

Targeted Watershed Assessment of the Bear Lake Watershed, Waupaca County, Wisconsin

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David Bolha-Water Quality Biologist-Oshkosh



Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state's Water Quality Management Planning and Water Resources Monitoring Programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy 2015-2020 goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act, Section 208. Condition information and resource management recommendations support and guide program priorities for the plan area.

This plan is hereby approved by the Wisconsin DNR Water Quality Program and is a formal update to Wisconsin's Statewide Areawide Water Quality Management Plan. This plan will be forwarded to USEPA for certification as a formal plan update.

Dave Bolha, Water Quality Biologist, East District
Marsha Burzynski, Water Quality Bureau Field Operations Director
Greg Searle, Water Quality Bureau Field Operations Director
Timothy Asplund, Water Quality Bureau Monitoring Section Chief

Basin/Watershed Partners

- Waupaca County Land Conservation Department

Report Acknowledgements

- Dave Bolha, Author and Investigator, Eastern District, Wisconsin DNR
- Lisa Helmuth, Program Coordinator, Water Quality Bureau, Wisconsin DNR

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Wisconsin Department of Natural Resources

101 S. Webster Street • PO Box 7921 •
Madison, Wisconsin 53707-7921 608-266-2621



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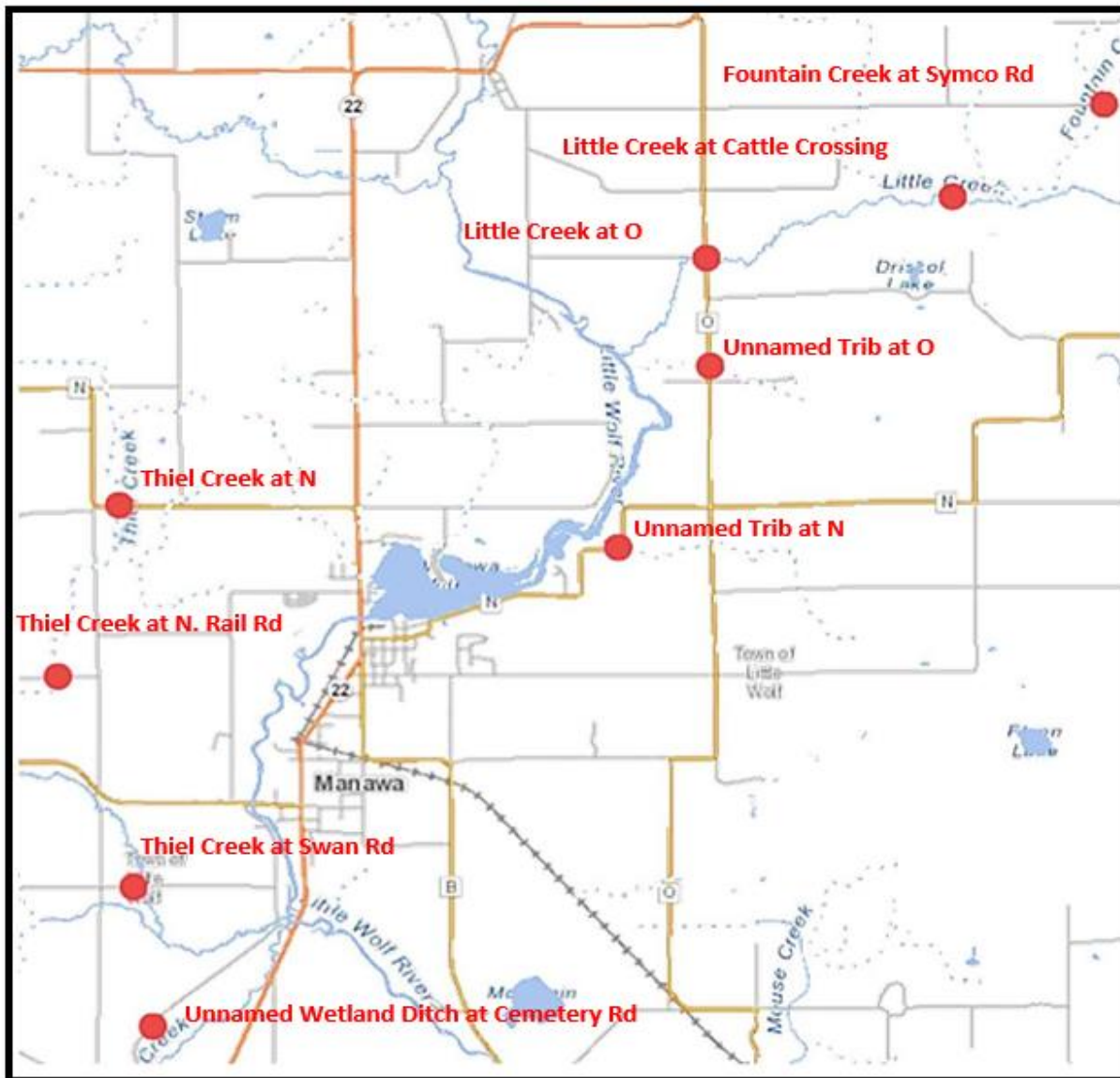
Purpose

The Bear Lake sub-watershed was selected as a National Water Quality Initiative Pilot Project (NRCS EQIP funds) for 2017 to reduce the impact of phosphorus and sediment reaching streams and ultimately the Little Wolf River. In 2015, the Bear Lake sub-watershed indicated tributary streams with the highest nutrient concentrations within the Little Wolf River Watershed. The sub-watershed was also one of the highest phosphorus loads in the Upper Fox-Wolf River Total Maximum Daily Load (TMDL) preliminary modeling. This Targeted Watershed Assessment provided baseline water quality data in support of NRCS's and Waupaca County's efforts to decrease nutrients and sediment runoff and the overall Upper Fox-Wolf River TMDL goals.

