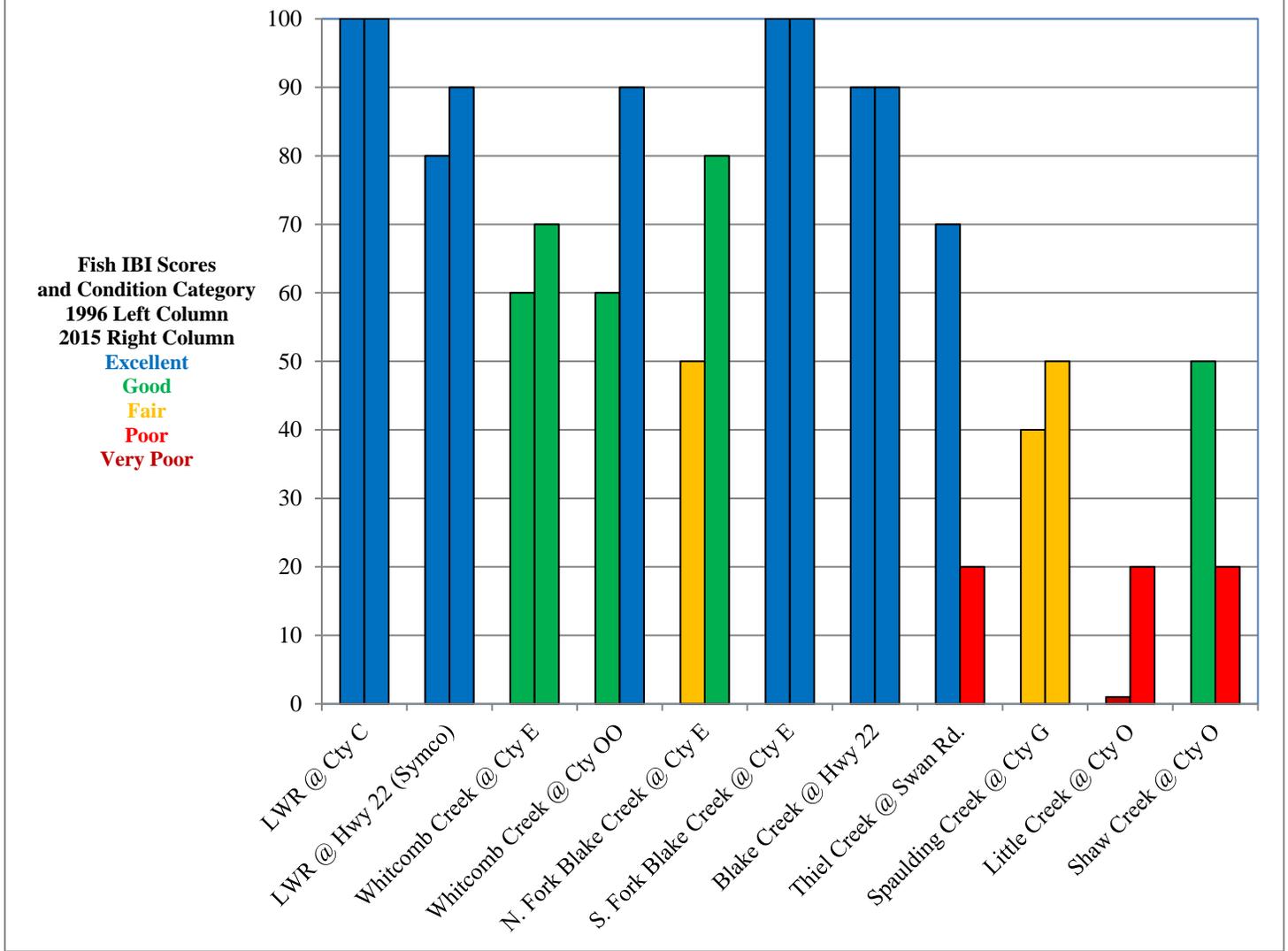


Chart 16: Historical and Current Fish Index of Biotic Integrity Scores and Condition Categories in the Lower Little Wolf River.

Conclusions

The water quality monitoring in 2015 demonstrated some water quality improvements (Spiegelberg Creek at Cemetery Rd) and declines (Thiel Creek at Swan Rd) since the implementation of the Priority Watershed Project of the late 1990s and early 2000s. The Mainstem of the Lower Little Wolf River maintained its good to excellent fish and aquatic macroinvertebrate communities and indicated a reduction in baseflow NO_3+NO_2 as N. Thiel, Little, and Shaw Creeks are not meeting their potential uses, demonstrate high nutrients, and sedimentation limits available fish and aquatic macroinvertebrate habitat; therefore, the need for watershed improvements remains throughout portions of the Lower Little Wolf River Watershed.

There are a few challenges to consider when comparing the pre-Priority Watershed monitoring results with the results of 2015. First, the majority of the BMPs installed during the Priority Watershed Project implementation

were soft practices (tillage and nutrient management). These practices may have been discontinued by the farmers in the watershed. Second, there may be unaccounted farming changes, such as fertilizer application rates and tillage adjustments throughout the watershed over time, that had an impact on the water quality of the Lower Little Wolf River and its tributaries observed in 2015. Thirdly, there may have been an increase in the land disposal of manure within the watershed since the beginning of the Priority Watershed Project. Lastly, watershed improvements may have been made since the implementation of the Priority Watershed that impacted the water quality observed in 2015. Therefore, the monitoring in 2015 does not solely reflect the changes in the watershed from the Priority Watershed Project implementation.

The BMPs that were implemented during the Priority Watershed Project were nutrient, residue, and barnyard-runoff management, streambank shaping, and manure storage throughout the watershed. Some of the land use characteristics observed during the 2015 monitoring project that can have a negative impact to the water quality of the Lower Little Wolf River and its tributaries were limited buffer protection along the stream corridors, eroding streambanks, cropland erosion, and sedimentation of fish and aquatic life habitat (Photo 2). Although good efforts were made to decrease the pollutant load during the Priority Watershed implementation, there are more opportunities to install practices to lower the nutrients and sediment reaching the Lower Little Wolf River.



Photo 2: Unnamed Tributary to the Little Wolf River. Photo taken by D. Bolha on October 21st, 2015.

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