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

Upper East River Targeted Watershed Assessment: A Water Quality Plan to Restore Wisconsin Watersheds

HUC: 040302040301, Monitored 2017

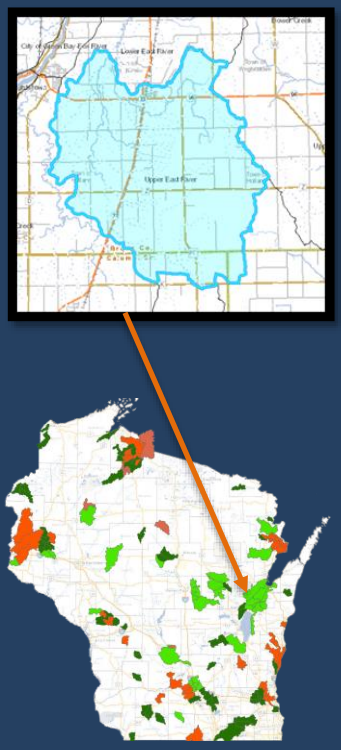

Photo by Andy Hudak, East District Water Quality Biologist
Wisconsin Department of Natural Resources.

To learn more about this area, see this plan on Wisconsin's TWA Projects Online!
Or search for specific waters and watersheds at *Explore Wisconsin's Waters Online!* for more details.

WISCONSIN DEPT. OF NATURAL RESOURCES

EGAD #3200-2020-22
Wisconsin DNR
Bureau of Water Quality

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Upper East River, 2017. Photo by Andy Hudak, DNR Water Quality Biologist

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 River Areawide Water Quality Management Plan and Wisconsin's Statewide Areawide Water Quality Management Plan. This plan will be forwarded to USEPA for certification as a formal plan update.

_____ _____
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Basin/Watershed Partners

- Fox Wolf Watershed Alliance
- Garners Creek Stormwater Utility District
- Fox Valley Technical College
- USFWS Service
- Nature Conservancy
- Outagamie County
- Calumet County

Report Acknowledgements

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Abbreviations

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

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

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

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

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

Natural Community. A system of categorizing waterbodies based on their inherent physical, hydrologic, and biological assemblages. Both Streams and Lakes are categorized using an array of "natural community" types.

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.

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

TWA: **Targeted Watershed Assessment.** A statewide study design; a rotating watershed approach to gathering of baseline monitoring data with specialized targeted assessments for unique and site specific concerns, such as effectiveness monitoring of management actions.

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

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.

Targeted Watershed Assessment

Watershed Goals

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

Watershed Overview

The Upper East River watershed is an extensively rural watershed that lies within the Lower Fox River Basin. This watershed drains 39.53 mi^2 and is the headwaters to the East River. The Upper East River watershed was previously part of the East River Priority Watershed Program from 1991-2003. Despite efforts to improve water quality, the East River is still considered one of the major contributors of phosphorous and suspended solids to the Lower Fox River and Green Bay. Agriculture sources of non-point sources of pollution continue to be the likely contributor to poor water quality in the watershed.

Figure 1: Upper East River Watershed

Hydrology

The Upper East River watershed is highly dependent on surface water. The headwaters of the streams in the watershed lie atop and alongside the western edge of Niagara escarpment which is a large dolomite geologic landform. These headwaters streams are often steep in gradient as they flow north and west toward the confluence of the main branch of the East River. Few hydrologic modifications such as ditching, straightening, and stream realignment have occurred throughout the predominantly agricultural watershed. Alterations to hydrology in the watershed come in the form of an increase in the rate of delivery of stormwater to the streams. The installation of agricultural tile lines, loss of infiltration capacity of the soils, loss of wetland, and increases in impervious surfaces has made the stream more prone to flashy flow regimes in the watershed.

Land Use

The Upper East River watershed is 35.93 mi^2. Land use in the watershed is dominated by agricultural lands. There are still intermixed forested areas interspersed throughout the agricultural setting and large tract of publicly owned property, the Holland Wildlife Area. There are currently 46 known livestock operations in the watersheds of which 6 are CAFO's. (Outagamie and Brown County, LCD). Only the small community of Green Leaf is located within the watershed.

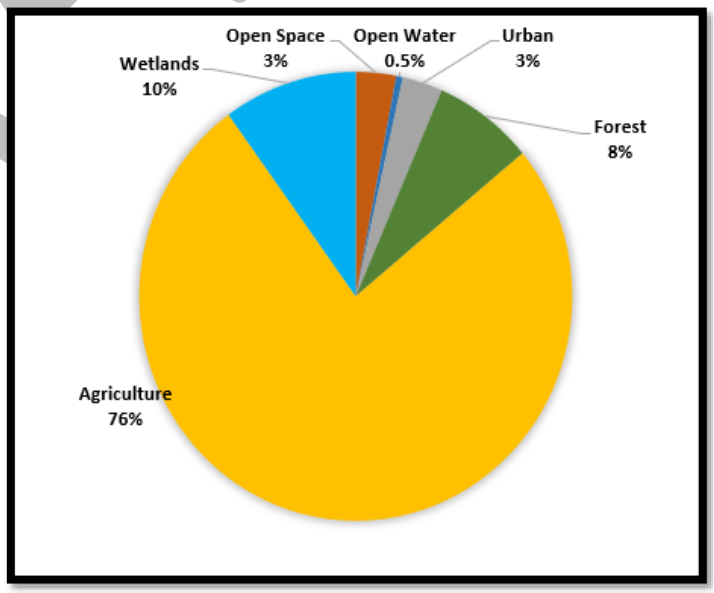


Figure 2: Land use in the Upper East River Watershed

Study Summary

Streams in the Upper East River watershed are consistent with cool-warm to warm headwaters streams. The streams typically have 4-10 species, many of them dominated by transitional to warm species such as Creek Chub, Central Mudminnow, Brook Stickleback and Johnny Darters. There was an absence of intolerant species throughout the entire watershed and majority of the total number of fish observed were tolerant to environmental degradation. Overall habitat conditions were mostly in the fair to good category however these scores were likely maintained by a lack of disturbance within 10 m on either side of the stream. Bank erosion and deposition of fine sediment along with the elimination of pool habitat and cover for fish are the most impacted metrics in habitat quality observed.

Historically these streams may have been flow and habitat limited, however it is evident that significant impacts from altered hydrology and agricultural inputs are continuing to limit the aquatic life in these systems. In comparing stream conditions throughout the watershed, it is easy to observe the critical benefits that wetlands play in water quality. The Unnamed Tributary that originates atop the Niagara Escarpment in the Holland Wildlife Area and Holland Red Maple State Natural Area still maintains good to excellent habitat and a diverse fish community relative for a small headwater stream.

The strategy to improve conditions within the Upper East River and the other small tributaries in this watershed would appear straight forward however there are complex, long term limitations to the recovery. The extensive agricultural land use in the watershed has eliminated wetland acres, altered riparian corridors, degraded soil conditions, altered the nutrient dynamics, and permanently altered stream conditions. Efforts should focus on improving the condition of the riparian corridor by managing forest cover types and land use, encouraging soil health principles to be adopted, manage the complex needs of modern agriculture, restore wetlands, and improve habitat within the streams.