Site Selection

Below is a map of the sites sampled for this study. These sites are referred to through this document.

Map 1: Bear Lake Watershed Sample Locations in 2017.



Methods

Water Chemistry

During the growing season of 2017, Total Phosphorus (TP) samples were collected at 9 locations twice per month in May and June, and once per month in July and October (Table 1, Map 1). In addition, Total Suspended Solids (TSS) samples were collected twice per month in May and June 2017 and once per month in July and October at the 9 locations listed in Table 1. All samples were collected using the standard WDNR grab sampling method for a total of 108 samples (WDNR 2014). All nutrient and suspended solids 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.

Table 1: Inorganic Chemistry Monitoring Sites Sampled in the Bear Lake Watershed May Through October 2017.

SWIMS Station ID	Site Name	Surface Water WBIC
10048066	Fountain Creek US Symco Rd	280800
10048065	Little Creek at Cattle Crossing 3200m US County O	280700
693145	Little Creek at County O	280700
10048064	Unnamed Trib to Little Wolf River US County O	5018179
10048067	Unnamed Trib to Little Wolf River US County N	5018549
10048063	Thiel Creek US County N	280100
10048062	Thiel Creek US North Rail Rd	280100
693143	Thiel Creek at Swan Rd	280100
10048061	Unnamed wetland ditch to Spiegelberg Cr US Cemetery Rd	NA

Macroinvertebrates

Five locations were sampled for aquatic macroinvertebrates in October 2017 (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 available gravel, overhanging vegetation, woody debris, or other vegetation would be sampled. 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 Biomonitoring Laboratory (ABL) for lowest possible taxonomic identification. Staff at the ABL entered the data into the SWIMS database in 2018.

Table 2: Aquatic Macroinvertebrate Monitoring Locations Sampled in the Bear Lake Watershed in 2017.

SWIMS Station ID	Site Name	Surface Water WBIC
10048066	Fountain Creek US Symco Rd	280800
10048065	Little Creek at Cattle Crossing 3200m US County O	280700
10048064	Unnamed Trib to Little Wolf River US County O	5018179
10048067	Unnamed Trib to Little Wolf River US County N	5018549
10048062	Thiel Creek US North Rail Rd	280100

Fisheries

Between June and July 2017, wadable fish surveys were conducted at 7 sites (Map 1, Table 3). The 7 wadable fish surveys were conducted following the WDNR *Guidelines for Assessing Fish Communities of Wadable Streams in Wisconsin* (2001). All 7 wadable sites were surveyed in June through July 2017 during the guidance-recommended summertime 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). A 12 Volt, 18 Amp Hour battery-powered backpack shocker was used for all 7 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.

Table 3: Wadable Fish Survey Locations Sampled in the Bear Lake Watershed between June and July 2017.

SWIMS Station ID	Site Name	Surface Water WBIC
10048066	Fountain Creek US Symco Rd	280800
10048065	Little Creek at Cattle Crossing 3200m US County O	280700
693145	Little Creek at Cth O	280700
10048064	Unnamed Trib to Little Wolf River US County O	5018179
10048067	Unnamed Trib to Little Wolf River US County N	5018549
10048062	Thiel Creek US North Rail Rd	280100
693143	Thiel Creek at Swan Rd	280100

Continuous Temperature

Onset Hobo Pendant thermistors were deployed to collect temperature data from May through October at 3 locations in the Bear Lake Watershed (Table 4, Map 1). Temperature measurements were taken once per hour at each location from May through October. Temperature measurements were taken with an Onset Hobo Pendant thermistor attached to a fence post driven into the stream bed of the creek. 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.

Table 4: Temperature Monitoring Locations in the Bear Lake Watershed Sampled from May through October 2017.

SWIMS Station ID	Site Name	Surface Water WBIC
10048065	Little Creek at Cattle Crossing 3200m US County O	280700
10048064	Unnamed Trib to Little Wolf River US County O	5018179
10048067	Unnamed Trib to Little Wolf River US County N	5018549

Habitat

Quantitative habitat surveys were conducted at 4 locations in the Bear Lake Watershed between August and October 2017 (Table 5, Map 1). 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 longitudinally even-spaced 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.

Table 5: Quantitative Habitat Survey Locations in the Bear Lake Watershed Conducted in August and October 2017.

SWIMS Station ID	Site Name	Surface Water WBIC
10048066	Fountain Creek US Symco Rd	280800
10048065	Little Creek at Cattle Crossing 3200m US County O	280700
10048064	Unnamed Trib to Little Wolf River US County O	5018179
10048067	Unnamed Trib to Little Wolf River US County N	5018549

