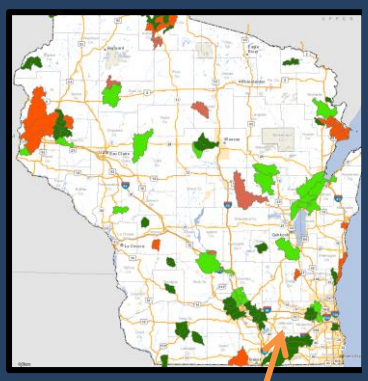
Public Review Draft – for Public Comment

Upper Fox-Pebble Targeted Watershed Assessment: A Plan to Restore Wisconsin Watersheds, 2020

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

Upper Fox River – Illnois (FX07)
HUC: 071200060101-105, Monitored 2014-2015

Fox River at Hwy JJ
Photo by Rachel Sabre, South District Water Quality Biologist, DNR



*To learn more about this area, see this **Wisconsin TWA Project Online**!*

Find more about these waters, watersheds, and projects on *Explore Wisconsin's Waters Online* !

WISCONSIN DEPT. OF NATURAL RESOURCES

EGAD # 3200-2020-04
Water Quality Bureau,
Wisconsin DNR

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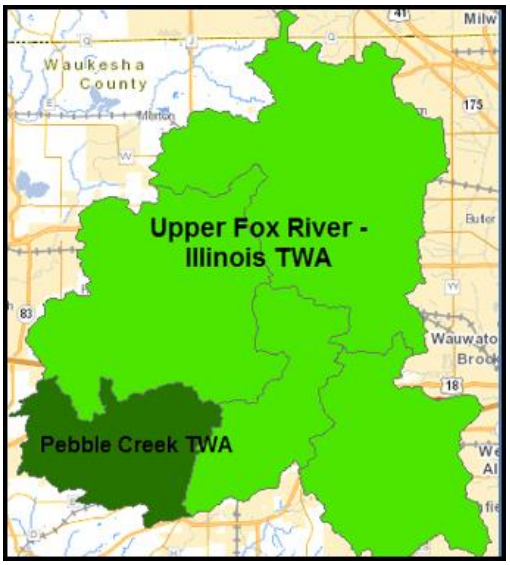
Targeted Watershed Assessment Study Summary



This is a two-year study that was initially developed to identify conditions in the Pebble Creek watershed and was later expanded to the Upper Fox River - Illinois Watershed to prepare data condition information for possible creation of a Nine Key Element Plan. During 2014-15, DNR conducted fish IBI sampling, macroinvertebrate sampling, continuous temperature monitoring and water chemistry sampling for total phosphorus.

Watershed monitoring sites were selected based on stream access, natural community modeling transitions, and position within the watershed. These watersheds contained few streams with limited road access. Site selection focused on existing road crossing, previous fisheries and water resources management sites, and access via public lands.

Data was collected during the field season in the Pebble Creek Watershed in 2014 calendar year and expanded to include the Pewaukee River Watershed, Poplar Creek Watershed and a second year of Pebble Creek Watershed Monitoring in 2015. The final HUC 12 watershed in the Upper Illinois Fox River Basin is Sussex Creek which was monitored in 2009/2010 (Appendix D for report). Fish and qualitative habitat surveys were conducted at 22 stream sites and Macroinvertebrate samples were collected at 22 sites. Water chemistry samples were collected monthly from the Fox River, Pewaukee River, and Poplar Creek during the growing season (May through October) for total phosphorus. The sites were located at the furthest downstream road crossing or access point within the HUC 12's to best represent each watershed.

This sampling included sites on: Pebble Creek (771300), Unnamed Trib to Pebble Creek (3000120), Unnamed Trib to Pebble Creek (3000119), Unnamed Trib to Pebble Creek (5035967), Brandy Brook (771400), Unnamed Trib to Brandy Brook (5036048), Unnamed Trib to Brandy Brook (5036099), Fox River (742500), Pewaukee River (771700), Unnamed Trib to the Pewaukee River (771800), Coco Creek (772100), Zion Creek (772400), Poplar Creek (772800) and Deer Creek (772900). Data was entered into the Fish and Habitat Management and SWIMS databases during the winter 2014 and 2015 for the field season.

About the Watershed

The project area covers the entire Upper Fox River - Illinois Watershed (FX07), a 151 square mile drainage area located almost entirely in Waukesha, with a very small portion located in Washington County in a wetland where the Fox River originates. The watershed contains approximately 153 miles of perennial and intermittent streams and one major lake, Pewaukee Lake, with a surface area of 2,493 acres. The Upper Fox River is the principal perennial stream in the watershed. Other significant perennial streams include Brandy Brook, Deer Creek, Pebble Creek, Pewaukee River, Poplar Creek and Sussex Creek. There are many incorporated municipalities within the watershed including the Cities of Brookfield, Delafield, New Berlin, Pewaukee and Waukesha. Also included are the Villages of Hartland, Lannon, Menomonee Falls, Pewaukee, Sussex and Wales.

Management Priorities

- Identify the sources of phosphorus in the Upper Fox River, Poplar Creek, Pewaukee River and Pebble Creek Watersheds and pursue local runoff management, lake and river/stream grants to reduce phosphorous inputs into local resources.
- Identify potential partners and stakeholders to participate in an overall awareness and behavioral change program in the watersheds that result in reduced erosion and phosphorus inputs.
- The department should work with watershed organizations on outreach efforts with landowners in the watershed, environmental programs in Upper Fox River watershed, and research opportunities for stream bank stabilization opportunities.
- Capitalize on the efforts of the Wisconsin DNR, Waukesha Lake County LCD, Pewaukee Lake Sanitary District, Pewaukee Lake Association, Southeastern Wisconsin Fox River Commission, NRCS, and USGS in these subwatersheds by implementing BMPs (stream bank restoration, sediment basins, vegetative buffers, etc.) where needed will likely have a significant improvement of the water quality in the creeks in the Upper Fox River Watershed and Pewaukee Lake.
- Working with landowners and county partners in the watershed to encourage restoration of stream banks and reduction of erosion is a high priority.
- Increasing buffer widths in these subwatersheds will likely have a nutrient and sediment reduction effect.

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 Fox IL 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.

_____	_____
Rachel Sabre, Water Quality Biologist, South District	Date
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Greg Searle, Water Quality Bureau Field Operations Director	Date
_____	_____
Timothy Asplund, Water Quality Bureau Monitoring Section Chief	Date

Basin/Watershed Partners

- University of Wisconsin - Extension
- Southeastern Wisconsin Fox River Commission
- Waukesha County
- Waukesha Land Conservancy
- Waukesha County Natural Resource Conservation Service
- Municipalities including all or portions of City of New Berlin, City and Town of Brookfield, Village of Menomonee Falls, Village of Lannon, Village of Sussex, City and Village of Pewaukee, City and Town of Waukesha, Village of Hartland, Town of Delafield, Town of Lisbon, Town of Genesee, Town of Merton, & Village of Wales
- Waukesha Environmental Action League
- Lake Pewaukee Sanitary District
- Pewaukee River Watershed Protection Plan Working Group
- Pewaukee River Partnership
- Southeastern Wisconsin Regional Planning Commission
- Carroll University

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- Lisa Helmuth, Program Coordinator, Water Quality Bureau, Wisconsin DNR

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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 land management practice used to prevent or reduce nonpoint source pollution such as runoff, total suspended solids, or excess nutrients.

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 support 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 – or Fish 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 gauge water condition based on biological data. Results indicate condition and provide insight into potential degradation sources. In Wisconsin, specific fish IBI tools are developed for specific natural communities. Biologists review and confirm the natural community to use the correct fish IBI tool.

HUC: **Hydrologic Unit Code.** A HUC is a code that represents nested hydrologic watersheds delineated by multiple agencies at the federal and state level including USGS, USFS, and Wisconsin DNR.

MIBI: **Macroinvertebrate Index of biological integrity.** In Wisconsin, the MIBI, or macroinvertebrate Index of biological integrity, was developed to assess macroinvertebrate community condition.

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

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.

NC: Natural Community. A system of categorizing water based on inherent physical, hydrologic, and biological components. Streams and Lakes have uniquely derived systems that result in specific natural community designations for each lake and river segment in the state. These designations dictate the appropriate assessment tools which improves the condition result, reflecting detailed nuances reflecting the modeling and analysis work foundational to the assessment systems.

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

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 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 number is the unique monitoring station identification number for the location of monitoring data.

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.

TWA: **Targeted Watershed Assessment.** A monitoring study design centered on catchments or watersheds that uses a blend of geometric study design and targeted site selection to gather baseline data and additional collection work for unique and site-specific concerns for complex environmental questions including effectiveness monitoring of management actions, evaluation surveys for site specific criteria or permits, protection projects, and generalized watershed planning studies.

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 Cod**e**. The WATERS ID is a unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code." This code is used to identify unique stream segments or lakes assessed and stored in the WATERS system.

WBIC: Water Body Identification Code. WDNR'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.

WSLH: Wisconsin State Laboratory of Hygiene– the state's certified laboratory that provides a wide range of analytical services including toxicology, chemistry, and data sharing.

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

Pebble Creek, Downstream at Madison Road. Photo by Rachel Sabre, DNR Water Quality Biologist, 2015.

Water Quality Plan Goals

The overall goal of this plan is to improve and protect water quality in the Upper Fox River – Illinois Watershed (Figure 1). 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.

This watershed is one of several included in the Fox River (Illinois) Basin, which is currently in the monitoring phase of TMDL development. A TMDL is a report that outlines nutrient and sediment reduction goals to restore the larger basin. Between the years of 2014 to the present, WDNR is monitoring subwatersheds to document contemporary conditions prior to publication of the TMDL. DNR anticipates monitoring to continue through 2022 and pollutant load modeling will occur through 2024, followed by the publication of a TMDL in 2026.

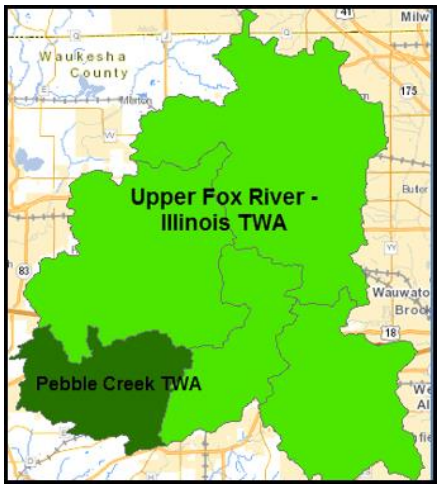


Figure 1: Watershed map

Resources Overview

Watershed

The Upper Fox River Watershed contains over 80 miles of perennial streams exhibiting a wide range of quality. The Fox River, Frame Park Creek, Lannon Creek, Spring (Sussex) Creek, Poplar Creek, Deer Creek, Zion Creek and several unnamed perennial streams are listed as impaired waters on the state's 303(d) list. Coco Creek, which flows into Pewaukee Lake, has the potential to support a cold-water community. Brandy Brook which is a Tributary to Pebble Creek which flows directly into the Fox River; both tributaries have the potential to support a cold-water community.

The Pewaukee River contains a decent forage and gamefish population. Sussex Creek has been impacted by development and mining in the area. Poplar Creek and Deer Creek have been impacted by residential, commercial and industrial development. These areas are severely impacted by development and by increases in the overall percentage of impervious surfaces. This contributes to the flashy nature of the streams in this watershed. Impoundments contribute to decreased fish migration and degraded water quality. Narratives describing each of these areas are in the report appendix.

Population, Land Use

The Upper Fox River - Illinois Watershed is 151.08 mi², which Pebble Creek, Pewaukee River, & Poplar Creek watersheds are a part of. Land use in the whole watershed is primarily suburban (37%), agricultural (27%) and a mix of forest (13%) and other uses (23%). This watershed has 218.00 stream miles, 2,907.45 lake acres and 12,048.42 wetland acres (Figure 2).

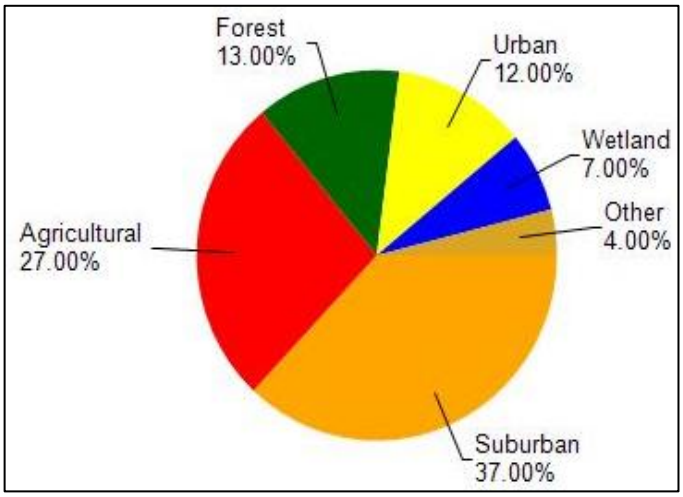


Figure 2: Land use percentages in the Upper Fox River – Illinois Watershed

Hydrology

The hydrologic cycle describes the various ways water is exchanged from one form or location to another. In Wisconsin, precipitation, in the form of rain, snow, and everything in-between, falls onto the earth's surface. It either soaks into the ground or flows across the land. The water that soaks into the ground recharges the groundwater table or flows laterally through the ground into a lake or stream. Water generally moves more quickly in coarse sand, sometimes as much as several feet per day. When precipitation infiltrates the sandier soils in this watershed, the water quickly moves vertically through the soils into the shallow Sand and Gravel Aquifer.

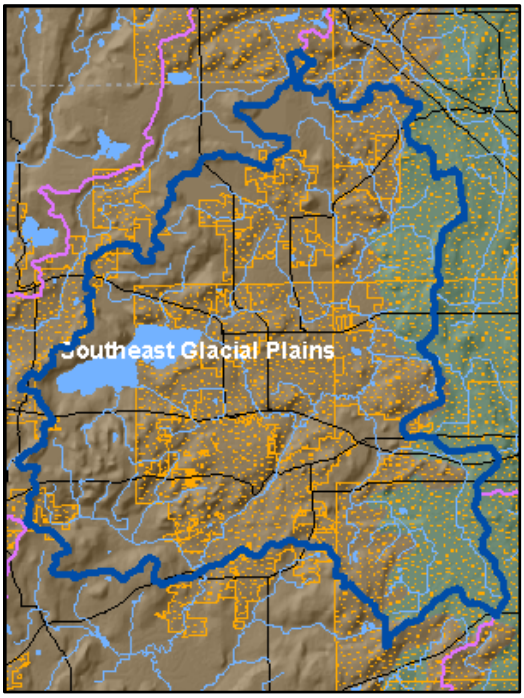
This Upper Fox River watershed includes 5 sub watersheds of Sussex Creek, Pewaukee River, Poplar Creek, Pebble Creek and City of Waukesha. There is one major lake within the watershed, Pewaukee Lake. There are 7 dams located in the watershed. Stream channelization has caused some degradation of water quality and habitat in the watershed. Also, impervious surfaces (such as roads, roofs, and parking lots) are increasing as urbanization proceeds. Impervious surfaces increase stormwater runoff, contributing to problems with erosion, water pollution, and flooding. The loss of original wetlands in the watershed has also had negative consequences.

Ecological Landscapes

The Upper Fox River - Illinois is located primarily in the Southeast Glacial Plains Ecological Landscape (Figure 3) which makes up the bulk of the non-coastal land area in southeast Wisconsin. This Ecological Landscape is made up of glacial till plains and moraines. Most of this Ecological Landscape is composed of glacial materials deposited during the Wisconsin Ice Age, but the southwest portion consists of older, pre-Wisconsin till with a more dissected topography. Soils are lime-rich tills overlain in most areas by a silt-loam loess cap. Agricultural and residential interests throughout the landscape have significantly altered the historical vegetation.

Most of the rare natural communities that remain are associated with large moraines or in areas where the Niagara Escarpment occurs close to the surface. Historically, vegetation in the Southeast Glacial Plains consisted of a mix of prairie, oak forests and savanna, and maple-basswood forests. Wet-mesic prairies, southern sedge meadows, emergent marshes, and calcareous fens were found in lower portions of the Landscape. End moraines and drumlins supported savannas and forests. Agricultural and urban land use practices have drastically changed the land cover of the Southeast Glacial Plains since Euro-American settlement. The current vegetation is primarily agricultural cropland. Remaining forests occupy only about 10% of the land area and consist of maple-basswood, lowland hardwoods, and oak. No large mesic forests exist today except on the Kettle Interlobate Moraine which has topography too rugged for agriculture. Some existing forest patches that were formerly savannas have succeeded to hardwood forest due to fire suppression.

Figure 3: Ecological Landscapes



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 much of the state. Efforts have been made to list all trout streams in the State of Wisconsin, but it is recognized that this listing in not exhaustive. Trout waters in this watershed are listed in Table 1.