Recommendations and Priorities

- Advance the understanding and use of Soil Health principles throughout the watershed.
- Develop a riparian corridor management strategy. The management strategy should promote the establishment of diverse, healthy forest cover types to improve infiltration, provide for nutrient and sediment sequestration, provide for stabile bank conditions, and increase cover for fish.
- Vegetative buffer widths should be increased in the headwaters and concentrated flow paths should be established into grassed waterways where possible.
- Identify opportunities for wetland restorations in the headwaters of the watersheds.
- Focused efforts on strategic bank stabilization should be taken to address watershed wide bank erosion and failures.
- Continue monitoring monthly growing season total phosphorus, orthophosphate and total suspended solids at Mallard Road on East River to track progress of BMP installation throughout the watersheds on water quality.
- Management of woody vegetation to prevent overgrowth along banks, to control regrowth and use management practices that avoid destabilization of banks.
- Within 5 years following the BMP implementation through Upper East River 9KE plan repeat monitoring at the 16 locations to evaluate contemporary conditions within the watershed.
- Continue to monitor monthly growing season TP, TSS, and DOP at the Mallard Road crossing to tacks trends in water quality and effects of BMP implementation on instream water quality conditions.

Resources

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 current information. Impaired waters in this watershed are impaired non-point sources of discharges associated from rural or urban sources, highway/roadway/bride non-related runoff). Impaired waters in the Upper East River watershed include the East River (Table 1).

Table 1: Impaired waters in the Upper East River Watershed.

Watershed	Local Name	WBIC	Start Mile	End Mile (acres)	Pollutant	Impairment	Sources	303 Status
LF01	East River	118000	14.15	42.25	Total Phosphorus	Degraded Biological Community, Low DO	Non-Point Source (Rural or Urban)	TMDL Approved
LF01	East River	118000	14.15	42.25	Unspecified Metals	Chronic Aquatic Toxicity	Highway/Road/Bridge Runoff (Non-construction Related)	303d Listed
LF01	East River	118000	14.15	42.25	Sediment/Total Suspended Solids	Degraded Habitat	Non-Point Source (Rural or Urban)	TMDL Approved

Aquatic Invasive Species

Rusty Crawfish were observed and verified during surveys in 2017.

Project Discussion

Purpose of Project

This monitoring study was conducted to support the Upper East River Watershed Implementation Plan, which is a nine-key element plan created by Outagamie and Brown County to restore and protect the water resources of the area. The Upper East Watershed is a HUC 12 size sub-watershed of the Lower Fox River Watershed and is in east central Wisconsin in Brown and Outagamie Counties. The Upper East River Watershed is the headwaters to the East River which empty into the Lower Fox River draining approximately 22,995 acres. This monitoring study was designed to provide a baseline of contemporary information regarding resource condition following the completion of the East River Priority Watershed Plan and prior to the implementation of the Upper East River Nine Key Element plan, which has the following goals:

- Goal #1: Improve surface water quality to meet the TMDL limits for total phosphorus and sediment.
- Goal #2: Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.
- Goal #3: Reduce flood levels during peak storm events.
- Goal #4: Improve stream bank stability and reduce amount of streambank degradation.

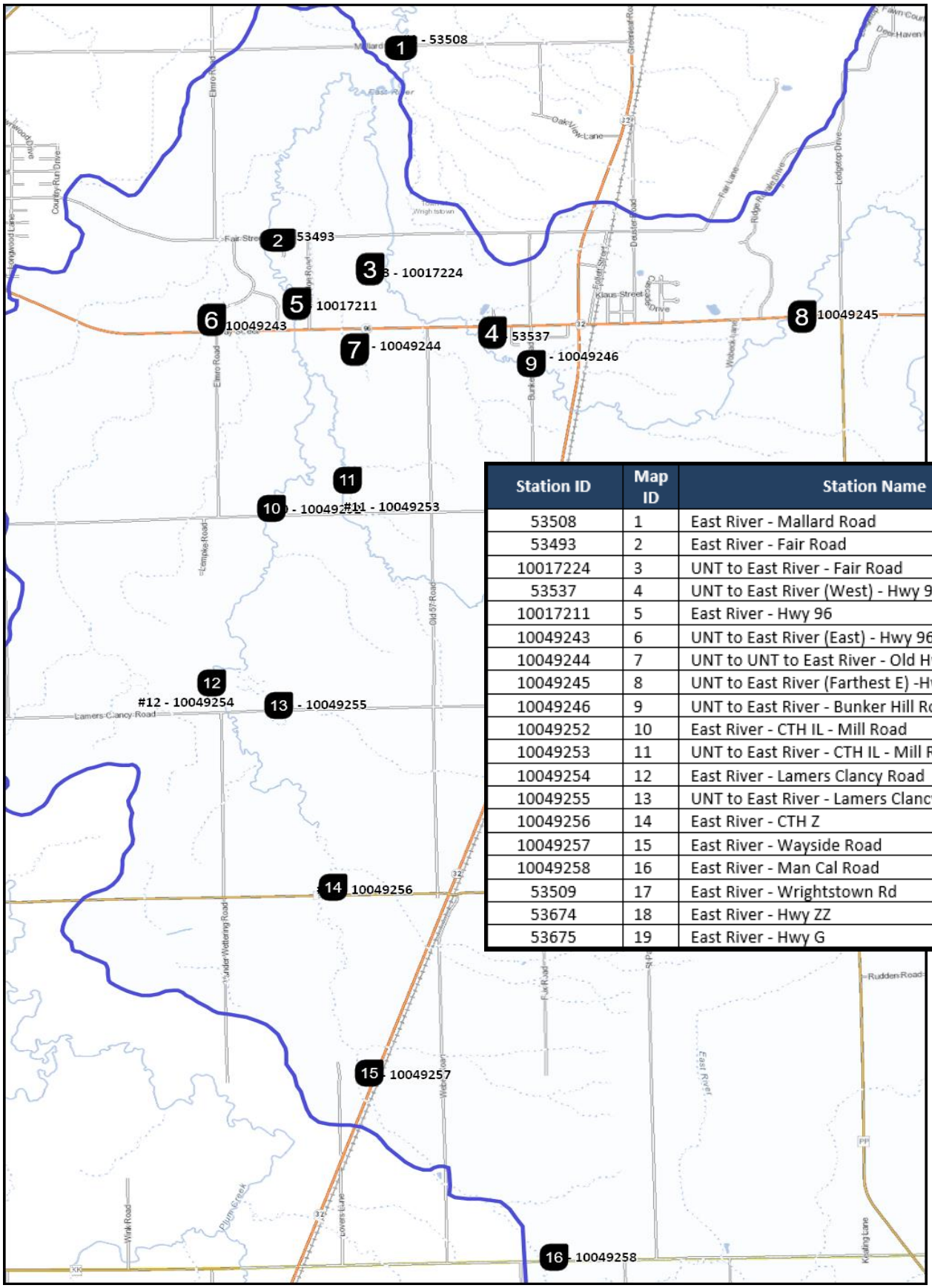
Site Selection and Study Design

The evaluation was to focus on watershed scale alterations and changes in water quality criteria, the biological community, and habitat. Monitoring was conducted on 6 streams across 16 sites. Sites were selected for two primary purposes; 1) to provide an overall evaluation of contemporary conditions of streams in the watershed and 2) to target BMP installations to evaluate potential improvements of instream conditions. Sample stations were established to limit outside influences and set-up using DNR field procedures manuals of 35 times the mean stream width (Modified from Simonson, et al. 1994). Stations were no less than the minimum of 100 meters and no more than the maximum of 400 meters.