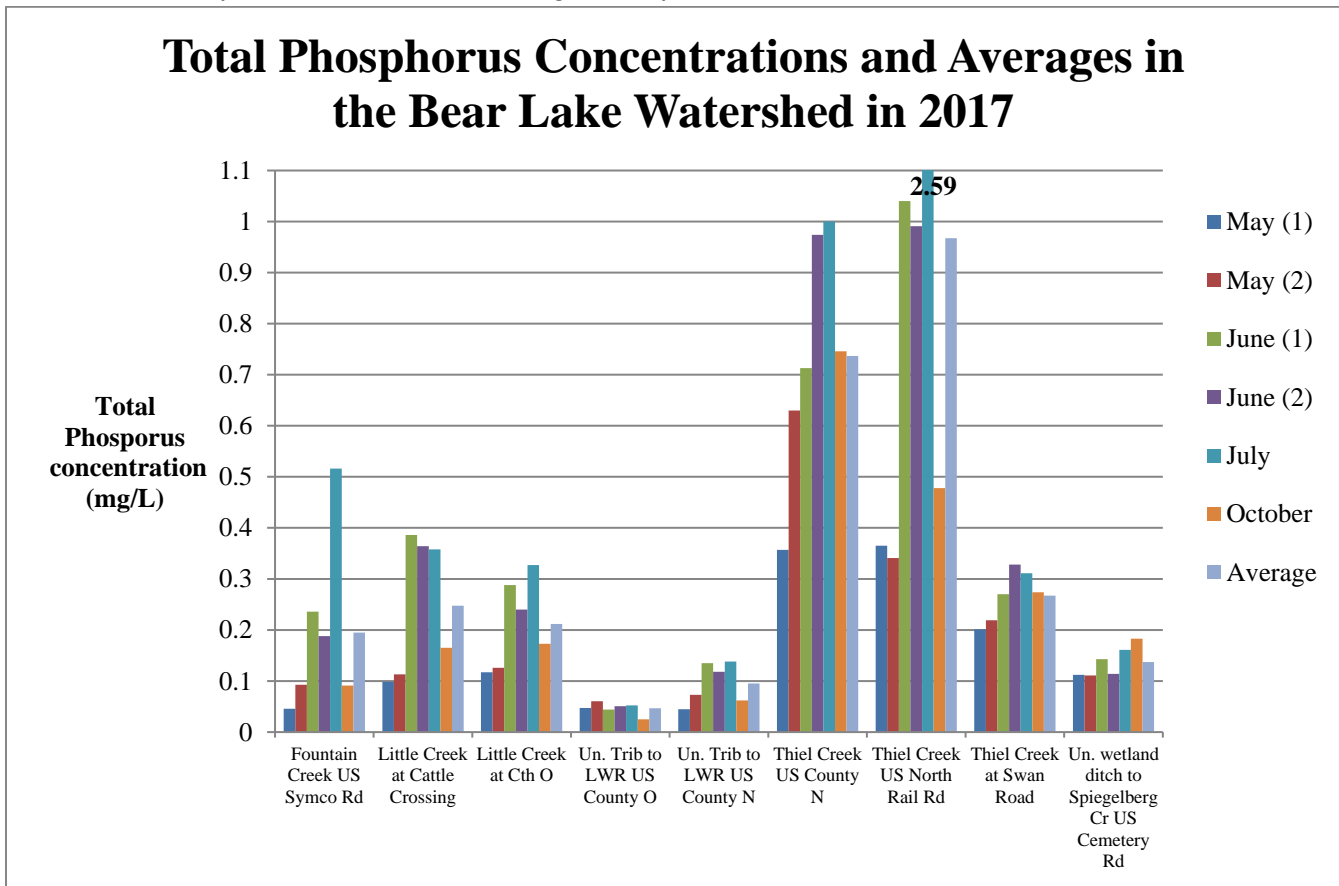
Results

The 2017 TP sample analysis results in the Bear Lake Watershed ranged from 0.0250 mg/L at the Unnamed Trib at County O in October to 2.59 mg/L at Thiel Creek at North Rail Rd in July (Table 6, Chart 1). The average TP concentrations for the 9 sites in this project ranged from 0.0466 mg/L at the Unnamed Trib at County O to 0.9675 mg/L in Thiel Creek at North Rail Rd. (Table 6, Chart 1).

Table 6: Total Phosphorus Concentrations and Averages of Samples Collected in the Bear Lake Watershed in 2017.

Sample Event Month	Fountain Cr. US Symco Rd (mg/L)	Little Cr. at Cattle Crossing 3200m US Cty O (mg/L)	Little Cr. at Cth O (mg/L)	Un. Trib. to Little Wolf River US Cty O (mg/L)	Un. Trib. to Little Wolf River US Cty N (mg/L)	Thiel Cr. US Cty N (mg/L)	Thiel Cr. US North Rail Rd (mg/L)	Thiel Cr. at Swan Road (mg/L)	Un. wetland ditch to Spiegelberg Cr. US Cemetery Rd (mg/L)
May (1)	0.0458	0.0984	0.117	0.0474	0.0447	0.357	0.365	0.201	0.112
May (2)	0.0926	0.113	0.126	0.0604	0.0728	0.630	0.341	0.219	0.111
June (1)	0.236	0.386	0.288	0.0441	0.135	0.713	1.04	0.270	0.143
June (2)	0.188	0.364	0.240	0.0506	0.118	0.974	0.991	0.328	0.114
July	0.516	0.358	0.327	0.0523	0.138	1.00	2.59	0.311	0.161
Oct	0.0912	0.165	0.173	0.0250	0.0621	0.746	0.478	0.274	0.183
Ave	0.1949	0.2474	0.2118	0.0466	0.0951	0.7367	0.9675	0.2672	0.1373

Chart 1: Total Phosphorus Concentrations and Averages of Samples Collected in the Bear Lake Watershed in 2017.



TSS analysis was also conducted on samples collected at all 9 Bear Lake Watershed project locations during the same sampling events as TP in 2017. TSS samples were collected twice per month in May and June, and once per month in July and October (Table 7, Chart 2). 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 analytical support for

including these systems to the CWA 303d list for habitat degradation. The TSS concentration of the Bear Lake watershed ranged from No Detection (ND), which is <2.0 mg/L, to 109 mg/L in July at Fountain Creek (Table 7, Chart 2).