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. Therefore, stocking is required to maintain a desirable sport fishery. These streams have good survival and carryover of adult trout, often producing some fish larger than average size. 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 1: Listed Trout waters in the Upper Fox River – Illinois Watershed (FX07)

Local Waterbody Name	WBIC	Start Mile	End Mile	Trout Class
Pebble Creek	771300	1.1	6.9	CLASS II
Brandy Brook	771400	0	5	CLASS I
Coco Creek	772100	0.51	2.36	CLASS II
Coco Creek	772100	2.36	3.49	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 2).

Impaired waters in the Upper Fox River – Illinois Watershed are polluted by sediment, PCBs, total phosphorus, and mercury. Sources of these pollutants include contaminated sediment, non-point source runoff, discharges from municipal separate storm sewer systems, landfills, atmospheric deposition, and legacy pollutants.

Table 2: Listed impaired waters in the Upper Fox River – Illinois Watershed (FX07), Waukesha County.

Official Name (Click for Details)	Local Name (Click for Map)	Start Mile	End Mile	WBIC	Pollutant	Impairment	Status
Fox River	Fox River (Below Barstow Impoundment)	105.34	109.21	742500	PCBs	PCBs Contaminated Fish Tissue	303d Listed
Fox River	Fox River	113.99	121.06	742500	PCBs	PCBs Contaminated Fish Tissue	303d Listed
Fox River	Fox River, Upper Barstow Impoundment	110.29	113.99	742500	PCBs	PCBs Contaminated Fish Tissue	303d Listed
Fox River	Fox River	113.99	121.06	742500	Sediment/Total Suspended Solids	Low DO	303d Listed
Fox River	Fox River	113.99	121.06	742500	Total Phosphorus	Low DO	303d Listed
Fox River	Fox River, Upper Barstow Impoundment	110.29	113.99	742500	Sediment/Total Suspended Solids	Low DO	303d Listed
Fox River	Fox River, Upper Barstow Impoundment	110.29	113.99	742500	Total Phosphorus	Low DO, Degraded Biological Community	303d Listed
Fox River	Fox River (Below Barstow Impoundment)	105.34	109.21	742500	Total Phosphorus	Low DO	303d Listed
Fox River	Fox River (Below Barstow Impoundment)	105.34	109.21	742500	Sediment/Total Suspended Solids	Degraded Habitat	303d Listed
Fox River	Fox River	121.06	130.55	742500	PCBs	PCBs Contaminated Fish Tissue	303d Listed
Lannon Creek	Lannon Creek	0.00	5.48	773700	Sediment/Total Suspended Solids	Degraded Habitat	303d Listed
Pewaukee River	Pewaukee River	0.00	6.43	771700	Chloride	NA	Delist
Poplar Creek	Poplar River (Creek)	0.00	3.64	772800	Total Phosphorus	Impairment Unknown	303d Listed
Poplar Creek	Poplar Creek	3.65	6.01	772800	Unknown Pollutant	Low DO	303d Listed
Poplar Creek	Poplar Creek	6.01	8.06	772800	Unknown Pollutant	Low DO	303d Listed
Poplar Creek	Poplar River (Creek)	0.00	3.64	772800	Unknown Pollutant	Low DO	303d Listed
Saratoga Lake	Lower Barstow Impoundment (Fox River)			771600	Sediment/Total Suspended Solids	Low DO, Turbidity	303d Listed
Saratoga Lake	Lower Barstow Impoundment (Fox River)			771600	PCBs	PCBs Contaminated Fish Tissue	303d Listed
Saratoga Lake	Lower Barstow Impoundment (Fox River)			771600	Total Phosphorus	Low DO, Turbidity	303d Listed
Saratoga Lake	Lower Barstow Impoundment (Fox River)			771600	Mercury	Mercury Contaminated Fish Tissue	303d Listed
Spring Creek	Spring Creek	0.00	6.57	773400	Total Phosphorus	Low DO	303d Listed
Unnamed	Deer Creek	0.00	8.09	772900	Elevated Water Temperature	Degraded Habitat	303d Listed
Unnamed	Deer Creek	0.00	8.09	772900	Total Phosphorus	Excess Algal Growth	303d Listed
Unnamed	Perennial Stream C (Sc011)	0.00	2.96	3000121	Total Phosphorus	Elevated Water Temperature	303d Listed
Unnamed	Frame Park Creek	0.00	1.26	771650	Total Phosphorus	Low DO	TMDL Development

Official Name (Click for Details)	Local Name (Click for Map)	Start Mile	End Mile	WBIC	Pollutant	Impairment	Status
Unnamed	Frame Park Creek	0.00	1.26	771650	Unspecified Metals	Chronic Aquatic Toxicity	303d Listed
Unnamed	Meadow Brook Creek	0.00	3.14	772300	Chloride	Chronic Aquatic Toxicity	303d Listed
Unnamed	Deer Creek	0.00	8.09	772900	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed
Unnamed	Coco Creek	0.51	2.36	772100	Unknown Pollutant	Degraded Biological Community	303d Listed
Unnamed	Perennial Stream C (Pb018)	0.00	1.88	3000119	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed
Unnamed	Perennial Stream C (Sc011)	0.00	2.96	3000121	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed
Unnamed	Frame Park Creek	0.00	1.26	771650	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed
Unnamed	Perennial Stream D (Pb016)	0.00	0.72	3000120	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed
Unnamed	Frame Park Creek	0.00	1.26	771650	PAHs	PAHs Contaminated Sediments	303d Listed
Unnamed	Master Disposal Drainage Channel	0.00	0.99	773300	Unknown Pollutant	Chronic Aquatic Toxicity	303d Listed
Unnamed	Local Water	0.00	4.45	771800	Chloride	Chronic Aquatic Toxicity	Proposed for List
Willow Creek	Willow Creek	0.00	2.80	18800	Fecal Coliform	Recreational Restrictions - Pathogens	TMDL Approved
Zion Creek	Zion Creek	0.00	1.65	772400	Total Phosphorus	Low DO	303d Listed
Zion Creek	Zion Creek	0.00	1.65	772400	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	303d Listed

Fish Consumption

Wisconsin's fish consumption advisory is based on the work of public health, water quality, and fisheries experts from eight Great Lakes states. Based on the best available scientific evidence, these scientists determined how much fish is safe to eat over a lifetime based on the contaminants found in the fish and how those contaminants affect human health. Advisories are based on concentrations of contaminants, along with angler habits, fishing regulations, and other factors.

In 2001, Wisconsin adopted a statewide general fish consumption advisory that applies to all (non-Great Lakes) waters of the state based on statewide distribution of mercury in fish and species differences in mercury concentrations. The statewide general advisory eliminated the need for many of the pre-2001 advisories because the equivalent of more stringent advice now applied through the general advisory. In addition to the statewide general advisory, some waters still require more stringent advice or exceptions to the general advisory. Exceptions to the general advice apply to some species of fish from specific waters where higher concentrations of mercury, PCBs, or other chemicals require advice more stringent than the general advisory. More information about the specific consumption advisory can be found in the publication: Choose wisely: a health guide for eating fish in Wisconsin [PUB-FH-824], which is found online at http://dnr.wi.gov/topic/fishing/consumption/index.html. The Fox River has had a specific restricted fish consumption advisory in effect for polychlorinated biphenyls (PCBs) since 1998.

AIS Species

Many waterways in the Upper Fox River Watershed host a variety of Aquatic Invasive Species, including but not limited to the following: Eurasian Water Milfoil, Curl Leaf Pondweed, Yellow Floating Heart, Rusty Crayfish, Chinese Mystery Snail, Banded Mystery Snail and Zebra Mussels It should be noted that there are likely invasive plant species that exist in wetland and riparian areas along the Fox River and its tributaries, including Japanese knotweed, purple loosestrife, reed canary grass, phragmites, garlic mustard and glossy buckthorn.

State Natural and Wildlife Areas

An amendment to the regional natural areas and critical species habitat protection and management plan for Southeastern Wisconsin was completed by SEWRPC in 2010. The plan seeks to identify and protect what remains of the landscape of the region as it existed pre-European settlement. The plan also seeks to identify and protect other areas found to be vital to the maintenance of endangered, threatened, and rare plant and animal species. Both plan objectives foster biodiversity in the Region. Under the plan, natural areas are defined as tracts of land or water so little modified by human activity, or which have sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of the pre-European-settlement landscape.

Critical species habitats are defined as additional tracts of land or water which support endangered, threatened, or rare plant or animal species. Natural areas, totaling 2,449 acres were identified in the Upper Fox River -Illinois Watershed. Three natural areas, totaling 19 acres, are protected within the watershed under public ownership; six natural areas, totaling 354 acres within the watershed, are under private ownership; and ten natural areas, totaling 2,076 acres, is protected within the watershed under partial private, partial public, and partial private conservation ownership. The 19 natural areas were identified, ranked according to their quality, and classified into one of the following three categories:

1. NA-1 Areas: native biotic communities of statewide significance that contain excellent examples of nearly complete and relatively undisturbed plant and animal communities that are believed to closely resemble those present during pre-European settlement times.

2. NA-2 Areas: native biotic communities that are judged to be of lower than NA-1 significance, perhaps on a county or regional basis. These areas are probably so designated because of evidence of a limited amount of human disturbance. They may also be of a high biotic quality, but of less than the minimum size necessary for an NA-1 ranking. In the future, some NA-2 sites may become of higher significance because of recovery from past disturbance, because of a sudden substantial decrease in the acreage of a once-common type, or after a more detailed inventory.

3. NA-3 Areas: native biotic communities substantially altered by human activities, but yet of local natural area significance. These sites often contain excellent wildlife habitat and also provide refuge for a large number of native plant species that no longer exist in the surrounding region because of land use activities. Specifically, the classification of an area into one of the foregoing categories is based upon consideration of the diversity of plant and animal species and community types present; the expected structure and integrity of the native plant or animal community; the extent of disturbance from human activities, such as logging, grazing, water-level changes, and pollution; the commonness of the plant and animal communities present; any unique natural features within the area; and the size of the area.

There were no natural areas within the Upper Fox River-Illinois Watershed that were ranked NA-1; 16 natural areas were ranked NA-2; and three natural areas were ranked NA-3. The total of 2,449 acres included within designated natural areas represents about 35 percent of the watershed. *Three critical species habitat sites, totaling 73 acres, were identified within the Upper Fox River -Illinois Watershed. One of these site, totaling 16 acres, is under public ownership, and one site, totaling 23 acres, are under private ownership and the final site, totaling 34 acres is under a mix of Public and Private ownership. (SEWRPC, 2010).*

Study Summary

Best Management Plan Evaluation

The primary purpose of this study was to identify the status of the Upper Fox River – Illinois Watershed (FX07) HUCs 071200060101-105 (Figure 4). Monitoring was conducted in 2014-15 to evaluate the success of best management practices (BMPs) implemented following a Runoff Management Planning Grant and planning report published in 2004. Through that grant process, *the Pebble Creek Watershed Protection Plan* (2004) to address stormwater runoff in the area.

Since that time, interest in creating a Nine Key Element Plan has increased and the need for compilation of water quality status has surfaced. This Clean Water Act Section 319 funded project evaluated the Upper Fox River Watershed, consisting of five HUC 12's (071200060101-105) which range in size from 10,953 acres to 30,781 acres.

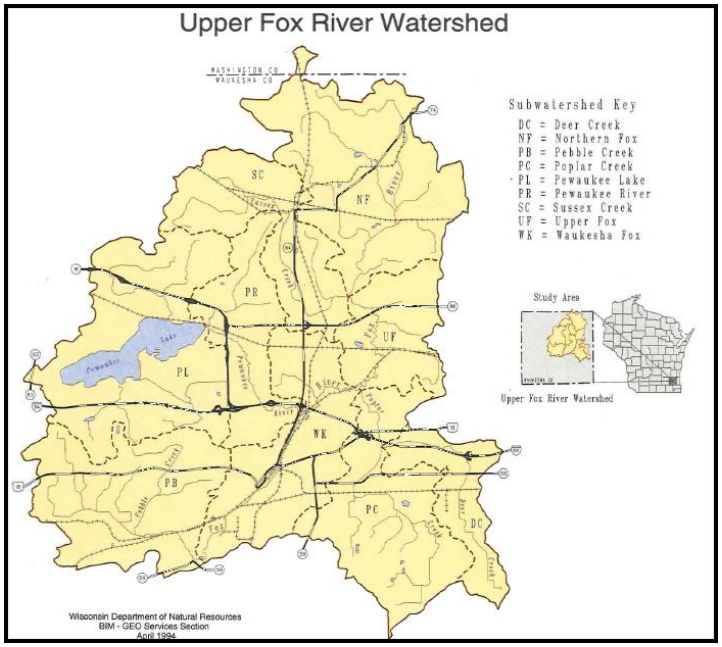


Figure 4. Upper Fox River Priority Watershed Map

The Waukesha County Division of Land Conservation along with WDNR, DATCP and the Upper Fox River Advisory Committee created the initial priority watershed plan in 1994 as part of the Wisconsin Nonpoint Source Water Pollution Abetment Program. Waukesha County Land Conservation Department worked with landowners over approximately a 10-year period to install various non-point BMPs throughout the watershed. DNR monitored 25-30 sites on various streams that received BMP implementation. Where there is limited background information available untreated reference reaches for comparative purposes may need to be selected.

Clean Water Act Condition Status

A secondary goal of this project was to determine Wisconsin Administrative Code ch. NR 102 (NR 102) phosphorus water quality criteria exceedances and degraded biological community and habitat impairments for USEPA Clean Water Act Section 303d (CWA 303d) listing purposes for the creeks in this area of the HUC 12 watershed. In 2014-15, an assessment was conducted by Wisconsin Department of Natural Resources Water Resources program staff.

The results helped determine whether these streams are achieving their attainable use to update the state's Clean Water Act Section 305(b) overall water quality condition data which is shared through Wisconsin's Water Quality Report to Congress. This work involves identifying waters that are not meeting their designated and attainable uses (Section 303(d)) and assess the overall health of the watersheds as required by Sections 305(b) and 208 of the Clean Water Act. The data, used in conjunction with observations about watershed health, are also used to guide planning for improvements where needed. The follow are outcomes of this study:

- Watershed was monitored with a baseline survey
- Watershed was monitored to understand status and presence of and sources of impairments.
- Streams in the system were monitored as a follow up to verify condition.
- Waters are the subject of the watershed plan.

Methods, Equipment and Quality Assurance

Collection of total phosphorus (TP), aquatic macroinvertebrates, stream flow, continuous temperature monitoring, fish, and habitat used standard WDNR data collection methods and samples were sent to certified laboratories in the state. No specific in-field duplicates, replicates or blanks were collected for the study; however quality assurance sampling procedures were used in the collection and preservation of samples for all parameters.

Water Chemistry - Total Phosphorus (TP)

TP Samples were collected using the standard DNR grab sampling method. All TP samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the Surface Water Integrated Monitoring System (SWIMS) database. Water Chemistry Samples were collected by volunteers and the water quality biologist.

- Guidelines and Procedures for Surface Water Grab Sampling (Dec. 2005 Version 3)
- 2301 open channel flow measurement
- Guidance for Dissolved Oxygen Meter Sampling

Continuous Temperature Monitoring

DNR staff deployed Tidbit's or small battery-powered devices that record temperatures over time. 6 Tidbits were deployed in Spring of 2014, however only 5 were recovered in Fall/Winter of 2014. The Tidbits collected temperature data every 30-60-minute intervals at these 5 locations. This data was used to determine if any of the sites meet the Coldwater temperature standards.

Macroinvertebrate Evaluation

All sites were sampled using the *WDNR Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams (2000).* A D-shaped kicknet with 600-micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then overhanging vegetation, woody debris, or other vegetation would be sampled. This is 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 University of Wisconsin-Stevens Point Aquatic Entomology Laboratory (UWSP AEL) for lowest possible taxonomic identification. Macroinvertebrate samples: were collected at 22 locations during the fall period Sept 14 through Oct 31, 2014 and 2015. Staff at the UWSP AEL entered the data into the SWIMS database in summer 2015 and 2016.

- Guidelines for Collecting Macroinvertebrate Samples in Wadeable Streams (2000)
- Wadeable Macroinvertebrate Field Data Report Form 3200-081 (R 08/14)

Fish Assemblage

All sites were surveyed following the *WDNR Guidelines for Evaluating Habitat of Wadable Streams (2002).* The fisheries assemblage was determined by a quantitative survey involving electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). All fish were collected, identified, and counted. All gamefish were measured for length. Fish IBI surveys were conducted on 22 stations May 15 through Sept 15. Data entered into the statewide FH database. Protocols were consistent with those outlined by Integrated Science Services.

