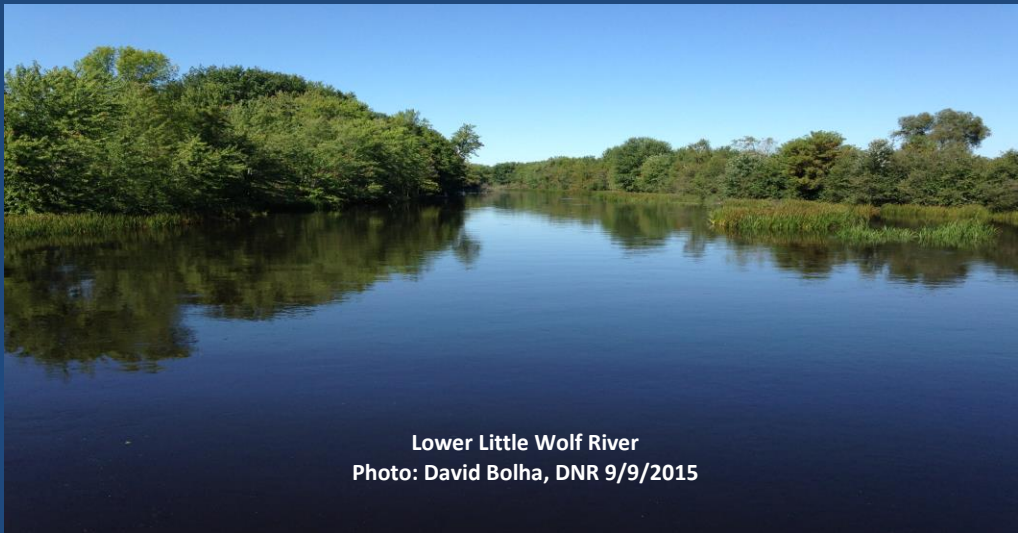


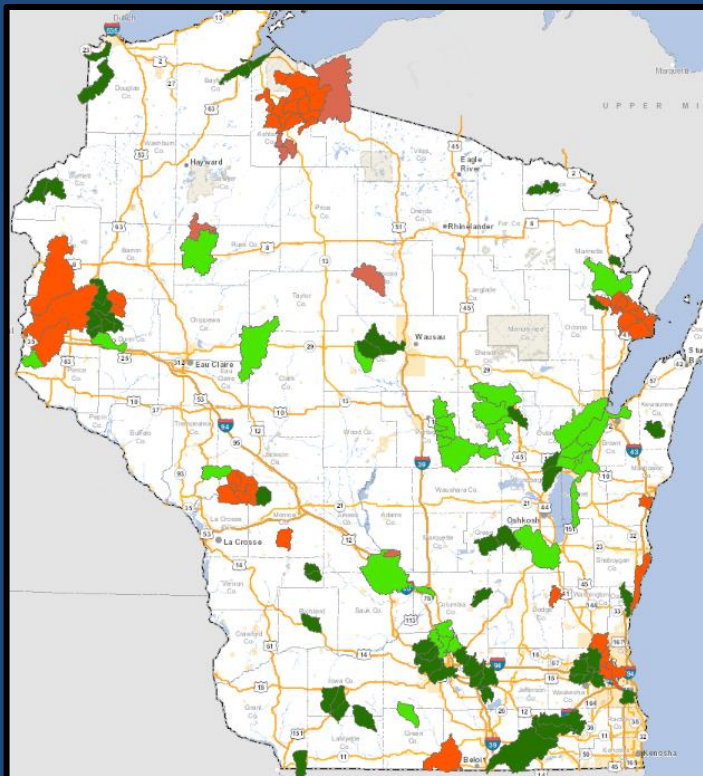


Lower Little Wolf River
Photo: David Bolha, DNR 9/9/2015

*A Watershed Report
created by the Bureau of
Water Quality in support
of the Clean Water Act.*

LOWER LITTLE WOLF RIVER TWA WQM PLAN 2017

Lower Little Wolf River (WR06)
HUC: 0403020217
Monitored in 2015



EGAD # 3200-2017-06
Water Quality Bureau,
Wisconsin DNR

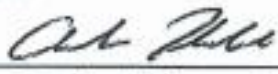
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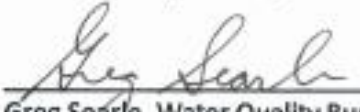
Wisconsin Water Quality Monitoring and Planning

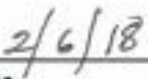
This Water Quality Management Plan was created under the state's Water Quality Management Planning and Water Resources Monitoring Programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy 2015-2020 goals and priorities and fulfills Areawide Water Quality Management Planning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

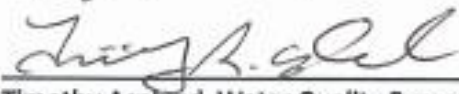
This plan is hereby approved by the Wisconsin DNR Water Quality Program and is a formal update to the Wolf River Areawide Water Quality Management Plan and Wisconsin's Statewide Areawide Water Quality Management Plan. This plan will be forwarded to USEPA for certification as a formal plan update.

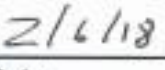

Water Quality Field Supervisor - Acting


Date


Greg Searle, Water Quality Bureau Field Operations Director


Date


Timothy Asplund, Water Quality Bureau Monitoring Section Chief


Date

Basin/Watershed Partners

- Waupaca County Land and Water Conservation Department
- Waupaca County Natural Resources Conservation Service

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Wisconsin Department of Natural Resources
101 S. Webster Street • PO Box 7921 •
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Abbreviations

AEL: Aquatic Entomology Laboratory at UW – Stevens Point. The primary laboratory for analysis of macroinvertebrate taxonomy in the State of Wisconsin.

BMP: Best Management Practice. A practice that is determined effective and practicable (including technological, economic, and institutional considerations) in preventing or reducing pollution generated from nonpoint sources to a level compatible with water quality goals.

DATCP: Wisconsin Department of Agriculture, Trade and Consumer Protection. The state agency in partnership with DNR responsible for a variety of land and water related programs.

DNR: Department of Natural Resources. Wisconsin Department of Natural Resources is an agency of the State of Wisconsin created to preserve, protect, manage, and maintain natural resources.

END: Endangered Species. Wisconsin species designated as rare or unique due to proximity to the farthest extent of their natural range or due to anthropogenic deleterious impacts on the landscape or both.

ERW: Exceptional Resource Water. Wisconsin's designation under state water quality standards to waters with exceptional quality and which may be provided a higher level of protection through various programs and processes.

FHMD: Fisheries and Habitat Management Database. The state's repository for fish taxonomy and auto-calculated metrics involving fish assemblage condition and related.

FIBI: Fish Index of biological integrity (Fish IBI). An Index of Biological Integrity (IBI) is a scientific tool used to identify and classify water pollution problems. An IBI associates anthropogenic influences on a water body with biological activity in the water and is formulated using data developed from biosurveys. In Wisconsin, Fish IBIs are created for each type of natural community in the state's stream system.

HUC: Hydrologic Unit Code. A code or sequence of numbers that identify one of a number of nested and interlocked hydrologic catchments delineated by a consortium of agencies including USGS, USFS, and Wisconsin DNR.

MIBI: Macroinvertebrate Index of biological integrity. In Wisconsin, the MIBI, or macroinvertebrate Index of biological integrity, was developed specifically to assess Wisconsin's macroinvertebrate community (see also Fish IBI).

NC. Natural Community. A system of categorizing water based on inherent physical, hydrologic, and biological assemblages. Streams and lakes are categorized using an array of "natural community" types.

MDM: Maximum Daily Averages. Maximum daily average is a calculated metric that may be used for temperature, dissolved oxygen and related chemistry parameters to characterize water condition.

mg/L: milligrams per liter. A volumetric measure typically used in chemistry analysis characterizations.

Monitoring Seq. No. Monitoring Sequence Number. A unique identification code generated by the Surface Water Integrated Monitoring System (SWIMS), which holds much of the state's water quality monitoring data.

NOAA: National Oceanic and Atmospheric Administration. A federal agency responsible for water / aquatic related activities involve the open waters, seas and Great Lakes.

ND: No detection. A term used typically in analytical settings to identify when a parameter or chemical constituent was not present at levels higher than the limit of detection.

NRCS: USDA Natural Resources Conservation Service. The federal agency providing local support and land management outreach work with landowners and partners such as state agencies.

ORW: Outstanding Resource Water. Wisconsin's designation under state water quality standards to waters with outstanding quality and which may be provided a higher level of protection through various programs and processes.

SC: Species of Special Concern. Species in Wisconsin designated as special concern due to proximity to the farthest extent of their natural range or due to anthropogenic deleterious impacts on the landscape, or both.

SWIMS ID. Surface Water Integrated Monitoring System (SWIMS) Identification Code. An unique monitoring station identification number for the location where monitoring data was gathered.

TDP: Total Dissolved Phosphorus. An analyzed chemistry parameter collected in aquatic systems positively correlated with excess productivity and eutrophication in Wisconsin waters.

TMDL: Total Maximum Daily Load. A technical report required for impaired waters Clean Water Act. TMDLs identify sources, sinks and impairments associated with the pollutant causing documented impairments.

TP: Total Phosphorus. An analyzed chemical parameter collected in aquatic systems frequently positively correlated with excess productivity and eutrophication in many of Wisconsin's waters.

THR: Threatened Species. Wisconsin species designated as threatened due to proximity to the farthest extent of their natural range or due to anthropogenic deleterious impacts on the landscape, or both.

TWA: Targeted Watershed Assessment. A study design described in Wisconsin's Water Resources Monitoring Strategy 2015-2020 that integrates multiple program goals and interests for monitoring, assessing, and planning for maintaining, protecting and managing the state's resources.

TSS: Total suspended solids. An analyzed physical parameter collected in aquatic systems that is frequently positively correlated with excess productivity, reduced water clarity, reduced dissolved oxygen and degraded biological communities.

WATERS ID: The Waterbody Assessment, Tracking and Electronic Reporting System Identification Code. A unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code".

WBIC: Water Body Identification Code. DNR's unique identification codes assigned to water features in the state. The lines and information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

WQC: Water quality criteria. A component of Wisconsin's water quality standards that provide numerical endpoints for specific chemical, physical, and biological constituents.

Watershed Discussion & Management Recommendations

Watershed Goals

The overall goal of this plan is to improve and protect water quality in the basin. This Targeted Watershed Assessment monitoring project provided substantial data to analyze current conditions and to make recommendations for future management actions in the area. This plan is designed to present monitoring study results, identify issues or concerns in the area found during the project and to make recommendations to improve or protect water quality consistent with Clean Water Act guidelines and state water quality standards.

Watershed Overview

The Lower Little Wolf River watershed is 152 square miles and lies in central Waupaca County. Approximately 27 miles of the Little Wolf River are in this watershed, from the confluence of the South Branch Little Wolf River (watershed WR08) to the dam at Big Falls. The Winnebago Comprehensive Management Plan ranked this watershed as a medium priority for watershed selection due to local soil erosion and animal waste problems. The data for the Wolf River Basin Plan indicated that problems related to polluted runoff exist in this watershed.

The Lower Little Wolf River Watershed was selected as a priority watershed in 1995 and expired at the end of year 2008. The priority watershed plan was prepared cooperatively by the DNR, the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), and the Waupaca Land and Water Conservation Department, with assistance from the University of Wisconsin-Extension and the USDA Natural Resources Conservation Service (NRCS).

The approved watershed plan is considered an amendment to this plan. The soils, geology and other physical resources of the western and central 20 percent of this watershed indicate the area is highly susceptible to groundwater contamination by poor land use practices (WDNR and WGNHS, 1987). The remaining 80 percent of the watershed lies in an area of medium susceptibility. A data search revealed groundwater samples contaminated mainly from pesticides.

Population, Land Use, Site Characteristics

The Lower Little Wolf River watershed is 153.60 mi². Land use in the watershed is primarily agricultural (48%), forest (29%) and a mix of wetland (16%) and other uses (5%) (Figure 2). This watershed has 189.20 stream miles, 1,038.51 lake acres and 21,932.16 wetland acres.

Ecological Landscapes

The Lower Little Wolf River Watershed lies primarily in two ecological landscapes: the Central Lake Michigan Coastal Ecological Landscape in the south and the Forest Transition Ecological Landscape in the north. The Central Lake Michigan Coastal Ecological Landscape stretches from southern Door County west across Green Bay to the Wolf River drainage, then southward in a narrowing strip along the Lake Michigan shore to central Milwaukee County. Owing to the influence of Lake Michigan in the eastern part of this landscape, summers there are cooler, winters warmer, and precipitation levels greater than at locations farther inland.

Dolomites and shales underlie the glacial deposits that blanket virtually all of the Central Lake Michigan Coastal Ecological Landscape. The dolomite Niagara Escarpment is the major bedrock feature, running across the entire landscape from northeast to southwest. A series of dolomite cliffs provide critical habitat for rare terrestrial snails, bats, and specialized plants. The primary glacial landforms are ground moraine, outwash, and lake plain.

Historically, most of this landscape was vegetated with mesic hardwood forest composed primarily of sugar maple, basswood, and beech. Hemlock and white pine were locally important, but hemlock was generally restricted to cool moist sites near Lake Michigan. Areas of poorly drained glacial lake plain supported wet forests of tamarack, white cedar, black ash, red maple, and elm, while the Wolf and

Figure 1: Lower Little Wolf River TWA.

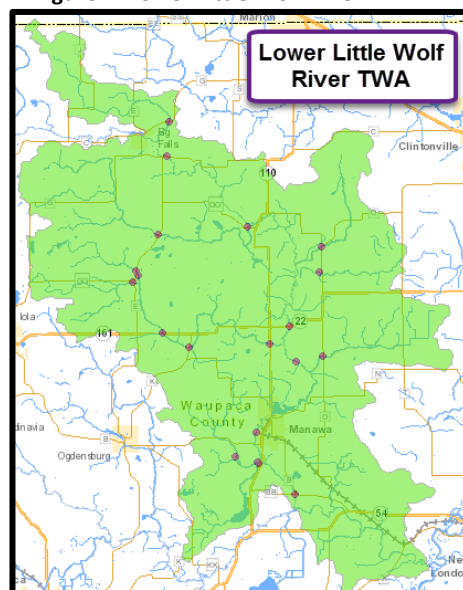
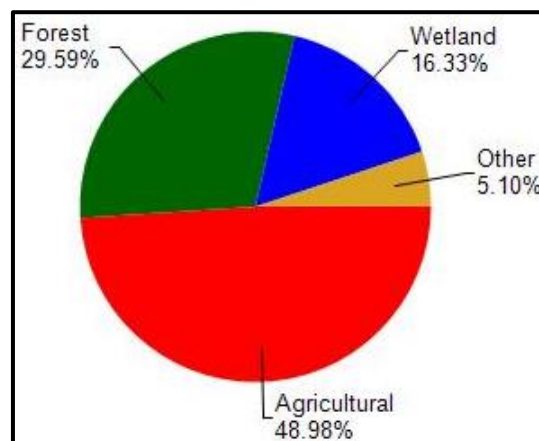


Figure 2: Land use percentages in the Lower Little Wolf River TWA.



Embarrass Rivers flowed through extensive floodplain forests of silver maple, green ash, and swamp white oak. Emergent marshes and wet meadows were common in and adjacent to lower Green Bay, while Lake Michigan shoreline areas featured beaches, dunes, interdunal wetlands, marshes, and highly diverse ridge and swale vegetation. Small patches of prairie and oak savanna were present in the southwestern portion of this landscape.

The Forest Transition Ecological Landscape lies along the northern border of Wisconsin's Tension Zone, through the central and western part of the state, and supports both northern forests and agricultural areas. The central portion of the Forest Transition lies primarily on a glacial till plain that was deposited by glaciation between 25,000 and 790,000 years ago. The eastern and western portions are on moraines of the Wisconsin glaciation.

The growing season in this part of the state is long enough that agriculture is viable, although climatic conditions are not as favorable as in southern Wisconsin. Soils are diverse, ranging from sandy loam to loam or shallow silt loam, and from poorly drained to well drained. The historic vegetation of the Forest Transition was primarily northern hardwood forest. These northern hardwoods were dominated by sugar maple and hemlock, and contained some yellow birch, red pine and white pine. Currently, over 60% of this Ecological Landscape is non-forested. Forested areas consist primarily of northern hardwoods and aspen, with smaller amounts of oak and lowland hardwoods. The eastern portion of the Ecological Landscape differs from the rest of the area in that it remains primarily forested and includes some ecologically significant areas. Throughout the Ecological Landscape, small areas of conifer swamp are found near the headwaters of streams and associated with lakes in kettle depressions on moraines.

Hydrology

The hydrology of the Lower Little Wolf River Watershed begins below the Big Falls Dam. The Lower Little Wolf River generally flows southeast through pre-dominantly agriculture landscapes. Overall, the Lower Little Wolf River is a slow, clear and hard warmwater river with some sections of rapids and moderate current. The watershed that drains into the Lower Little Wolf River from the west is more of a mix of forest, wetlands and agriculture. The watershed that drains from the east of the Lower Little Wolf River is dominated by agriculture with a lower percentage of wetland and forested landscape. There is one notable dam and associated millpond in the City of Manawa between Big Falls and the Lower Little Wolf River confluence with the Wolf River near Royalton. The tributaries on the west side of the watershed have a higher groundwater proportion of their flow and are generally cooler. The tributaries on the east side of the watershed demonstrate higher surface runoff inputs creating higher flow volumes for shorter periods of time or flashiness.

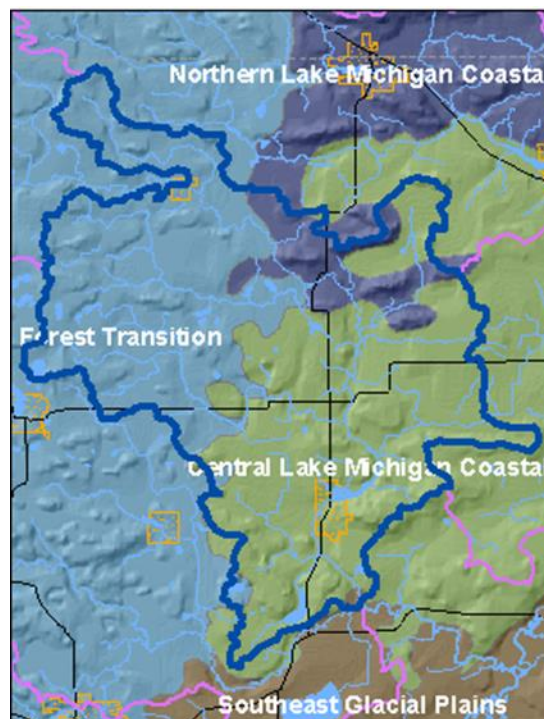
Study Summary

In 2015, DNR Water Resources staff 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. 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.

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 good to excellent fish and aquatic macroinvertebrate communities and indicated a reduction in baseflow $\text{NO}_3 + \text{NO}_2$ 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 Best Management Practices (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

Figure 3: Ecological landscapes in the Lower Little Wolf River TWA.



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.

BMPs implemented during the Priority Watershed Project were nutrient, residue, and barnyard-runoff management, streambank shaping, and manure storage. Some land use characteristics observed during 2015 monitoring that can have a negative impact on 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. 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.

Management Recommendations

- DNR should work with Waupaca County Land and Water Conservation Department (LWCD) and Natural Resources Conservation Services (NRCS) to implement BMPs to reduce non-point source sediment and nutrients reaching surface waters from streambank and cropland erosion.
- Little and Thiel Creeks should be added to the state's 2018 303(d) list of impaired waters due to the phosphorus levels. The department should increase the water quality monitoring in these sub-watersheds to determine which areas within the sub-watershed need BMPs to reduce phosphorus delivery to the streams.
- Monitoring phosphorus and nitrate concentrations in Lower Little Wolf streams should continue.
- Monitoring of temperature, phosphorus, and sediment concentrations above and below Big Falls and Manawa should continue to assess the impacts from millponds on water quality of the River.

Ecological, Aquatic Resources

Outstanding and Exceptional Resource Waters

Wisconsin has designated many of the state's highest quality waters as Outstanding Resource Waters (ORWs) or Exceptional Resource Waters (ERWs). Waters designated as ORW or ERW are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. ORW and ERW status identifies waters that the State of Wisconsin has determined warrant additional protection from the effects of pollution.

Table 1: List of outstanding and exceptional resource waters in Little Wolf River watershed (WR06).

Waterbody Name	WBIC	ORW/ERW	Start Mile	End Mile
Blake Creek	280900	ERW	10.06	12.86
Little Wolf River	272400	ERW	0	14.02
Blake Creek-N. Fork	281500	ERW	0	4.98
Blake Creek - S. Fork	282100	ERW	1	6.34
Blake Creek-S. Fork	282100	ERW	0	1
Spaulding Creek	284900	ORW	0	9.12
Whitcomb Creek	283400	ORW	0	15.82

Trout Waters

DNR uses three categories to classify the different types of trout streams throughout Wisconsin. These are evident in Wisconsin Trout Stream Maps, which provides a comprehensive list of trout streams and a set of trout stream maps covering the majority of the state. Efforts have been made to list all trout streams in the State of Wisconsin, but it is recognized that this listing is not exhaustive. High quality trout waters (Class I) that have sufficient natural reproduction to sustain populations of wild trout, at or near carry capacity. Consequently, streams in this category require no stocking of hatchery trout. These streams or stream sections are often small and may contain small or slow-growing trout, especially in the headwaters. Class II streams may have some natural reproduction, but not enough to utilize available food and space. Class III are marginal trout habitat with no natural reproduction occurring. They require annual stocking of trout to provide trout fishing. Generally, there is no carryover of trout from one year to the next.

Table 2: List of trout waters in Little Wolf River watershed (WR06).