Table 2: Monitoring Stations in the Upper East River TWA

Station ID	Map ID	Station Name	WBIC	Water Body Name
53508	1	East River - Mallard Road	118000	East River
53493	2	East River - Fair Road	118000	East River
10017224	3	UNT to East River - Fair Road	120500	Unnamed Trib to East River
53537	4	UNT to East River (West) - Hwy 96	120500	Unnamed Trib to East River
10017211	5	East River - Hwy 96	118000	East River
10049243	6	UNT to East River (East) - Hwy 96	120900	Unnamed Trib to East River
10049244	7	UNT to UNT to East River - Old Hwy 57	5021240	Unnamed Trib to East River
10049245	8	UNT to East River (Farthest E) -Hwy 96	120500	Unnamed Trib to East River
10049246	9	UNT to East River - Bunker Hill Road	120500	Unnamed Trib to East River
10049252	10	East River - CTH IL - Mill Road	118000	East River
10049253	11	UNT to East River - CTH IL - Mill Road	121000	Unnamed Trib to East River
10049254	12	East River - Lamers Clancy Road	118000	East River
10049255	13	UNT to East River - Lamers Clancy Road	121300	Unnamed Trib to East River
10049256	14	East River - CTH Z	118000	East River
10049257	15	East River - Wayside Road	118000	East River
10049258	16	East River - Man Cal Road	118000	East River
53509	17	East River - Wrightstown Rd	118000	East River
53674	18	East River - Hwy ZZ	118000	East River
53675	19	East River - Hwy G	118000	East River

Figure 3: Monitoring Sites in the Upper East River TWA



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10049246	9	UNT to East River - Bunker Hill Road
10049252	10	East River - CTH IL - Mill Road
10049253	11	UNT to East River - CTH IL - Mill Road
10049254	12	East River - Lamers Clancy Road
10049255	13	UNT to East River - Lamers Clancy Road
10049256	14	East River - CTH Z
10049257	15	East River - Wayside Road
10049258	16	East River - Man Cal Road
53509	17	East River - Wrightstown Rd
53674	18	East River - Hwy ZZ
53675	19	East River - Hwy G

Methods, Equipment and Quality Assurance

Collection of total phosphorus (TP), quantitative habitat, fish, and aquatic macroinvertebrates used standard DNR data collection methods and samples were sent to certified laboratories in the state for specific analysis. 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 (TP, ORP, TSS)

Water Chemistry samples were collected by volunteers associated with the WAV program and Southern Brown County Chapter of the Isaac Walton League. These samples were collected using standard DNR grab sampling methods at 2 locations in 2017 (Table 3)

Additionally, in 2018, a long-term monitoring station for Total Phosphorous (TP), Total Suspended Solids (TSS), and Orthophosphate (ORP) was established at the Mallard Road crossing. (Table 3). All 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.

Fish Assemblage

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. All other DNR sampling protocols were used to assess the fish community for purposes of calculating the index of biotic integrity. DNR staff entered the fish data into the DNR Fisheries Database.

Habitat Surveys

Habitat was evaluated throughout each fish survey station. Quantitative habitat survey station lengths were 35 times the mean stream width of the survey station. Following the determination of station length, the station was divided into 12 transects. At each transect, substrate, sedimentation, erosion, water depth, and riparian land use data were collected. DNR staff entered the quantitative habitat data into the DNR Fisheries and Habitat Management Database (FHMD).

Macroinvertebrates

All sites were sampled using the DNR Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams (2000). A D-shaped kicknet with 600-micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then overhanging vegetation, woody debris, or other vegetation would be sampled. 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. Staff at the UWSP AEL entered the data into the SWIMS database upon final taxonomic identification.

Project Results

Total Phosphorus

All inorganic chemistry samples were sent to the WISLOH in Madison for analysis. The two sample sites in 2017 and the one in 2018, for this project 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 3). Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2018) requires a parametric statistical approach to assess stream 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 stream segment (assessment unit) is considered to exceed the criterion. The LCLs were calculated for each creek’s TP samples (Table 3). Both sites sampled in the Upper East River Watershed in 2017 had calculated LCLs that exceeded the water quality criterion for TP as did the sample location in 2018. (Figure 4 and Figure 56.

Table 3: Total Phosphorus Concentrations in Streams in the Upper East River Watershed 2017

SWIMS Station ID	Station Name	May	June	July	August	September	October	Mean	Median	Lower 90% Median	Upper 90% Median
053493	East River - Fair Road	0.122	0.449	0.365	0.369	0.272	0.321	0.316	0.343	0.250	0.380
10017224	UNT to East River - Fair Road	0.194	0.521	0.484	0.463	0.750	0.587	0.500	0.503	0.390	0.610

Figure 4: Lower 90% confidence limit of Total Phosphorus concentrations in 2017 in the Upper East River Watershed