- Wadeable Stream Fish Community Evaluation Form 3600-230 (R 7/00)
- Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin (2002)

Qualitative Habitat

Each qualitative habitat survey station length was 35 times the mean stream width of the survey station. Following the determination of station length, the staff took notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were also recorded. Qualitative Habitat Surveys: were collected at 22 locations the same day as the fishery surveys.

- Qualitative Habitat Rating less that 10m Form (3600-532A) (R 6/07)
- Guidelines for Qualitative Physical Habitat Evaluation of Wadeable Streams (2007)

Site Selection and Study Design

DNR staff conducted a combination of Fish IBI surveys (FS), macroinvertebrate sampling (MS), Qualitative Habitat Monitoring (QH) continuous temperature monitoring (CTM), Diatom sampling (DNI) and water chemistry (WC) sampling for total phosphorus at the sites listed below in the watershed (Table 3, Figure 5).

Major waters in the watershed that were sampled in this study include: Pebble Creek, Brandy Brook, Pewaukee River, Zion Creek, Coco Creek, Deer Creek Poplar Creek, and the Fox River. The watershed also includes Sussex Creek, Lannon Creek, and Frame Park Creek, which were not monitored in this study.

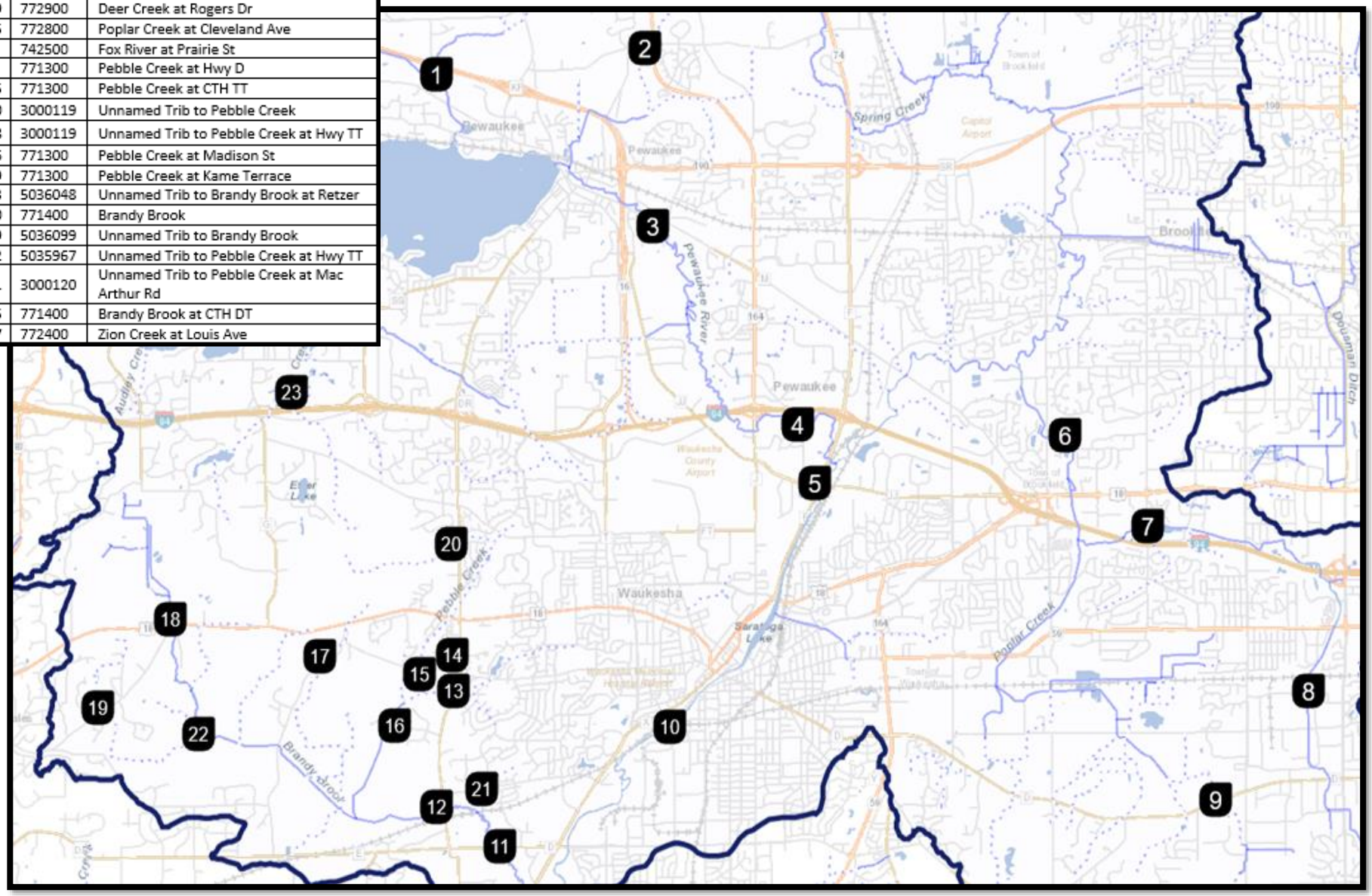
This study selected three HUC 12's after evaluating locations of BMP's installed on the landscape over the years. The number of fish stations for IBI's was 22, the number of macroinvertebrate sites was 22, number of DNI samples was 3, the number of qualitative habitat sites was 22. Water chemistry samples were collected at 23 sites including of 4 sites at 6 monthly samples.

Table 3: Monitoring stations and parameters sampled in the Upper Fox - Pebble Creek TWA Project

Map ID	Station ID	WBIC	Station Name	Year Monitored	Parameters Monitored	Fish	Habitat	Macro-inverte brate	Water Quality
1	10011876	772100	Coco Creek at Yench Rd	2015		X	X	X	X
2	10029789	771800	Unnamed Trib to Pewaukee River at Lindsey Rd	2015		X	X	X	X
3	10038944	771700	Pewaukee River at Hwy M	2015		X	X	X	X
4	10037396	771700	Pewaukee River at Busse Rd	2013; 2015		X	X	X	X
5	683225	742500	Fox River at CTH JJ	2015		X	X	X	X
6	10043144	772800	Poplar Creek Barker Rd	2014; 2015	DNI	X	X	X	X
7	10037059	772900	Deer Creek at Brookfield Rd	2015		X	X	X	X
8	10016039	772900	Deer Creek at Rogers Dr	2015		X	X	X	X
9	10040235	772800	Poplar Creek at Cleveland Ave	2015		X	X	X	X
10	683310	742500	Fox River at Prairie St	2015				X	X
11	683458	771300	Pebble Creek at Hwy D	2014	CTM, DNI	X	X	X	X
12	10016495	771300	Pebble Creek at CTH TT	2015	CTM	X	X		X
13	10041570	3000119	Unnamed Trib to Pebble Creek	2015	CTM	X	X	X	X
14	10043698	3000119	Unnamed Trib to Pebble Creek at Hwy TT	2014; 2015	CTM	X	X	X	X
15	10008076	771300	Pebble Creek at Madison St	2015		X	X	X	X
16	10039799	771300	Pebble Creek at Kame Terrace	2012; 2015	CTM	X	X	X	X
17	10041573	5036048	Unnamed Trib to Brandy Brook at Retzer	2014; 2015	CTM	X	X	X	X
18	10021350	771400	Brandy Brook	2014	CTM	X	X	X	X
19	10041569	5036099	Unnamed Trib to Brandy Brook	2014; 2015	CTM	X	X	X	X
20	10041572	5035967	Unnamed Trib to Pebble Creek at Hwy TT	2014	CTM	X	X		X
21	10041571	3000120	Unnamed Trib to Pebble Creek at Mac Arthur Rd	2014	CTM	X	X	X	X
22	10029545	771400	Brandy Brook at CTH DT	2014	CTM	X	X	X	X
23	10037387	772400	Zion Creek at Louis Ave	2013		X	X	X	X

Figure 5: Upper Fox River – Pebble Creek Watershed Monitoring Stations (FX07).

Map ID	Station ID	WBIC	Station Name
1	10011876	772100	Coco Creek at Yench Rd
2	10029789	771800	Unnamed Trib to Pewaukee River at Lindsey Rd
3	10038944	771700	Pewaukee River at Hwy M
4	10037396	771700	Pewaukee River at Busse Rd
5	683225	742500	Fox River at CTH JJ
6	10043144	772800	Poplar Creek Barker Rd
7	10037059	772900	Deer Creek at Brookfield Rd
8	10016039	772900	Deer Creek at Rogers Dr
9	10040235	772800	Poplar Creek at Cleveland Ave
10	683310	742500	Fox River at Prairie St
11	683458	771300	Pebble Creek at Hwy D
12	10016495	771300	Pebble Creek at CTH TT
13	10041570	3000119	Unnamed Trib to Pebble Creek
14	10043698	3000119	Unnamed Trib to Pebble Creek at Hwy TT
15	10008076	771300	Pebble Creek at Madison St
16	10039799	771300	Pebble Creek at Kame Terrace
17	10041573	5036048	Unnamed Trib to Brandy Brook at Retzer
18	10021350	771400	Brandy Brook
19	10041569	5036099	Unnamed Trib to Brandy Brook
20	10041572	5035967	Unnamed Trib to Pebble Creek at Hwy TT
21	10041571	3000120	Unnamed Trib to Pebble Creek at Mac Arthur Rd
22	10029545	771400	Brandy Brook at CTH DT
23	10037387	772400	Zion Creek at Louis Ave



Project Results

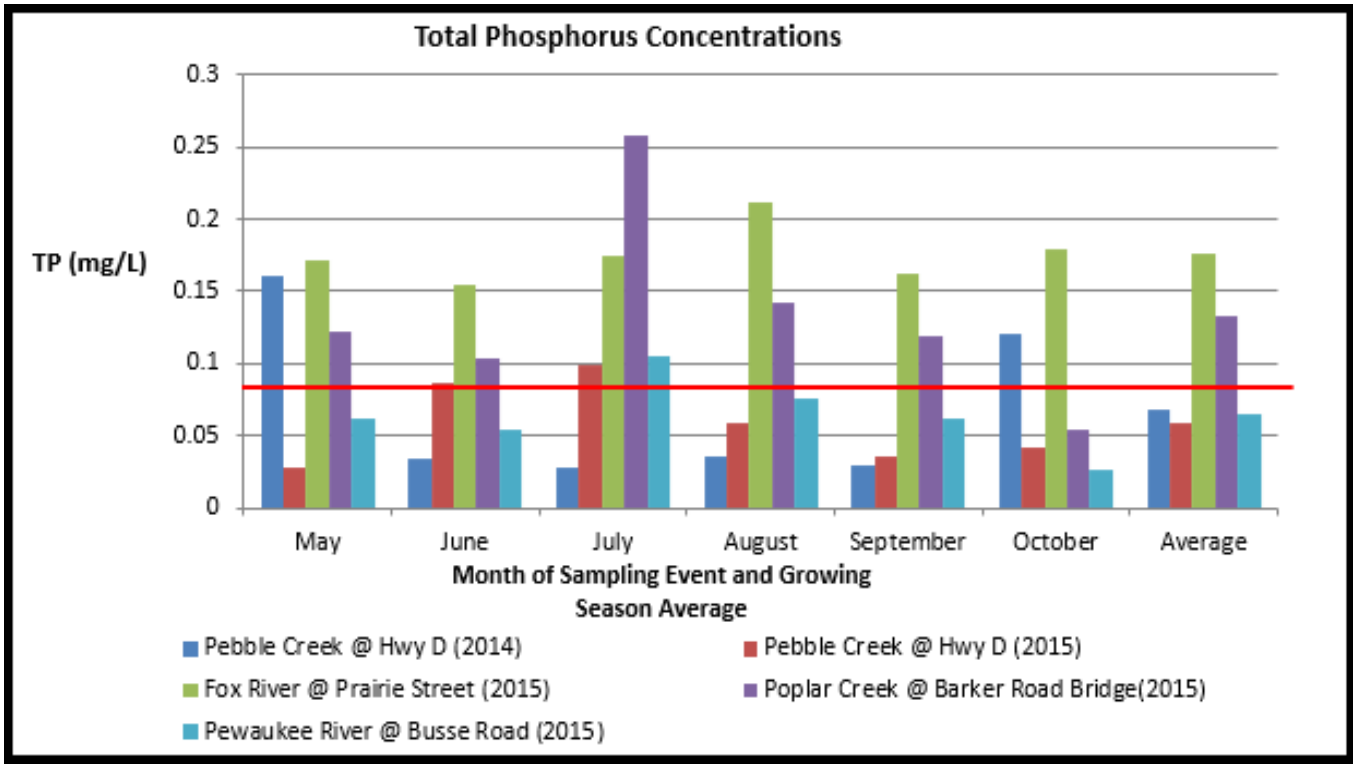
Water Chemistry - Total Phosphorus

All inorganic chemistry samples were sent to the WISLOH in Madison for analysis. Two of the four creeks' samples in the Upper Fox River watershed had an average TP concentration (mg/L) exceeding the NR 102 water quality criteria (WQC) for creeks and rivers of 0.075 mg/L (Table 4, Figure 6).

Table 4: Total Phosphorus Concentrations and Averages in 4 Creeks Sampled in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015

Map ID	11	11	10	6	4
Month of Sampling Event	Pebble Creek at Hwy D (2014)	Pebble Creek at Hwy D (2015)	Fox River at Prairie St (2015)	Poplar Creek at Barker Rd (2015)	Pewaukee River at Busse Rd (2015)
May	0.161	0.0284	0.171	0.122	0.0614
June	0.0345	0.087	0.155	0.104	0.055
July	0.0274	0.0987	0.175	0.258	0.105
August	0.035	0.0584	0.212	0.142	0.0758
September	0.0289	0.0365	0.162	0.119	0.0625
October	0.121	0.0415	0.18	0.055	0.0267
Average	**0.0680**	**0.0584**	**0.1758**	**0.1333**	**0.0644**

Figure 6: Total Phosphorus Concentrations and Averages (with 0.075 mg/L WQC red line) in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015.



Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2018) requires a parametric statistical approach to assess creek TP data against the applicable water quality criterion found in NR 102. 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 creek segment (assessment unit) is exceeding the criterion. The LCLs were calculated for each creek's TP samples at the 4 of the HUC 12 watershed pour points (Table 5). Two of the four creeks' samples LCLs met the water quality criterion for TP at Pebble Creek and Pewaukee River, while two exceeded (Table 5, Figure 7) Fox River and Poplar Creek.

Table 5: Total Phosphorus Lower 90% Confidence Limits and Water Quality Criteria Exceedance Status of 4 Streams in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015

Map ID	11	10	6	4
	Pebble Creek at Hwy D (2015)	Fox River at Prairie St (2015)	Poplar Creek at Barker Rd (2015)	Pewaukee River at Busse Rd (2015)
LCL (90%) mg/L	0.0408	0.1114	0.0891	0.0453
Exceedance Level	Meets	Exceeds	Exceeds	Meets

Single Total Phosphorous samples were taken at 17 sample sites in the 2014 and 2015 sample seasons. A total of seven of those 17 sites exceed the 0.075mg/L water quality criteria (Table 6, Figure 8).