Waterbody Name	WBIC	Start Mile	End Mile	Trout Class
Blake Creek	280900	10.06	12.86	CLASS II
Whitcomb Creek	283400	0	15.82	CLASS I
Blake Creek-S. Fork	282100	0	1	CLASS II
Spaulding Creek	284900	0	9.12	CLASS I
Blake Creek-N. Fork	281500	0	4.98	CLASS II
Blake Creek - S. Fork	282100	1	6.34	CLASS I

Impaired Waters

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that do not meet water quality standards. The list, also known as the Impaired Waters List, is updated to reflect waters that are newly added or removed based on new information. Impaired waters in this watershed are impaired for historical discharges, mine tailings, and runoff issues (Table 3). School Section Lake is impaired with the impairment of excess algal growth from the pollutant total phosphorus and is currently under total maximum daily (TMDL) development (Table 3).

Table 3: List of impaired waterbodies in the Little Wolf River watershed (WR06).

Local Name	WBIC	Acres	Pollutant	Impairment	Sources	303 Status
School Section Lake	283600	39	Total Phosphorus	Excess Algal Growth	Non-Point Source (Rural or Urban)	TMDL Development

Endangered, Threatened, and Species of Special Concern

Listed endangered (END), threatened (THR), and species of special concern (SC) include Freshwater Mussels Snuffbox (END), Slippershell (THR), and Pistolgrip (THR), Blanding's Turtle and Wood Turtle (SC), Lake Sturgeon (SC) and River redhorse (THR) in Waupaca County. Additionally, Pygmy Snaketail Dragonfly (SC) has been documented in the Little Wolf River.

Monitoring Project Discussion

Purpose of Project

This project evaluated water quality improvements made in the Lower Little Wolf River Watershed from BMPs 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, Equipment and Quality Assurance

During the growing season of 2015, Total Phosphorus (TP) samples were collected at 12 locations once per month from May through October (Table 4, 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 4. Thirdly, Dissolved Nitrates + Nitrites as Nitrogen ($\text{NO}_3 + \text{NO}_2$ as N) samples were collected in June and August 2015 at 12 locations in the Lower Little Wolf River Watershed (Table 4). Finally, Total Suspended Solids (TSS) samples were collected in May through October 2015 at 10 of the 12 locations in Table 4. All samples were collected using the standard DNR grab sampling method for a total of 159 samples (WDNR 2014). Neither baseflow nor storm or

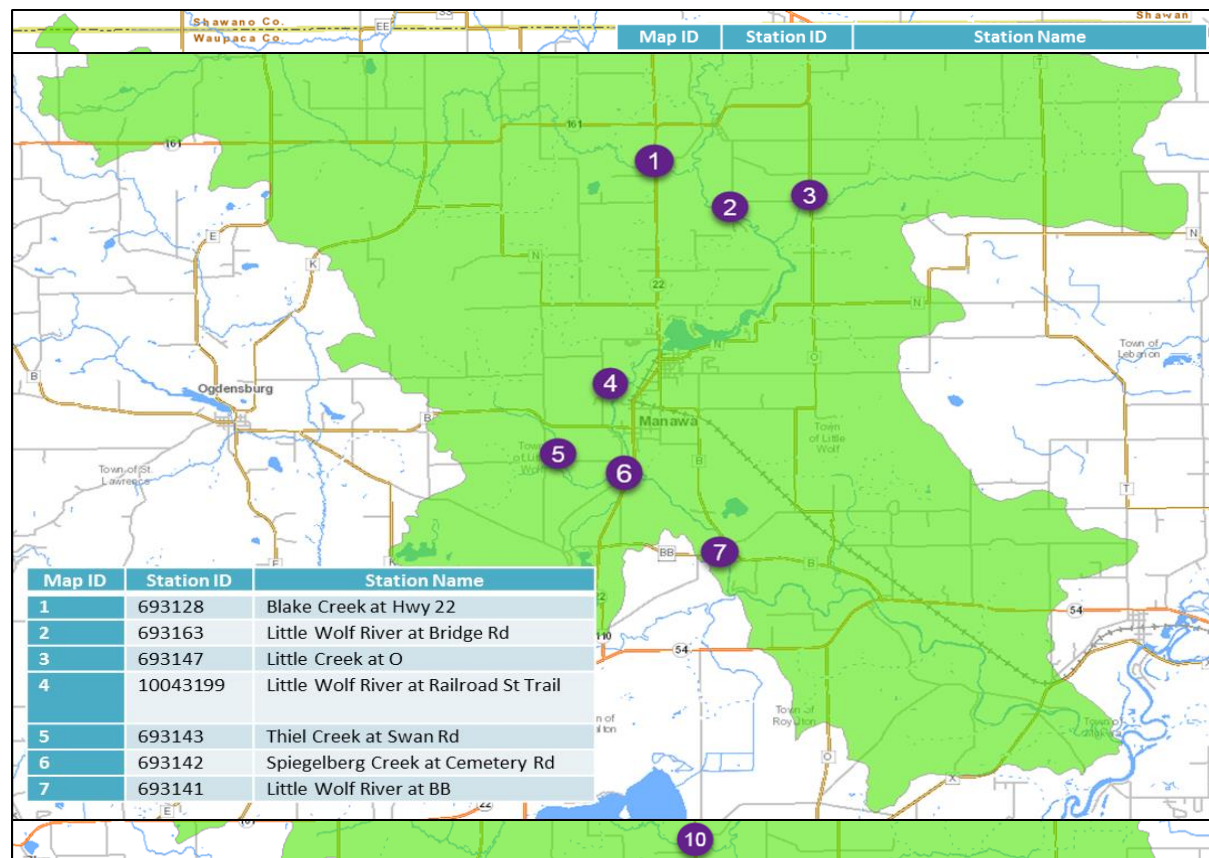
snowmelt event sampling were targeted during this project, following the protocol of Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2014). However, the June sampling was conducted following a rain event based upon the National Oceanic and Atmospheric Administration (NOAA) historical precipitation data (NOAA 2016). Additionally, the August and October samples were collected during baseflow conditions. All nutrient samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the DNR Surface Water Integrated Monitoring System (SWIMS).

Table 4: Inorganic Chemistry Monitoring Sites Lower Little Wolf River Watershed May through October 2015.

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



Little Wolf River at County BB Facing US 9, September 2015. Photo by Dave Bolha, Wisconsin DNR.

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 (11) creek and river locations were sampled for aquatic macroinvertebrates in October 2015 (Map 1-2, Table 5). Blake Creek and its South Fork were sampled in May 2016 for macroinvertebrates to fill out the dataset (Map 1, Table 5). All sites were sampled using the DNR *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 UW-Stevens Point Aquatic Entomology Laboratory (AEL) for lowest possible taxonomic identification. Staff at the AEL entered the data into the SWIMS database in 2016.

Table 5: Aquatic Macroinvertebrate Monitoring Locations Lower Little Wolf River Watershed in 2015, 2016.

SWIMS Station ID	Site Name	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

Between July and September 2015, wadable fish surveys were conducted at 13 sites (Map 1-2, Table 6). Wadable fish surveys were conducted at 10 of the 11 sites listed in Table 5. 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 DNR *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 Fisheries and Habitat Management Database (FHMD) by DNR Water Resources staff.

Table 6: Wadable Fish Survey Locations Sampled in the Lower Little Wolf River Watershed between July and September 2015.

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

SWIMS Station ID	Site Name	Surface Water WBIC
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

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 7, 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 DNR Water Resources staff.

Table 7: Temperature Monitoring Locations Lower Little Wolf River Watershed May through October 2015.

SWIMS ID	Site Name	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
SWIMS ID	Site Name	WBIC
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

Quantitative habitat surveys were conducted at 10 locations in the Lower Little Wolf River Watershed in October 2015 (Table 8, Map 1-2). In May 2016, a quantitative habitat survey was conducted in Little Creek at County O (Table 8, Map 2). All sites were surveyed following the DNR *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. DNR Water Resources staff entered the quantitative habitat data into the FHMD.

Table 8: Quantitative Habitat Survey Locations in the Lower Little Wolf River Watershed Conducted in October 2015 and May 2016.

SWIMS ID	Site Name	WBIC
693151	Little Wolf River at Ct CTH h 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

Project 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 10, 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 9, 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 9-10, Chart 1-2). Eight of the 12 locations had average TP concentrations less than the WQC (Table 9-10, 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 9-10, Chart 1-2).

Table 9: Total Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem from Upstream to Downstream in 2015.

Site Name				
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

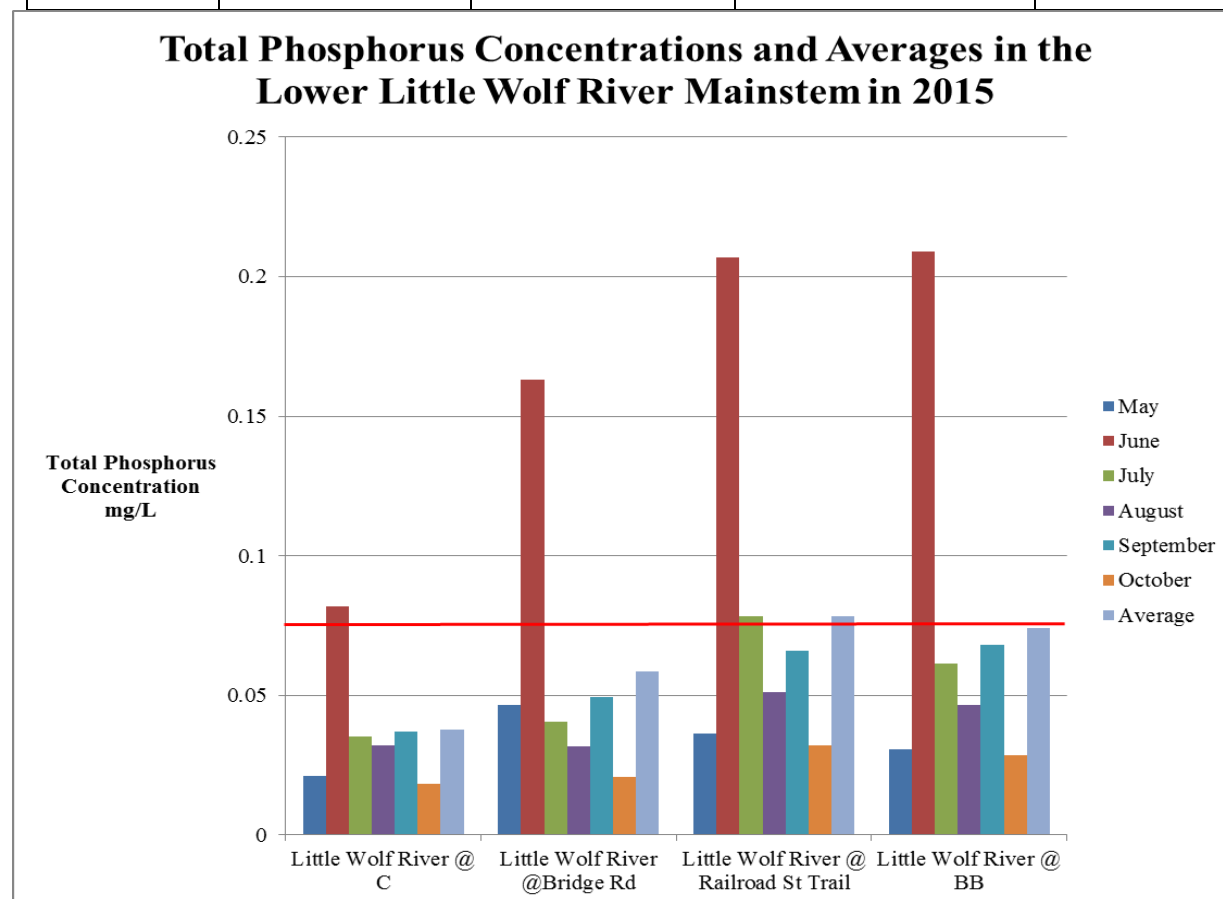


Chart 1: Total Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem from Upstream to Downstream in 2015. Red line indicates water quality standard at 0.075 mg/L.

Table 10: 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).

Site Name								
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

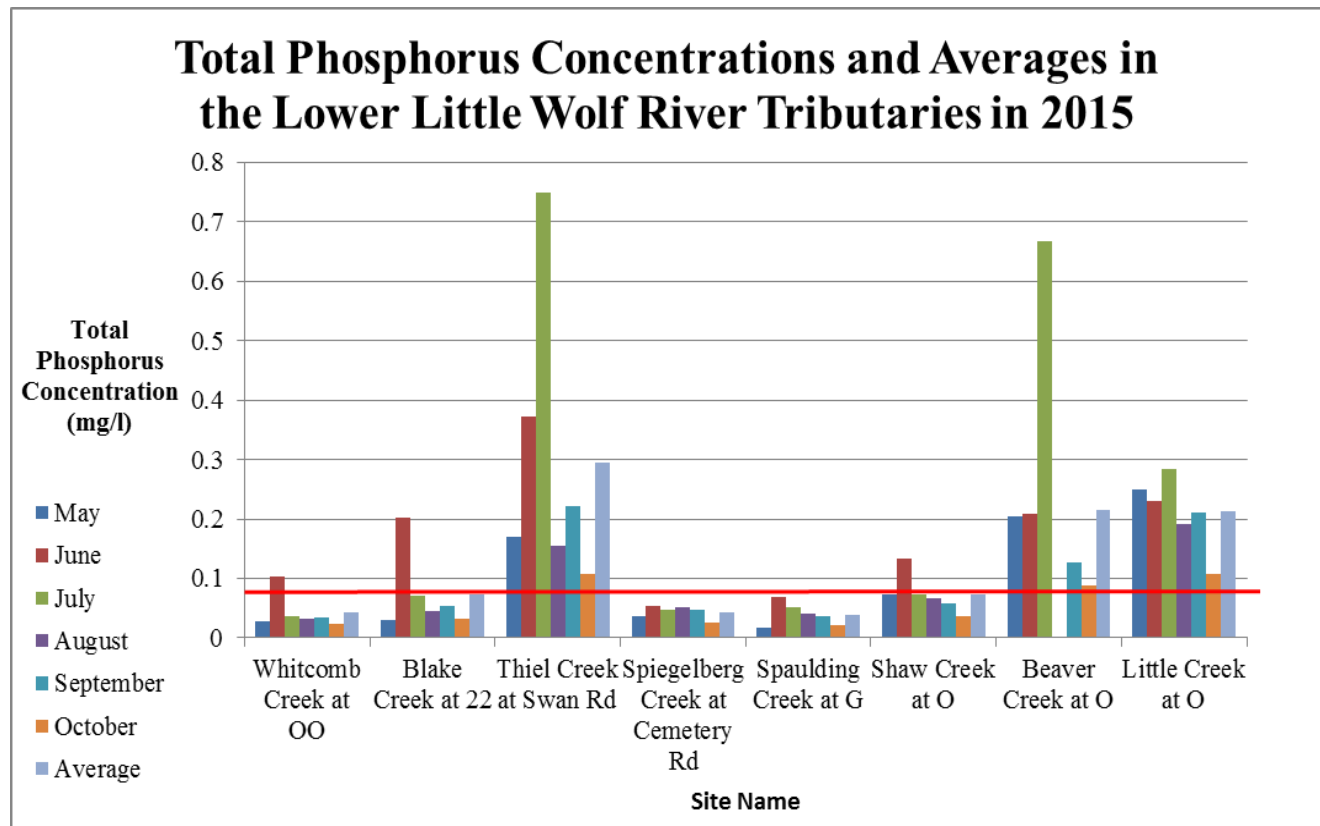


Chart 2: Total Phosphorus Concentrations and Averages of Samples Collected in the Tributaries of the Lower Little Wolf River Watershed in 2015. Red line indicates water quality standard at 0.075 mg/L. (Beaver Creek was dry in August 2015).

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 11, 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

12, Chart 4).

Table 11: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem in 2015.

<u>Site Name</u>				
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

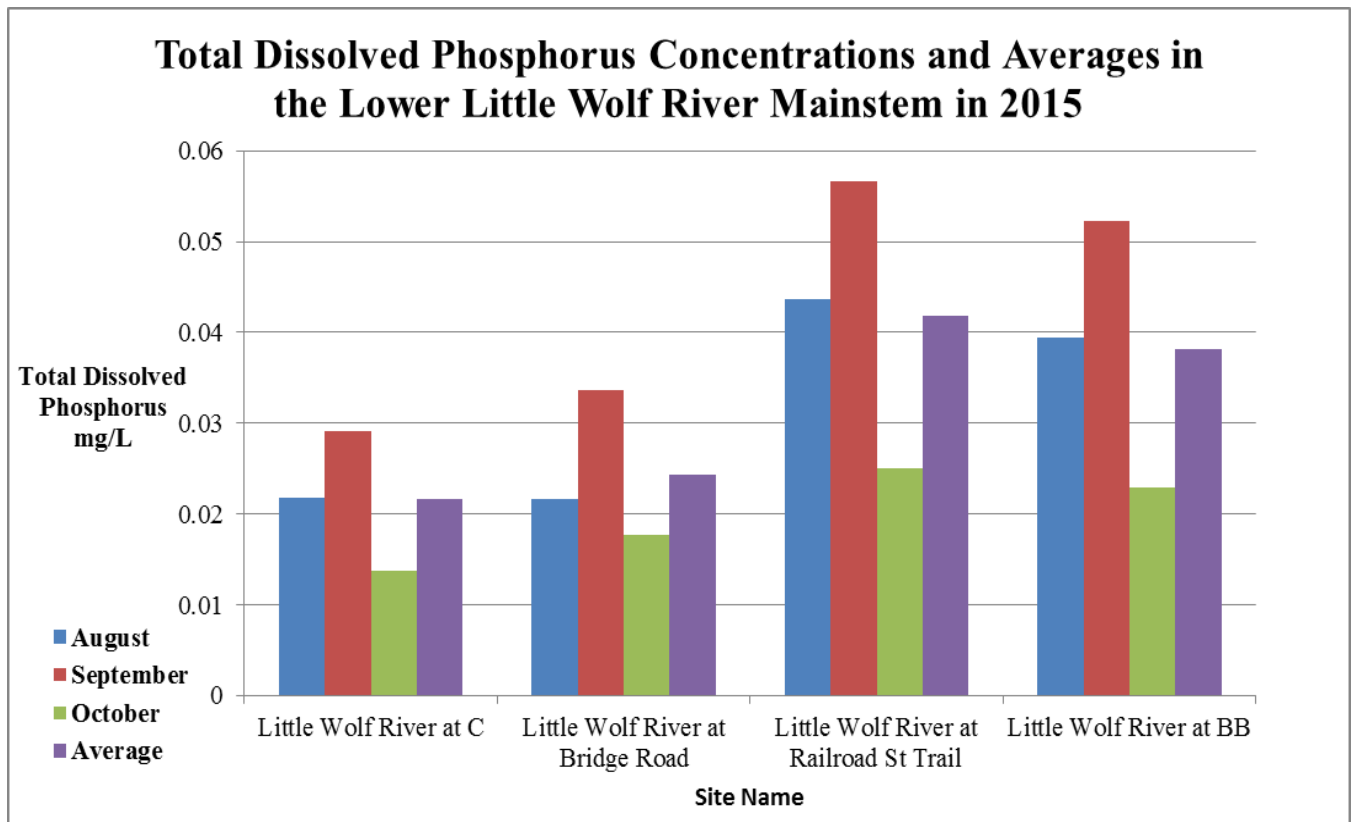


Chart 3: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in the Lower Little Wolf River Mainstem in 2015.

Table 12: 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).

Site Name								
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

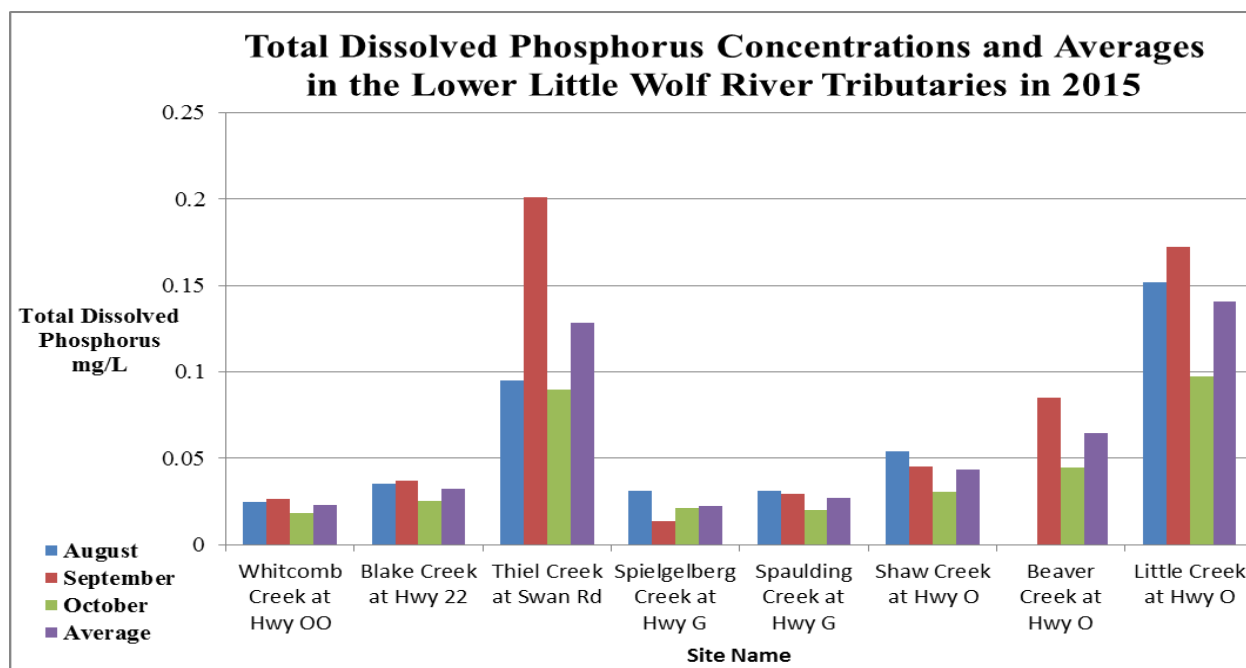


Chart 4: Total Dissolved Phosphorus Concentrations and Averages of Samples Collected in Tributaries of the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015).