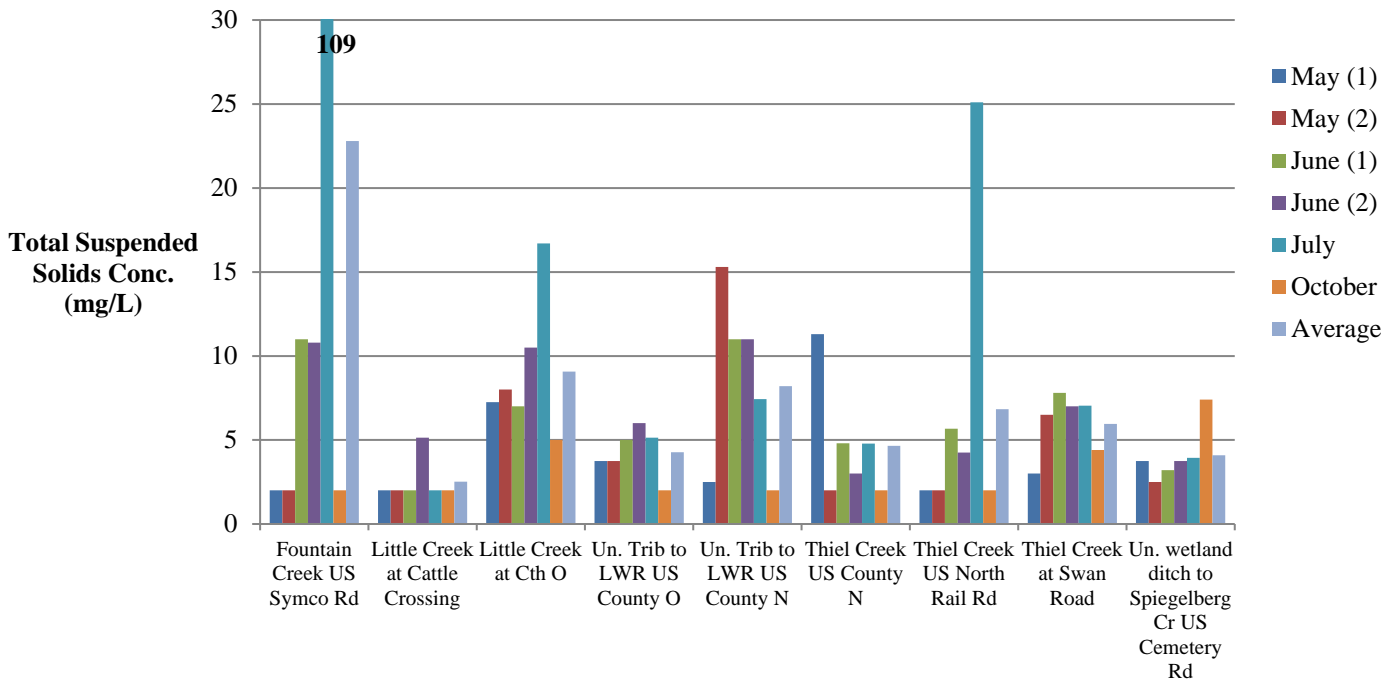
Table 7: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Bear Lake Watershed in 2017.

Sample Event Month	Fountain Cr. US Symco Rd	Little Cr. at Cattle Crossing 3200m US Cty O	Little Cr. at Cth O	Un. Trib. to Little Wolf River US Cty O	Un. Trib. to Little Wolf River US Cty N	Thiel Cr. US Cty N	Thiel Cr. US North Rail Rd	Thiel Cr. at Swan Road	Un. wetland ditch to Spiegelberg Cr. US Cemetery Rd
May (1)	ND	ND	7.25	3.75	2.50	11.3	ND	3.00	3.75
May (2)	ND	ND	8.00	3.75	15.3	ND	ND	6.50	2.50
June (1)	11.0	ND	7.00	5.00	11.0	4.80	5.67	7.80	3.20
June (2)	10.8	5.14	10.5	6.00	11.0	3.00	4.25	7.00	3.75
July	109	ND	16.7	5.14	7.43	4.79	25.1	7.04	3.94
Oct	ND	ND	5.00	ND	ND	ND	ND	4.40	7.40
Ave	22.8	2.52	9.08	4.27	8.21	4.65	6.84	5.96	4.09

(ND = No Detection) (Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

Chart 2: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Bear Lake Watershed in 2017.

Total Suspended Solids Concentrations and Averages in the Bear Lake Watershed in 2017