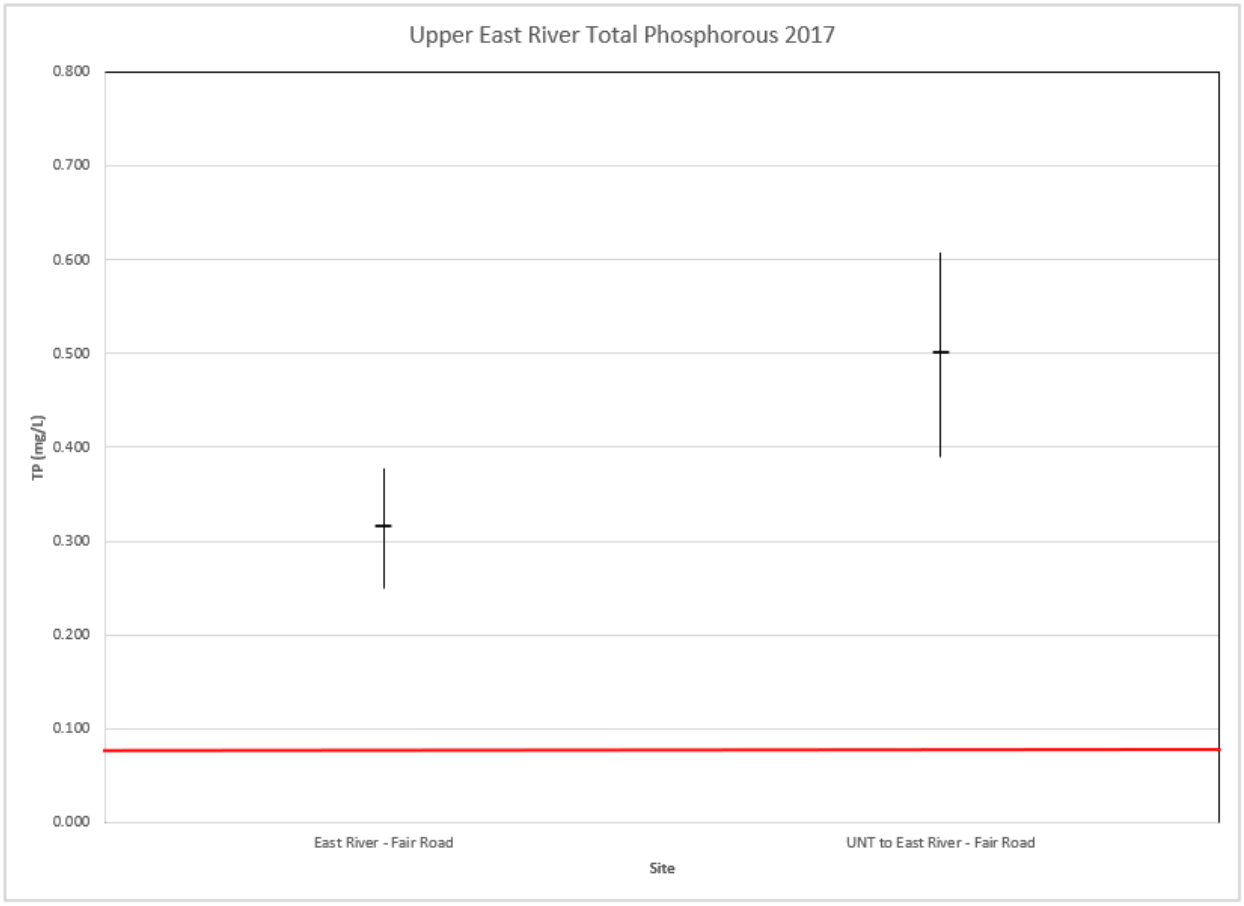
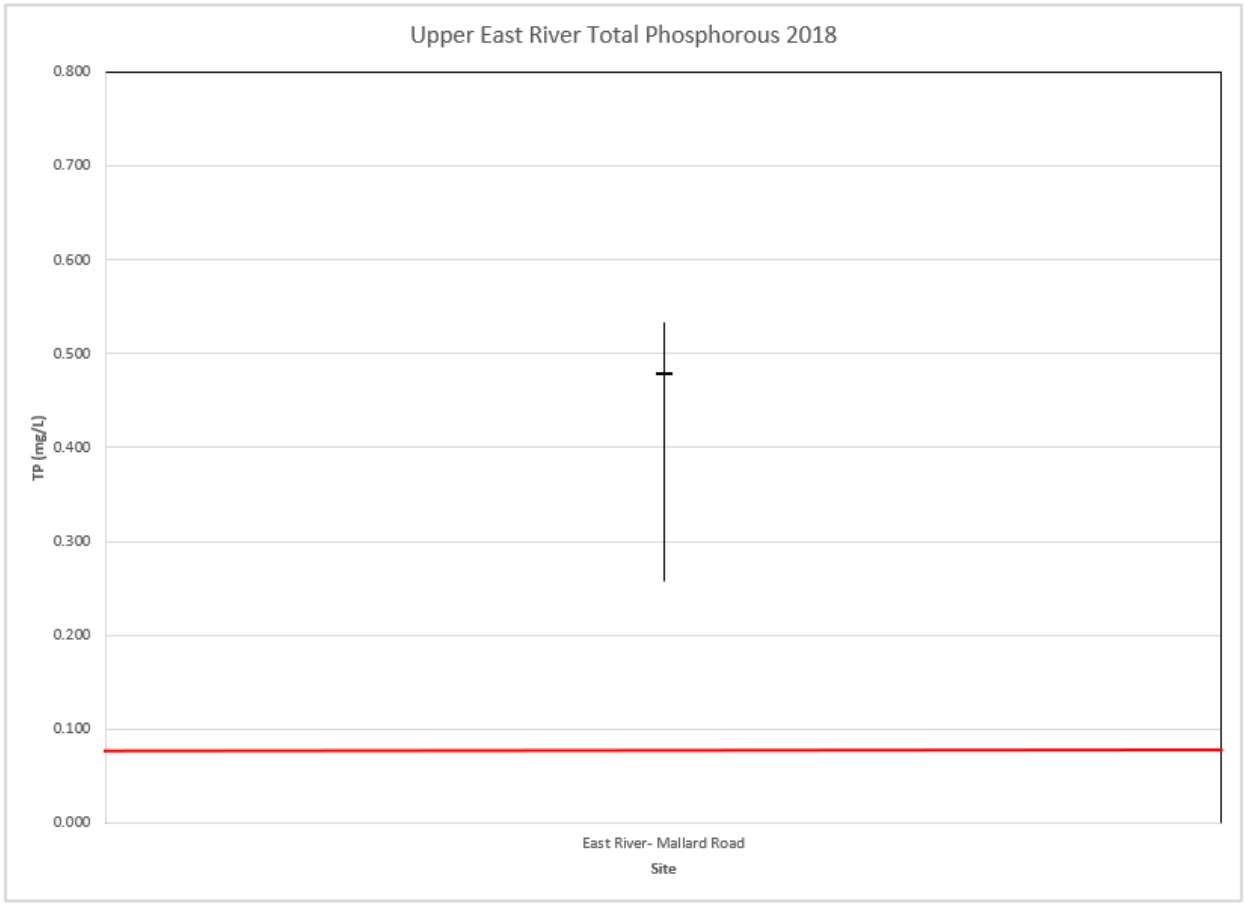


Table 4: Total Phosphorus Concentrations East River Mallard Road

East River- Mallard Road	Average	Median	L90%CI	U90%CI
TP	0.424	0.478	0.257	0.536
ORP	0.337	0.345	-	-
TSS	31.8	31.8	-	-

Figure 5: Water Chemistry Results East River Mallard Road-2018 (Station 053508)



Fish Assessments

Fish surveys were completed on 16 stream sites between May and September in 2017. Some fish species are tolerant of environmental degradation, some species are moderately tolerant, and some others are intolerant. Based upon the representative fish collected during the survey and their associated tolerance to environmental degradation, a Fish Index of Biotic Integrity (FIBI) was calculated to indicate the water quality of the streams in the Upper East River Watershed. The FIBI scores range from 20 to 100. Of the 16 fish surveys completed, 1 had a condition of poor, 3 had a condition of Fair, 8 had a condition of Good, and 4 had a condition of Excellent. (Table 5, Figure 6 and 7).

Table 5: Fish IBI Condition Values, Upper East TWA

Map ID	Station	Station Name	WBIC	Waterbody Name	Score	Rating	Verif. Natural Community
1	53508	East River - Mallard Road	118000	East River	50	Good	CWHW
2	53493	East River - Fair Road	118000	East River	40	Fair	CWHW
3	10017224	UNT to East River - Fair Road	120500	Unnamed Trib to East River	50	Good	CWHW
4	53537	UNT to East River (West) - Hwy 96	120500	Unnamed Trib to East River	90	Excellent	WHW
5	10017211	East River - Hwy 96	118000	East River	30	Fair	CWHW
6	10049243	UNT to East River (East) - Hwy 96	120900	Unnamed Trib to East River	30	Fair	CWHW
7	10049244	UNT to UNT to East River - Old Hwy 57	5021240	Unnamed Trib to East River	50	Good	CWHW
8	10049245	UNT to East River (Farthest East) - Hwy 96	120500	Unnamed Trib to East River	100	Excellent	CWHW
9	10049246	UNT to East River - Bunker Hill Road	120500	Unnamed Trib to East River	50	Good	WHW
10	10049252	East River - CTH IL - Mill Road	118000	East River	70	Good	CWHW
11	10049253	UNT to East River - CTH IL - Mill Road	121000	Unnamed Trib to East River	10	Poor	MACRO
12	10049254	East River - Lamers Clancy Road	118000	East River	70	Good	WHW
13	10049255	UNT to East River - Lamers Clancy Road	121300	Unnamed Trib to East River	90	Excellent	CWHW
14	10049256	East River - CTH Z	118000	East River	100	Excellent	WHW
15	10049257	East River - Wayside Road	118000	East River	80	Good	WHW
16	10049258	East River - Man Cal Road	118000	East River	80	Good	WHW