At the 12 locations in Table 1, $\text{NO}_3 + \text{NO}_2$ as N analysis was conducted on samples collected in June and August 2015 (Table 13, Chart 5). The 2 samples at County Hwy C had the lowest and highest $\text{NO}_3 + \text{NO}_2$ 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 13). The 2015 $\text{NO}_3 + \text{NO}_2$ as N concentrations of the Tributaries of the Lower Little Wolf River Watershed ranged from 0.052 mg/L in June in Spaulding Creek to 2.01 mg/L in August in Little Creek (Table 13, Chart 5).

Table 13: 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).

Sample Location	Dissolved Nitrates + Nitrites (mg/L)	
	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

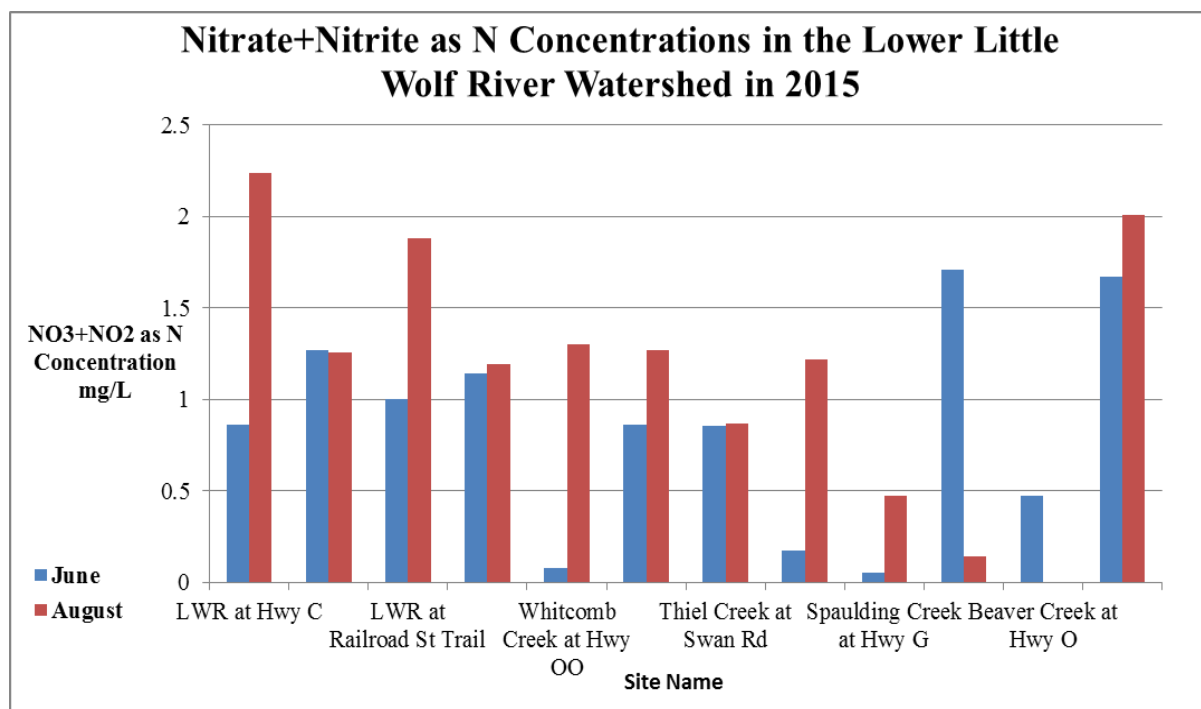


Chart 5: Dissolved Nitrates + Nitrites as Nitrogen Concentrations (mg/L) of Samples Collected in the Lower Little Wolf River Watershed in 2015. (Beaver Creek was dry in August 2015).

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 14-15, 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 14, 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 15, Chart 6).

Table 14: Total Suspended Solids Concentrations and Station Average (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).

Site Name		
Month of Sampling Event	Little Wolf River at Hwy C (TSS mg/L)	Little Wolf River at Hwy BB (TSS mg/L)
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 15: Total Suspended Solids Concentrations and Station Average 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).

Site Name								
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

Aquatic macroinvertebrate communities were sampled at 11 locations in October 2015 (Table 5). In addition, macroinvertebrate samples were collected from Blake Creek at County K and its South Fork at County E in May 2016 (Table 5).

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 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 16, 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 16, Chart 7). 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.

Table 16: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Lower Little Wolf River Watershed in 2015 and 2016.

SWIMS 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



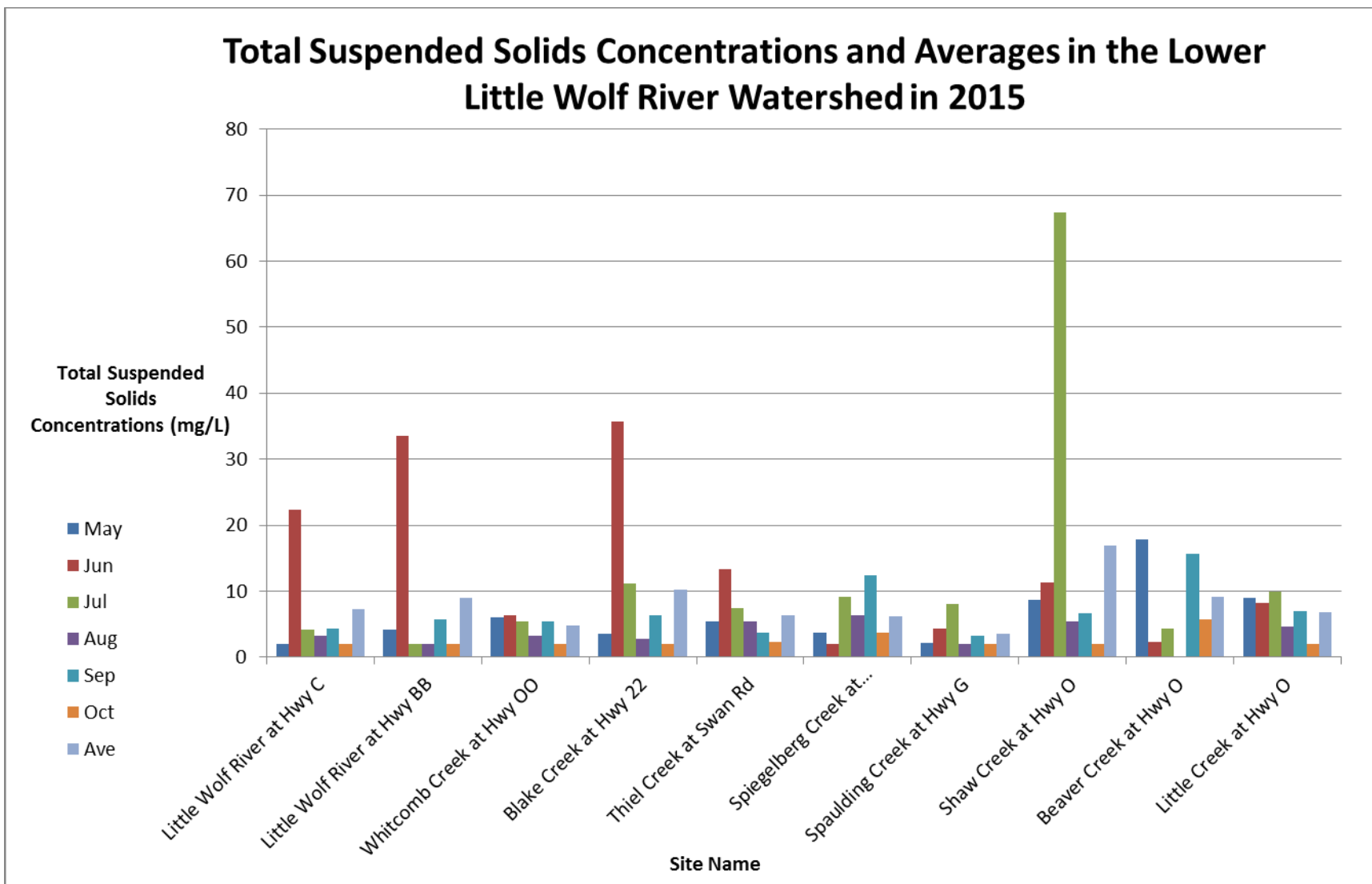


Chart 6: Total Suspended Solids Concentrations and Station Average (mg/L) of Samples Collected in the Lower Little Wolf River Watershed in 2015. (Limit of Detection 2.0 mg/L Used for Average Concentration Calculation)

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

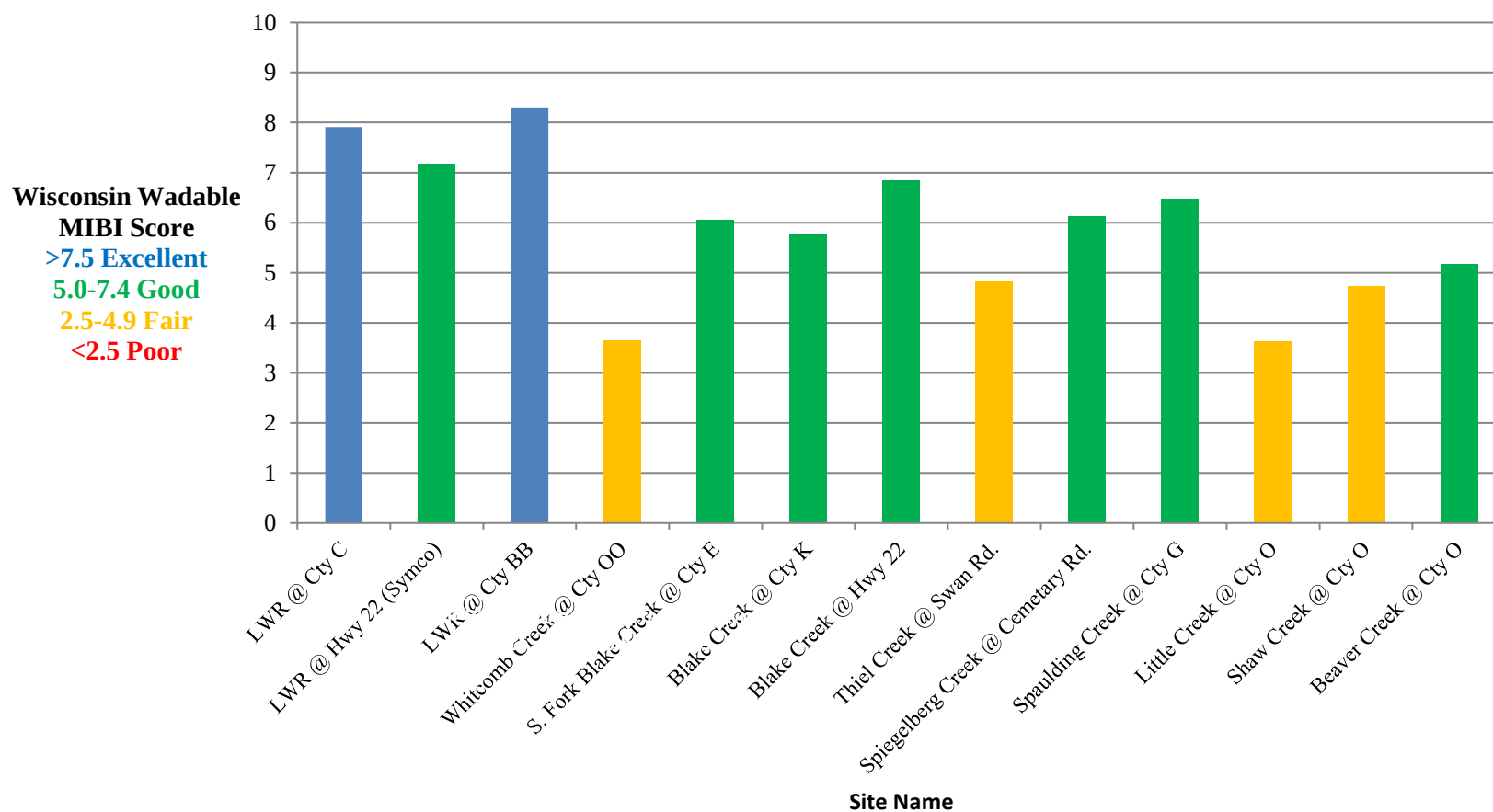


Chart 7: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Lower Little Wolf River Watershed in 2015 and 2016.

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 (FBI) was calculated to indicate the water quality of each creek or river (Table 17, Chart 8). The FBI scores ranged from 20 in Shaw, Thiel, and Little Creeks to 100 in the Little Wolf River at County Hwy C (Table 17, 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 FBI scores ranging from 90 to 100. Three of the remaining 10 tributary sites demonstrated a Condition Category of Excellent (Table 17, 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 17, Chart 8).

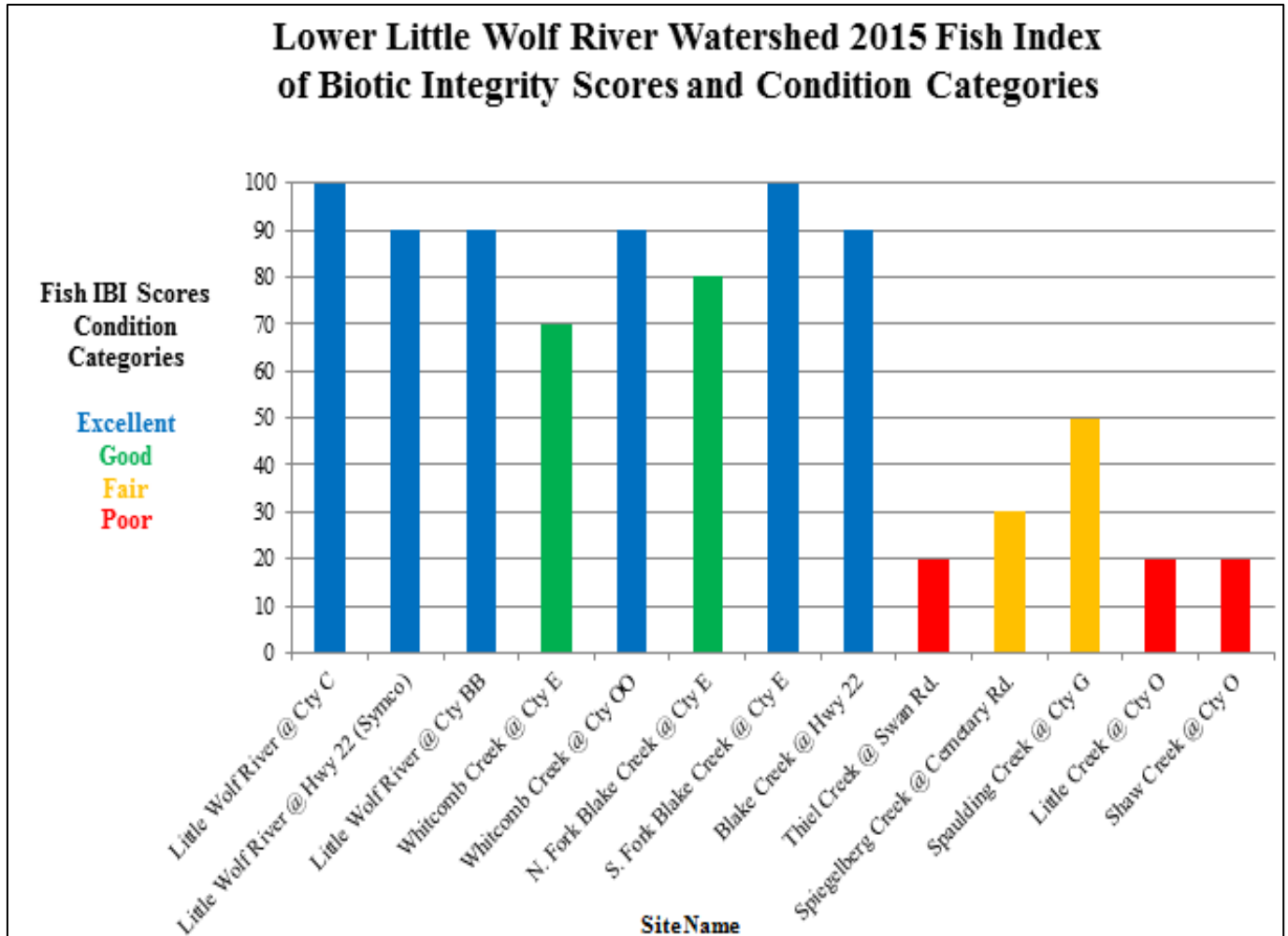
Each fish community surveyed was used to verify or update the modeled Natural Community for that stream segment. The modeled Natural Community for the Little Wolf River was verified as Cool-Warm Mainstem from County Hwy C to County Hwy BB. Each of the 10 tributary streams' Natural Community was verified 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 FBI was used to determine the water quality of that stream segment. The results of the calculated FBI calculations displayed in Table 17 and Chart 8 are based upon the verified or changed Natural Community.

Table 17: Fish Survey Results in the Lower Little Wolf River Watershed Conducted in July through September 2015.

SWIMS ID	Site Name	Fish FBI 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

Water temperature data was collected from May through October or November 2015 at 14 locations in the Little Wolf River Watershed (Table 7, 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 18, 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 18, Chart 9).

Chart 8: Fish Table 18: 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.

Site Name	Average June Temp.	Average July Temp.	Average August Temp.	Average September Temp.	Average Maximum Daily Temp.
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
Spiegelberg 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

Survey Results in the Lower Little Wolf River Watershed Conducted in July through September 2015.

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

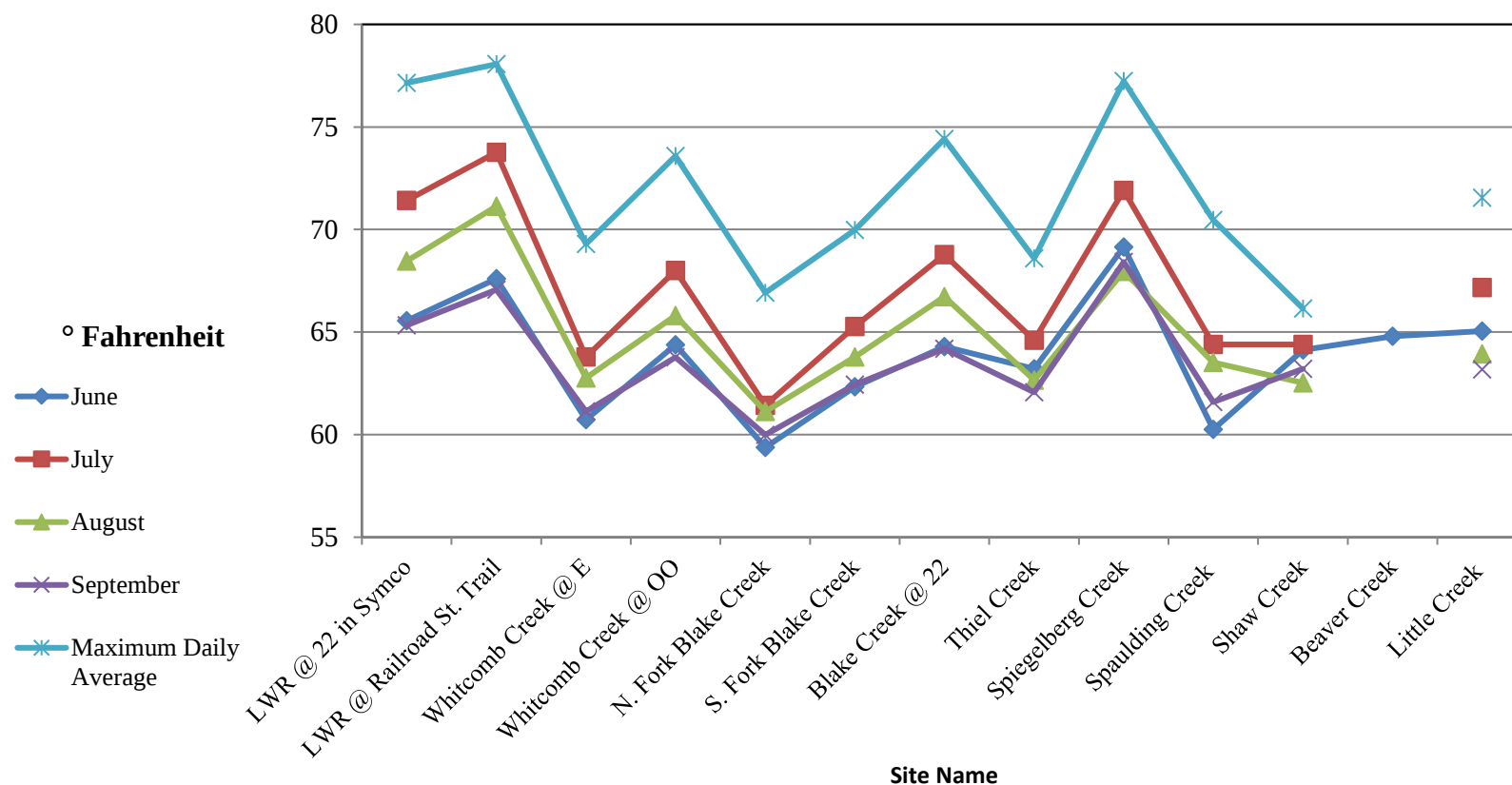


Chart 9: Monthly Average and Maximum Daily Average Temperatures in the Lower Little Wolf River Watershed in 2015. Beaver Creek water levels became too low in July.