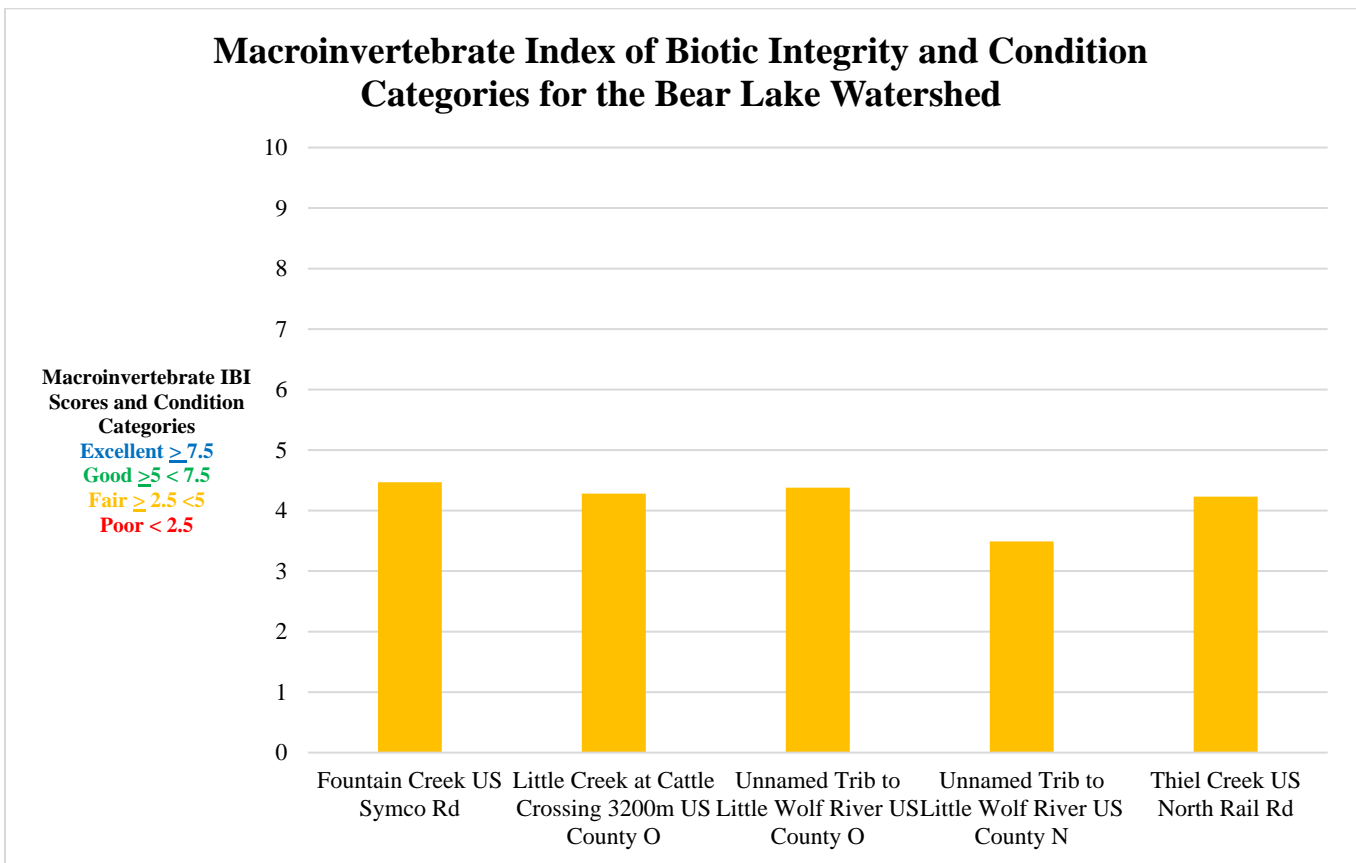
(Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

Aquatic macroinvertebrate communities were sampled at 5 locations in October 2017 (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 8, Chart 3). In general, the higher the MIBI score, the better the water quality rating for a waterbody. Each of the 5 locations sampled in the Bear Lake Watershed indicate a water quality condition category of Fair, ranging from 3.49 to 4.47.

Table 8: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in Bear Lake Watershed in 2017.

SWIMS Station ID	Stream Name and Location	Macroinvertebrate IBI Score	Condition Category
10048066	Fountain Creek US Symco Rd	4.47	Fair
10048065	Little Creek at Cattle Crossing 3200m US County O	4.28	Fair
10048064	Un Trib to Little Wolf River US County O	4.38	Fair
10048067	Un Trib to Little Wolf River US County N	3.49	Fair
10048062	Thiel Creek US North Rail Rd	4.23	Fair

Chart 3: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in Bear Lake Watershed in 2017.



Between June and July 2017, 7 sites in the Bear Lake 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 9, Chart 4). The FIBI scores ranged from 10 in the Unnamed Trib to the Little Wolf River at County O to 40 in Thiel Creek at Swan Rd (Table 9, Chart 8). The Condition Category for the 7 sites ranged from Poor to Fair.

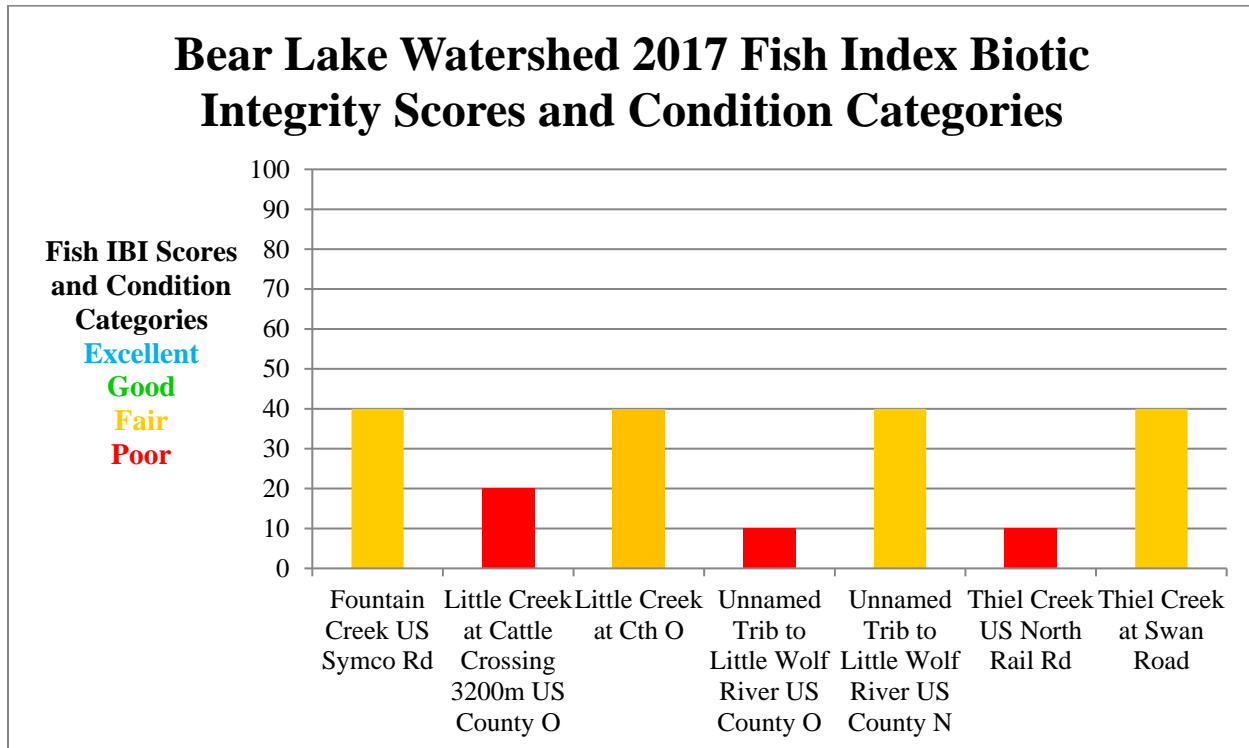
Each fish community surveyed was used to verify or update the modeled Natural Community for that stream segment. Each of the 7 tributary streams' Natural Community was verified or changed based upon the fish caught in the survey (and any historical known surveys in that stream segment). Verifying or 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 9 and Chart 4 are based upon the verified or changed Natural Community.