Figure 7: Total Phosphorus Lower 90% Confidence Limit (with 0.075 mg/L WQC red line) in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015

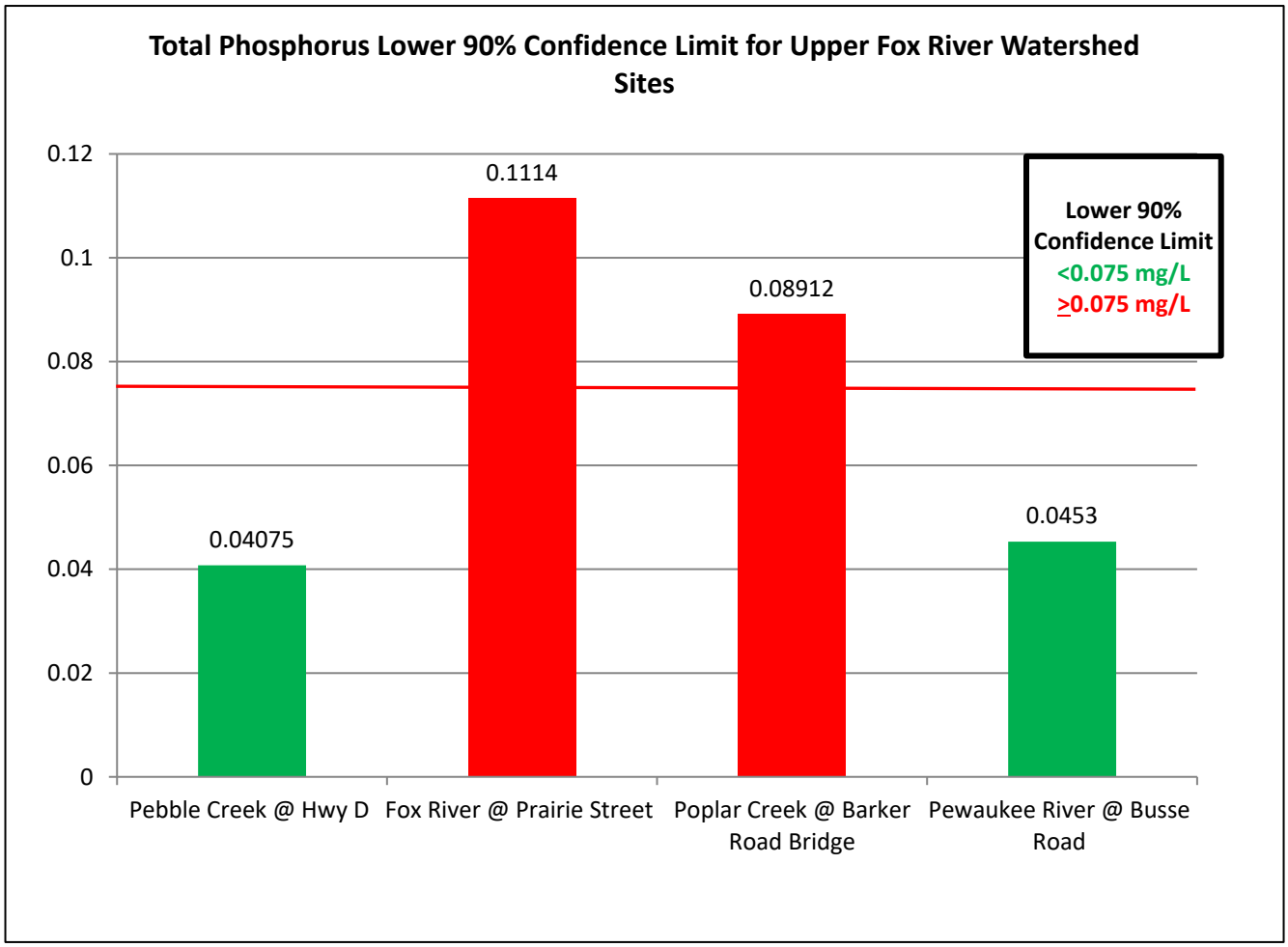
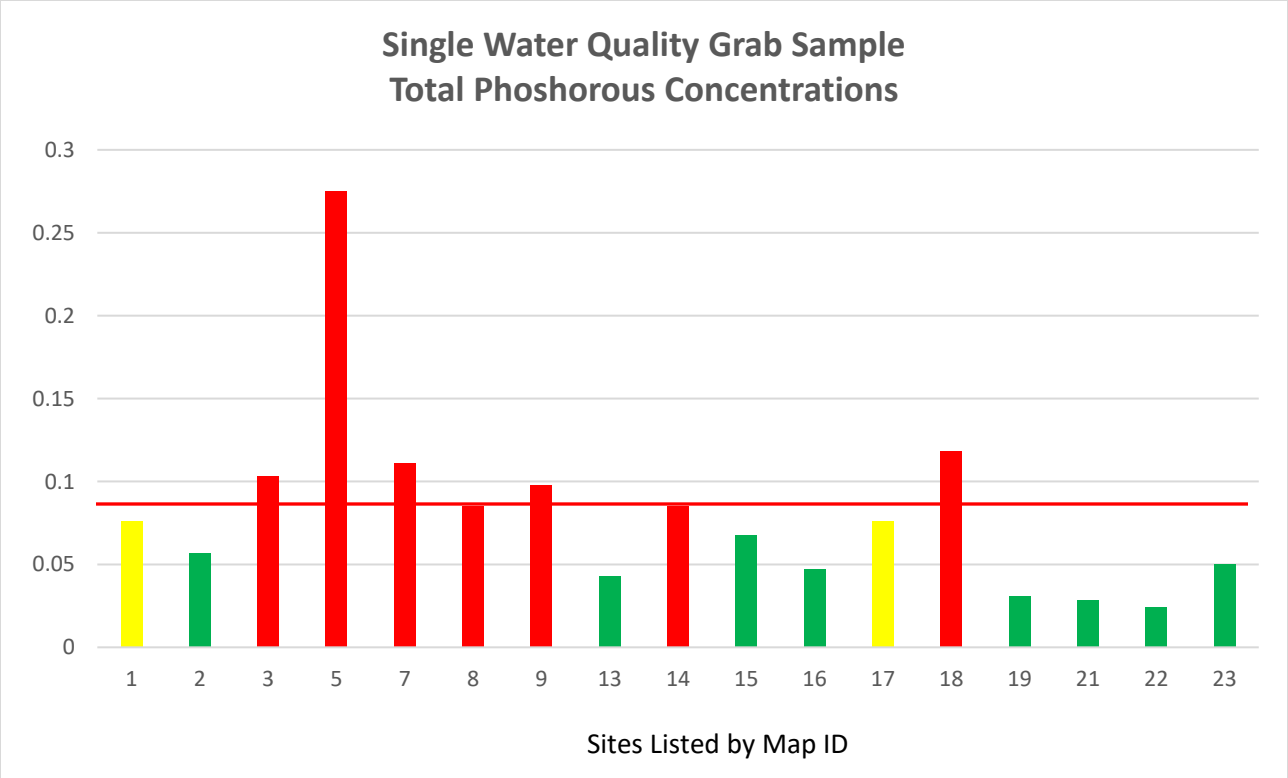


Table 6: Total Phosphorus Concentrations for single grab samples at sites in the Upper Fox River – Illinois Watershed (FX07) in 2014

Map ID	Stream Name and Site Location	TP mg/L	Single Sample Date
1	Coco Creek at Yench Road	0.0763	06/25/15
2	Pewaukee River at Lindsey Road	0.0566	06/25/15
3	Pewaukee River at HWY M	0.103	08/05/15
5	Fox River at CTH TT	0.275	08/12/15
7	Deer Creek at Brookfield Road	0.111	08/11/15
8	Deer Creek at W Rogers Drive	0.0852	06/18/15
9	Poplar Creek at W Cleveland Ave	0.0976	06/18/15
13	Unnamed Trib to Pebble Creek	0.0429	07/21/14
14	Unnamed Trib to Pebble Creek at Hwy TT	0.0852	06/19/15
15	Pebble Creek at Madison St.	0.0679	06/18/15
16	Pebble Creek at Kame Terrace	0.0473	06/29/15
17	Unnamed Trib to Brandy Brook at Retzer	0.0758	07/21/14
18	Brandy Brook	0.118	07/21/14
19	Unnamed Trib to Brandy Brook	0.0308	07/21/14
21	Unnamed Trib to Pebble Creek at Mac Arthur Rd	0.0283	07/21/14
22	Brandy Brook at CTH DT	0.0245	07/21/14
23	Zion Creek at Louis Ave	0.05	08/13/13

Figure 8 Total Phosphorus Concentrations for single grab sample sites (with 0.075 mg/L WQC red line) in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015



Continuous Temperature Monitoring

Seven Continuous Temperature Monitoring devices were deployed in May of 2014 in the Pebble Creek Watershed. Only 5 of the 7 were retrieved in October of 2014 when macroinvertebrate sampling occurred at the sites. One of the sites, the brick was located, however the device was no longer attached and not found. For the second missing device site, the brick and device were never found. The monitoring devices were set to record water temperature every hour on the hour till retrieved. Most sites had a minimum of 3000 individual temperature measurements logged. Unfortunately, the temperature monitor located on the main stem of Brandy Brook, a Class I trout stream and one of the only sites to have trout found in the fish survey, was one of the two sites that the continuous temperature monitoring device was lost.

For two of the five sites, the temperature data confirmed that the streams meet the cold-water criteria for temperature. This was also confirmed with the presence of several spring head found during site visits. One of the five sites are within the range of the cool water temperature of 72 to 77-degree Fahrenheit for the maximum summer daily mean temperature. The last two sites had maximum temperatures during the summer that exceed the 77-degree Fahrenheit temperature to meet the warm water temperature criteria.

No follow up continuous temperature monitoring was conducted as part of the 2015 Upper Fox River Project.

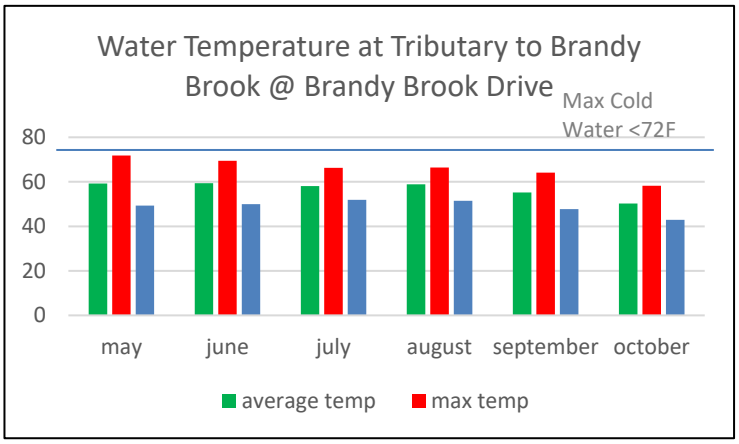
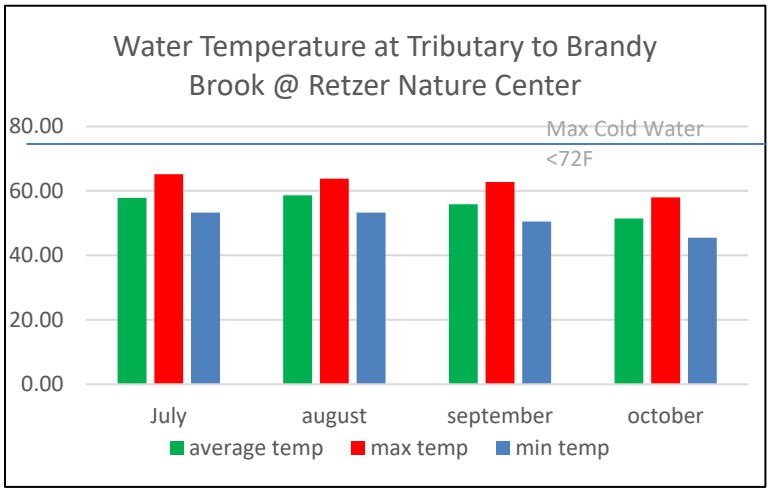


Figure 9: Tributary to Brandy Brook (Map ID #19) Average, Maximum and Minimum Monthly Water Temperature in 2014

Figure 10: Tributary to Brandy Brook (Map ID #17) at Retzer Nature Center Average, Maximum and Minimum Water Temperatures in 2014



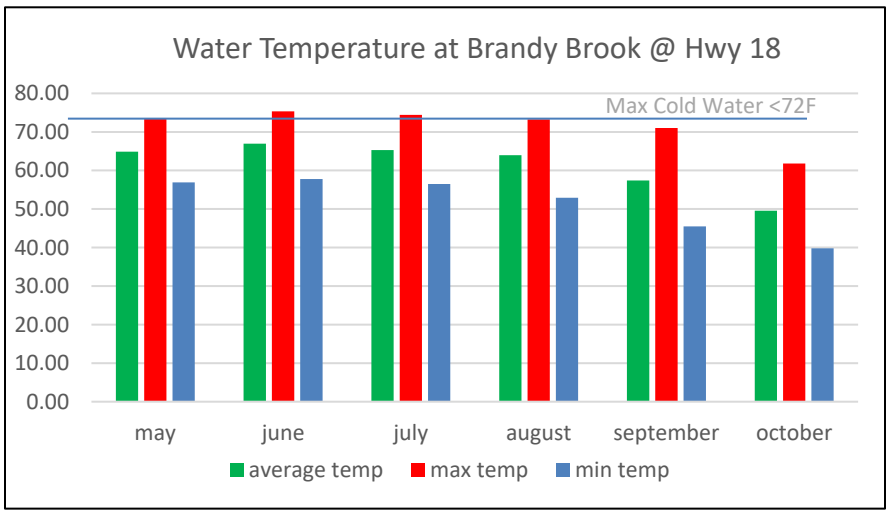
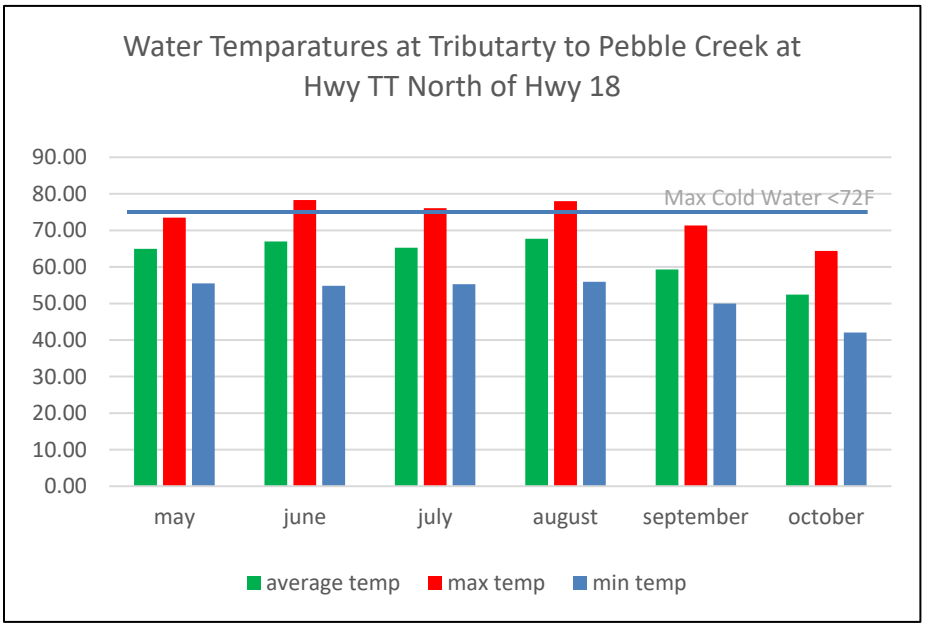


Figure 11: Brandy Brook @ Hwy 18 (Map ID # 18) Average, Maximum and Minimum Monthly Water Temperature in 2014

Figure 12: Tributary to Pebble Creek north of Hwy at TT (Map ID #20) Average, Maximum and Minimum Water Temperatures in 2014



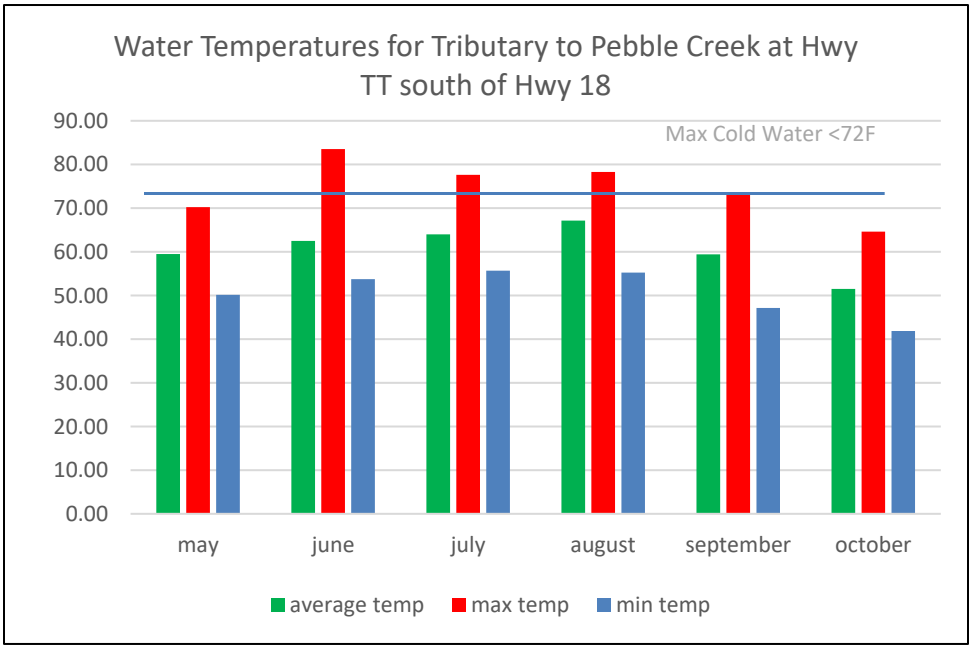


Figure 13: Tributary to Pebble Creek at Hwy TT south of Hwy 18 (Map ID #14) Average, Maximum and Minimum Water Temperatures in 2014