East River Site #4

Figure 6: Fish IBI Condition Values

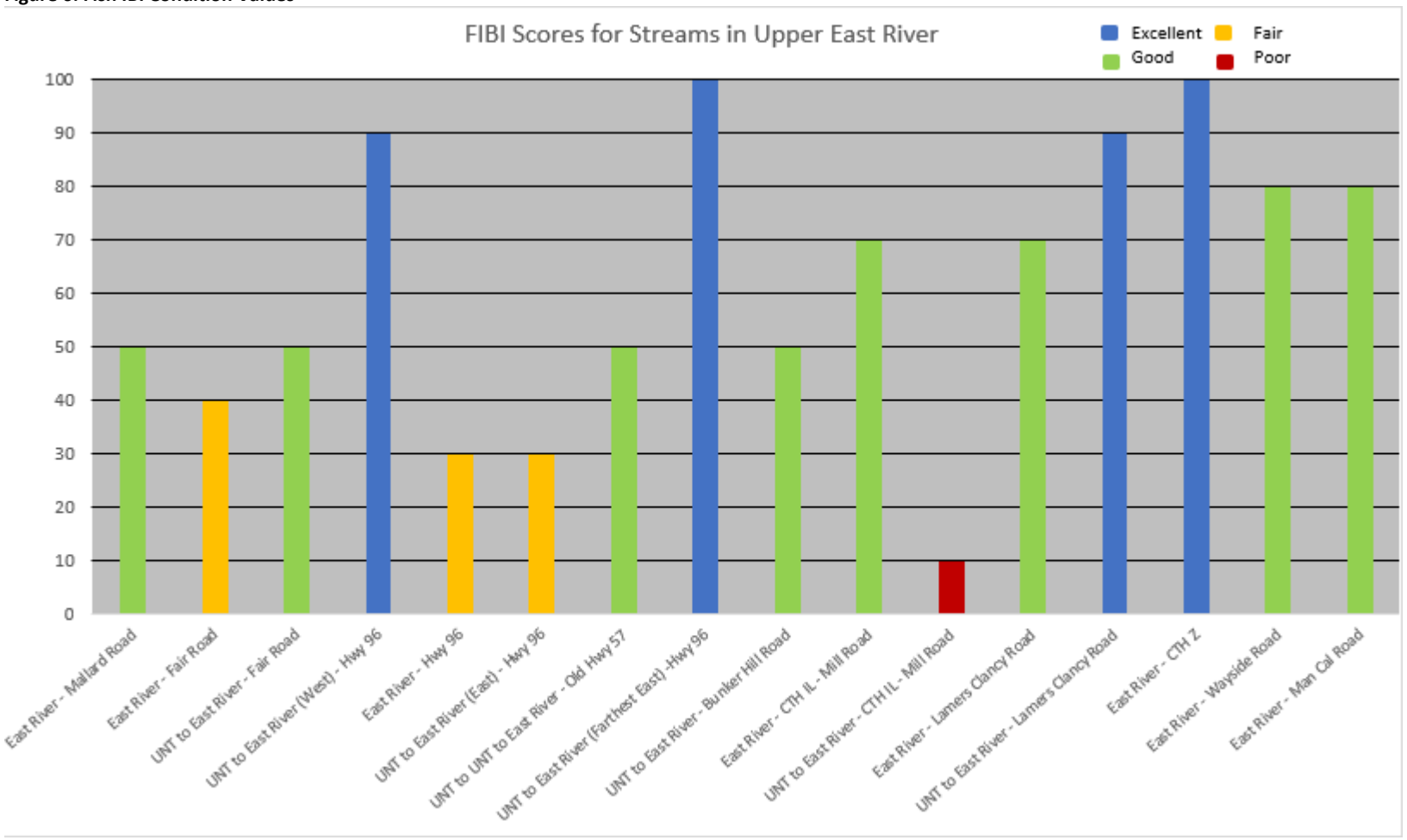
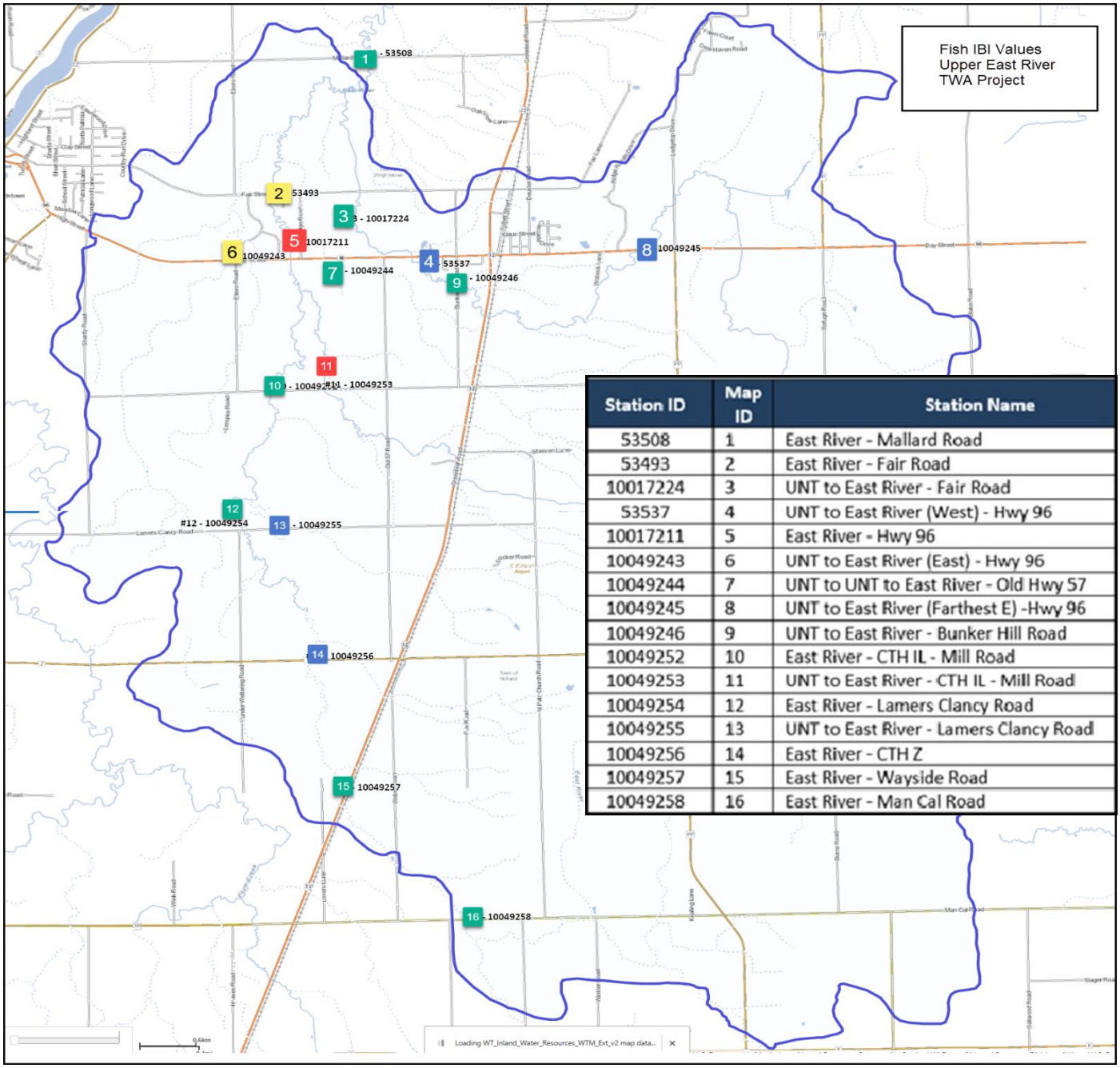


Figure 7: Map of Fish IBI Condition Values



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10049255	13	UNT to East River - Lamers Clancy Road
10049256	14	East River - CTH Z
10049257	15	East River - Wayside Road
10049258	16	East River - Man Cal Road

Macroinvertebrates

In the fall of 2017, macroinvertebrate samples were collected from 16 sites for calculating the macroinvertebrate Index of Biotic integrity (MIBI). Some aquatic macroinvertebrate species are tolerant of environmental degradation, some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate samples collected and their associated tolerance to environmental degradation, the MIBI was calculated to indicate the water quality condition of the stream (Table 6, Figure 9). The MIBI scores ranged from 2.14 to 4.91 which demonstrated these sites are likely impacted from environmental degradation.