Table 9: Fish Survey Results in the Bear Lake Watershed Conducted in June through July 2017.

SWIMS Station ID	Site Name	Fish IBI Score	Condition Category	Natural Community
10048066	Fountain Creek US Symco Rd	40	Fair	Cool-Warm Headwater
10048065	Little Creek at Cattle Crossing 3200m US County O	20	Poor	Cool-Warm Mainstem
693145	Little Creek at County O	40	Fair	Cool-Warm Mainstem
10048064	Unnamed Trib to Little Wolf River US County O	10	Poor	Cool-Cold Headwater
10048067	Unnamed Trib to Little Wolf River US County N	40	Fair	Cool-Cold Headwater
10048062	Thiel Creek US North Rail Rd	10	Poor	Cool-Warm Headwater
693143	Thiel Creek at Swan Rd	40	Fair	Cool-Warm Mainstem

Chart 4: Fish Survey Results in the Bear Lake Watershed Conducted in June through July 2017.

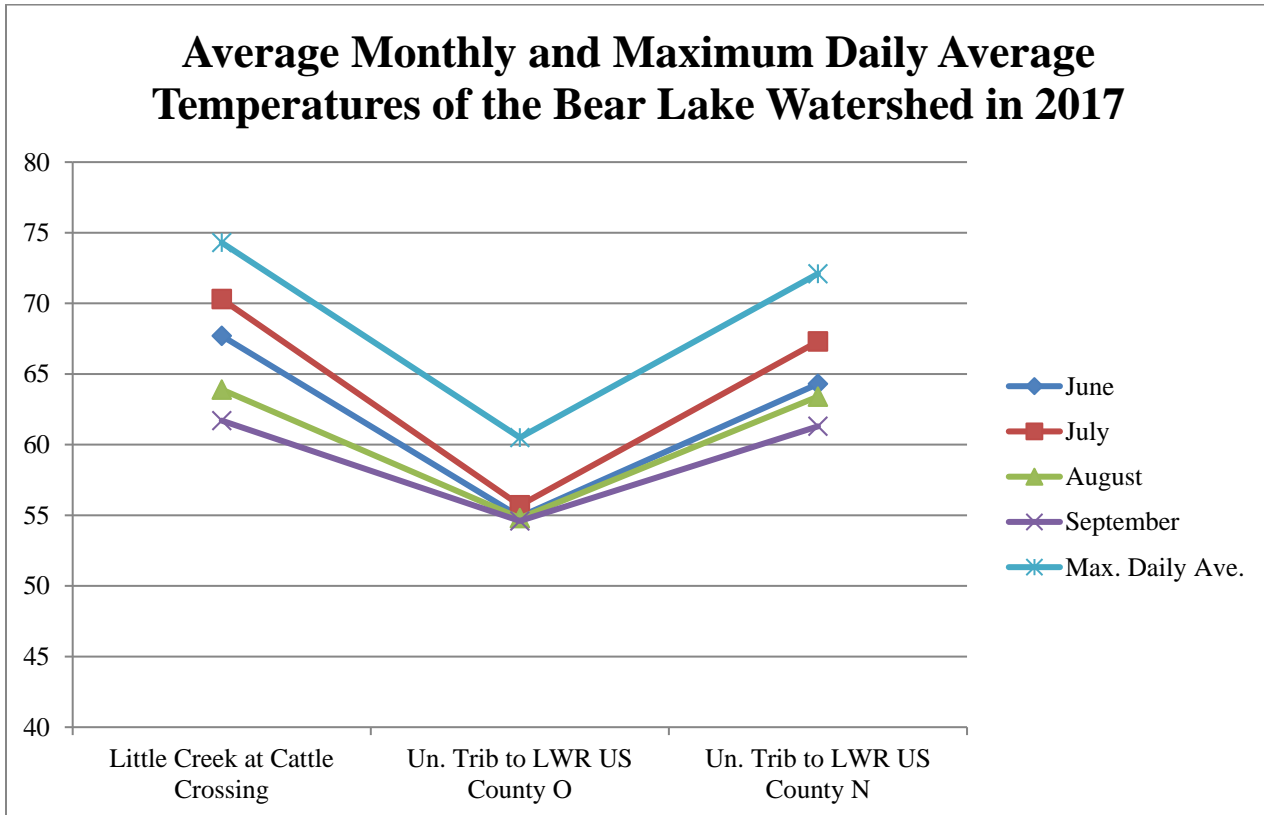


Water temperature data was collected from May through October 2017 at 3 locations in the Bear Lake Watershed (Table 4, Map 1). Monthly average temperatures were reported for months with complete data only (Table 10, Chart 5). The Unnamed Tributary to the Little Wolf River at County O had lowest recorded temperature overall, the lowest monthly average temperature, and the lowest Maximum Daily Average (MDM) temperature at 48.0F, 54.6F, and 60.5F, respectively. Whereas, Little Creek at the cattle crossing (SWIMS 10048065) had the warmest recorded temperature overall, the warmest monthly average, and the warmest MDM at 80.9F, 70.3F, and 74.3F respectively (Table 10, Chart 5).