In October 2015, quantitative habitat surveys were conducted at 10 locations in the Lower Little Wolf River Watershed (Table 19, Map1-2). A quantitative habitat survey was conducted at one location (Little Creek) in May 2016 (Table 19, 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 19, 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 19, 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 19, Chart 10). Whitcomb Creek, Spaulding, Little and Shaw Creeks had a Fair Condition Category, with scores ranging from 25 to 48 (Table 19, Chart 10). None of the habitat surveys demonstrated Poor habitat.

Table 19: Quantitative Habitat Survey Scores and Condition Categories for the Lower Little Wolf River Watershed in 2015 and 2016.

SWIMS 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 @ Cemetery Rd.	25	Fair
693130	Spaulding Creek @ Cty G	55	Good
693131	Shaw Creek @ Cty O	40	Fair
693145	Little Creek @ Cty O	48	Fair

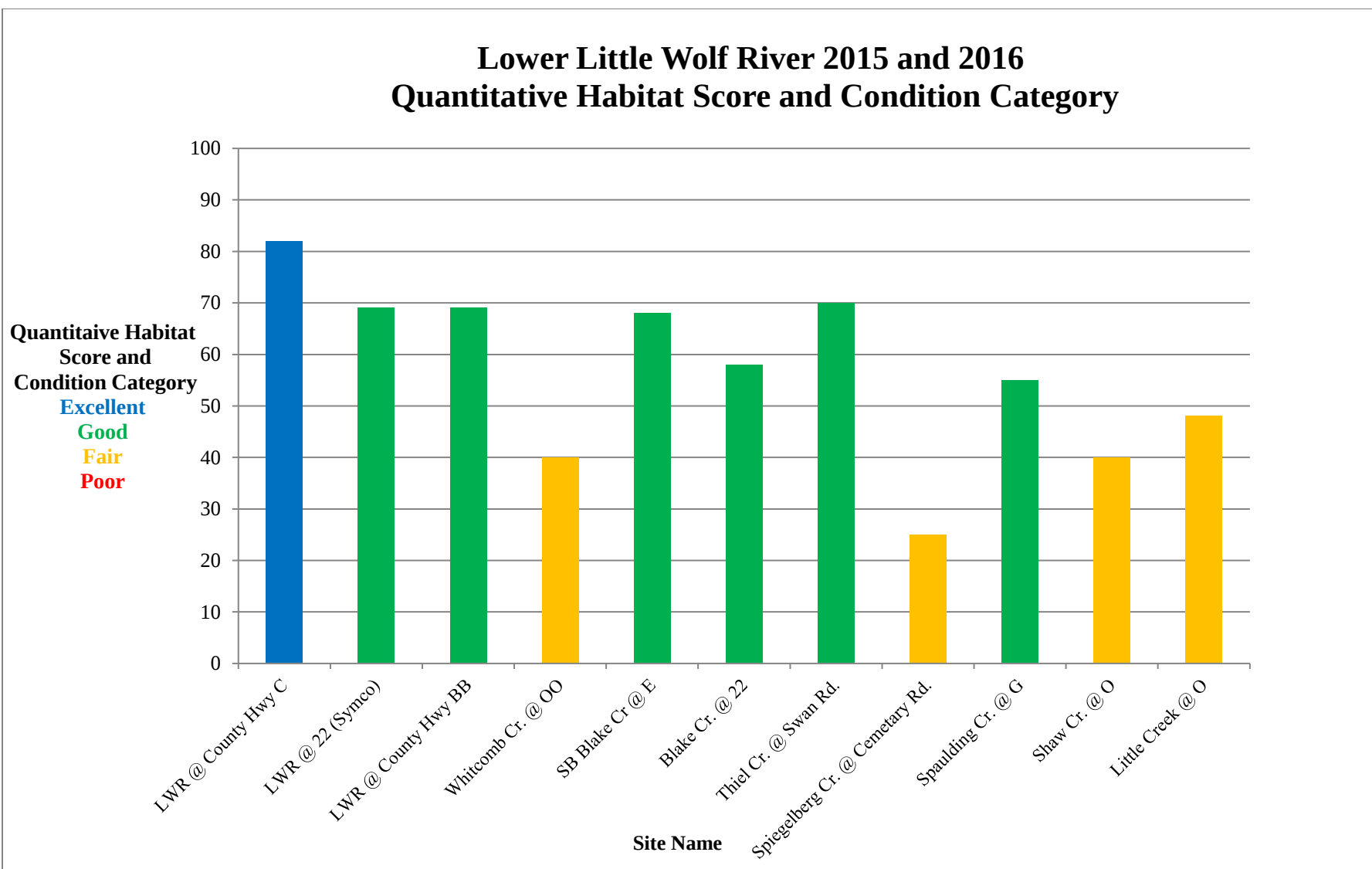


Chart 10: Quantitative Habitat Survey Scores and Condition Categories for the Lower Little Wolf River Watershed in 2015 and 2016.

Discussion

The purpose of this project was to evaluate water quality improvements made in the Little Wolf River Watershed from BMPs 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 ranges from 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).

Shaw Creek had the lowest baseflow NO_3+NO_2 as N concentration of any of the Lower Little Wolf River tributaries in 2015.

Between September 1995 and September 1996, biological, physical and chemistry monitoring was conducted by the DNR 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 DNR staff Bradley Johnson (WDNR 1997). In addition, water quality monitoring was conducted in 2001 by staff at the University of Wisconsin – 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 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 20-23, 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 20-23, 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 20, Chart 11).

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.

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 $\text{NO}_3 + \text{NO}_2$ 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 20, Chart 11). The lower $\text{NO}_3 + \text{NO}_2$ as N in baseflow in the Mainstem suggests that the groundwater influx to the Mainstem and its tributaries has overall decreased in $\text{NO}_3 + \text{NO}_2$ as N concentration following the Priority Watershed Project.

Table 20: Pre-existing, Mid, and Post Priority Watershed Project $\text{NO}_2 + \text{NO}_3$ as N Concentrations during Baseflow Conditions in the Lower Little Wolf River Watershed.

Site Name	1995-1996 (Pre) Baseflow $\text{NO}_2 + \text{NO}_3$ (N)	2001 (Mid) Baseflow $\text{NO}_2 + \text{NO}_3$ (N)	August (Post) Baseflow 2015 $\text{NO}_2 + \text{NO}_3$ (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		0.2	1.2
Thiel Creek at Swan Rd		0.04	0.9
Whitcomb Creek at OO		1	1.3

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

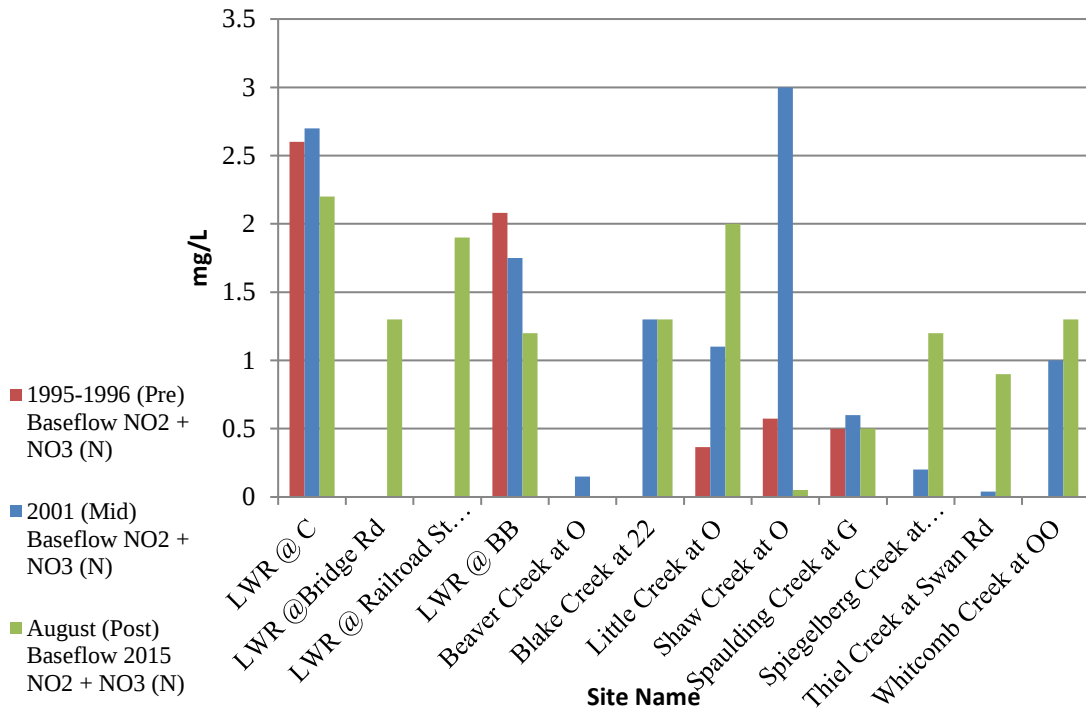


Chart 11: Pre-existing, Mid, and Post Priority Watershed Project NO₂ + NO₃ as N Concentrations during Baseflow Conditions in the Lower Little Wolf River Watershed.

The runoff event monitoring $\text{NO}_3 + \text{NO}_2$ 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 $\text{NO}_3 + \text{NO}_2$ 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 $\text{NO}_3 + \text{NO}_2$ 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 21, Chart 12). Beaver, Blake, Spaulding, Spiegelberg, Thiel and Whitcomb Creeks runoff concentrations either remained relatively similar or showed some slight decrease in $\text{NO}_3 + \text{NO}_2$ as N concentration. Runoff events in Little and Shaw Creeks increased in $\text{NO}_3 + \text{NO}_2$ as N concentration from 2001 to 2015.

Table 21: Pre-existing, Mid, and Post Priority Watershed Project $\text{NO}_2 + \text{NO}_3$ as N Concentrations during Runoff Event Conditions in the Lower Little Wolf River Watershed.

Site Name	Event 1995-1996 $\text{NO}_2 + \text{NO}_3$ (N)	Event 2001 $\text{NO}_2 + \text{NO}_3$ (N)	Event 2015 $\text{NO}_2 + \text{NO}_3$ (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

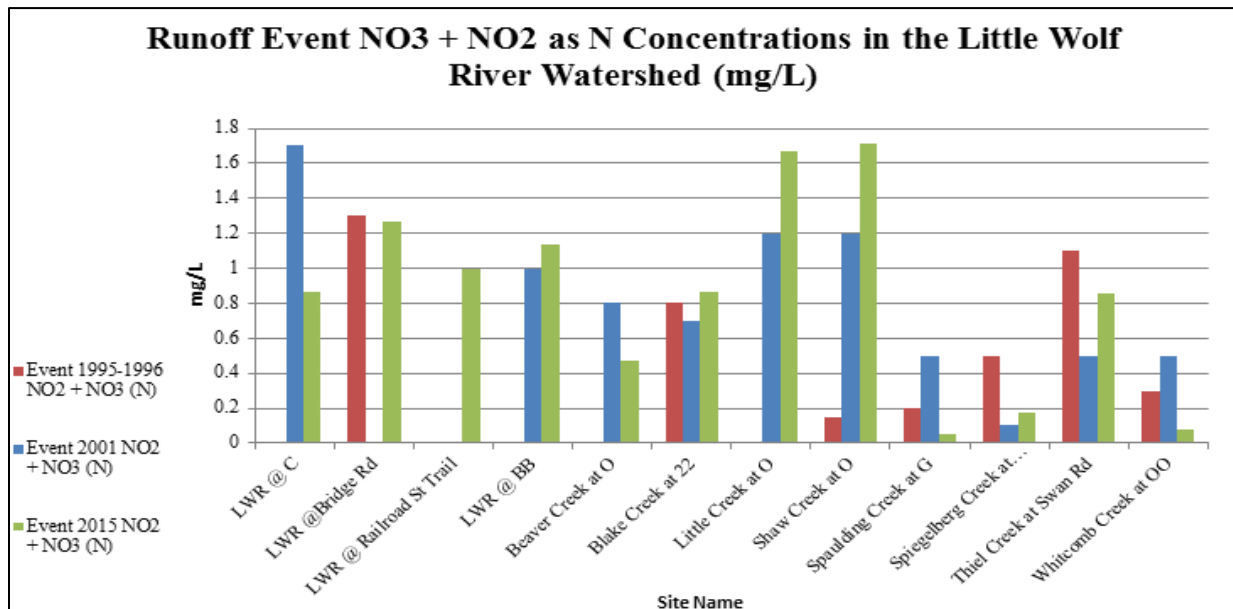


Chart 12: Pre-existing, Mid, and Post Priority Watershed Project $\text{NO}_2 + \text{NO}_3$ as N Concentrations during Runoff Event Conditions in the Lower Little Wolf River Watershed.

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 22, 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 22, 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.

The 2015 baseflow TP concentrations were lower in Beaver, Little, and Thiel Creeks than the 2001 baseflow concentrations.

In contrast to the runoff event NO_3+NO_2 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 stream bank 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 22, 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.

Table 22: Pre-existing, Mid, and Post Priority Watershed Project Total Phosphorus Concentrations during Baseflow and Runoff Event Conditions in the Lower Little Wolf River Watershed.

Site Name	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

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

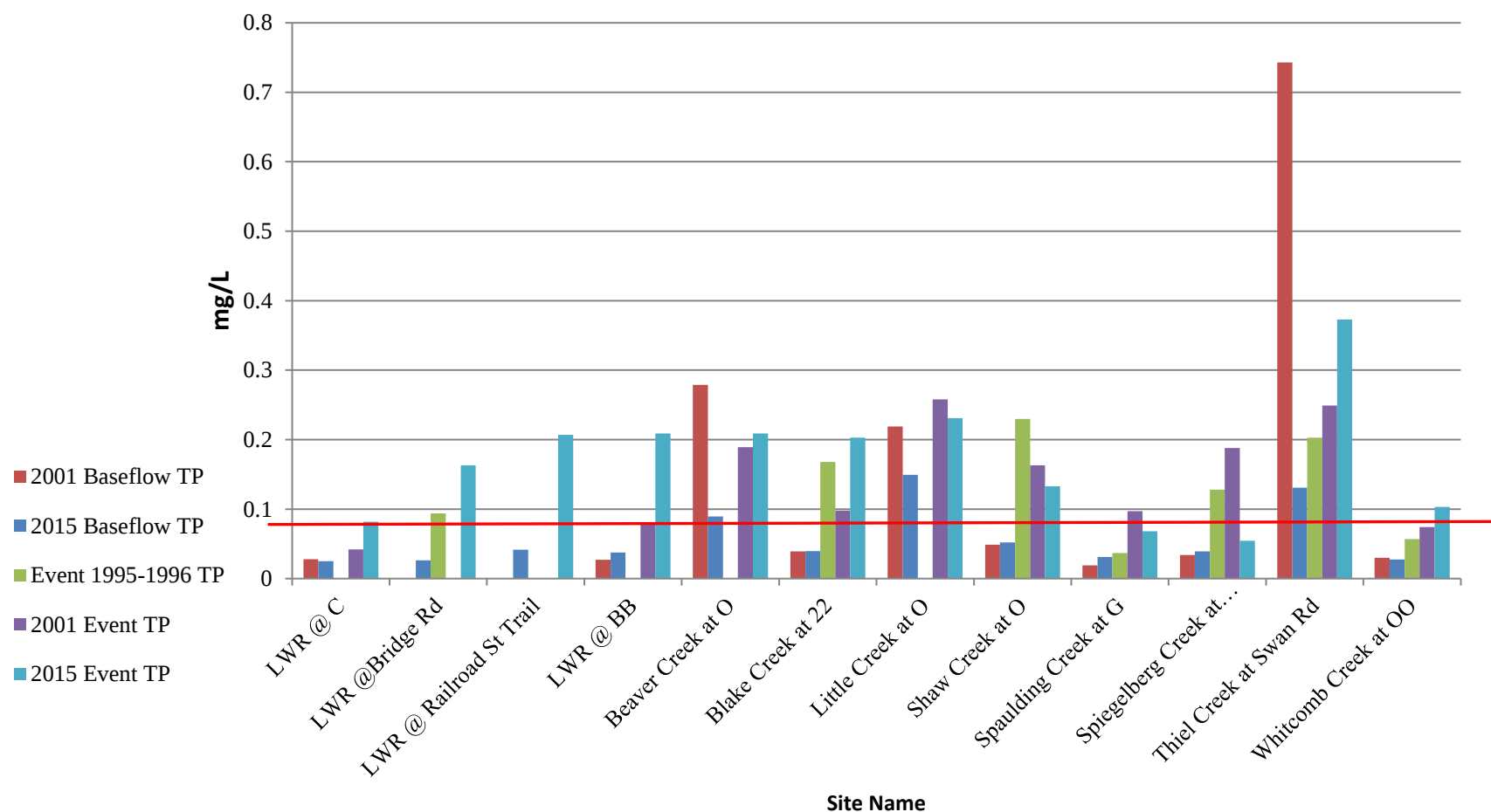


Chart 13: Pre-existing, Mid, and Post Priority Watershed Project Baseflow and Runoff Event Total Phosphorus Concentrations in the Little Wolf Watershed. Red line indicates NR 102 Water Quality Criteria for Total Phosphorus (0.075mg/L) for the Lower Little Wolf River and its tributaries.

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.

Little and Thiel Creeks will be recommended for the 2018 CWA 303d IWL due to the pollutant phosphorus.

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 23). 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 $\geq 0.15\text{mg/L}$) the water quality criterion for TP (Table 23, Chart 14). Little and Thiel Creeks will be recommended for the 2018 CWA 303d IWL due to the pollutant phosphorus.

Table 23: Total Phosphorus Lower 90% Confidence Limits in the Lower Little Wolf River Watershed in 2015.

Site Name	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

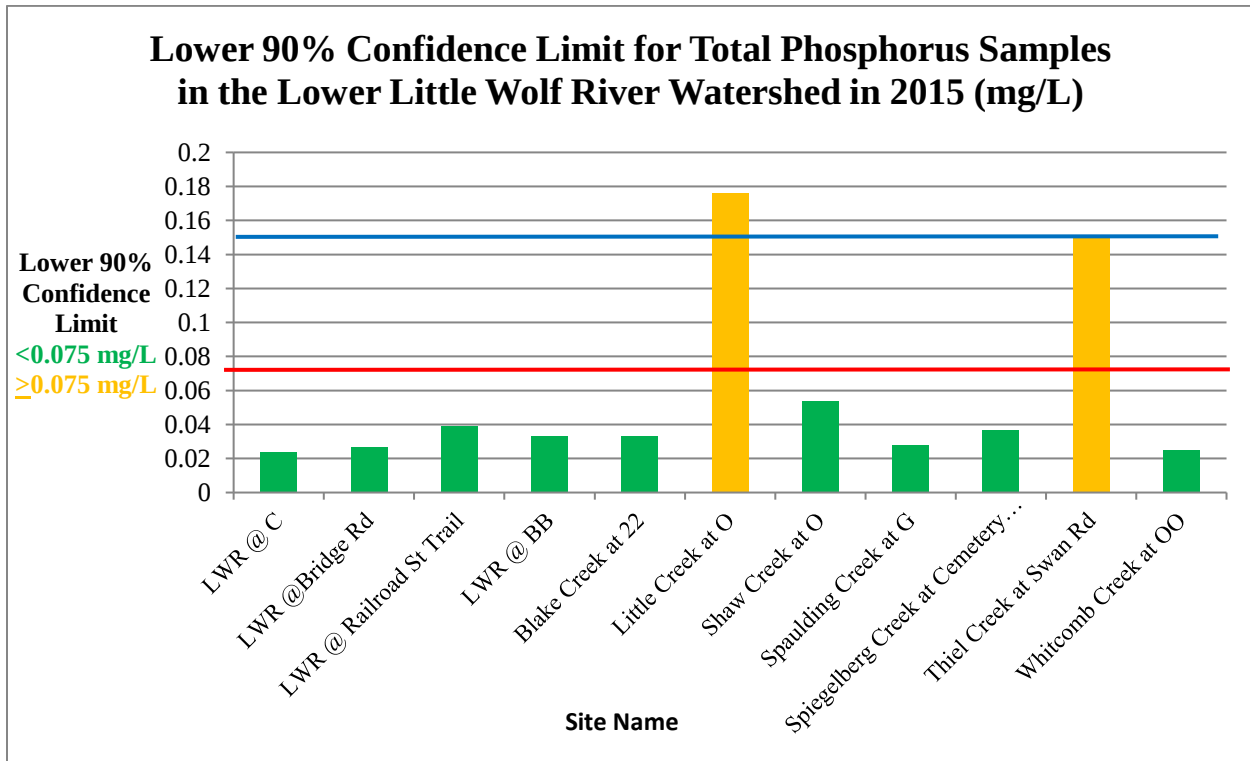


Chart 14: Total Phosphorus Lower 90% Confidence Limits in the Lower Little Wolf River Watershed in 2015. Red line indicates the NR 102 WQC for Total Phosphorus (0.075mg/L) for the Lower Little Wolf River and its Tributaries. Blue line indicates an Overwhelming Exceedance of NR 102 WQC for Total Phosphorus.

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 24, 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 24, 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 24, Chart 15).

Beaver, Little, Spiegelberg and Whitcomb Creeks decreased in runoff TSS concentrations (Table 24, Chart 15).

Table 24: 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.