Table 6: Macroinvertebrate Index of Biotic Integrity scores and rating

Map ID	Station	Waterbody Name	WBIC	Station Name	Score	Rating
1	53508	East River	118000	East River - Mallard Road	2.14	Poor
2	53493	East River	118000	East River - Fair Road	2.92	Fair
3	10017224	UNT to East River	120500	UNT to East River - Fair Rd	3.28	Fair
4	53537	UNT to East River	120500	UNT to East River - Hwy 96	4.47	Fair
8	10049245	UNT to East River	120500	UNT to East River - STH 96	4.22	Fair
10	10049252	East River	118000	East River - Mill Rd	3.25	Fair
11	10049253	UNT to East River	121000	UNT to East River - Mill Rd	3.18	Fair
12	10049254	East River	118000	East River - Lamers Clancy Rd	4.00	Fair
13	10049255	UNT to East River	121300	UNT to East River - Lamers Clancy Rd	3.20	Fair
14	10049256	East River	118000	East River - CTH Z	3.98	Fair
16	10049258	East River	118000	East River - Man Cal Rd	4.09	Fair
17	53509	East River	118000	East River - Wrightstown Rd	4.65	Fair
18	53674	East River	118000	East River - Hwy ZZ	2.62	Fair
19	53675	East River	118000	East River - Hwy G	4.91	Fair
20	10016765	East River	118000	East River - Hwy W Pp Bridge	2.84	Fair
21	10049271	UNT to East River	120900	UNT to East River - Fair Rd	3.18	Fair

Figure 8: Macroinvertebrate IBI Condition Values

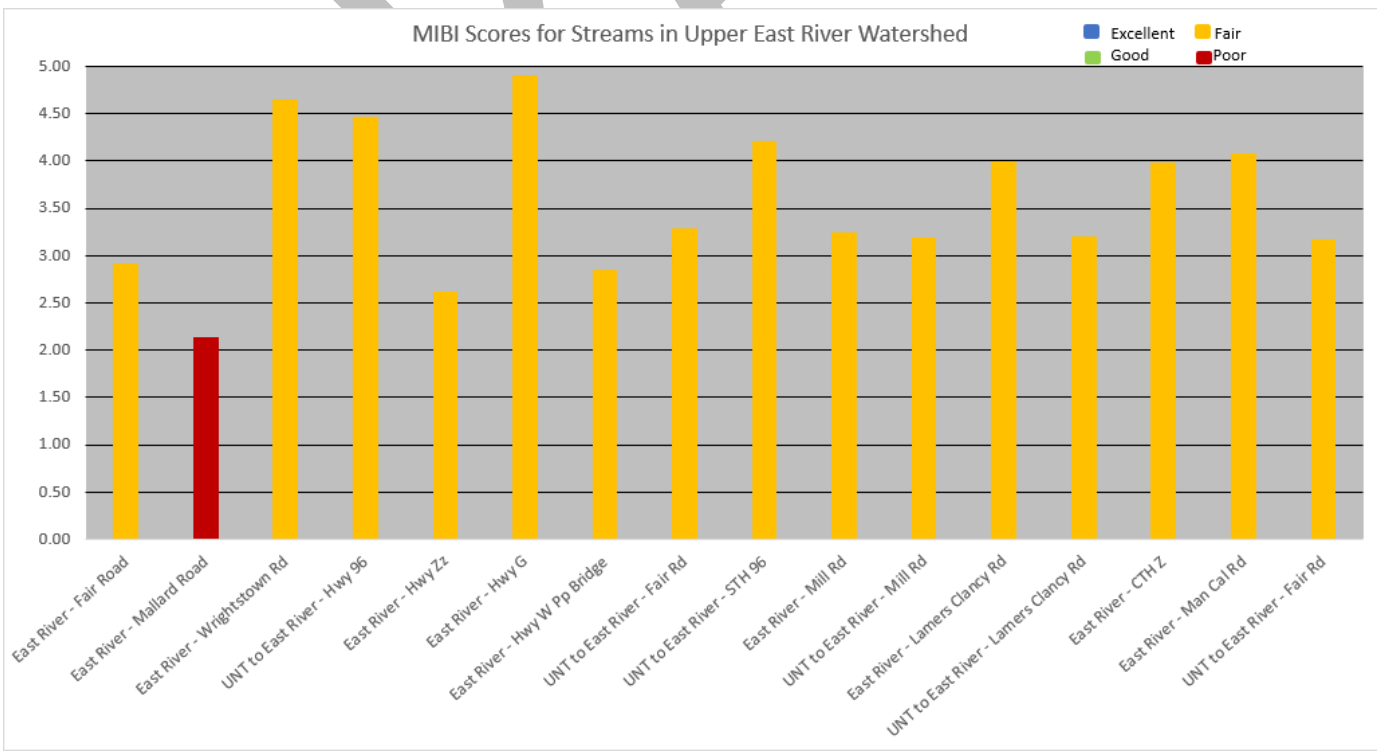
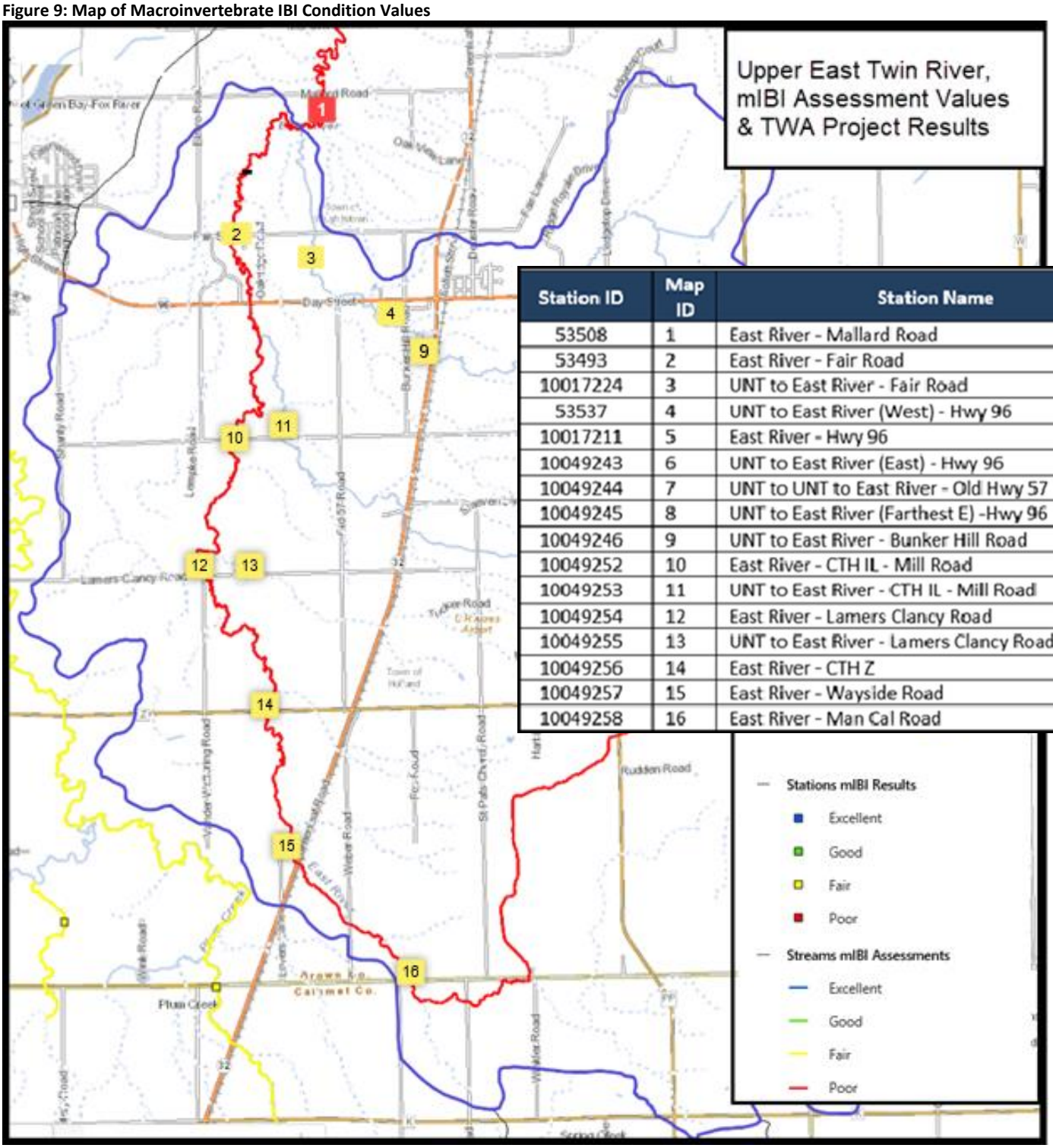