Macroinvertebrates

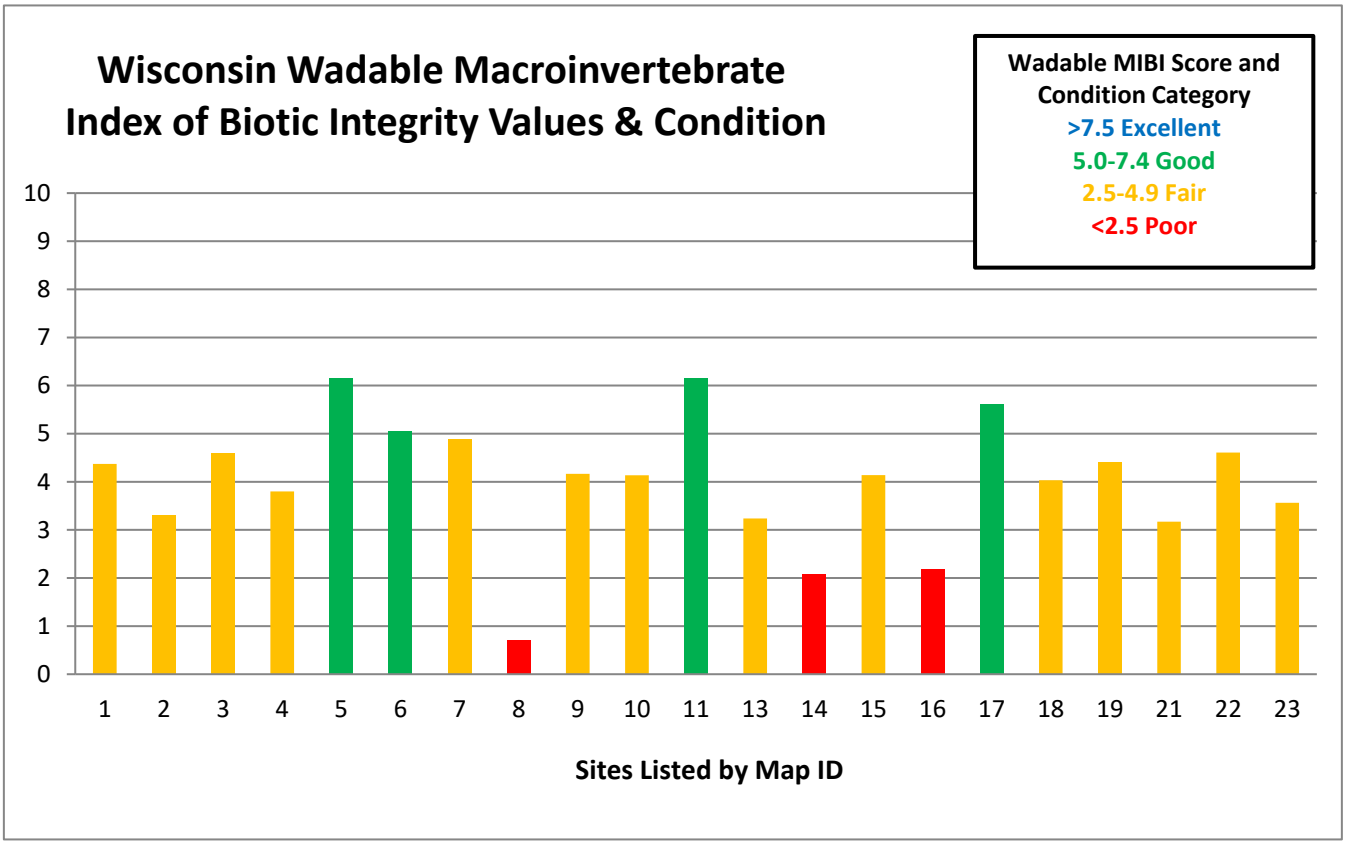
In October 2014 and 2015, each of the 22 streams sites in Table 3 were sampled for aquatic macroinvertebrate communities in the Upper Fox River watershed (Figure 14). Some aquatic macroinvertebrate species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate sample collected and their associated tolerance to environmental degradation, a Macroinvertebrate Index of Biotic Integrity (MIBI) was calculated to indicate the water quality condition of the stream (Table 7, Figure 14). The MIBI scores ranged from 0.71 at Deer Creek at Rogers Road to 6.149 at Fox River Upstream of Hwy JJ. The Condition Categories for the sites were from Poor to Good (Table 7, Figure 14). All but 4 of the streams demonstrated a macroinvertebrate community significantly impacted by environmental degradation.

Table 7: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Upper Fox River – Illinois Watershed (FX07) in October 2014 and 2015

Map ID	Stream Name and Location	Macroinvertebrate IBI Score	Condition Category
1	Coco Creek at Yench Rd	4.370	Fair
2	Pewaukee River at Lindsey Rd	3.294	Fair
3	Pewaukee River at Hwy M	4.601	Fair
4	Pewaukee River at Busse Rd	3.799	Fair
5	Fox River at CTH TT	6.149	Good
6	Poplar Creek Barker Rd	5.051	Good
7	Deer Creek at Brookfield Rd	4.884	Fair
8	Deer Creek at Rogers Dr	0.711	Poor
9	Poplar Creek at Cleveland Ave	4.166	Fair
10	Fox River at Prairie St	4.134	Fair
11	Pebble Creek at Hwy D	6.142	Good
13	Unnamed Trib to Pebble Creek	3.236	Fair
14	Unnamed Trib to Pebble Creek at Hwy TT	2.087	Poor
15	Pebble Creek at Madison St.	4.138	Fair
16	Pebble Creek at Kame Terrace	2.185	Poor
17	Unnamed Trib to Brandy Brook at Retzer	5.621	Good
18	Brandy Brook	4.031	Fair
19	Unnamed Trib to Brandy Brook	4.413	Fair
21	Unnamed Trib to Pebble Creek at Mac Arthur Rd	3.171	Fair
22	Brandy Brook at CTH DT	4.609	Fair
23	Zion Creek at Louis Ave	3.564	Fair

Biologist Rachel Sabre holding a Northern Pike during the Pebble Creek at Hwy D fish survey (Photo by Craig Helker)

Figure 14: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Upper Fox River – Illinois Watershed (FX07) in October 2014 and 2015



Fish Species

The fish community is an environmental indicator that can help characterize the water quality of a stream resource. Fish species are classified as tolerant, intermediate and intolerant and can indicate the presence of environmental stressors including thermal, chemical, or habitat issues.

Survey sites included streams in the Upper Fox River Watershed on named and unnamed streams (Table 8 and 9). A total of 30 species of fish were captured in the 22 fish surveys. Thirteen fish species were found in headwater streams including 5 tolerant and 3 intolerant species. Seventeen species of fish were found in the mainstem sites including 6 tolerant and 3 intolerant species. (Table 8 and 9).

A total of 18 sites were assessed for a condition category based on the modeled natural community type of each waterway (Table 8, 9, 10 and Figure 22)). Seven of the streams are modeled as a Cool-Cold Headwater Stream. Of those seven streams four are in Poor condition. Two are in Fair condition and one is in Good condition. One stream, Pebble Creek at Hwy D is modeled as a Cool-Warm Mainstem and received a Condition Category of Good. Seven of the streams are modeled as a Cool-Warm Headwater Stream. Of those seven streams three are in Poor condition, three are in Fair condition and one is in Good condition. Three of the streams are modeled as Warm Mainstem and of those three sites, one site each is listed as Poor, Fair and Good conditions.

Table 8: Fish species sampled in the Upper Fox River -Illinois Watershed in 2014

Map ID	11	13	17	18	20	21	22	
Species Common Name	Pebble Creek at Hwy D	Trib to Pebble Creek	Trib to Brandy Retzer	Brandy Brook	Trib to Pebble US TT	Trib to Pebble Creek at Mac Arthur	Brandy Brook DS of CTH DT	Fish Tolerance Rating
Brown Trout							16	Intolerant
Northern Pike	5							Intermediate
Central Mudminnow	130	3		4	1	1	3	Tolerant
Spotfin Shiner		2			2			Intermediate
Fathead Minnow	45							Tolerant
White Sucker	80						5	Tolerant
Black Bullhead		1						Tolerant
Rock Bass	4							Intolerant
Green Sunfish	4							Tolerant
Pumpkinseed	1							Intermediate
Bluegill	8							Intermediate
Mottled Sculpin	30						127	Intolerant
Brook Stickleback	6	1	2			2		Tolerant
Rainbow Darter	1						1	Intolerant
Johnny Darter	78							Intermediate
Fish Totals	392	7*	2*	4*	3*	3*	152	*Less than 50 fish in survey
Species Total	12	4	1	1	2	2	5	

Table 9: Fish species sampled in the Upper Fox River -Illinois Watershed in 2015

Map ID	1	2	3	4	5	6	7	8	9	13	14	15	16	20	
Species Common Name	**Coco Creek at Yench Rd**	**Pewaukee River at Lindsey Rd**	**Pewaukee River at Hwy M**	**Pewaukee River at Busse Rd**	**Fox River at CTH JJ**	**Poplar Creek at Barker Rd**	**Deer Creek at Brookfield Rd**	**Deer Creek at Rogers Dr**	**Poplar Creek at Cleveland Ave**	**Trib to Pebble US TT**	**Trib to Pebble Creek at Hwy TT**	**Pebble Creek at Madison St**	**Pebble Creek at Kame Terrace (2012 survey)**	**Trib to Pebble Creek**	Fish Tolerance Rating
Brown Trout	2												1		Intolerant
Northern Pike			1		1	2									Intermediate
Central Mudminnow	67		129	1	13	65	99		16	1		1		1	Tolerant
Common Carp					5	17	11								Tolerant
Hornyhead Chub				208	20										Intermediate
Common Shiner			4	94	8		7								Intermediate
Bluntnose Minnow			1				8			1				1	Tolerant
Fathead Minnow					1			3	1	1		2	3	1	Tolerant
Creek Chub				6	1		50	6	34	9		1	19	9	Tolerant
White Sucker			8	11	23	26	8	17	4			1	28		Tolerant
Black Bullhead			12			4							3		Tolerant
Yellow Bullhead			62	21		2									Tolerant
Stonecat		2		5	12										Intermediate
Rock Bass			13	9	124	5									Intolerant
Green Sunfish	3		6	17	22	5			13			4	47		Tolerant
Pumpkinseed	5		7		1										Intermediate
Bluegill			2		5	2							10		Intermediate
Smallmouth Bass					5										Intolerant
Largemouth Bass					1	2	2								Intermediate
Bowfin						1									Intermediate
Mottled Sculpin												1	10		Intolerant
Brook Stickleback						4	5		2	2	1			2	Tolerant
Rainbow Darter				4	21										Intolerant
Johnny Darter	1		4	2	104	46	8		24				21		Intermediate
Yellow Perch			1												Intermediate
Blackside Darter						5									Intermediate
Golden Shiner													2		Tolerant
Fish Totals	78	2*	250	378	367	186	198	26*	94	14*	1*	10*	144	14*	*Less than 50 fish in survey
Species Total	5	1	13	11	17	14	9	3	7	5	1	6	10	5	

The most common fish species collected from the tributaries were creek chub, hornyhead chub, common shiner, johnny darters, and central mudminnows. These species accounted for 60% of the total fish collected in the headwater streams. Twenty nine percent of the total fish captured in Headwater streams were tolerant species (Figure 15).

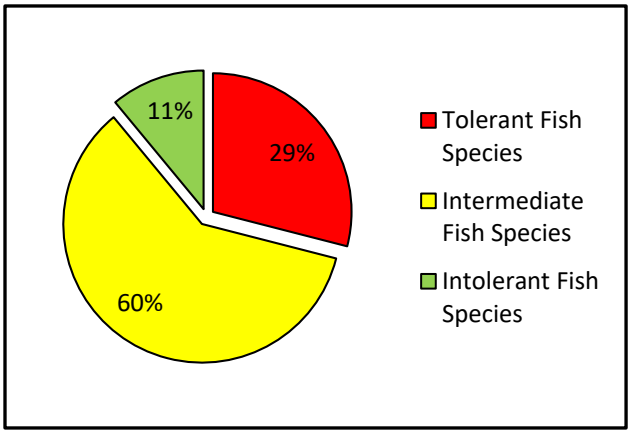


Figure 15: Fish Assemblage in Headwater Stream Fish Species Tolerance Levels

Natural Communities and Condition

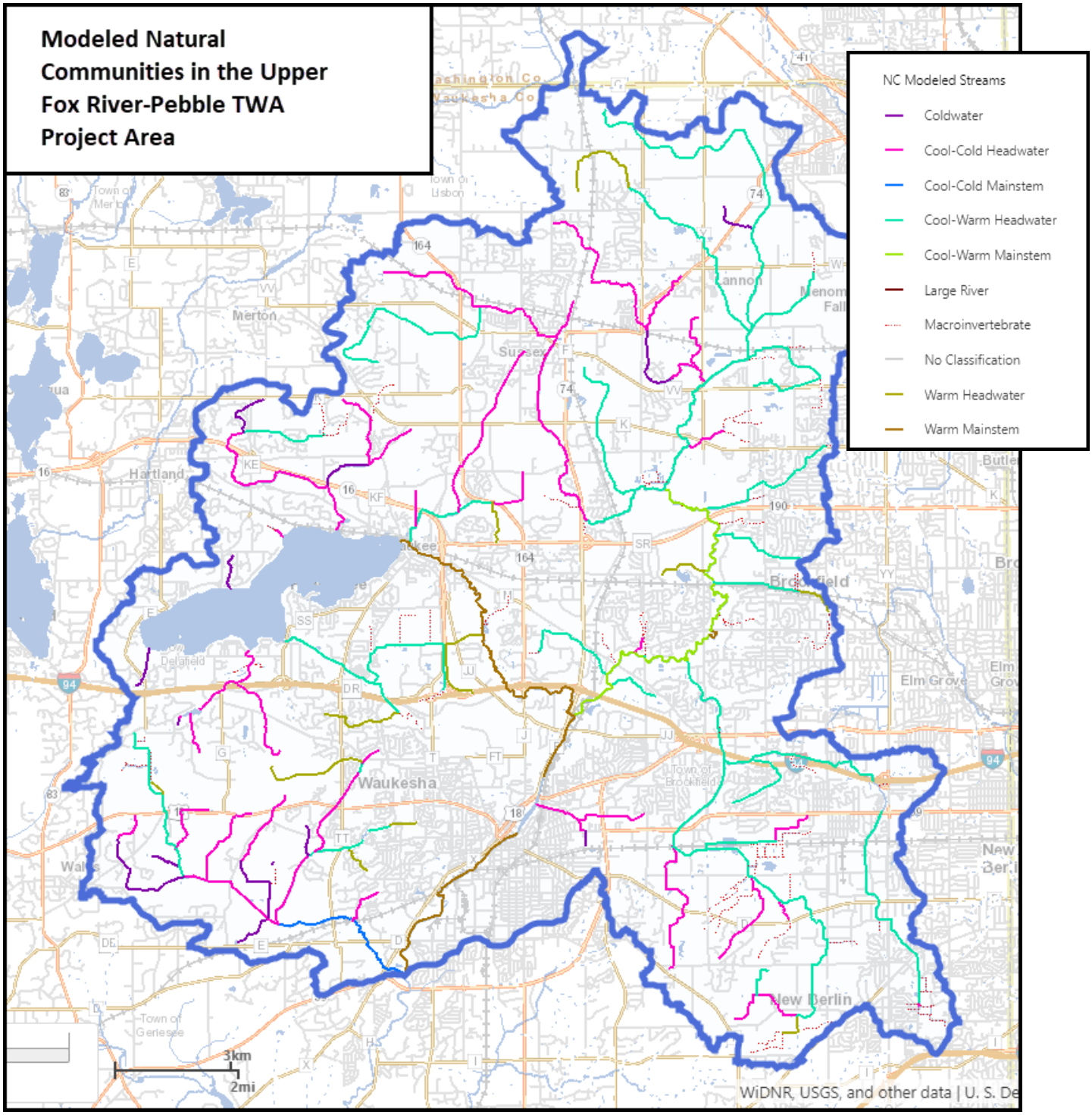
Table 10 and Figure 16 display the modeled natural communities for stations in the study.