Site Name	Event 1995-1996 TSS (mg/L)	Event 2001 TSS (mg/L)	Event 2015 TSS (mg/L)
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		11.4	6.4

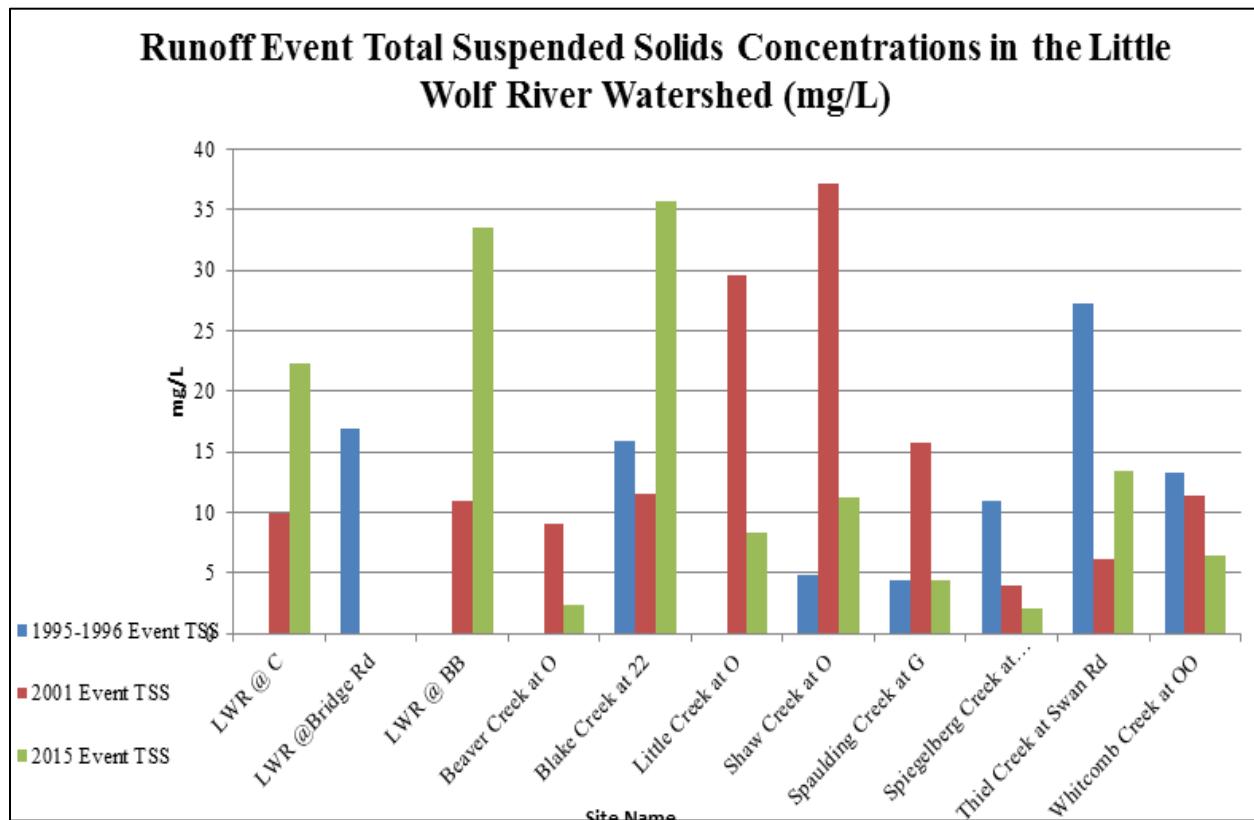


Chart 15: Pre-existing, Mid, and Post Priority Watershed Project Runoff Event Total Suspended Solids Concentrations in the Lower Little Wolf Watershed.

In October 1995, aquatic macroinvertebrate surveys were conducted at 8 locations in the Lower Little Wolf River Watershed (WDNR 1997). The DNR 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 25, Chart 16). Four of the 8 2015 MIBI scores were similar (± 1) when compared to the 1995 MIBI scores (Table 25, Chart 16). Thiel and Spiegelberg Creeks increased in MIBI score from 1995 to 2015 (Table 25, 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.

Table 25: 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.

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

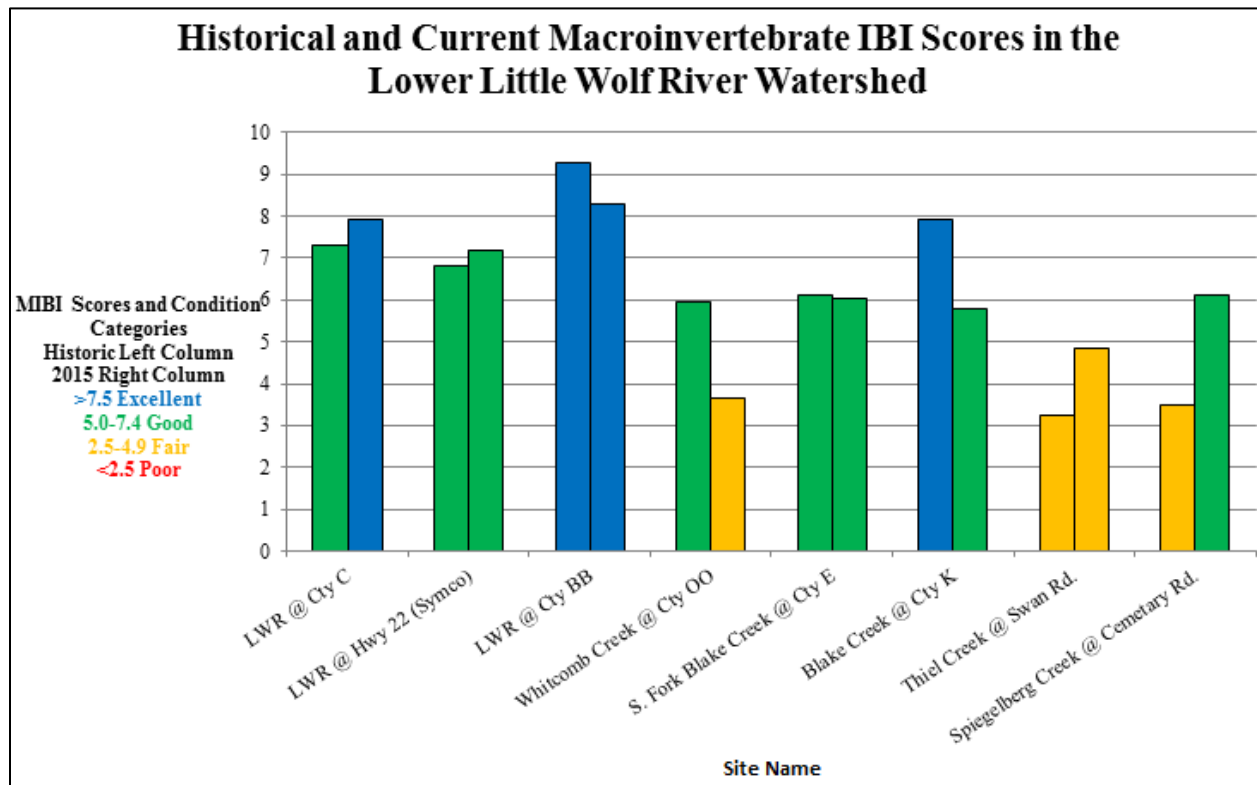


Chart 16: Comparison of 1995 Wisconsin MIBI (Left Column) Scores to 2015 Wisconsin MIBI (Right Column) Scores at 8 Locations in the Lower Little Wolf River Watershed.

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 26, Chart 17). Nine of the 11 2015 FIBI scores were similar or increased when compared to the 1996 FIBI scores (Table 26, Chart 17). Thiel and Shaw Creek decreased in FIBI score and Condition Category from 1996 to 2015 (Table 26, Chart 17).

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.

Table 26: Historical and Current Fish Index of Biotic Integrity Scores and Condition Categories in the Lower Little Wolf River.

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

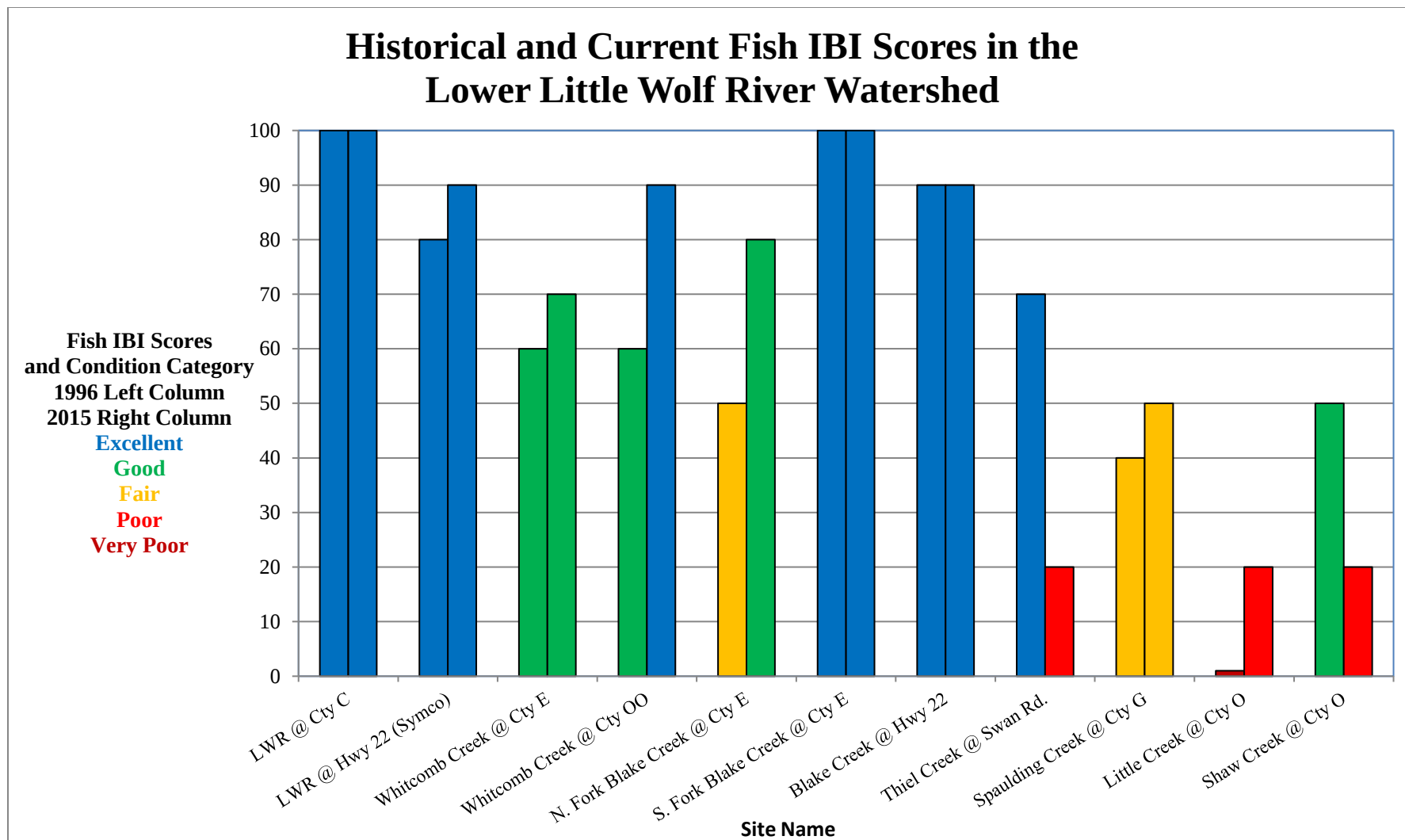


Chart 17: Historical and Current Fish Index of Biotic Integrity Scores and Condition Categories in the Lower Little Wolf River.

Management Actions

Management Priorities

- Improve the water quality of Little and Thiel Creeks by reducing the phosphorus and sediment loads from reaching the stream.
- Maintain the water quality of the Lower Little Wolf River and its habitat for fish and aquatic life.

Management Goals

- Reduce summer time phosphorus concentrations to below NR 102 water quality standard (0.075mg/L) in Thiel and Little Creeks.
- Identify target areas within Thiel and Little Creek watersheds in need of BMPs to reduce phosphorus and sediment.

Monitoring and Assessment Recommendations

- Little and Thiel Creeks should be added to the state's 2018 303(d) list of impaired waters due to the pollutant phosphorus. The department should increase the water quality monitoring in these sub-watersheds to determine which areas need BMPs to reduce phosphorus delivery to the streams.
- Monitoring of temperature, phosphorus, and sediment concentrations above and below Big Falls and Manawa should continue to assess the impacts from the millponds on the water quality of the River.
- Monitoring of phosphorus and nitrate concentrations in the streams of the Lower Little Wolf River should continue.

Management Recommendations for DNR and External Partners

- The department should work with Waupaca County LWCD and NRCS to implement BMPs to reduce non-point source sediment and nutrients reaching surface waters from stream bank and cropland erosion.
- DNR encourages local governments and nonprofit organizations to apply for runoff management grants and river grants to reduce phosphorus delivery in the larger watershed (WR06).



Little Wolf River at County BB Photo by Dave Bolha, Wisconsin DNR. September 9, 2015.

Appendix A: References

- NOAA (National Oceanic and Atmospheric Administration), 2015, Precipitation data, accessed on March 15th, 2016, at <http://water.weather.gov/precip/>.
- Turyk et al UWSP-CWSE (University of Wisconsin-Stevens Point Center for Watershed Science and Education). 2003. Water Quality Assessment of the Lower Little Wolf Watershed.
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- WDNR (Wisconsin Department of Natural Resources). 1997. Nonpoint Source Control Plan for the Lower Little Wolf River.
- WDNR (Wisconsin Department of Natural Resources). 2000. Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams.
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- WDNR (Wisconsin Department of Natural Resources). 2002. Guidelines for Evaluating Habitat of Wadable Streams.
- WDNR (Wisconsin Department of Natural Resources). 2010. Wisconsin Administrative Code ch. NR 102: Water Quality Standards for Wisconsin Surface Waters.
- WDNR (Wisconsin Department of Natural Resources). 2014. Total Phosphorus Sampling Methods: Water Action Volunteers Manual 2014.
- WDNR (Wisconsin Department of Natural Resources). 2014. Wisconsin Consolidated Assessment and Listing Methodology Guidance Document.

Appendix B: Waterbody Narratives

School Section Lake

WBIC: 283600

(Historical 1971) School Section Lake is a clear, hard water drained basin fed primarily by springs. A small outlet stream flows north into Whitcomb Creek. Four sub-basins lie within the main lake basin; depth of each basin is as follows; 20 feet, 30 feet, 35 feet and 38 feet. Marl is the predominant littoral bottom type. Management is for largemouth bass and panfish. The most common species present include largemouth bass, bluegill, black crappie, pumpkinseed, and perch. Northern pike are also present. The lake is noted for fine bass fishing. Nesting bluewing teal utilize the lake as do migrant puddle ducks and diving ducks. A significant population of muskrats is also found on the lake. Hunting is allowed. Developments include one public boat landing, two boat liveries, and three cottages.

School Section Lake, in the Lower Little Wolf River Watershed, is a 38.53-acre lake that falls in Waupaca County. School Section Lake was placed on the impaired waters list for total phosphorus in 2014. The 2016 assessments showed continued excess algal growth; chlorophyll sample data exceed 2016 WisCALM listing thresholds for the Recreation use, however, total phosphorus did not exceed REC thresholds. Total phosphorus and chlorophyll data were clearly below Fish and Aquatic Life listing thresholds. Based on the most updated information, no change in existing impaired waters listing is needed.

Spaulding Creek

WBIC: 284900

(Overview) All 10 miles of Spaulding Creek are trout waters. The Class I portion is listed in NR 102 as an Outstanding Resource Water. Some stream improvement projects have been completed. There are some problems with beaver activity in the area. Recent monitoring indicates Fair to Good water quality.

Gregerson Lake

WBIC: 186900

(Historical 1971) Gregerson Lake has drastic water level fluctuations which are a major problem encountered on this hard water seepage lake. In 1959 the lake was completely dry. Annual complete winterkill precludes the establishment of a desirable fishery however the lake does provide habitat for waterfowl and aquatic furbearers. Wildlife inhabitants include a significant population of muskrats and nesting mallards and during the spring and fall migrations. Development consists of one farm near the lake. Gregerson Lake is landlocked.

(Overview) Gregerson Lake, in the Lower Little Wolf River Watershed, is a 36.71-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Blue Mountain Lake

WBIC: 182400

(Historical) Muck and sand are the major littoral bottom materials of this landlocked lake containing soft, clear water. Bullheads are the only fish found in appreciable numbers. Severe winterkills occur almost every year thereby precluding past various attempts to initiate a good fishery have met with failure. In 1964 the lake was unsuccessfully treated with fish toxicants to remove the bullheads. Northern pike and perch stocked did not survive. Puddle ducks use the lake as a resting area during spring and fall migrations. This lake supports a significant population of muskrats. Hunting and trapping is allowed. Twelve cottages are present. An unimproved public access is located on the east side.

(Overview) Blue Mountain Lake, in the Lower Little Wolf River Watershed, is an 8.17-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Beaver Creek

WBIC: 283000

(Overview) Beaver Creek, in the Lower Little Wolf River Watershed, is a 5.38-mile river that falls in Waupaca County. Recent surveys indicate good water quality but high in phosphorus concentrations.

Shaw Creek

WBIC: 283100

(Overview) Shaw Creek, in the Lower Little Wolf River Watershed, is a 7.95-mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired. Recent surveys indicate fair to poor water quality.

Whitcomb Creek

WBIC: 283400

(Overview) The Class I trout portion of Whitcomb Creek is listed as an Outstanding Resource Water in NR 102. The water quality of this stream is threatened by nonpoint sources in the watershed. The department believes that this stream could be even better with the installation of best management practices. There are also problems with beaver activity in the area. Recent surveys indicate fair to excellent water quality in Whitcomb Creek.

Hatch Lake**WBIC: 282800**

(Historical 1971) Hatch Lake is a clear, hard water seepage fed lake drained by the South Fork Blake Brook. Sand and muck are the primary littoral bottom materials. The fishery is composed of northern pike, perch, largemouth bass, bluegill, and brown bullhead. Severe partial winterkills occur every two to three years limiting the management potential of Hatch Lake. This problem is further compounded by natural water level fluctuations. The lake supports a significant population of muskrats and a few nesting bluewing teal. Fairly large numbers of both diving and puddle ducks utilize the lake and adjoining wetlands during spring and fall migrations. Twenty-nine cottages and dwellings are located around the lake. Access is available from two public landings located on the east side of the lake. Hunting is allowed.

(Overview) Hatch Lake, in the Lower Little Wolf River Watershed, is a 113.35-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Roland Lake**WBIC: 197200**

(Historical 1971) Rolands Lake is a landlocked basin containing clear soft water low in productivity. The principle water source is seepage. Sand and muck are the major littoral bottom materials. The lake is managed for largemouth bass and panfish. Occasional partial winterkill occurs, however, winterkill generally does not cause problems. Both mallards and bluewing teal are known to nest here while migrant puddle ducks use the water as a resting and feeding area. Hunting is allowed. Dense aquatic vegetation and a lack of public access limit the recreational values. There are no cottages or other developments.

(Overview) Rolands Bestful Lake, in the Lower Little Wolf River Watershed, is a 15.45-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Lutz Lake**WBIC: 282000**

(Historical 1971) This basin is a clear, hard water lake fed by seepage and springs. There is no inlet and the outlet flows only a short distance before entering Moon (Goodhal) Lake. In effect this lake system is landlocked. Muck is the only littoral bottom material present. Largemouth bass, bluegill, black crappie, and yellow bullheads are present. The lake supports nesting mallards and bluewing teal as well as a significant population of muskrats. Both diving ducks and puddle ducks use the lake as a rest area during spring and fall migrations. There is no public access. There are no developments present on the shoreline.

(Overview) Kruse Lutz Lake, in the Lower Little Wolf River Watershed, is a 17.00 acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Little Creek**WBIC: 280700**

(Overview) Little Creek, in the Lower Little Wolf River and North Branch and Mainstem Embarrass Rive Watersheds, is a 5.89 mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired, but will be added to the 2018 impaired waters list for the pollutant phosphorus. Recent surveys indicate fair to poor water quality in Little Creek.

Blake Creek**WBIC: 280900**

(Overview) This 14-mile-long tributary to the North Branch of the Little Wolf River is classified as Class II trout waters above Highway 161 and a warm water sport fishery below Highway 161. This stream has problems with sedimentation due to cattle watering at or in the stream, although recent monitoring indicates good to excellent water quality.

Little Wolf River**WBIC: 272400**

(Overview) About 9 miles of the Little Wolf River flows through the Lower Wolf River watershed (WR04), the portion from its mouth at the Wolf River upstream to the mouth of the South Branch Little Wolf River. In this section of the Little Wolf River it is a low gradient stream which passes through primarily farmland. 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. Recent monitoring indicates good to excellent water quality throughout the Lower Little Wolf River. The Little Wolf's fishery is similar to the Wolf River, with diverse warm water fish and rough fish. DNR fisheries personnel have created a master plan for the Little Wolf River. The Little Wolf River from the junction with the Wolf River upstream to Manawa Dam is designated an Exceptional Resource Water per Chapter NR 102, Wisconsin Administrative Code. In the Upper Little Wolf River watershed (WR07) (upstream of Big Falls), different portions of the Little Wolf River are classified as a warmwater sport fishery and Class I and II trout waters.

Twin Lake**WBIC: 284000**

(Historical 1971) South Twin Lake is very similar in all respects to North Twin Lake. Fishery and wildlife values are identical and there is no public access. A boat livery located on South Twin also services North Twin. One cottage is present. Source: 1971, Surface Water Resources of Waupaca County Twin Lake, South (Little), T24N, R13E, Section 7 Surface Acres = 10.5; S.D.F. = 2.64, Maximum Depth = 23 feet

(Overview) Twin Lake, Little, in the Lower Little Wolf River Watershed, is a 10.49-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Spiegelberg Creek**WBIC: 279600**

(Overview) Spiegelburg Creek, in the Lower Little Wolf River Watershed, is a 4.65-mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired. Recent monitoring indicate good to fair water quality of Spiegelberg Creek. The water quality of the creek is influenced by the water quality of Bear Lake.