Table 10: Monthly Average and Maximum Daily Average Temperatures in the Bear Lake Watershed in 2017.

Location	June Average Temperature	July Average Temperature	August Average Temperature	September Average Temperature	Maximum Daily Average Temperature
Little Creek at Cattle Crossing 3200m US County O	67.7	70.3	63.9	61.7	74.3
Unnamed Trib to Little Wolf River US County O	54.9	55.7	54.8	54.6	60.5
Unnamed Trib to Little Wolf River US County N	64.3	67.3	63.4	61.3	72.1

Chart 5: Monthly Average and Maximum Daily Average Temperatures in the Bear Lake Watershed in 2017.

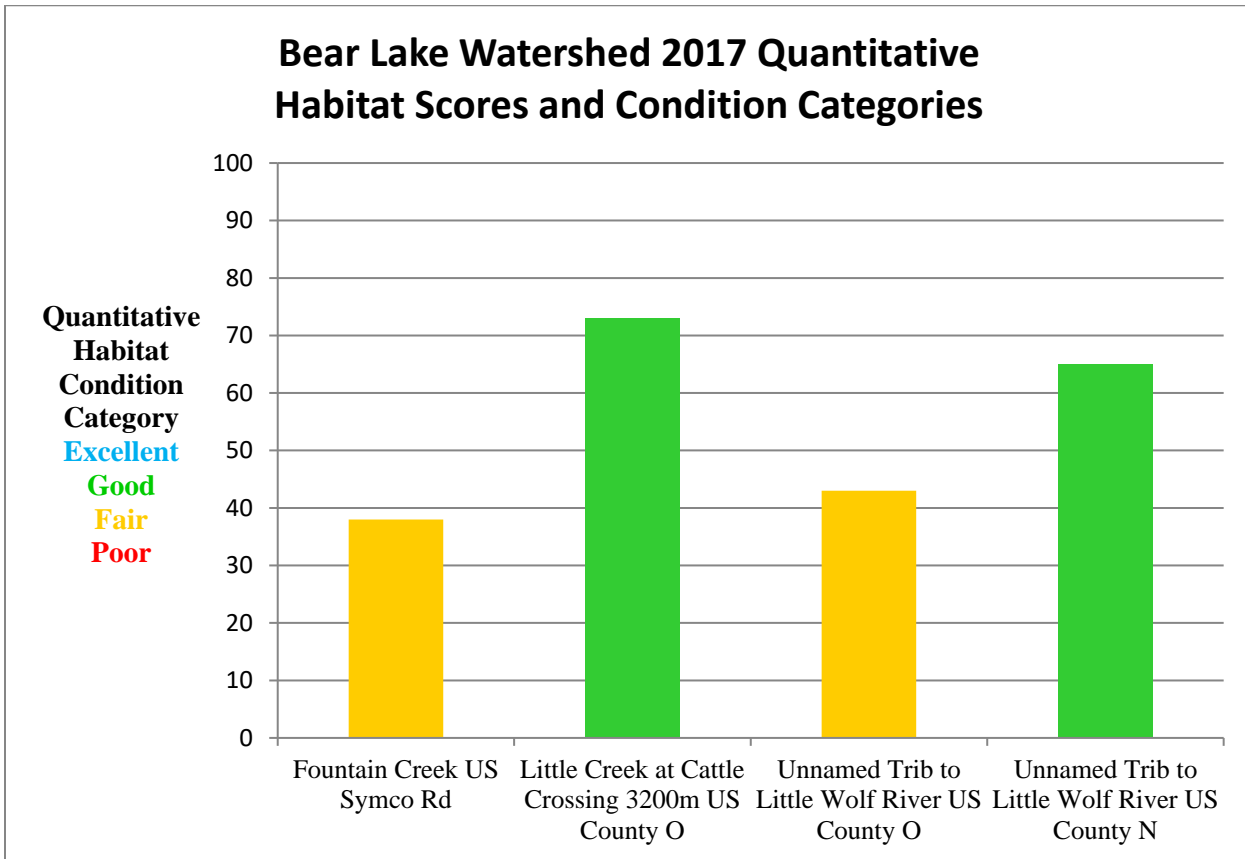


In August and October 2017, quantitative habitat surveys were conducted at 4 locations in the Bear Lake Watershed (Table 11, Map 1). Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for game fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2017 surveys, a habitat rating was calculated for the 4 locations (Table 11, Chart 6). The quantitative habitat scores ranged from 38 in Fountain Creek to 73 in Little Creek at the cattle crossing (Table 11, Chart 6). Little Creek at the cattle crossing and the unnamed tributary to the Little Wolf River at County N had a Good Condition Category, while the remaining 2 sites (Fountain Creek and Unnamed Tributary to Little Wolf River at County O) received a Condition Category of Fair (Table 11, Chart 6). None of the habitat surveys demonstrated Poor habitat.

Table 11: Quantitative Habitat Survey Scores and Condition Categories for the Bear Lake Watershed in 2017.