Table 10: Index of Biotic Integrity Scores and Condition Category for Fish Surveys in the Upper Fox River – Illinois Watershed (FX07) in 2014 and 2015

Map ID	Site Name	FIBI Score	Condition Category	Modeled Natural Community
1	Coco Creek at Yench Road	20	Poor	Cool-Cold Headwater
3	Pewaukee River at Hwy M	25	Poor	Warm Mainstem
4	Pewaukee River at Busse Rd	47	Fair	Warm Mainstem
5	Fox River at CTH JJ	52	Good	Warm Mainstem
6	Poplar Creek Barker Rd	70	Good	Cool-Warm Headwater
7	Deer Creek at Brookfield Rd	50	Fair	Cool-Warm Headwater
8	Deer Creek at Rogers Dr	30*	Poor	Cool-Warm Headwater
9	Poplar Creek at Cleveland Ave	60	Fair	Cool-Warm Headwater
11	Pebble Creek at Hwy D	60	Good	Cool-Cold Mainstem
13	Unnamed Trib to Pebble Creek	40*	Fair	Cool-Warm Headwater
14	Unnamed Trib to Pebble Creek at Hwy TT	10*	Poor	Cool-Warm Headwater
15	Pebble Creek at Madison St	60*	Fair	Cool-Cold Headwater
16	Pebble Creek at Kame Terrace	80	Good	Cool-Cold Headwater
17	Unnamed Trib to Brandy Brook at Retzer	10*	Poor	Cool-Cold Headwater
18	Brandy Brook	0*	Poor	Cool-Warm Headwater
21	Unnamed Trib to Pebble Creek at Mac Arthur Rd	10*	Poor	Cool-Cold Headwater
22	Brandy Brook at CTH DT	50	Fair	Cool-Cold Headwater
23	Zion Creek at Louis Ave	10*	Poor	Cool-Cold Headwater

**Less than 50 Fish in Survey*

Figure 16. Modeled Natural Communities in the Upper Fox River – Illinois Watershed (FX07)



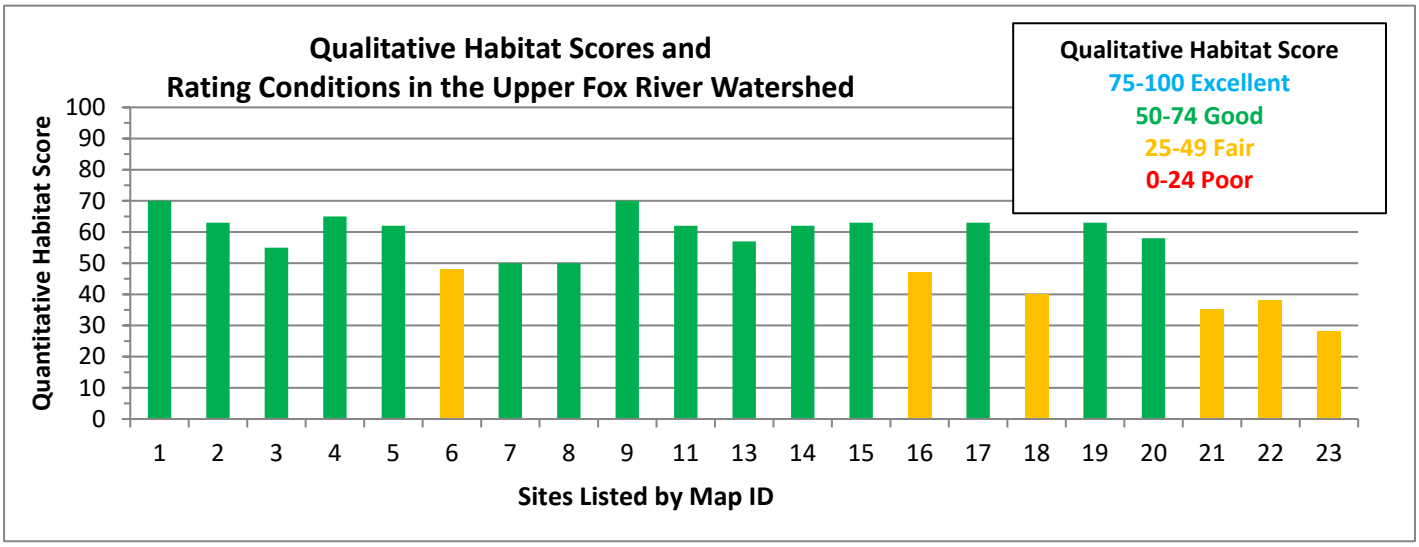
Habitat Survey

Between June and September 2014 and 2015, quantitative habitat surveys were conducted at the 15 streams listed in Table 5 (21 sites) in the Upper Fox River watershed. 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 2014 and 2015 surveys, a habitat rating was calculated for the 21 creeks (Table 11, Figure 15). The habitat condition scores were relatively similar for all streams. The habitat rating scores ranged from 28 at the Zion Creek to 70 at Poplar Creek and Coco Creek (Table 11, Figure 18). Six of 21 the surveys demonstrated a Condition Category of Fair, with scores ranging from 28-48. The remaining survey stations scored a Good Condition Category, with a score of 50-70 (Table 11, Figure 17).

Table 11: Quantitative Habitat Scores and Condition Category in the Upper Fox River Watershed in 2014 and 2015

Map ID	Stream Name and Site Location	Quantitative Habitat Score	Condition Category
1	Coco Creek at Yench Road (75m Upstream)	70	Good
2	Pewaukee River at Lindsey Road	63	Good
3	Pewaukee River @ HWY M Bridge	55	Good
4	Pewaukee River 14M US of Busse Rd S of I-94	65	Good
5	Fox River at CTH TT (Bi Survey)	62	Good
6	Poplar Creek Barker Road Bridge	48	Fair
7	Deer Creek at Brookfield Road	50	Good
8	Deer Creek at W Rogers Drive	50	Good
9	Poplar Creek at W Cleveland Ave 0.2 mi W of S Calhoun Rd	70	Good
11	Pebble Creek - 0184-B at Hwy D	62	Good
13	Unnamed Trib to Pebble Creek	57	Good
14	Unnamed Trib to Pebble Creek DS of Hwy TT	62	Good
15	Pebble Creek - 1-Madison St.	63	Good
16	Pebble Creek at Kame Terrace Culvert	47	Fair
17	Unnamed Trib to Brandy Brook at Retzer	63	Good
18	Brandy Brook	40	Fair
19	UN Trib to Brandy Brook	63	Good
20	UN Trib to Pebble Creek at Hwy TT	58	Good
21	UN Trib to Pebble Creek at Mac Arthur Rd	35	Fair
22	Brandy Brook 210m DS of CTH DT	38	Fair
23	Zion Creek 40m US of Louis Ave	28	Fair

Figure 17. : Qualitative Habitat Scores for sites in the Upper Fox River Watershed in 2014 and 2015

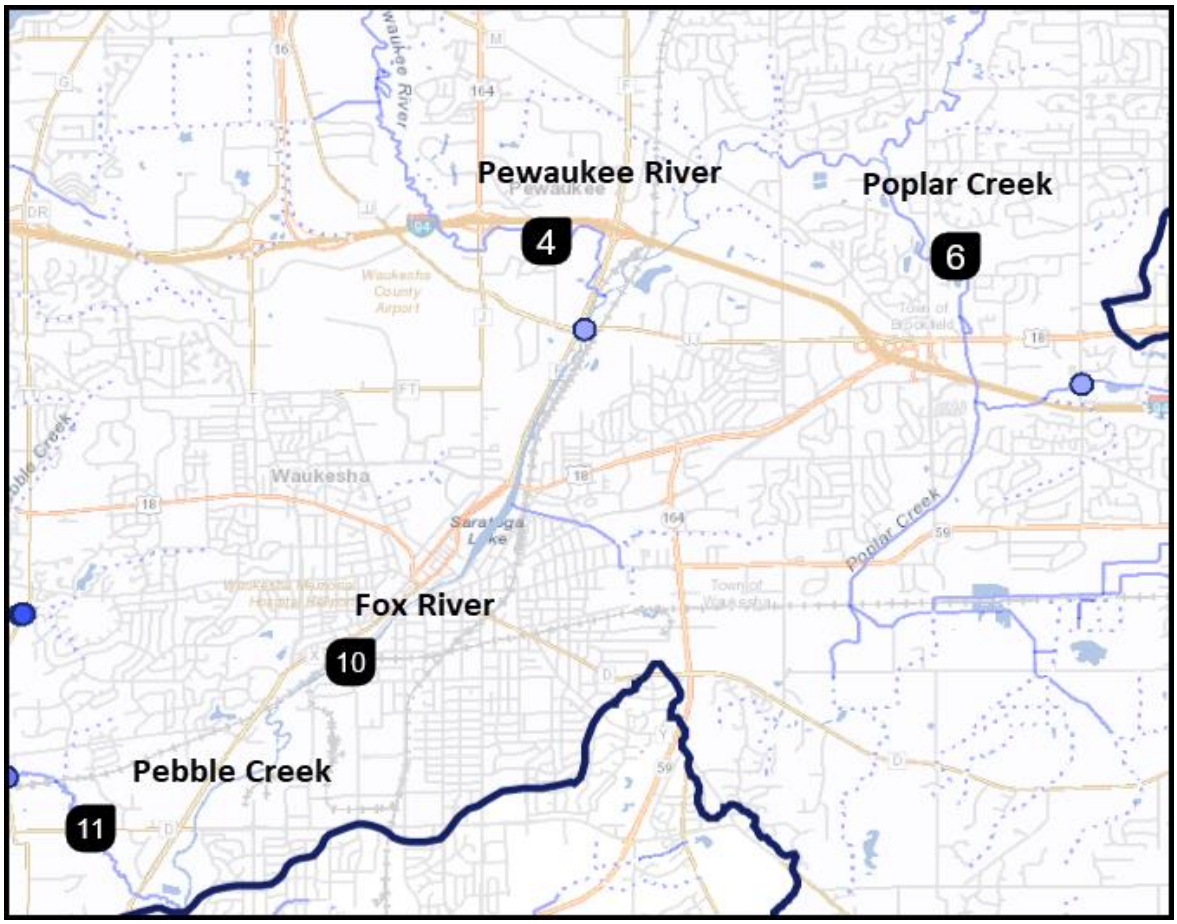


Discussion

Total phosphorus

Four sites were chosen to take monthly Total Phosphorous (TP) samples at what is considered the most downstream point of the sub watershed in 2015 (Figure 18). The Fox River site was the only not located on the most downstream portion of the watershed. Originally this site was proposed to include a fish and habitat survey, however a majority of the site was non wadable which did not allow for a fish survey to be completed and it was too late in the season to complete all six-monthly samples at another downstream site. The other three sites were on the Pebble Creek, Poplar Creek and the Pewaukee River. Of the four sites, the Pewaukee River meet the criteria for TP samples of 0.075mg/L. The Pebble Creek site was sampled for 6 monthly samples in 2014 and 2015 and both times meet the criteria for TP. Poplar Creek exceeded the criteria for TP and is currently on the 303d list for Low DO with an unknown Pollutant and is proposed for the 2018-303d list to be added for TP. The final site on the Fox River clearly exceeded the criteria for TP and was currently on the 303d list for TP and will not change on the proposed 2018 list.

Figure 18: Monthly TP Sampling site locations



Additional single TP samples were taken at the 15 other sites in the TWA project area. Of those 15 samples 6 of those sites exceeded the 0.075mg/L criteria for TP. Those sites were on the Fox River (0.275mg/L), Deer Creek (2 sites- 0.0852mg/L; 0.111mg/L), Pewaukee River (0.103mg/L) and Poplar Creek (0.0976mg/L). The Fox River and Deer Creek are already listed on the 303d list for TP and Poplar Creek as discussed previously is proposed for the 2018 list. The Pewaukee River site that exceeded was upstream of the 6-monthly sample site where the monthly samples did not exceed the criteria. Further sampling should continue, the Pewaukee River as is relatively close to exceeding criterion on occasion. This waterway has historically and currently is monitored by the Water Action Volunteer Program. Two other sites, Coco Creek and a Tributary to Brandy Brook samples were at or close to exceeding the TP limit of 0.075mg/L. Zion Creek which is currently listed on the 303d list for TP, did not exceed the limit and data from 2013 monthly data, also showed lower levels of TP. Further monitoring of this waterway is recommended for an additional year as for the concern of upstream sources phosphorous (e.g. golf course, online ponds). If additional monitoring shows monthly samples did not exceed, it will be recommended for delisting.

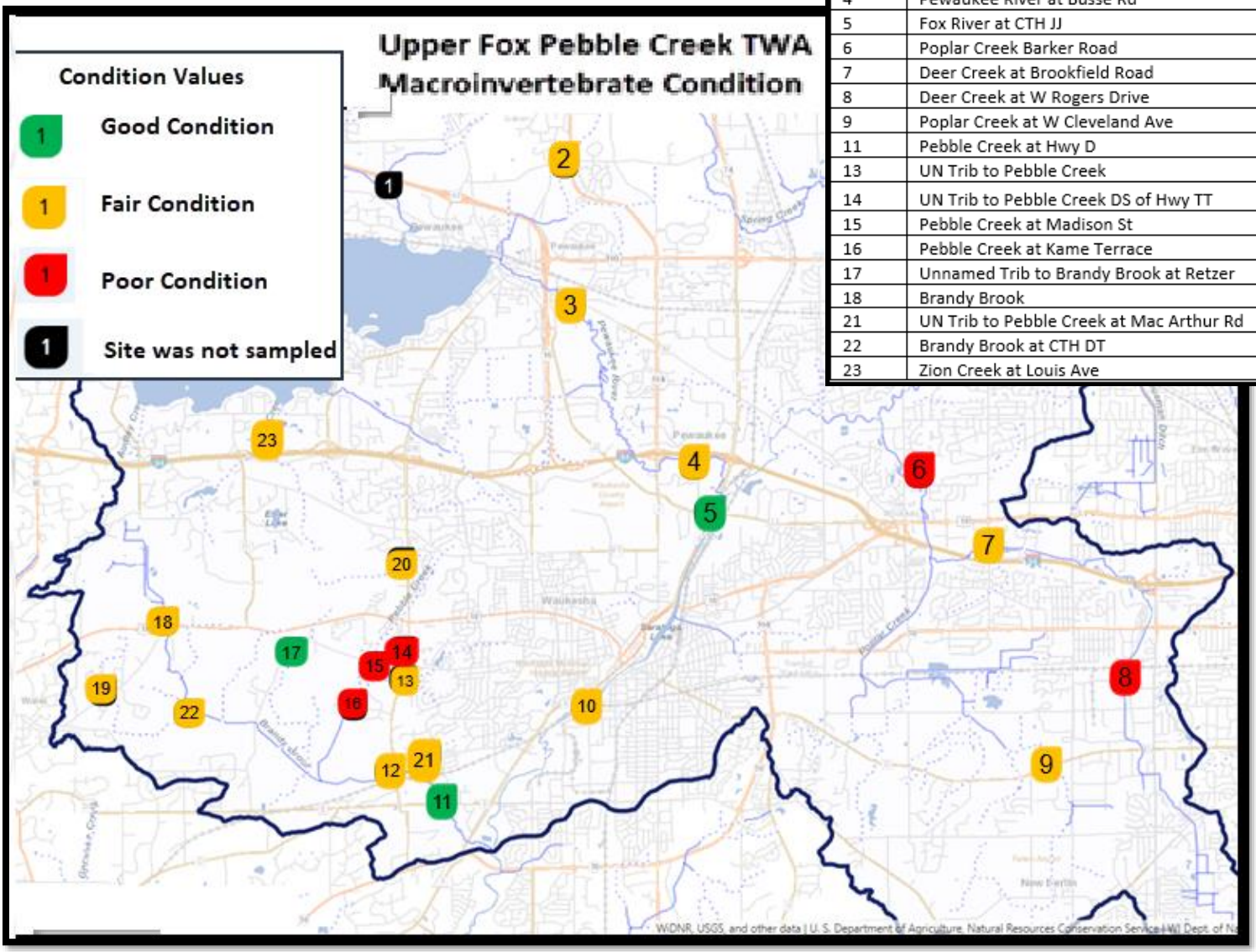
Continuous Temperature

Long term temperature monitoring confirmed 2 sites (Tributaries to Brandy Brook Map ID #17 & 19) meet the criteria for cold water with the maximum summer temps being below 72F. Other sites that were on the brink of cool vs. cold water, like the headwaters of Brandy Brook are impacted heavily by runoff, development and realignment and straightening of the stream channel to improve local farmland productivity. The biological assessments also confirm impacts to the waterways. The Tributary to Pebble Creek at Hwy TT south of Hwy 18 (Map ID 14) also has an online pond just upstream of the site, as well as increase residential development that is most likely contributing to the higher water temperatures logged on the monitoring devices during the 2014 field season.

Macroinvertebrates

Macroinvertebrate samples taken at the 22 sites in the project area (see Figure 19) ranged from Poor to Good condition based on the Macroinvertebrate Indices of Biological Integrity (M-IBI) (Weigel, et. al 2003). Three of the sites where within the range of Poor, which where Deer Creek at Rogers Drive (0.71052), Unnamed Trib to Pebble Creek at Hwy TT (2.08697) and Pebble Creek at Kame Terrace (2.18507). Of those three that where in the Poor range, 2 of those sites (Deer Creek and Unnamed Trib to Pebble Creek) also exceed the TP criteria, however these two streams are already on the 303d list.