Thiel Creek**WBIC: 280100**

(Overview) Thiel Creek, in the Lower Little Wolf River Watershed, is a 6.70-mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired but will be added to the 2018 impaired waters list for the pollutant phosphorus. Recent surveys indicate fair to poor water quality in Thiel Creek.

North Fork Blake Creek**WBIC: 281500**

(Overview) Blake Creek-N. Fork, in the Lower Little Wolf River Watershed, is a 5.74-mile river that falls in Waupaca County. This river is an outstanding/exceptional resource water under NR102 as well as a Class II Trout Water under the Fisheries Program. This river is managed for fishing and swimming and is currently not considered impaired. Recent monitoring indicates good water quality.

Goodhal Lake**WBIC: 281900**

(Historical 1971) Goodhal Lake (Moon Lake) lies in a landlocked basin also containing Krause Lake. The two lakes are connected by a small stream. The water is clear, transparent and hard. The extensive littoral zone is a predominantly marl bottom, but some sand is present. The fishery includes northern pike, perch, largemouth bass, bluegill, black crappie, green sunfish, and brown bullhead. The lake is noted for the abundance of large bluegills. Mallards and bluewing teal nest on the lake. Fairly large numbers of diving ducks and puddle ducks use the lake as a resting and feeding area during spring and fall migrations. A town road with parking facilities for 15 to 20 cars provides access. Fourteen cottages are located around the lake. Hunting is allowed.

(Overview) Goodhal Lake, in the Lower Little Wolf River Watershed, is a 33.05-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Campbell Lake**WBIC: 284300**

(Historical 1971) Seepage, marsh drainage and overflow from Price Lake provide most of the water necessary to maintain the level of this hard water drained lake. The predominant littoral bottom material is marl while the immediate shoreline is largely a brush swamp. Marl particles present impart a slight green tint to the otherwise clear water. The fishery consists of northern pike, perch, largemouth bass, bluegill, black bullhead, yellow bullhead, and white sucker. Winterkill occasionally affects the less hardy largemouth bass- panfish population. Dense beds of aquatic plants limit the recreational potential of this lake. Nesting bluewing teal utilize the lake as do fairly large numbers of migrating puddle ducks. Hunting is allowed. An unimproved access site with parking is located on the east edge of the lake. Navigable water access is available via Whitcomb Creek and the outlet stream provides additional access.

(Overview) Campbell Lake, in the Lower Little Wolf River Watershed, is a 39.87-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Chapin Lake**WBIC: 183300**

(Historical 1971) This is a small landlocked lake completely surrounded by a black spruce bog. The brown alkaline water is very soft and low in productivity. The littoral zone is quite limited and completely lined with muck. Largemouth bass, yellow bullhead, and bluegills are the major fish species present. Both wood ducks and bluewing teal use the lake as a nesting area. Puddle ducks rest here during the spring and fall migrations. Hunting is allowed. This wilderness lake has no developments nor does it have a public access.

(Overview) Chapin Lake, in the Lower Little Wolf River Watershed, is a 7.33-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Driscoll Lake**WBIC: 185100**

(Historical 1971) This very soft water seepage lake is completely surrounded by a narrow band of cattails. The lake has no inlet or outlet. Detritus covers the entire littoral bottom. An annual complete winterkill prevents the establishment of a fishery. A few bluewing teal use the lake during spring migrations. Since about two-thirds of the shoreline is pastured it would appear that the main use is for cattle watering. There is no public access and there are no developments. The recreational use potential of this lake is very limited.

(Overview) Driscoll Lake, in the Lower Little Wolf River Watershed, is a 3.60-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Fountain Creek**WBIC: 280800**

(Overview) Fountain Creek, in the Lower Little Wolf River Watershed, is a 2.26-mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired.

South Fork Whitcomb Creek**WBIC: 284700**

(Overview) Whitcomb Creek-S. Fork, in the Lower Little Wolf River Watershed, is a 4.24-mile river that falls in Waupaca County. This river is managed for fishing and swimming and is currently not considered impaired.

Storm Lake**WBIC: 199500**

(Historical 1971) Strum Lake is a landlocked seepage lake containing clear, soft water. Muck and sand are the predominant littoral bottom materials. Winterkill and fluctuating water levels limit fish productivity. Species found are bluegill, pumpkinseed, green sunfish and black bullhead. Predatory species are lacking. Nesting mallards and bluewing teal use the lake as do otter and muskrats. Hunting and trapping is allowed. Primary use of the lake is for duck hunting. There is no public access and there are no developments.

(Overview) Strum Lake, in the Lower Little Wolf River Watershed, is a 14.67-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Woodnorth Lake**WBIC: 280000**

(Historical 1971) Woodnorth Lake is a clear, hard water drained lake fed by springs and ground seepage. There is no defined inlet but there is a small outlet that flows into nearby Fox Lake. Woodnorth Lake contains a well-balanced fishery of largemouth bass, bluegill, and black crappie. A few large carp are present but cause no problems. Waterfowl use is very limited. Hunting is allowed. Developments consist of one boat livery and a private day area. There is no public access.

(Overview) Woodnorth Lake, in the Lower Little Wolf River Watershed, is a 5.11-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Mountain Lake**WBIC: 193100**

(Historical 1971) Mountain Lake is a landlocked seepage basin containing clear, moderately hard water. Muck and gravel are found covering the extensive littoral zone. Severe natural water level fluctuations and annual complete winterkill precludes the establishment of a desirable fishery. Mallards nest on the lake and some puddle ducks rest there during spring and fall migrations. Hunting is allowed. There are no developments including public access. Mountain Lake is a wilderness type lake.

(Overview) Mountain Lake, in the Lower Little Wolf River Watershed, is a 41.83-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Twin Lake**WBIC: 284100**

(Historical 1971) North Twin Lake and its sister, South Twin Lake lie within a common basin virtually landlocked except for an intermittent channel to Whitcomb Creek. An artificial channel connects the two lakes and allows the boat traffic to pass between the two. North Twin Lake contains clear hard water, fed mainly by ground seepage. Muck is the predominant littoral bottom type. Aquatic vegetation and slow growing panfish are use problems. Fish present are northern pike, perch, largemouth bass, bluegill, black crappie, pumpkinseed, green sunfish, bullhead, and white sucker. Bluewing teal nest here and large numbers of puddle ducks and diving ducks use the area during spring and fall migrations. The lake and adjoining wetlands support a large population of muskrats. There is no public access but there is a boat livery. There are no other developments.

(Overview) Twin Lake, North (Big Twin), in the Lower Little Wolf River Watershed, is a 17.39-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Fox Lake

WBIC: 279900

(Historical 1971) Fox Lake is a small hard water wilderness lake with springs and drainage being the principle water sources. A wooded swamp completely surrounds this lake which probably accounts for the light brown water color. Littoral bottom materials consist entirely of muck. There is a small inlet and a small outlet that flows into Spiegelberg Creek. Panfish and forage species are the only known species present. Fox Lake suffers from periodic severe winterkill. Wood ducks, mallard, and bluewing teal are known to nest here. Migratory puddle ducks and coots rest on the lake each spring and ducks and coots rest on the lake each spring and fall. Hunting is allowed. There are no developments nor is there a public access on Fox Lake.

(Overview) Fox Lake, in the Lower Little Wolf River Watershed, is a 3.55-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Price Lake

WBIC: 284400

(Historical 1971) Price Lake is a clear, hard water drained basin fed primarily by marsh drainage and seepage. Originally the basin was landlocked but several years ago Waupaca County blasted a channel from Price Lake to nearby Campbell Lake. This venture was only partially successful however, because the channel soon silted in making navigation virtually impossible. A shrub swam surrounds nearly 80 percent of the lake and provides cover for nesting bluewing teal and wood ducks. Migrant puddle ducks also use the lake as a rest area. Fish present are bluegill and largemouth bass; however, little is known of the overall fishery. Hunting is allowed but there is no public access. Three cottages are present.

(Overview) Price Lake, in the Lower Little Wolf River Watershed, is a 16.01-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Vesey Lake

WBIC: 240100

(Historical 1971) Vesey Lake is a shallow landlocked basin containing clear, moderately soft water and is fed mainly by ground water seepage. Sand, gravel, and muck are predominately bottom materials. The lake contains a fishery consisting of perch, bullheads, and forage minnows. Winterkill and fluctuating water levels are fishery problems. The primary use of the lake is for duck hunting. Mallards and bluewing teal nest on the lake shore. Large numbers of migrant puddle ducks use the lake as a resting and feeding area. Hunting is allowed but there is no public access. There are no developments.

(Overview) Vesely Lake, in the Lower Little Wolf River Watershed, is a 54.46-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Cedar Lake

WBIC: 283800

(Historical 1971) Cedar Lake is a hard, clear water seepage fed lake with a small intermittent outlet to Whitcomb Creek. Littoral bottom materials consist of marl, sand, and muck. Northern pike, perch, largemouth bass, bluegill, black crappie, rock bass, green sunfish, and white sucker are the most abundant species. Other fish present in lesser numbers are walleye, yellow bullhead, brown trout and rainbow trout. According to local residents a conflict between water skiers and fishermen is becoming a serious problem. Developments include one resort and 12 cottages. An access without parking is located off a town road on the northeast side of the lake. Waterfowl use is restricted to limited resting puddle ducks during spring and fall migrations.

(Overview) Cedar Lake, in the Lower Little Wolf River Watershed, is a 45.62-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Preuss Lake

WBIC: 281100

(Historical 1971) Preuss Lake is a clear, hard water drained lake located in the center of a fairly large wooded wetland. Springs are the major water source. The lake has no inlet but does have an outlet flowing into Blake Brook. Marl is the predominant littoral bottom material. Northern pike, largemouth bass, bluegill, black crappie, and pumpkinseed are present. The panfish are reported to be stunted. A few puddle ducks use the lake as a resting area during spring and fall migrations. Bluewing teal nest on the lake. Hunting is allowed. There is no public access, and there are no developments. Preuss Lake is classed as a wilderness lake.

(Overview) Preuss Lake, in the Lower Little Wolf River Watershed, is a 2.76-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Jones Lake**WBIC: 282500**

(Historical 1971) Jones Lake is a small clear water wilderness lake located on a tributary to the South Fork Blake Brook. The water is alkaline hard, and high in productivity. Muck is the major littoral bottom material. The fishery consists of northern pike, perch, largemouth bass, and bluegill. Mallard and bluewing teal nest on the lake and migrating puddle ducks use the lake as a rest area. Hunting is allowed. There is no public access and there are no developments.

(Overview) Jones Lake, in the Lower Little Wolf River Watershed, is a 7.22-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Mud Lake**WBIC: 283300**

(Historical 1971) This is a moderately hard water drained lake located in the middle of a vast wetland known as Marble Swamp. Springs and seepage are the major water supplier. A small outlet stream flows in a northerly direction to join Shaw Creek less than a mile from Mud Lake. The water in Mud Lake is light brown color. Muck is the predominant bottom type. Natural water level fluctuations and winterkill prevent a suitable fishery from becoming established. Muskrats are quite common. Nestling bluewing teal, mallards, and wood ducks utilize the ideal habitat found near Mud Lake. Puddle ducks and diving ducks make heavy use of these waters during spring and fall migrations. There is no public access; the lake is classified as a wilderness lake.

(Overview) Mud Lake, in the Lower Little Wolf River Watershed, is a 9.88-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Bear Lake**WBIC: 279700**

(Historical 1971) Marl, with lesser amounts of muck and sand, is the predominant bottom material in Bear Lake, a hard water drainage lake. Spiegleberg Creek, a small tributary to the N.Br.Little Wolf River, flows through Bear Lake. Northern pike, largemouth bass, bluegill, perch, black crappie, green sunfish, rock bass, black bullhead, white sucker, and carp constitute the fishery. A few brown or rainbow trout are also present. Aquatic vegetation is not abundant. Great blue heron and bluewing teal use the lake as a nesting area. Puddle ducks can be found during spring and fall migrations. Aquatic furbearers are scarce. Hunting is allowed with permission. Conflicts between fishermen and pleasure boaters have led to the establishment of a water skiing and speed boating zone. Developments include one resort, one boat livery, 68 cottages, and one private campground. A public boat landing is maintained by Waupaca County on the south side of the lake. Heavy grazing causes erosion and siltation in some areas. Additional pollutants enter the lake in the form of barnyard drainage.

(Overview) Bear Lake, in the Lower Little Wolf River Watershed, is a 199.52-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

Manawa Millpond**WBIC: 280400**

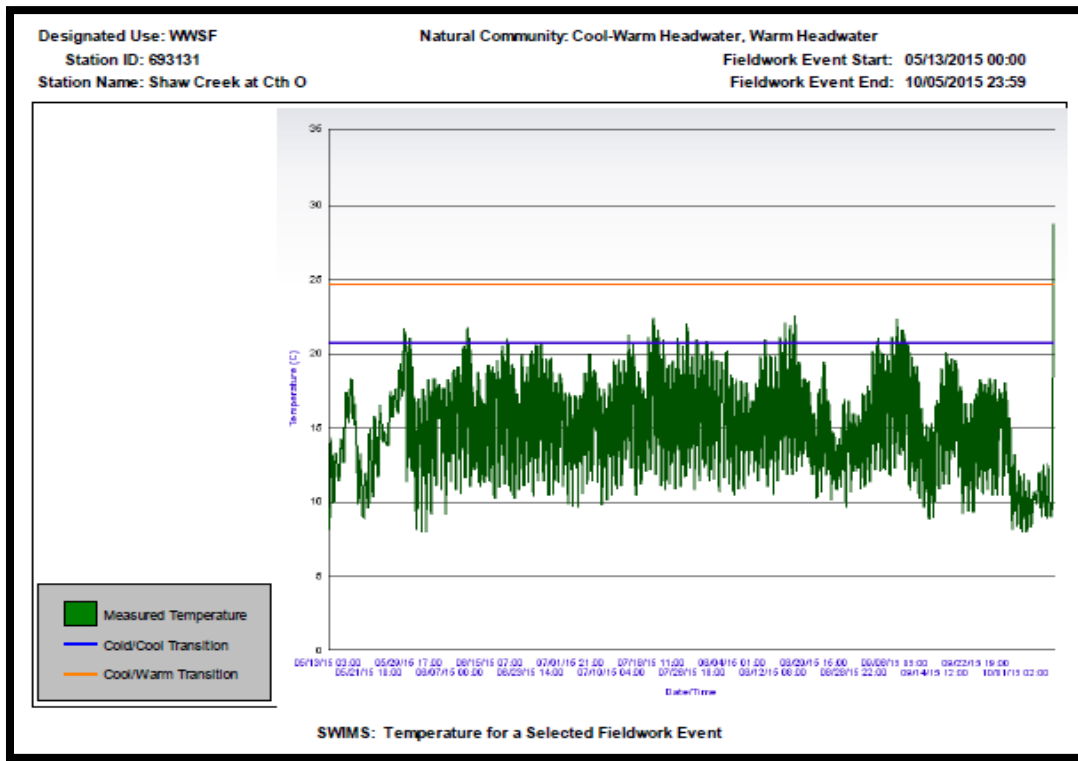
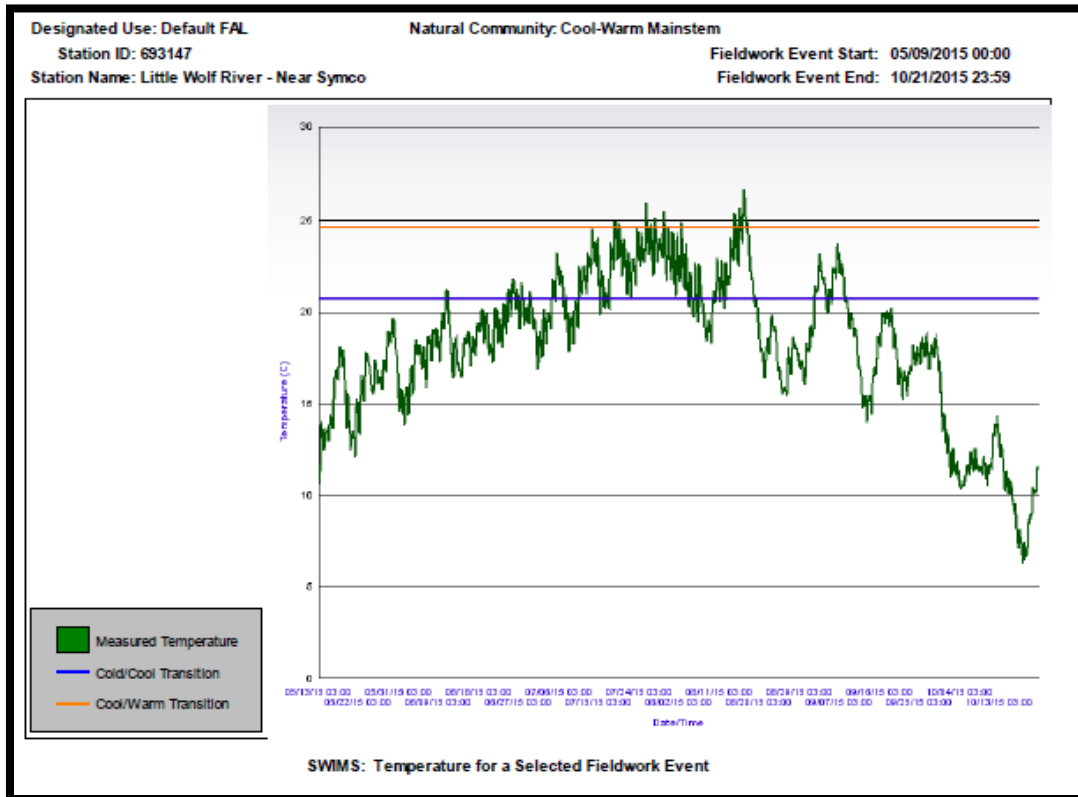
(Historical 1971) Manawa Millpond is an impoundment on the Lower Little Wolf River. The water is hard and medium brown in color. An impoundment of some type has existed from at least 1895 when the Eischner-Nelson Milling Works operated a grist and flour mill at this location. The mill exists; however the river is no longer used as a source of power. Water levels of the impoundment are presently maintained by a dam about nine feet high. The extensive littoral zone has a predominantly sand bottom. The immediate shoreline is almost completely upland types with about one-fourth of the shoreline lying in the City of Manawa. The remainder is a combination of upland hardwoods, pasture, and cultivated lands. Access is available from a county park, a city beach, and city landing. The newly developed beach receives heavy use. The Manawa Millpond provides navigable water access for small boats and canoes. Twenty-four dwellings are located on the pond. Fish present are northern pike, largemouth bass, bluegill, bullhead, and perch. Dense growths of aquatic vegetation limit the fishing and boating values afforded by this impoundment. No evidence of duck or aquatic furbearers was noted on the day of investigation. Hunting is restricted to the portions of the impoundment lying outside the City of Manawa.