Figure 9: Map of Macroinvertebrate IBI Condition Values



Station ID	Map ID	Station Name
53508	1	East River - Mallard Road
53493	2	East River - Fair Road
10017224	3	UNT to East River - Fair Road
53537	4	UNT to East River (West) - Hwy 96
10017211	5	East River - Hwy 96
10049243	6	UNT to East River (East) - Hwy 96
10049244	7	UNT to UNT to East River - Old Hwy 57
10049245	8	UNT to East River (Farthest E) -Hwy 96
10049246	9	UNT to East River - Bunker Hill Road
10049252	10	East River - CTH IL - Mill Road
10049253	11	UNT to East River - CTH IL - Mill Road
10049254	12	East River - Lamers Clancy Road
10049255	13	UNT to East River - Lamers Clancy Road
10049256	14	East River - CTH Z
10049257	15	East River - Wayside Road
10049258	16	East River - Man Cal Road

Habitat Assessments

Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2017 surveys, a habitat rating was calculated for the 16 small streams less than 10m wide. (Table 7, Figure 10). The habitat rating scores were relatively similar for all streams whereas 6 scored in the Fair range, 9 scored in the Good range, and 1 scored Excellent. The greatest factor influencing the score and rating of Fair to Good is the undisturbed buffer width, bank erosion, and cover for fish score. Most streams had very good riffle sequences and or bends. Fine sediment was extensive. The site that scored excellent was well buffered, had no bank erosion, and excellent cover for fish.

UNT to East River- HWY 96. (WBIC 5022162)

Table 7: Habitat Values in the Upper East River in 2017

Waterbody Name	WBIC	SWIMS ID	Station Name	AU	MSW (m)	Buffer Score	Erosion Score	Pool Score	W:D Score	Riff:Riff Score	Bend:Bend Score	Fine Sed. Score	Fish Cover Score	Score Small	Rating Small
East River	118000	53508	East River - Mallard Road	10680	5	15	5	0	10	0	15	0	5	50	Good
East River	118000	53493	East River - Fair Road	10680	7	10	5	0	10	0	15	0	5	45	Fair
UNT to East River (East)	120500	10017224	UNT to East River - Fair Road	10686	5	10	5	3	10	0	15	0	15	58	Good
UNT to East River (West)	120900	10049243	UNT to East River (West) - Hwy 96	6931836	4	10	5	0	10	0	0	0	0	25	Fair
East River	118000	10017211	East River - Hwy 96	10680	5	10	5	3	10	0	15	0	0	43	Fair
UNT to UNT to East River (West)	5021240	10049244	UNT to UNT to East River - Old Hwy 57	6933201	2	10	5	3	10	15	15	0	5	48	Fair
UNT to East River (East)	120500	53537	UNT to East River (East) - Hwy 96	10686	3	15	0	0	10	15	15	5	5	50	Good
UNT to East River (Farthest East)	120500	10049245	UNT to East River (Farthest East) -Hwy 96	10686	2.5	15	15	3	10	15	15	5	15	78	Excellent
UNT to East River	120500	10049246	Unt to East River - Bunker Hill Road	10686	3	10	5	3	10	15	5	5	0	48	Fair
East River	118000	10049252	East River - CTH IL - Mill Road	10680	5	15	5	3	10	15	15	5	0	53	Good
UNT to East River	121000	10049253	UNT to East River - CTH IL - Mill Road	6918586	2	15	10	0	10	10	0	5	0	50	Good
East River	118000	10049254	East River - Lamers Clancy Road	10680	5	15	5	3	10	15	15	5	0	53	Good
UNT to East River	121300	10049255	UNT to East River - Lamers Clancy Road	6931859	1	15	5	0	10	15	15	5	0	50	Good
East River	118000	10049256	East Road - CTH Z	10680	5	10	5	0	10	10	15	5	0	45	Fair
East River	118000	10049257	East River - Wayside Road	10680	4	15	5	3	10	10	15	5	5	58	Good
East River	118000	10049258	East River - Man Cal Road	10680	3	15	10	3	10	15	10	5	0	58	Good