Figure 19. Macroinvertebrate Condition Map



Map ID	Site Name
1	Coco Creek at Yench Road
3	Pewaukee River at HWY M
4	Pewaukee River at Busse Rd
5	Fox River at CTH JJ
6	Poplar Creek Barker Road
7	Deer Creek at Brookfield Road
8	Deer Creek at W Rogers Drive
9	Poplar Creek at W Cleveland Ave
11	Pebble Creek at Hwy D
13	UN Trib to Pebble Creek
14	UN Trib to Pebble Creek DS of Hwy TT
15	Pebble Creek at Madison St
16	Pebble Creek at Kame Terrace
17	Unnamed Trib to Brandy Brook at Retzer
18	Brandy Brook
21	UN Trib to Pebble Creek at Mac Arthur Rd
22	Brandy Brook at CTH DT
23	Zion Creek at Louis Ave

Fish Condition

Fish surveys taken at the 22 sites in the project area ranged from Poor to Good Condition. Eight of the 18 sites were listed as Poor. Six of those eight sites did not meet the minimum number of fish (50) to properly calculate a FIBI. Three of those six sites should consideration of a change in the modeled natural community to macroinvertebrate water due to the small size of fish in the survey (less than 25 fish) and due to the low flow located in the three sites. They however due have spring fed sources and the natural community site does change downstream of these sites. The three sites are the Trib to Pebble Creek at TT (Map ID 14), Trib to Brandy Brook at Retzer (Map ID 17) and Trib to Pebble Creek at Mac Arthur (Map ID 21). The other three sites natural modeled communities should remain the same, they have just been impacted by sources of pollution that have degraded the biological community. Coco Creek received a score of Poor, due to the high number of tolerant species found during the survey. Brown trout were present during the survey as well. This site should have follow-up monitoring completed.

The last site that received a score of Poor was Pewaukee River at Hwy M. This site was surveyed during July of 2015 and low dissolved oxygen occurs frequently in the Pewaukee River. The day of the survey the dissolved oxygen levels were at 5.64 mg/L. A combination of sources maybe contributing the Pewaukee Rivers low dissolved oxygen such as, but not limited to, little to no gradient on a large portion of the River, extensive wetland corridor surrounding the River and bottom draw dam on Pewaukee Lake. A total of 250 fish were captured during the survey. A total of 218 of those fish were tolerant species (Figure 20). The Pewaukee River in this location is proposed for the 2018-303d list for Chlorides as this FIBI is listed as poor, however the macroinvertebrate sample was categorized as good in this same location and year of sampling.

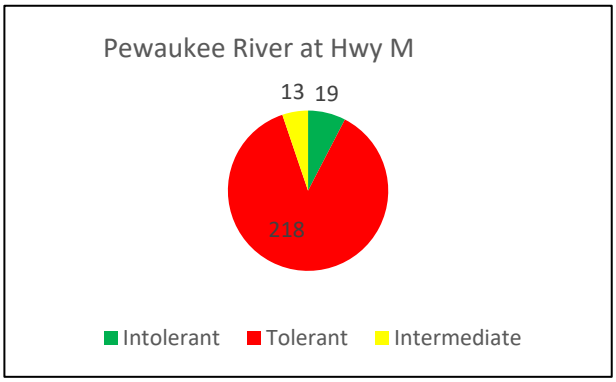


Figure 20: Pewaukee River at Hwy M Bridge (Map ID 3) fish tolerance numbers.

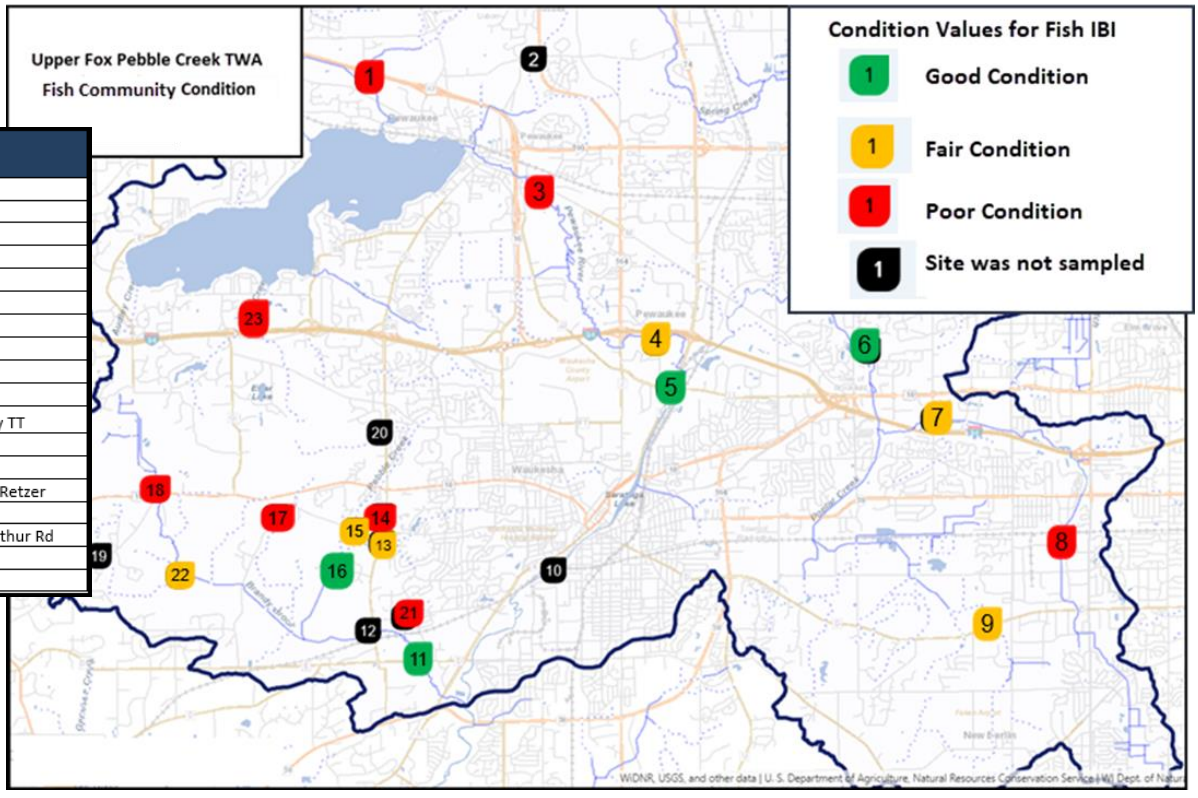
Figure 21 displays fish conditions based on fish IBI values (Figure 21). Six of the 18 sites were listed in Fair condition. However, two of the six sites did not meet the minimum number of fish (50) to properly calculate a FIBI. Of those two sites, the Trib to Pebble Creek at TT (Map ID 13) natural community should be changed to a macroinvertebrate water due to the small size of fish in the survey (less than 25 fish) and due to the low flow located in the three sites. They however due have spring fed sources and the natural community site does change downstream of this site. The other sites natural community should remain the same however, due to a higher gradient channel with a large riffle habitat sample station, made it difficult to capture fish to include in the FIBI. The final four sites received as condition category score of Good.

Habitat Condition

Habitat surveys taken at the 21 sites in the project area (Figure 22) ranged between Fair and Good. The closest Habitat score near the Poor category is Zion Creek, which is currently on the 303d list, however due to recent TP data is be recommended for further monitoring as monthly sampling in 2013 showed that it was not exceeding the criteria for monthly sampling (0.075mg/L).

Figure 21. Location of Fish & Habitat Surveys and Display of Fish Conditions

Map ID	Site Name
1	Coco Creek at Yench Road
3	Pewaukee River at HWY M
4	Pewaukee River at Busse Rd
5	Fox River at CTH JJ
6	Poplar Creek Barker Road
7	Deer Creek at Brookfield Road
8	Deer Creek at W Rogers Drive
9	Poplar Creek at W Cleveland Ave
11	Pebble Creek at Hwy D
13	UN Trib to Pebble Creek
14	UN Trib to Pebble Creek DS of Hwy TT
15	Pebble Creek at Madison St
16	Pebble Creek at Kame Terrace
17	Unnamed Trib to Brandy Brook at Retzer
18	Brandy Brook
21	UN Trib to Pebble Creek at Mac Arthur Rd
22	Brandy Brook at CTH DT
23	Zion Creek at Louis Ave



Management Actions

Management Priorities

- Identify the sources of phosphorus in the Upper Fox River, Poplar Creek, Pewaukee River and Pebble Creek Watersheds and pursue local runoff management, lake and river/stream grants to reduce phosphorous inputs into local resources.
- Identify potential partners and stakeholders to participate in an overall awareness and behavioral change program in the watersheds that result in reduced erosion and phosphorus inputs.
- The department should work with watershed organizations on outreach efforts with landowners in the watershed, environmental programs in Upper Fox River watershed, and research opportunities for stream bank stabilization opportunities.
- Capitalize on the efforts of the Wisconsin DNR, Waukesha Lake County LCD, Pewaukee Lake Sanitary District, Pewaukee Lake Association, Southeastern Wisconsin Fox River Commission, NRCS, and USGS in these subwatersheds by implementing BMPs (stream bank restoration, sediment basins, vegetative buffers, etc.) where needed will likely have a significant improvement of the water quality in the creeks in the Upper Fox River Watershed and Pewaukee Lake.
- Working with landowners and county partners in the watershed to encourage restoration of stream banks and reduction of erosion is a high priority.
- Increasing buffer widths in these subwatersheds will likely have a nutrient and sediment reduction effect.

Monitoring and Assessment Recommendations

- Monitoring of phosphorus concentrations in the streams such as Poplar Creek, Deer Creek, Coco Creek and Pewaukee River areas should continue as funding and volunteer efforts allow.
- Pewaukee River should continue to be monitored by the Water Action Volunteer program with Tier 2 monitoring. The Pewaukee River should also have additional biological monitoring (fish and macroinvertebrates) completed in the future.
- Zion Creek should have follow-up monitoring and evaluation conducted to possibly remove the impairment listing on the waterway, based on recent data.
- Monitoring of phosphorus, macroinvertebrate and fisheries values in streams of the Upper Fox River -Illinois Watershed should continue as funding and volunteer efforts allow.

Management Recommendations for DNR

- The department should work with watershed organizations on outreach efforts with landowners in the watershed, environmental programs in Upper Fox River -Illinois Watershed, and research opportunities for stream bank stabilization opportunities and buffer enhancements.

Management Recommendations for External Partners

- WDNR, county and local partners should work to obtain funds or grants to restore the identified unstable stream banks to reduce sedimentation and erosion in the Upper Fox River -Illinois watershed.
- Management agencies and landowners in the watershed should work toward enhancing a combination of forest and native grass buffers, which may have a better nutrient reduction than strictly grassed buffers.

Appendix A: References

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Appendix B: Waterbody Narratives

Upper Fox River is the principal perennial stream in the watershed. Other significant perennial streams include Brandy Brook, Deer Creek, Pebble Creek, Pewaukee River, Poplar Creek and Sussex Creek. There are many incorporated municipalities within the watershed including the Cities of Brookfield, Delafield, New Berlin, Pewaukee and Waukesha. Also included are the Villages of Hartland, Lannon, Menomonee Falls, Pewaukee, Sussex and Wales.

Upper Fox River

The Upper Fox River (742500) Southeast Wisconsin, described in the Nonpoint Source Control Plan for the Upper Fox River Priority Watershed Project, is a 33 mile perennial stream considered a warm water sport fishery that is dammed to form the Barstow Impoundment. The river condition is considered poor and has been placed on the Wisconsin's impaired waters list for exceedance of total phosphorus criteria. Most recently, this water was re-assessed in 2018 and the river below the Barstow Impoundment (miles 171.45-175.32) showed continued impairment by phosphorus. Available biological data did not fall in the poor category, did not indicate impairment on the most updated information, no change in the existing impaired waters listing was needed.

Brandy Brook upstream of Hwy DT Photo by: Rachel Sabre DNR

Brandy Brook

The entire length of Brandy Brook is Class I Trout cold waters.

Deer Creek

Deer Creek, in the Upper Fox River - Illinois Watershed, is a 6.05-mile river that falls in Waukesha County. This river is managed for fishing and swimming and is currently considered impaired. Deer Creek from its origin to Poplar Creek (LAL). Facility: New Berlin - Regal Manor

Deer Creek at Rogers Drive Photo by Rachel Sabre, DNR

Pebble Creek

Pebble Creek, and its major tributary Brandy Brook, drain approximately 18 square miles located in the extreme southwest corner of the Upper Fox River Basin before flowing into the Illinois Fox River just north of State Highway 59. Pebble Creek has the potential to support a coldwater Class I and II brook and brown trout fishery. Although Brook trout have never been recorded in this urbanizing watershed, healthy populations of mottled sculpin, a coldwater indicator species, have been recorded in the headwaters of this stream system. Since the mid-1990s, the WDNR has annually stocked brown trout at CTH TT and the trout have responded well to this effort.

Pebble Creek at Hwy D Bridge Photo by: Rachel Sabre DNR

Pewaukee River

The Pewaukee River originates from Pewaukee Lake and empties into the Fox River. The River contains a decent forage and gamefish population. Pewaukee River was assessed during the 2016 listing cycle and chloride sample data were clearly below 2016 WisCALM chronic and acute listing criteria for the Fish and Aquatic Life use. This water is meeting this use and is not considered impaired.

Poplar Creek

Poplar Creek is a tributary to the Fox River in Waukesha County. This segment of Poplar Creek is listed as impaired by low levels of dissolved oxygen caused by an unknown pollutant. From the treatment plant outfalls downstream to the Chicago & Northwestern railroad bridge [T6N R20E S9] the water is a limited aquatic life community (LAL); From the railroad bridge, downstream to the confluence of the Fox River the river is a limited forage fishery. (LFF).

Poplar Creek at Barker Road. Photo by Rachel Sabre, DNR

Appendix C: Sussex Creek[1] Biological Community Assessment

Craig Helker, WDNR February 8th, 2013

Project Overview:

In 2009 and 2010, personnel from the Wisconsin Department of Natural Resources conducted biological community monitoring on Sussex Creek and the Fox River, in Waukesha County. The purpose of the monitoring was to document impacts to the stream's biological community from excessive phosphorus. To that end, the fish and macroinvertebrate populations of three locations on Sussex Creek were sampled, along with an additional control location on the For River. The in-stream fish habitat at each location was also assessed, as was temperature, dissolved oxygen, pH, and other chemical parameters.

Results Summary:

Sussex Creek is on the list of Federally Impaired Waters and is on this 303(d) list due to dissolved oxygen problems as a result of elevated phosphorus. The fishery quality of Sussex Creek confirms the validity of the listing, with the overwhelming majority of fish present being tolerant of low dissolved oxygen. The habitat quality is generally "Good", so should support a more diverse fish community than that which is present in the stream.

The aquatic habitat of Sussex Creek is good (as scored), dominated by cobble, gravel, and sand, with areas of light siltation. Water temperatures are what would be considered in the cool range, and there is adequate shading throughout most of the stream's length. The macroinvertebrate community in the three sampled locations scored "Good", indicating some organic enrichment but less than what was found in the reference stream (Fox River). It is in the fishery community that we see significant impacts. The fish community in all three sampled locations of Sussex Creek was dominated by low-dissolved oxygen tolerant species.

The macroinvertebrate community in the stream is slightly impaired and suggestive of some organic loading. If Sussex Creek were subject to significant organic loading, it would be expected that BOTH the macroinvertebrate community and fish community would be considered "Poor". However, this is not the case, and it is only the fish community that being significantly affected. One explanation for this could be fish passage impediments that are present in the stream. Three are known to exist, and more may be present. These barriers would prevent the re-population of certain stream reaches following low dissolved oxygen conditions where the tolerant fish species survive at the expense of others.

Recommendations

The following are recommendations for the department of natural resources and partner agencies.

- Maintain current 303(d) listing for Sussex Creek.
- Document and effect removal of fish passage impediments within Sussex Creek.
- Work to reduce nutrient loading to Sussex Creek though existing WPDES permits.
- Conduct follow-up monitoring on or after 2019 to document biological conditions within Sussex Creek.

[1]Sussex Creek (WBIC….) is the local name of this water; Spring Creek is the official name.

Field Assessment **#1**

Location: Upstream of Duplainville Road, STATION # 683226
Dates: 07/08/2009 to 11/06/2009

Physical/Chemical Data

Segment Length: 180 m
Depth (Average): 0.51 m
Depth (Maximum): 0.73 m
Average Width: 4.7 m
Segment Gradient: 3.1 m/km
Substrate Material: Gravel, cobble, sand predominate.
Instream Flow: 6.87 cfs (07/10/2009)
Q7,2 flow 0 cfs
Q7,10 flow 0 cfs

Temperature, Instantaneous:
17.53^0 C. 07/08/2009
17.92^0 C. 07/10/2009
8.52^0 C. 11/06/2009

Dissolved Oxygen, Instantaneous
8.36 mg/l 07/08/2009
8.12 mg/l 07/10/2009
12.04 mg/l 11/06/2009

Macroinvertebrates:

Sampling date: 11/06/2009
Survey location: Upstream of Duplainville Road.
HBI: 5.47 (Good)

Interpretations Based on Existing Fish and Aquatic Life Community:

The fish populations present in this portion of Sussex Creek reflect challenging conditions, with the majority of the fish present able to tolerate low in-stream dissolved oxygen conditions. Macroinvertebrate populations reflect good water quality conditions. In-stream sport fish habitat is also good.