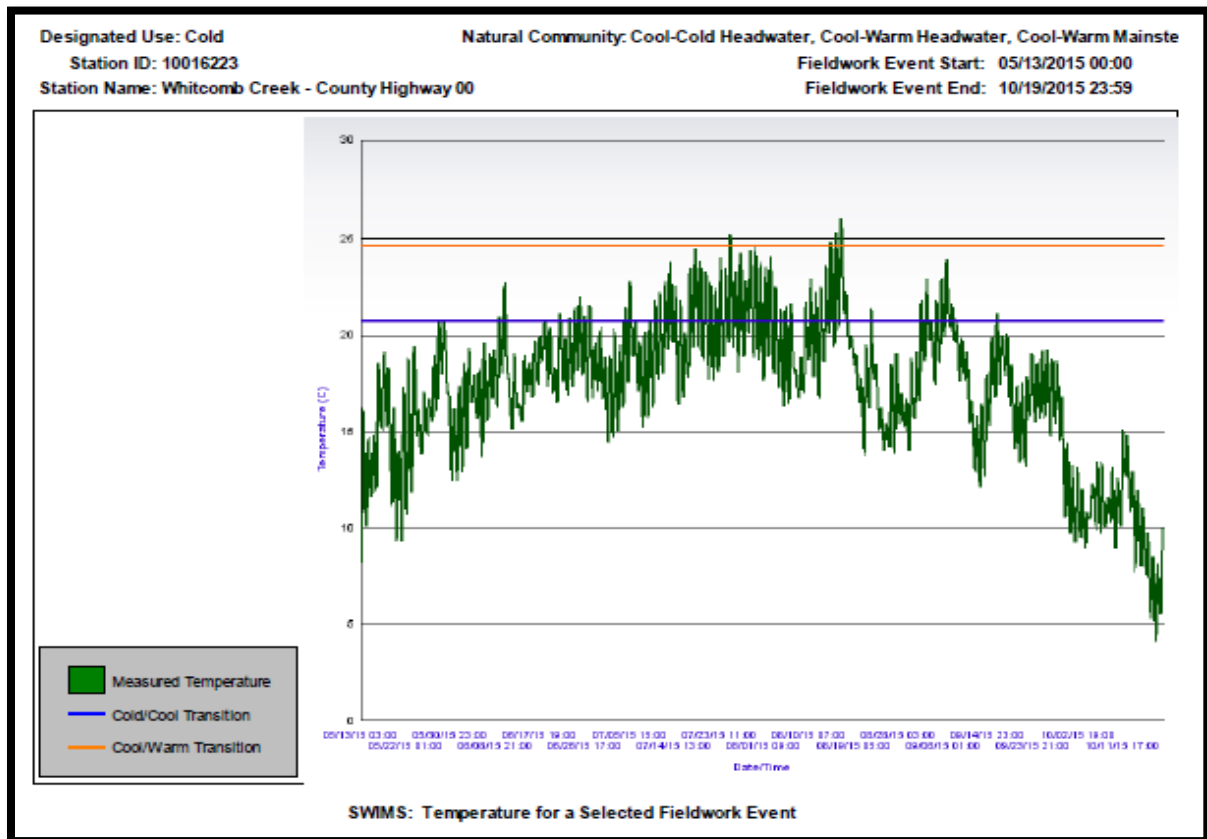
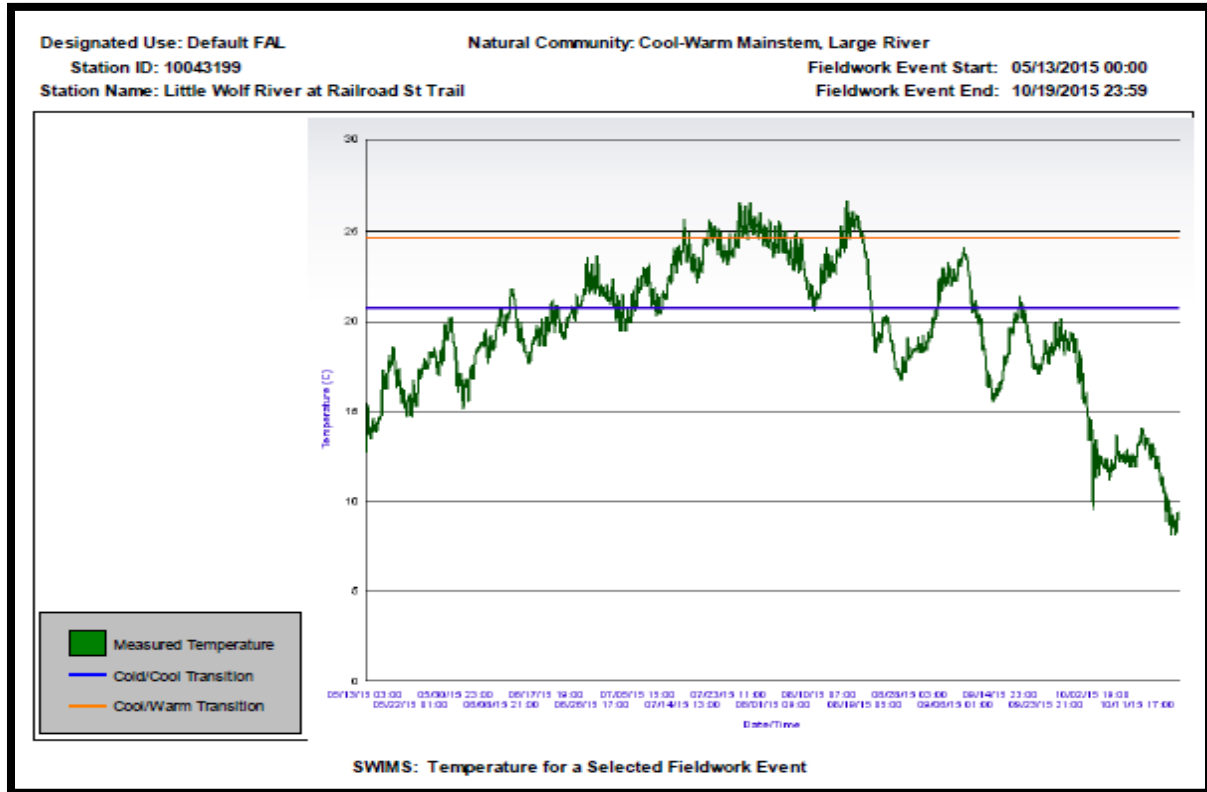
(Overview) Manawa Millpond, in the Lower Little Wolf River Watershed, is a 180.45-acre lake that falls in Waupaca County. This lake is managed for fishing and swimming and is currently not considered impaired.

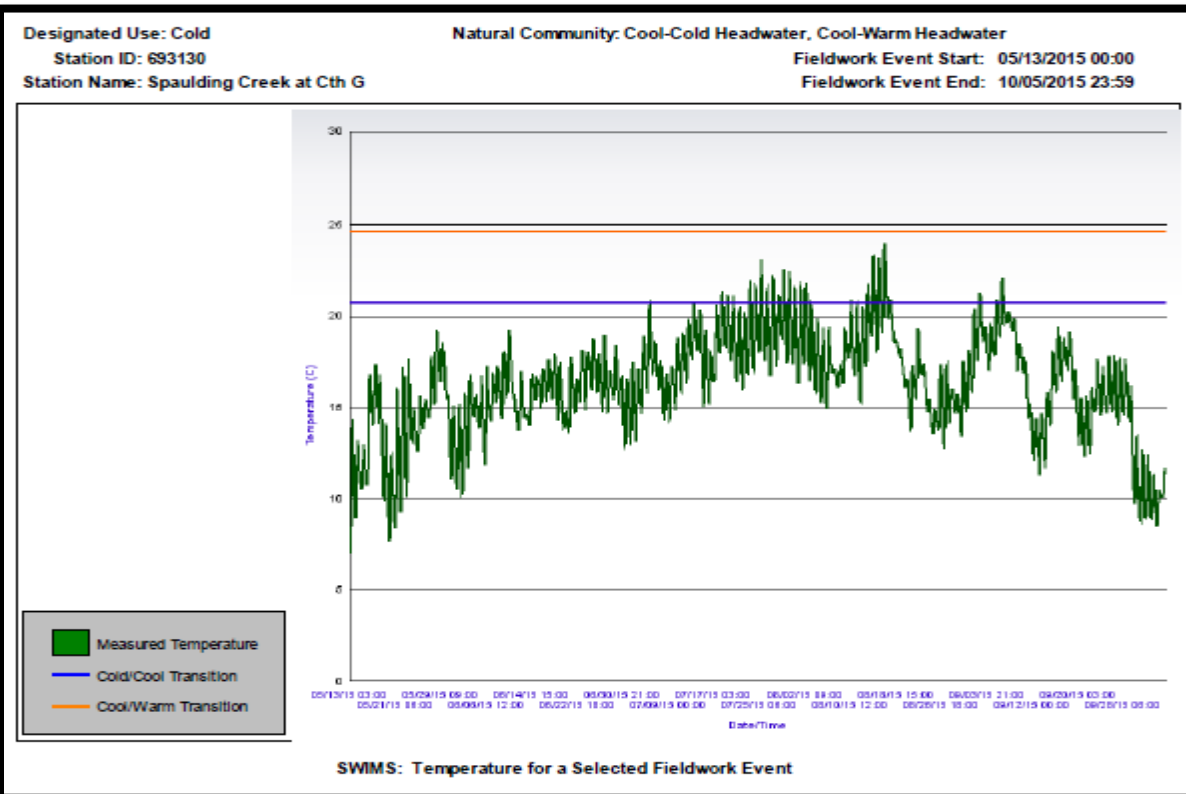
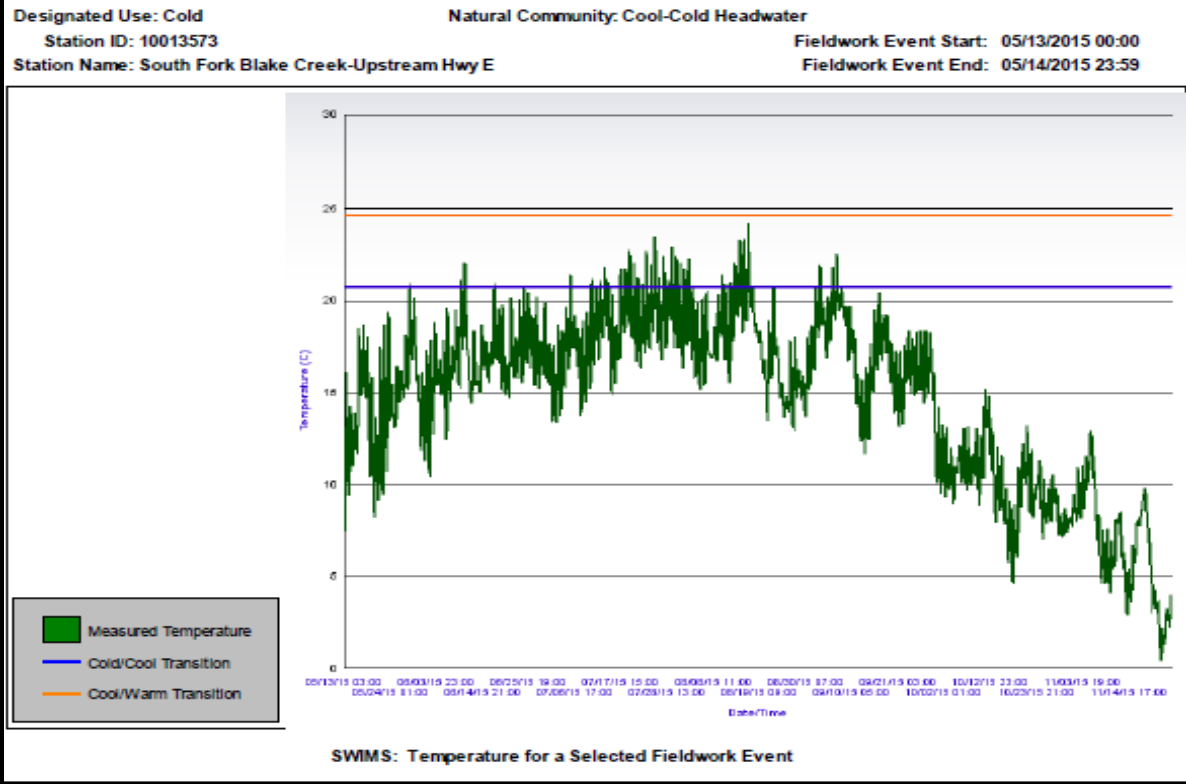
Big Falls Pond

WBIC: 285300 (Historical 1971) Big Falls Pond is a hard water impoundment of the Little Wolf River maintained by a dam 30 feet high. The fishery is composed of perch, largemouth bass, smallmouth bass, bluegill, black crappie, rock bass, black bullhead, green sunfish, and white sucker. The panfish are of little value to the sport fishery because of their small size. The entire pond, except for the main channel, is choked with dense growths of aquatic vegetation making boating and fishing difficult. Nesting bluewing teal and migrating puddle ducks use the pond. Hunting is allowed. Two dwellings are the only developments. Access is available from a public access site maintained by Waupaca County. Navigable water access is available via the inlet and the outlet. As is the case on many small impoundments silt is gradually filling the basin of Big Falls Pond.

Appendix C: Temperature Graphs







Designated Use: Cold

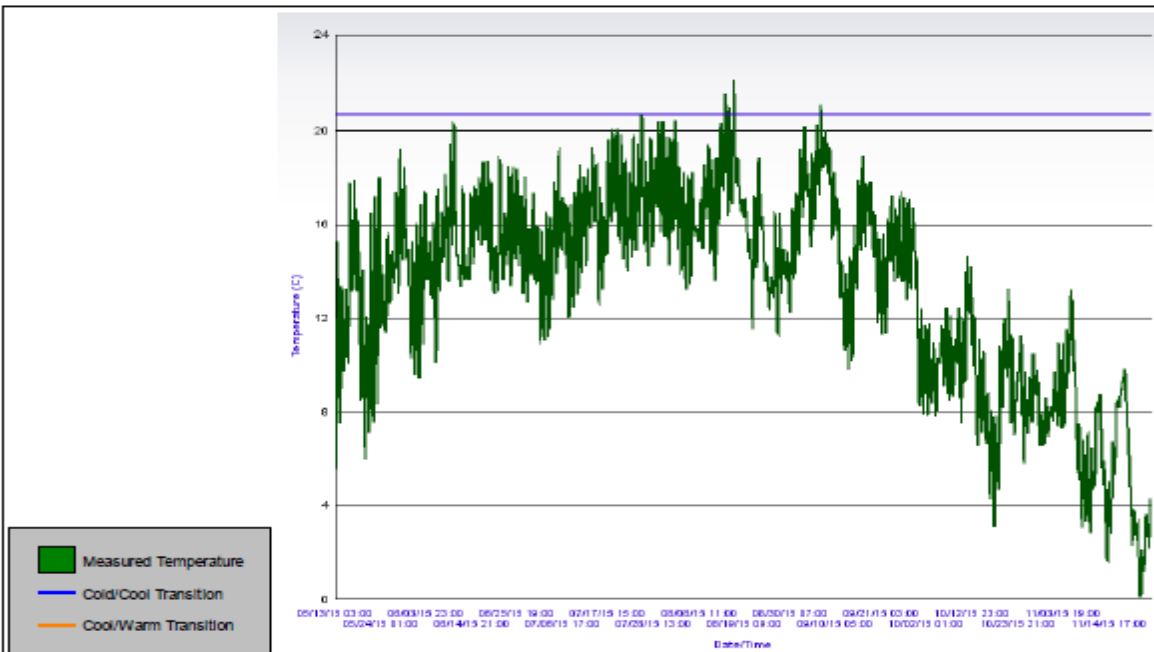
Station ID: 693154

Station Name: Blake Creek North Fork at Cth E

Natural Community: Cool-Warm Headwater, Warm Headwater

Fieldwork Event Start: 05/13/2015 00:00

Fieldwork Event End: 11/24/2015 23:59



Designated Use: Default FAL

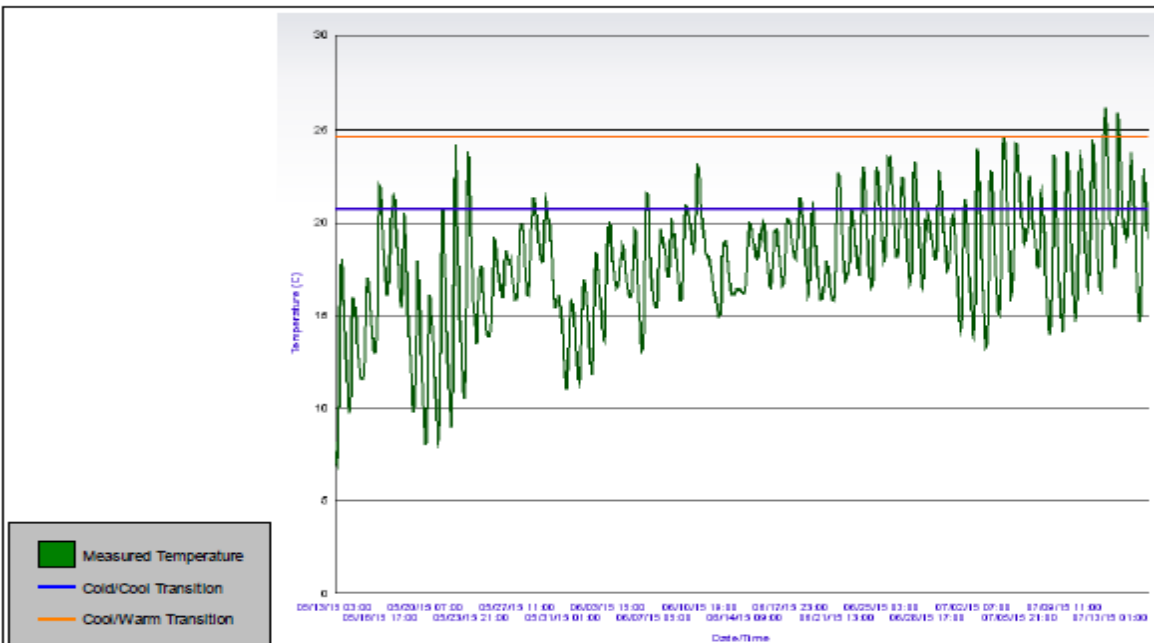
Station ID: 10030800

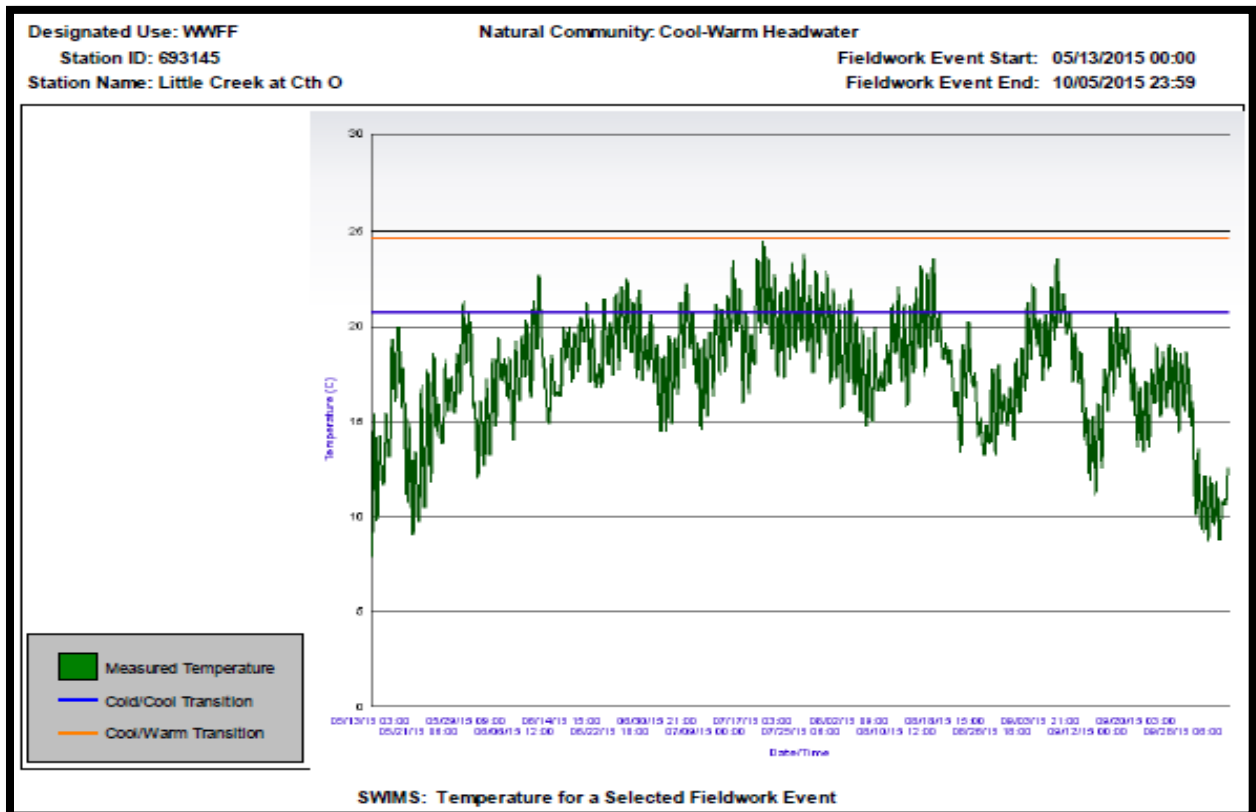
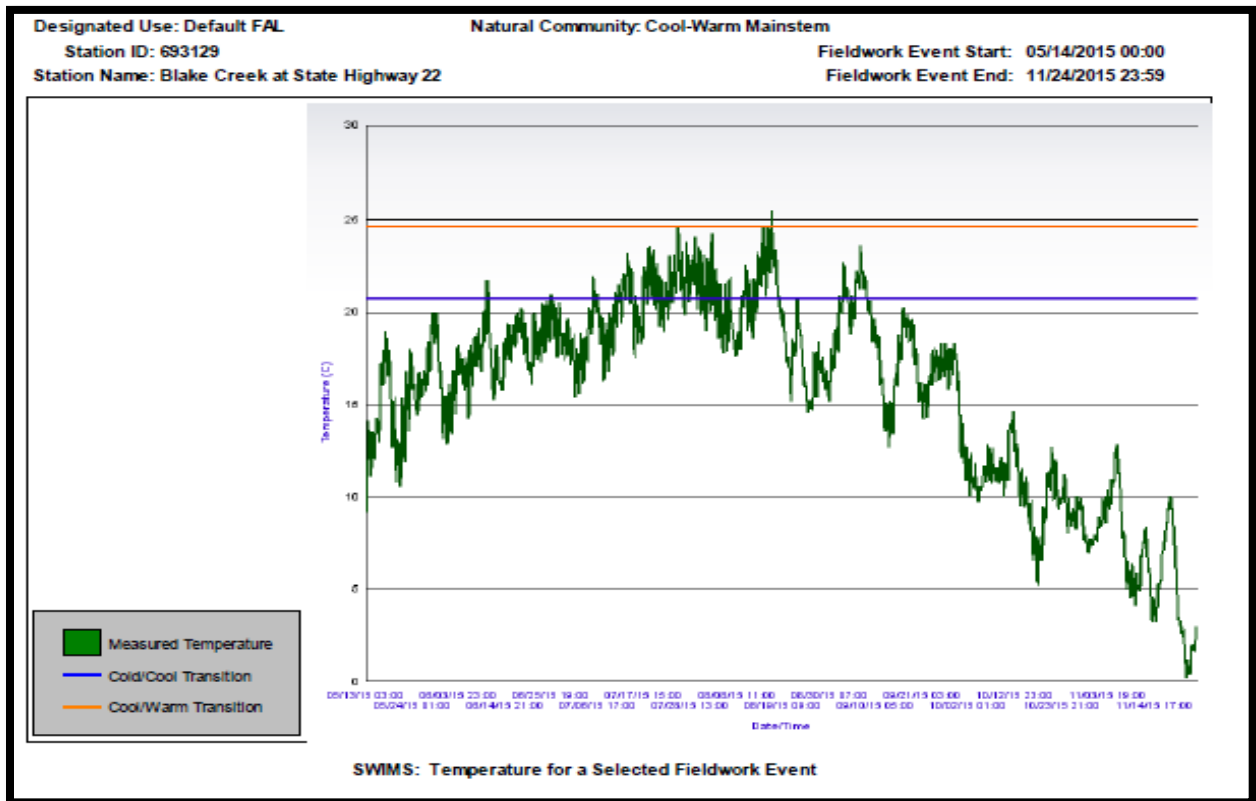
Station Name: Beaver Creek - 280 ft downstream CTH O