SWIMS Station ID	Stream Name and Site Location	Quantitative Habitat Score	Condition Category
10048066	Fountain Creek US Symco Rd	38	Fair
10048065	Little Creek at Cattle Crossing 3200m US County O	73	Good
10048064	Unnamed Trib to Little Wolf River US County O	43	Fair
10048067	Unnamed Trib to Little Wolf River US County N	65	Good

Chart 6: Quantitative Habitat Survey Scores and Condition Categories for the Bear Lake Watershed in 2017.



Discussion

This project provided baseline water quality monitoring of the Bear Lake sub-watershed of the Lower Little Wolf River Watershed by collecting nutrient and sediment concentrations, and habitat, temperature, and biological information. More specifically, this project provided the baseline data for developing an USEPA 9 Key Element Plan (9KE) for the Bear Lake Watershed. “Watershed plans consistent with USEPA’s 9KE provide a framework for improving the contributing causes and sources of non-point source pollution, involve key stakeholders and prioritize restoration and protection strategies to address water quality problems” (WDNR 2018). Having an approved 9KE plan can increase opportunities for federal and state funding for the installation of agricultural best management practices (BMPs), which focus on reducing the discharge of non-point source pollutants into the surface waters of the sub-watershed. The monitoring during this project provided the current water quality conditions of the surface waters in the Bear Lake Watershed and data that can be compared to the water quality conditions after BMPs have been installed. Waupaca County Land and Water Conservation Department (LWCD) has drafted and submitted a 9KE Plan to the WDNR for review in 2017 and received approval from the WDNR and USEPA in 2018. The phosphorus and biological monitoring in this project demonstrated that the water quality is between fair and poor in the Bear Lake Watershed.

The Bear Lake Watershed drains a 28,260 acre area into the Little Wolf River. The Bear Lake Watershed is located entirely within Waupaca County, near Manawa, Wisconsin, and drains 29% of the Lower Little Wolf River Watershed. The land use within the Bear Lake Watershed is dominated, 51.2%, by cropland, 36.5% as natural woodlands, grasslands, and wetlands, and <10% is considered urban. Typically, as increases in agricultural land use occur, there is a correlating increase in TP concentration in creeks in the watershed. There are 4 named creeks in the Bear Lake Watershed; Thiel, Little, Spiegelberg, and Shaw Creeks. In 2015, monitoring in Thiel and Little Creeks indicated TP concentrations exceeding the water quality criteria for Wisconsin streams; therefore, these two creeks were added to the 2018 CWA 303d list of Impaired Waters (WDNR 2017). In 2017, the sample locations were increased on each of the two Impaired Waters and added locations on 4 other unnamed tributaries to further assess sources of nutrients and sediment (Tables 6-7). This will provide a framework for comparison following the installation of BMPs within multiple areas of the watershed. The nutrient and sediment monitoring in the upper portions of the Thiel and Little Creeks indicate land use practices and stream degradation are a significant source to the Bear Lake Watershed. Conversely, improvements to the streams and drainage area will significantly reduce the TP and TSS reaching the Little Wolf River.

Waupaca County LWCD completed the 9KE plan for the Bear Lake Watershed in 2018. Through their modeling effort, the County LWCD determined that a sum of 2,323 tons of sediment are delivered to the Little Wolf River each year. Much of the sediment is delivered to the Little Wolf River by first being carried down the streams in the watershed. When sediment is transported in streams, there is an effect on the habitat and aquatic life within the stream. In 2017, TSS was used to measure instream sediment (amongst other suspended particles). Suspended solids, which are most commonly comprised of sediment and algae, absorb heat from sunlight, which increases water temperature and subsequently decreases levels of dissolved oxygen. Photosynthesis also decreases because TSS decreases light penetration, which thereby reduces dissolved oxygen levels. Additionally, TSS can destroy fish habitat as the solids settle to the bottom, smothering the eggs of fish and insects. Suspended solids can also clog fish gills and increase the difficulty for fish and insects to find food. Water quality, as indicated by the Fair to Poor FIBI and MIBI scores, in the Bear Lake Watershed has been impacted by the habitat degradation due to sedimentation. Bank erosion and fine sediments in the stream channels contributes to the degraded habitat and biological community (Photo 1).

Photo 1: Unnamed Tributary to Little Wolf River at County N. Photo taken by D. Bolha on October 11th, 2017.



Conclusions

The monitoring in 2017 demonstrates water quality in the Bear Lake Watershed ranges from poor to fair, indicating significant impacts from environmental degradation. Some of the land use characteristics observed during the 2017 monitoring project that can have a negative impact to the water quality of the streams in the Bear Lake Watershed were limited buffer protection along the stream corridors, eroding streambanks, wetland drainage, cropland erosion, channelization, tile drainage, presence of aquatic invasive species, and sedimentation of fish and aquatic life habitat (Photo 1-4). There are opportunities to install practices to lower the nutrients and sediment reaching the Little Wolf River. Efforts should be made to continue to work with landowners, farmers, municipalities, the County LWCD and NRCS staff to promote protection and restoration of the streams and wetlands by practices including, but not limited to, streambank and buffer protection, cover crops, nutrient management planning, reduced tillage, wetland restoration, and water and sediment control basins.

Photo 2: Thiel Creek at County N facing upstream. Photo taken by D. Bolha on October 11th, 2017.



Photo 3: Unnamed Wetland Ditch Near Spiegelberg Creek at Cemetery Rd. Photo taken by D. Bolha on October 11th, 2017.



Photo 4: Unnamed Tributary to Little Wolf River at County O. Photo taken by D. Bolha on June 29th, 2017.



References

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