The disparity between the poor quality fishery and the good habitat and macroinvertebrate community suggests challenging conditions within this portion of the stream. A "good" macroinvertebrate community means that there is some organic enrichment in this area of the waterway. However, the percentage of the fish community that is tolerant of low dissolved oxygen suggests that dissolved oxygen within the stream is occasionally low. This sampling location is near to the Fox River, so the possibility exists that fish that might seasonally reside in this reach during periods of better conditions, i.e. more flow and water depth, may have retreated downstream to the Fox River.

Habitat:

Sampling date: 07/10/2009
Habitat rating: 55 (Good) *Guidelines for Evaluating Habitat of Wadable Streams,* WDNR, 2001.

Fish Community

Sampling date: 07/08/2009
Survey Location: Start of Station is 50 m upstream of Duplainville Road.
Distance sampled: 180 m, Sampling Gear: Stream Shocker w/2 anodes.

Table 1. Fish collection data from Sussex Creek @ Duplainville Road.

Species	Number Caught
Creek Chub	4
White Sucker	27
Central Mudminnow	81
Common Shiner	3
Green Sunfish	11
Hornyhead Chub	8
Yellow Bullhead	1
No. Species = 7	135
IBI (Value, Condition)	16 (Very Poor)
No. of fish tolerant to low DO	93
Endangered/special category species	None

Field Assessment #2

Location: Upstream of Hwy VV., STATION # 10030702
Dates: 07/08/2009 to 11/06/2009

Physical/Chemical Data

Segment Length: 158 m
Depth (Average): 0.38 m
Depth (Maximum): 0.74 m
Average Width: 4.5 m
Segment Gradient: 1.8 m/km
Substrate Material: Gravel, cobble, sand, silt and boulder present.
Instream Flow: 6.87 cfs (07/09/2009)
Q7,2 flow 0 cfs
Q7,10 flow 0 cfs

Temperature, Instantaneous:
17.960 C. 07/08/2009
19.540 C. 07/10/2009
7.50 C. 11/06/2009

Dissolved Oxygen, Instantaneous
8.56 mg/l 07/08/2009
8.4 mg/l b 07/10/2009
12.63 mg/l 11/06/2009

Macroinvertebrates:

Sampling date: 11/06/2009
Survey location: Upstream of HWY VV .
HBI: 5.151 (Good)

Interpretations Based on Existing Fish and Aquatic Life Community:

The fish populations present in this portion of Sussex Creek are better than the downstream section, with significantly more numbers and species. The make-up of the fish community, however, still shows impairment – being ranked as "Poor", with the majority of the fish present able to tolerate low in-stream dissolved oxygen conditions. Fish habitat for sport fish is ranked as "Fair". Macroinvertebrate populations, as downstream, show "Good" water quality conditions.

Again, the disparity between the "Poor" fishery, "Fair" habitat, and "Good" macroinvertebrate community suggests challenging conditions within this portion of the stream for fish. It is likely that the primary challenge is the existence of fish passage impediments both up and downstream of this section.

Habitat:

Sampling date: 07/10/2009
Habitat rating: 45 (Fair) *Guidelines for Evaluating Habitat of Wadable Streams,* WDNR, 2001.

Fish Community

Sampling date: 07/08/2009
Survey Location: Start of Station is 75 m upstream of HWY VV Bridge
Distance sampled: 158 m, Sampling Gear: Stream Shocker w/2 anodes.

Table 2. Fish collection data from Sussex Creek @ Duplainville Road.

Species	Number Caught
Creek Chub	235
White Sucker	100
Fathead Minnow	4
Bluntnose Minnow	12
Central Mudminnow	113
Central Stoneroller	7
Brook Stickleback	17
Golden Shiner	1
Common Shiner	5
Johnny Darter	15
Green Sunfish	18
Bluegill x Green Sunfish	1
Pumpkinseed	1
No. Species = 7	529
IBI (Value, Condition)	27 (Poor)
No. of fish tolerant to low DO	483
Endangered/special category species	None

Field Assessment #3

Location: Unnamed Tributary to Sussex Creek,
STATION # 10030703
Dates: 11/06/2009 to 06/04/2010

Physical/Chemical Data

Segment Length: 100 m
Depth (Average): 0.2 m
Depth (Maximum): 0.26 m
Average Width: 2.3 m
Segment Gradient: 7.0 m/km
Substrate Material: Gravel, sand, cobble predominate.
Instream Flow: 1.77 cfs (06/04/2010)
Q7,2 flow 0 cfs
Q7,10 flow 0 cfs

Temperature, Instantaneous:
7.250 C. 11/06/2009
15.750 C. 06/04/2010

Dissolved Oxygen, Instantaneous
11.88 mg/l 11/06/2009
15.75 mg/l 06/04/2010

Macroinvertebrates:

Sampling date: 11/06/2009
Survey location: Under footbridge
HBI: 4.713 (Good)

Interpretations Based on Existing Fish and Aquatic Life Community:

The fish populations present in this tributary to Sussex Creek are few, with only three species present in limited numbers. The stream is quite narrow and shallow, and likely goes dry during years with very low precipitation. In addition, fish passage impediments exist both up and downstream of this reach. Given these conditions, it is better to rely on the macroinvertebrate populations to indicate stream quality. That score is "Good", showing some organic enrichment.

Habitat:

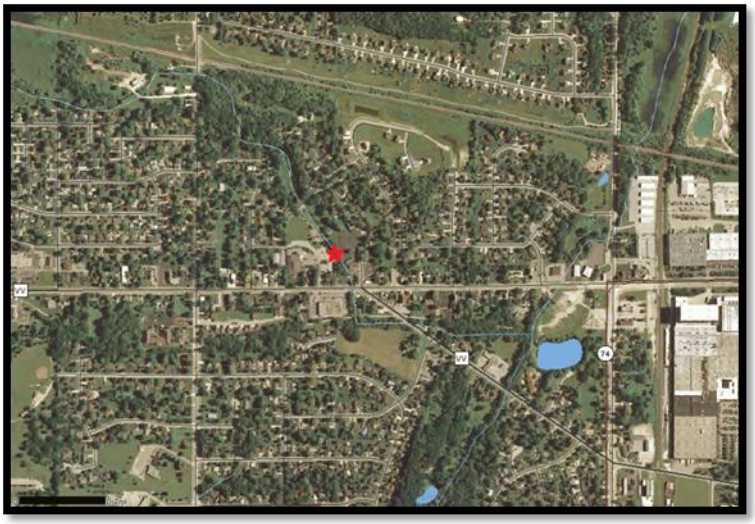
Sampling date: 07/10/2009
Habitat rating: 55 (Good) Guidelines for Evaluating Habitat of Wadable Streams. WDNR 2001.

Fish Community

Sampling date: 06/04/2010
Survey Location: Start of Station is upstream of City Hall, near footbridge. (See Table 3.)
Distance sampled: 100 m, Sampling Gear: Stream Shocker w/1 anodes.

Table 3. Fish collection data from Sussex Creek @ Duplainville Road.

Species	Number Caught
Creek Chub	3
Central Mudminnow	15
Central Stoneroller	1
No. Species = 3	529
IBI (Value, Condition)	Too few fish to calculate
No. of fish tolerant to low DO	15
Endangered/special category species	None



Field Assessment #4

Location: upstream of Custer Lane.,

Dates: 07/08/2009 to 06/04/2010

Physical/Chemical Data

Segment Length: 100 m
Depth (Average): 0.21 m
Depth (Maximum): 0.38 m
Average Width: 3.05 m
Segment Gradient: 1.98 m/km

Instream Flow: .27 cfs (06/04/2010)
Q7,2 flow 0 cfs
Q7,10 flow 0 cfs

Temperature, Instantaneous:
6.270 C. 11/06/2009
16.610 C. 06/04/2010

Dissolved Oxygen, Instantaneous
7.74 mg/l 11/06/2009
5.45 mg/l 06/04/2010

Macroinvertebrates:

Sampling date: 11/06/2009
Survey location: Up and downstream of Custer Lane
HBI: 6.93 (Fairly Poor)

Interpretations Based on Existing Fish and Aquatic Life Community:

This sampling location was chosen as a reference site, in order to give a comparison with the Sussex Creek sites. The biological community in this portion is of a lower quality than Sussex Creek, with both fish and macroinvertebrate communities in the Very Poor/Fairly Poor range. Additionally, sport fish habitat is ranked lower, with finer substrate present.

Habitat:

Sampling date: 06/04/2010
Habitat rating: 30 (Fair) Guidelines for Evaluating Habitat of Wadable Streams. WDNR 2001.

Fish Community

Sampling date: 06/04/2010
Survey Location: Start of Station is 30 m upstream of Custer Lane. (See Table 4.)
Distance sampled: 100 m, Sampling Gear: Stream Shocker w/1 anode.

Table 3. Fish collection data from Sussex Creek @ Duplainville Road.

Species	Number Caught
Northern Pike	1
Central Mudminnow	23
Brook Stickleback	3
Fathead Minnow	1
No. Species = 3	28
IBI (Value, Condition)	10 (Very Poor – Too few fish to calculate)
No. of fish tolerant to low DO	27
Endangered/special category species	None

Appendix D: Upper Fox River - Pebble Creek Photos

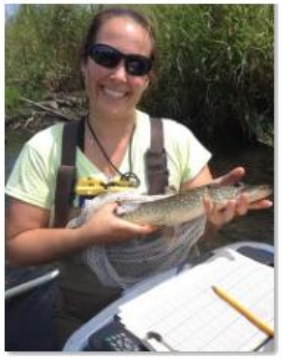
Upper Fox and Pebble Creek TWA Project Photos


DS of Fox River near tavern near end of station.JPG

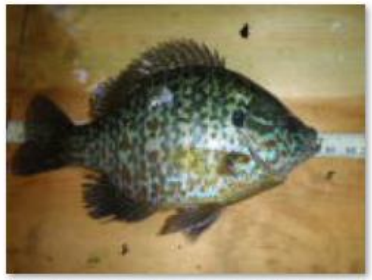

DS Pebble Creek at Kame Terrace.JPG


DS Pebble Creek of Madison.JPG


DS Poplar Creek at Barker Road near end of station.JPG


Northern and Mud Pebble Creek at Hwy D.JPG


Pebble Creek TWA 2014 Project fish (2) photo.JPG


Pebble Creek TWA 2014 Project fish photo.JPG


US Deer Creek at Rogers.JPG


Poplar Creek DS at Hwy D or Cleavland Ave.JPG

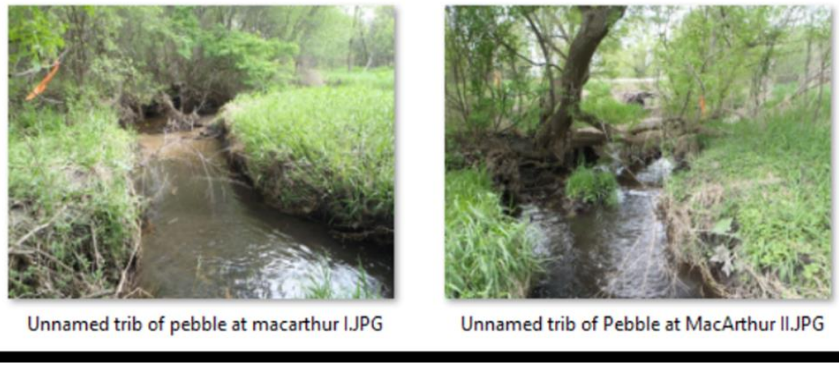

US trib to Brandy Brook.JPG


US of Fox River near tavern at end of station.JPG


US Pebble Creek at Kame Terrace.JPG


US Poplar Creek start station at Hwy D.JPG


US Trib to Brandy Brook at Brandy Brook Drive.JPG



Unnamed trib of pebble at macarthur I.JPG

Unnamed trib of Pebble at MacArthur II.JPG

Unnamed trib to Pebble at HWY TT north of 18 I.JPG

Unnamed trib to Pebble at HWY TT north of 18 II.JPG

Tributary to Brandy Brook at Golf Course

Photo 1.JPG

Photo 2.JPG

Photo 3.JPG

Brandy brook DS at DT.JPG

Brandy brook US at DT.JPG

Appendix E: Upper Fox River - Pebble Creek Water Quality Standards Attainment[i]

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Supporting Designated Use	Assessment	Qual	DNR Category
772700	Audley Creek	0	0.72	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed	NA	Category 3
771400	Brandy Brook	0	4.95	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Cold	1980 Trout Book Classification	Monitored	B1, B2	Category 2
772100	Coco Creek	0.51	2.36	Cold (Class II Trout)	Cold (Class II Trout)	Not Supporting	Cold	1980 Trout Book Classification	Monitored	B1, B4, T2, P3	Category 5A
772100	Coco Creek	2.36	3.49	Cold (Class I Trout)	Cold (Class I Trout)	Not Assessed	Cold	1980 Trout Book Classification	Monitored	B1	Category 3
772100	Coco Creek	3.49	4.84	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed	NA	Category 3
772900	Deer Creek	0	8.09	LAL	WWSF	Not Supporting	WWSF	Classification Survey Pending	Monitored	B1	Category 5A
740600	Etter Lake	0	10.13	Shallow Seepage	FAL	Supporting	Default FAL	NR102 Classification	Not Assessed	NA	Category 3
742275	Fox Brook Lake	0	19.68	FAL	FAL	Supporting	Default FAL	NR102 Classification	Evaluated	NA	Category 3
742500	Fox River	113.99	121.06	FAL	WWSF	Not Supporting	WWSF	Classification Survey Pending	Monitored	B1, P3	Category 5A
742500	Fox River	121.06	130.55	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored	B1, B4	Category 5A
742500	Fox River (Below Barstow Impoundment)	105.34	109.21	WWSF	WWSF	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
742500	Fox River, Upper Barstow Impoundment	110.29	113.99	WWSF	WWSF	Not Supporting	WWSF	Classification Survey Pending	Monitored	B1	Category 5A
771650	Frame Park Creek	0	1.26	LFF	LFF	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
740800	Lannon County Park Pond	0	14.35	Two-Story	FAL	Supporting	Default FAL	NR102 Classification	Monitored	P1	Category 2
773700	Lannon Creek	0	5.48	LAL	WWSF	Not Supporting	Default FAL	NR102 Classification	Evaluated	B1	Category 5A
771800	Local Water	0	4.45	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	T2	Category 5A
5034248	Local Water	0	0.96	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored	B2	Category 2

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Supporting Designated Use	Assessment	Qual	DNR Category
5036048	Local Water	0	2.82	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored	B3	Category 2
5036099	Local Water	0	2.61	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored	B3	Category 2
771600	Lower Barstow Impoundment (Fox River)	0	28.18	WWSF	WWSF	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
773300	Master Disposal Drainage Channel	0	0.99	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Evaluated: Older Data	B1	Category 5A
772300	Meadow Brook Creek	0	3.14	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	T2	Category 5A
771300	Pebble Creek	0	1.1	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored	B4, T2	Category 2
771300	Pebble Creek	1.1	6.9	Cold (Class II Trout)	Cold (Class II Trout)	Fully Supporting	Cold	1980 Trout Book Classification	Monitored	B1, B3	Category 2
3000119	Perennial Stream C (Pb018)	0	1.88	LFF	WWFF	Not Supporting	Default FAL	NR102 Classification	Evaluated: Older Data	B1	Category 5A
3000121	Perennial Stream C (Sc011)	0	2.96	LAL	LFF	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
3000120	Perennial Stream D (Pb016)	0	0.72	LFF	Cold	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
772000	Pewaukee Lake	0	2437.22	Deep Lowland	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored	P3, B2	Category 2
771700	Pewaukee River	0	6.43	FAL	WWSF	Fully Supporting	Default FAL	NR102 Classification	Monitored	B4, T2, P3, B2, T3	Category 2
772800	Poplar Creek	3.65	6.01	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
772800	Poplar Creek	6.01	8.06	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A
772800	Poplar River (Creek)	0	3.64	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	B1, P3, B3	Category 5A
773400	Spring Creek	0	6.57	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Supporting Designated Use	Assessment	Qual	DNR Category
773000	Trib to Poplar Creek	0	2.74	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed	NA	Category 3
742250	Un Lake	0	9.57	Small	FAL	Supporting	Default FAL	NR102 Classification	Evaluated: Modeled Data	NA	Category 3
18800	Willow Creek	0	2.8	FAL	WWFF	Supporting	Default FAL	NR102 Classification	Monitored	P3, B3	Category 4A
772400	Zion Creek	0	1.65	LFF	WWFF	Not Supporting	Default FAL	NR102 Classification	Monitored	B1	Category 5A

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.