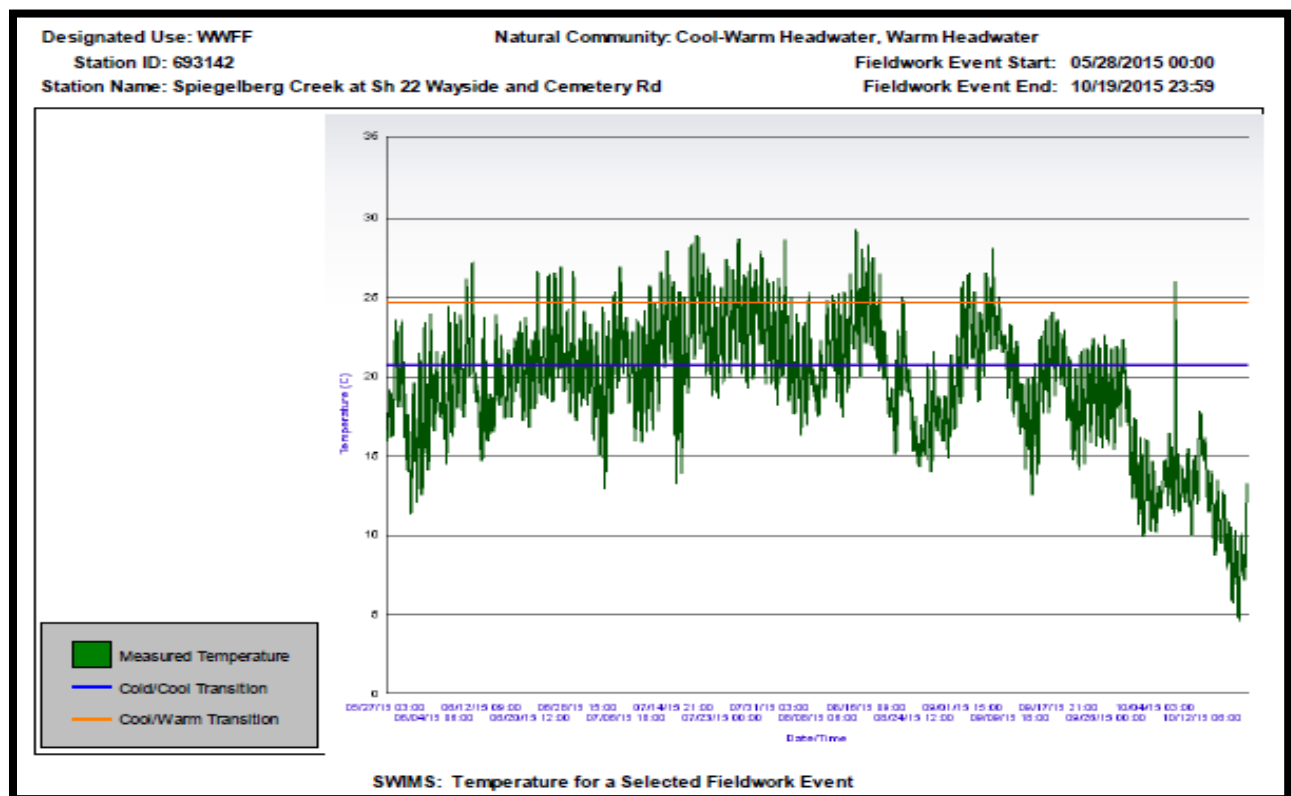
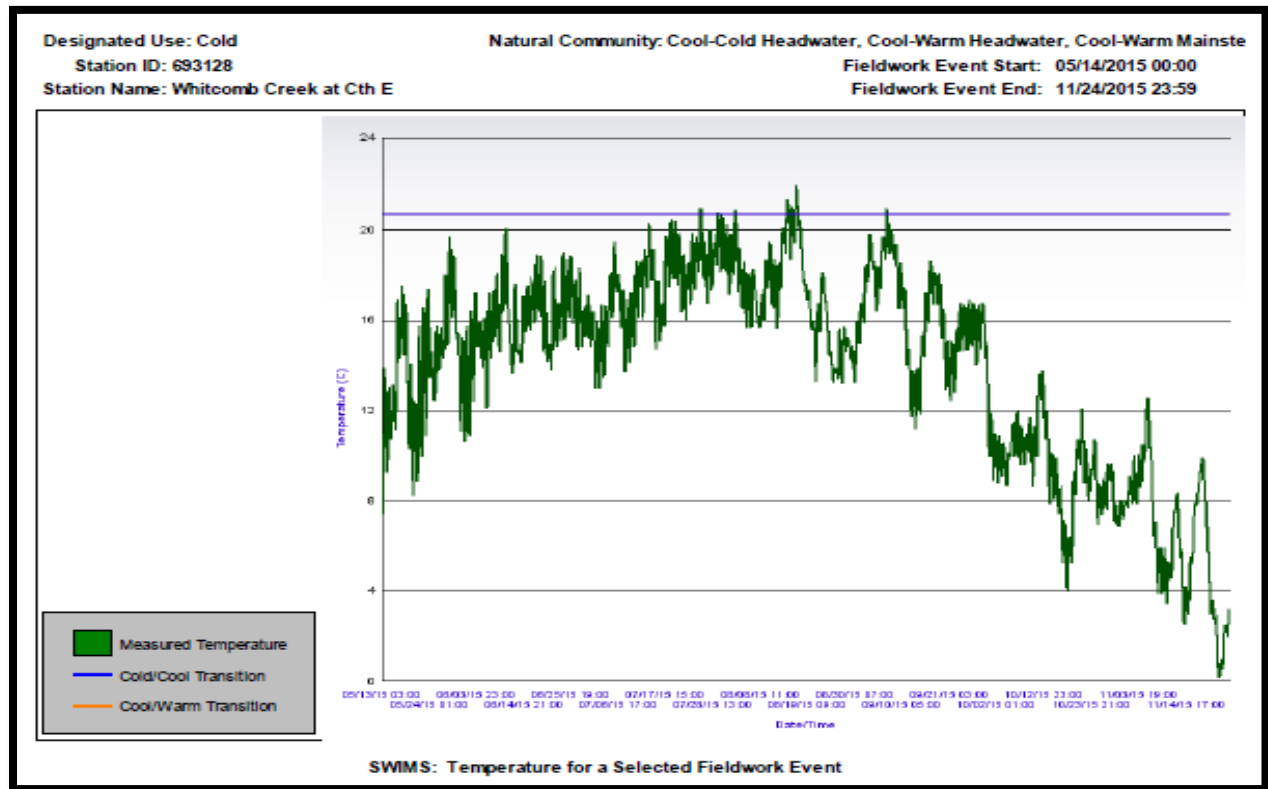
Natural Community:

Fieldwork Event Start: 05/13/2015 00:00

Fieldwork Event End: 07/15/2015 23:59







Designated Use: WWFF

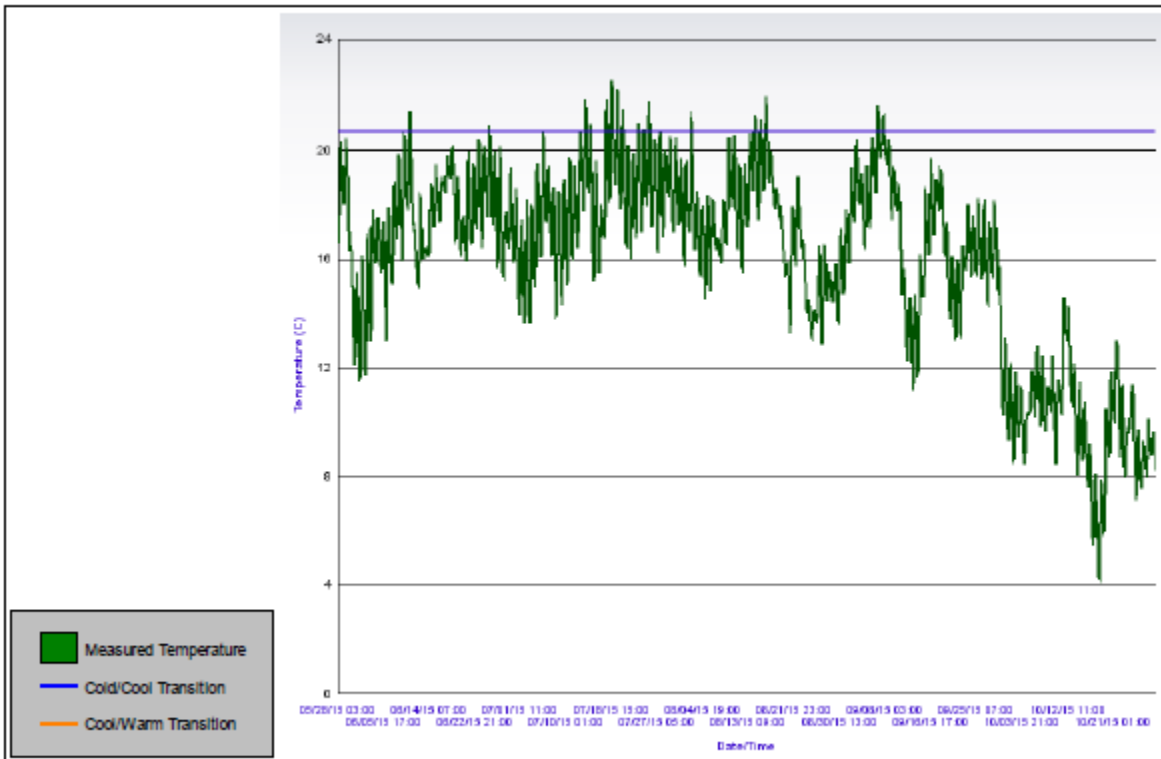
Natural Community: Cool-Warm Headwater, Macroinvertebrate, Warm Headwater

Station ID: 693143

Fieldwork Event Start: 05/29/2015 00:00

Station Name: Thiel Creek at Swan Road

Fieldwork Event End: 10/28/2015 23:59



SWIMS: Temperature for a Selected Fieldwork Event

Appendix D: Monitored Stations

Station ID	Station Name	WBIC	Earliest Fieldwork Date	Latest Fieldwork Date
693025	School Section Lake - Deep Hole	283600	03/01/1976	09/12/2016
693041	Bear Lake - Deepest Point	279700	08/07/1980	09/10/2016
10016782	Blake Creek - Upstream Of County Highway K	280900	05/02/1996	05/17/2016
10013573	South Fork Blake Creek-Upstream Hwy E	282100	10/11/1995	05/17/2016
693129	Blake Creek at State Highway 22	280900	08/17/1995	10/29/2015
693141	Little Wolf River at Cth Bb	272400	10/17/1995	10/29/2015
693143	Thiel Creek at Swan Road	280100	10/17/1995	10/29/2015
693147	Little Wolf River - Near Symco	272400	05/15/1979	10/22/2015
693142	Spiegelberg Creek at Sh 22 Wayside and Cemetery Rd	279600	10/11/1995	10/21/2015
10016223	Whitcomb Creek - County Highway 00	283400	05/15/1979	10/21/2015
693130	Spaulding Creek at Cth G	284900	08/17/1995	10/20/2015
693131	Shaw Creek at Cth O	283100	08/17/1995	10/20/2015
693145	Little Creek at Cth O	280700	03/05/1996	10/20/2015
693151	Little Wolf River at Cth C	272400	03/05/1996	10/20/2015
693163	Lower Little Wolf River at Bridge Rd	272400	04/11/1996	10/20/2015
10030800	Beaver Creek - 280 ft downstream CTH O	283000	05/03/2004	10/20/2015
10043199	Little Wolf River at Railroad St Trail	272400	01/01/2015	10/20/2015
10007356	Bear Lake	279700	07/27/1999	09/01/2015
693128	Whitcomb Creek at Cth E	283400	08/17/1995	08/27/2015
10007366	Cedar Lake	283800	07/27/1999	08/20/2015
10007358	Manawa Millpond	280400	07/27/1999	07/23/2015
10007364	Hatch Lake	282800	07/27/1999	07/23/2015
10007365	School Section Lake	283600	06/01/1993	07/23/2015
10007368	North Twin Lake	284100	07/27/1999	07/23/2015
10007369	Campbell Lake	284300	07/27/1999	07/23/2015
10007370	Price Lake	284400	07/27/1999	07/23/2015
693154	Blake Creek North Fork at Cth E	281500	03/05/1996	07/17/2015
10007269	Chapin Lake	183300	07/27/1999	07/15/2015
10007284	Mountain Lake	193100	07/27/1999	07/15/2015
10007286	Roland Lake	197200	07/27/1999	07/15/2015
10007304	Vesey Lake	240100	07/27/1999	07/15/2015
10007362	Lutz Lake	282000	07/27/1999	07/15/2015
10007367	South Twin Lake	284000	07/27/1999	07/15/2015
10039563	Purple Loosestrife Intersection of CTH B and N Murray Rd	NA	07/11/2012	07/12/2014
10019180	Bear Lake -- Access at S Side Of Lake Off Lake Street	279700	08/13/2011	07/06/2014
10044392	Wetland at Hatch Lake islands	282800	06/27/2014	06/27/2014

Station ID	Station Name	WBIC	Earliest Fieldwork Date	Latest Fieldwork Date
10007363	Jones Lake	282500	07/27/1999	09/27/2013
10007361	Goodhal Lake	281900	07/27/1999	08/06/2013
10041795	Purple Loosestrife - E6529 Mickel John Rd (stream in backyard)	272400	07/09/2013	07/09/2013
10041801	Purple Loosestrife - Roland Lake off of Campbell Rd	197200	07/08/2013	07/08/2013
10018200	School Section Lake -- Access	283600	07/15/2012	07/15/2012
10019079	Cedar Lake -- Access	283800	07/15/2012	07/15/2012
10019365	Campbell Lake -- Access	284300	07/15/2012	07/15/2012
10018130	Hatch Lake -- Access	282800	06/03/2012	06/03/2012
10022370	Whitcomb Creek Upstream From Cty Rd Oo	283400	05/03/2004	09/08/2011
10007275	Gregerson Lake	186900	07/27/1999	07/20/2011
10007357	Woodnorth Lake	280000	07/27/1999	07/17/2010
10007294	Storm Lake	199500	07/27/1999	07/01/2010
10007360	Unnamed Lake (T24 R12E S15)	281700	07/27/1999	07/01/2010
693171	Blue Mountain Lake - Middle	182400	06/29/1996	08/27/2009
10028747	Whitcomb Creek At Swamp Road	283400	05/21/2008	10/28/2008
10022184	Shaw Creek At Cth O (East Crossing)	283100	07/31/2007	10/03/2007
10022430	Whitcomb Creek Off Of Cth G Just South Of Boelter Rd	283400	07/31/2007	10/03/2007
10021237	Little Wolf River At Hwy 22 Bridge (25)	272400	08/03/2007	08/03/2007
10021238	Little Wolf River (26)	272400	08/03/2007	08/03/2007
10021239	Little Wolf River At Hwy Bb Bridge (27)	272400	08/03/2007	08/03/2007
10021232	Little Wolf River In Backwater Area (21)	272400	08/02/2007	08/02/2007
10021233	Little Wolf River (22)	272400	08/02/2007	08/02/2007
10021234	Little Wolf River (23)	272400	08/02/2007	08/02/2007
10021236	Thiel Creek (24)	280100	08/02/2007	08/02/2007
10040612	Spaulding Creek US of Little Wolf River	284900	05/02/2003	04/22/2006
10040637	Whitcomb Creek near CTH G bridge	283400	05/14/2003	04/03/2006
693160	Blake Creek South Fork at Phelps Rd	282100	03/05/1996	11/22/2005
10013268	Unnamed - East Bestul Rd	282200	11/22/2005	11/22/2005
10040609	South Branch of Blake Creek 1000 ft US from Bestul Rd	282100	08/14/2004	10/08/2005
693150	Shaw Creek at Cth Oo And Cth O	283100	03/05/1996	10/01/2005
693155	Whitcomb Creek at Cth G	283400	04/13/1995	10/01/2005
10016035	Spaulding Creek - Downstream 2140 Feet Of Cth G	284900	04/24/2000	10/01/2005
10013576	South Fork Blake Creek-Bestul Rd Upstream	282100	04/29/2004	10/01/2005
10030801	Trib to Whitcomb Creek - 50 ft downstream from Carper Rd	284500	05/03/2004	10/01/2005
10030804	Spaulding Creek - 70 ft downstream from CTH E	284900	05/12/2004	10/01/2005
693139	Manawa Millpond at Deepest Spot	280400	02/22/1996	09/16/2003

Station ID	Station Name	WBIC	Earliest Fieldwork Date	Latest Fieldwork Date
693047	Hatch Lake - Deep Hole	282800	06/24/1991	08/27/2003
693023	Cedar Lake - Deep Hole	283800	03/01/1976	09/27/2000
693194	Little Wolf River - Downst Footbr R. Gruenke	272400	04/25/2000	04/25/2000



Lower Little Wolf River at Schmidt Road

Appendix E: Watershed Assessment Report for Fish and Aquatic Lifeⁱ

WBIC	Waterbody Name	Start Mile	End Mile or Acres	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
182400	Blue Mountain (Goerke) Lake	0	8.17	Small	FAL	Supporting	Default FAL	NA	NA	Not Assessed	NA
183300	Chapin Lake	0	7.33	Small	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
185100	Driscoll Lake	0	3.6	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
186900	Gregerson Lake	0	35	Shallow Seepage	FAL	Supporting	Default FAL	NA	NA	No Assessment on File	NA
193100	Mountain Lake	0	43	Shallow Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
197200	Rolands Bestful Lake	0	15.45	Deep Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
199500	Strum Lake	0	14.67	Deep Seepage	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
240100	Vesely Lake	0	54	Shallow Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
272400	Little Wolf River	0	14.02	WWSF	WWSF	Fully Supporting	Default FAL	NA	NA	Monitored	NA
272400	Little Wolf River	14.02	37.84	WWSF	WWSF	Fully Supporting	Default FAL	NA	NA	Monitored	NA
279600	Spielgelburg Creek	0	5	WWFF	WWFF	Fully Supporting	WWFF	NA	NA	Evaluated: Older Data	NA
279700	Bear Lake	0	194	Deep Lowland	FAL	Supporting	Default FAL	NA	NA	Monitored	NA

WBIC	Waterbody Name	Start Mile	End Mile or Acres	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
279900	Fox Lake	0	3.55	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
280000	Woodnorth Lake	0	5.11	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
280100	Thiel Creek	0	6.7	WWFF	WWFF	Supporting	WWFF	NA	NA	Evaluated: Older Data	NA
280400	Manawa Millpond	0	192	Impounded Flowing Water	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
280700	Little Creek	0	7	WWFF	WWFF	Fully Supporting	WWFF	NA	NA	Evaluated: Older Data	NA
280800	Fountain Creek	0	2.26	FAL	FAL	Not Assessed	Default FAL	NA	NA	Evaluated: Older Data	NA
280900	Blake Creek	0	10.06	Cold (Class II Trout)	Cold (Class II Trout)	Fully Supporting	Default FAL	NA	NA	Monitored	NA
280900	Blake Creek	10.06	12.86	Cold (Class II Trout)	Cold (Class II Trout)	Not Assessed	Cold	NA	NA	Evaluated: Older Data	NA
281100	Preuss Lake	0	2.76	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
281500	Blake Creek-N. Fork	0	4.98	Cold (Class II Trout)	Cold (Class II Trout)	Fully Supporting	Cold	NA	NA	Monitored	NA
281900	Goodhal Lake	0	32	Shallow Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA

WBIC	Waterbody Name	Start Mile	End Mile or Acres	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
282000	Kruse Lutz Lake	0	17	Deep Headwater	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
282100	Blake Creek-S. Fork	0	1	Cold (Class II Trout)	Cold (Class II Trout)	Fully Supporting	Cold	NA	NA	Monitored	NA
282100	Blake Creek - S. Fork	1	6.34	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Cold	NA	NA	Evaluated: Older Data	NA
282500	Jones Lake	0	7.22	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
282800	Hatch Lake	0	106	Shallow Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
283000	Beaver Creek	0	5.38	FAL	FAL	Not Assessed	Default FAL	NA	NA	Evaluated: Older Data	NA
283100	Shaw Creek	0	9	WWSF	WWSF	Supporting	WWSF	NA	NA	Monitored	NA
283300	Mud Lake	0	9.88	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
283400	Whitcomb Creek	0	15.82	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Cold	NA	NA	Monitored	NA
283600	School Section Lake	0	39	Deep Headwater	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	TMDL Development
283800	Cedar Lake	0	45	Deep Headwater	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
284000	Twin Lake, Little	0	10.49	Deep Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA

WBIC	Waterbody Name	Start Mile	End Mile or Acres	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
284100	Twin Lake, North (Big Twin)	0	27	Deep Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
284300	Campbell Lake	0	38	Deep Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
284400	Price Lake	0	16.01	Deep Seepage	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
284700	Whitcomb Creek-S. Fork	0	5	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Default FAL	NA	NA	Evaluated: Older Data	NA
284900	Spaulding Creek	0	9.12	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Cold	NA	NA	Monitored	NA
285300	Big Falls Pond	0	0.44	Deep Lowland	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA

ⁱ The watershed assessment table reflects the condition of waters in the study area watershed. This table data is stored in the Water Assessment Tracking and Electronic Reporting System (WATERS) and is updated on an ongoing basis via monitoring data and assessment calculations. The following definitions apply:

- Current Use – current condition of water based on monitoring data.
- Attainable Use – “ecological potential” of water based on water type, natural community, lack of human-induced disturbances.
- Supporting Attainable Use – decision on whether the water’s current condition is supporting its designated use under “water quality standards”.
- Designated Use – the water’s classified use under NR102, Wisconsin Water Quality Standards, for Fish and Aquatic Life.
- Impairments – documented impacts on water condition due to pollution sources or changes in hydro-geomorphological changes.
- Assessment – field indicates what type of data or information supports the decisions in the table (current, attainable, and supporting attainable).
- Impaired Water Status – This column indicates the status of the impaired water for TMDL development.