Figure 10: Habitat Scores for Streams in the Upper East River Watershed

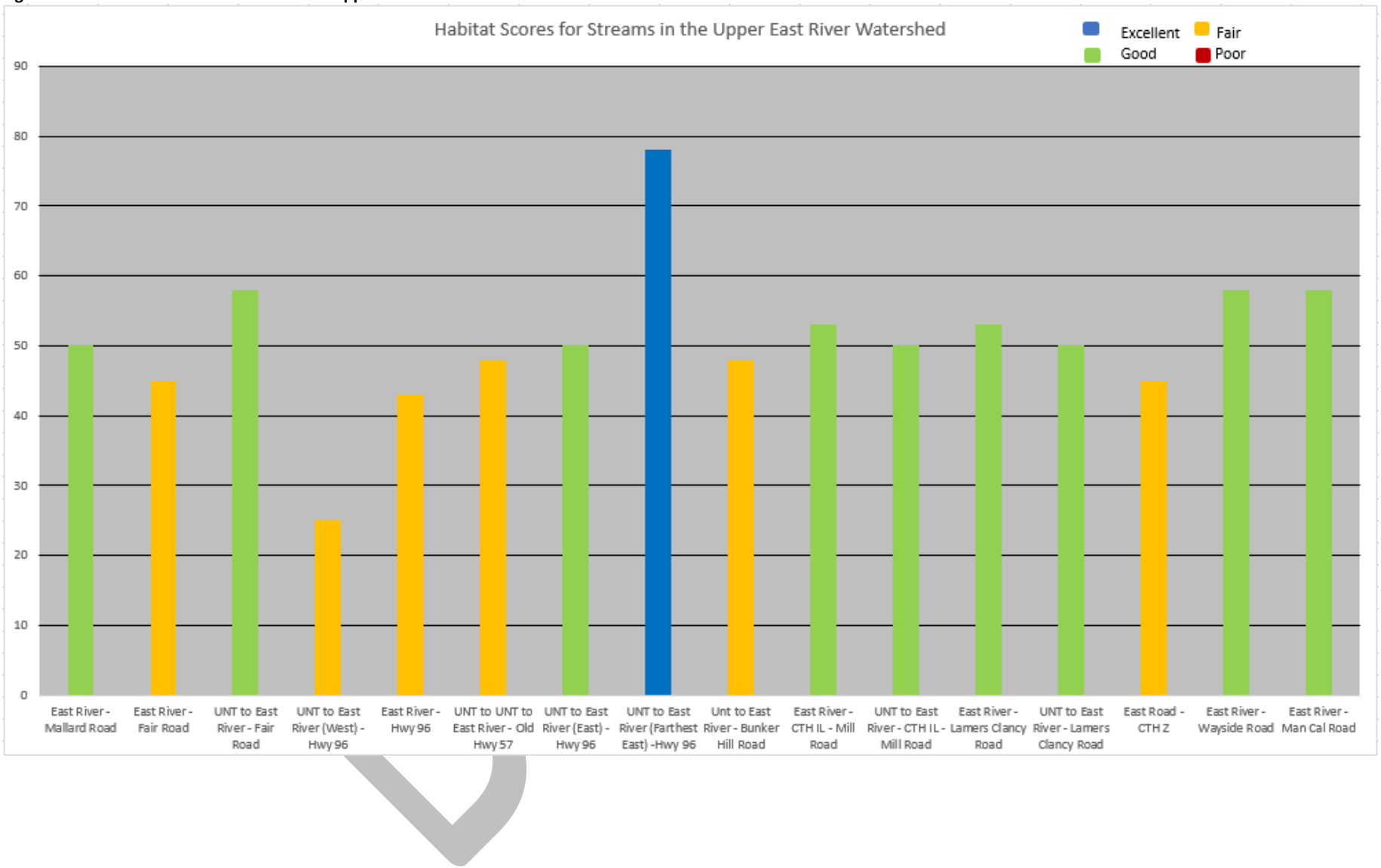
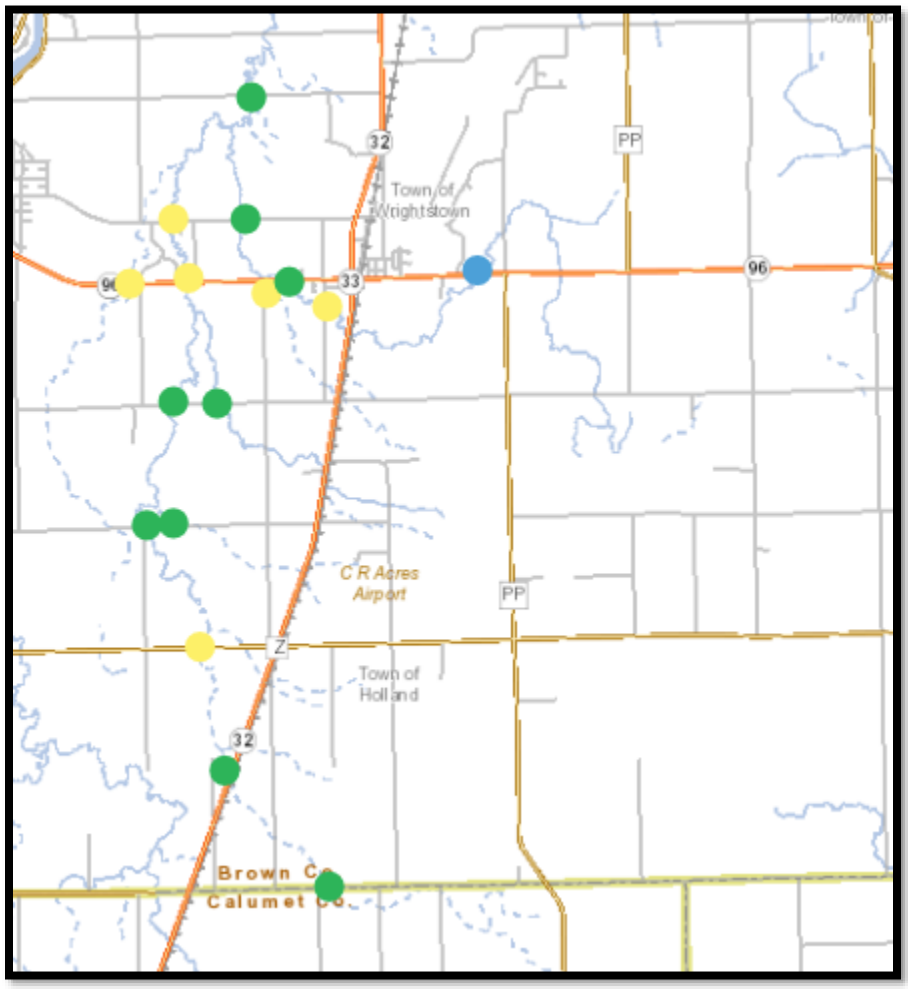


Figure 11: Map of Habitat Scores for Streams in the Upper East River Watershed



Discussion

Overall River and Stream Health

All streams monitored in this HUC 12 were modeled and verified to be cool-warm to warm headwaters (Lyons, 2008). The department has developed a methodology to determine whether the modeled natural community is accurate based on the fishery assemblage and climate conditions (Lyons, 2013). Environmental degradation can sometimes explain the discrepancy between the modelled and actual community where there is a lack of intolerant species and a dominance of tolerant ones. For the streams surveyed five contained tolerant fish communities that prevented a new natural community classification from being proposed. At two sites, a new natural community was proposed, however these changes did not require an alternative IBI to be calculated. It is highly likely that all streams in the watershed should be classified thought of as cool-warm headwaters streams. When the correct IBI was applied, impacts to the fish community from environmental degradation was not entirely evident at all but a few locations.

There were 18 species captured throughout the 16 survey stations and stations contained 1-11 species with the median number of species expected at 8. The most dominant species as far as percent of the total catch was the Creek Chub (39%) which occurred across 15 of the 16 stations. The most widely distributed species was the Brook Stickleback which occurred at all survey stations (n=16) and comprised (13%) of the total catch. The other dominant species included the Central Mudminnow (21%) (n=15) and Johnny Darter (10%) (n=11). All other species comprised 5% or less of the total catch and occurred at 8 or less sites. As one looks at the community assemblages across the watershed, it is hard to overlook the fact there is a lack of intolerant species present. In fact, there is largely an absence of moderately intolerant species in the downstream reaches of the East River and the UNT to East River at Fair Road. The decline in moderately intolerant species coincides with the biologist's observations of a decline in overall stream and riparian corridor condition.

Overall habitat conditions were mostly in the fair to good category however these scores were likely bolstered by several metrics that were favorable in this watershed as observed by the biologist. The undisturbed buffer width was maintained at many locations as was the width to depth score and riffle: riffle ratio or bend: bend ratio. Coincidently the streams are highly entrenched and have a high sinuosity which maintains these scores near their maximum. The riparian corridor may be undisturbed but it general is in a degraded quality. Old pastures have been allowed to fallow and revert to woodlots. These woodlots are often dominated by invasive species with limited functional values that enhance water quality. The best habitat areas occurred in open, undisturbed land use, with minimal canopy cover. In these settings, dense herbaceous grasses would stabilize banks and provide overhanging cover for fish. Coarse woody debris, when present, also provided limited habitat throughout the watershed. Too often, woody debris jams in these streams, caused flow deflection at severely eroded banks further degrading habitat quality and depositing sediment in the stream channel. While hard armoring may seem appropriate to protect severely eroding banks, managing the riparian corridor quality may serve to provide far greater ecosystem benefits. Selectively removing invasive or undesirable trees while promoting dense herbaceous bank cover will provide the greatest benefit to the streams in this watershed. Course woody debris should remain unless significant flow diversion and bank erosion results. Hard armoring should be avoided unless severe bank erosion threatens structures or is on a steep north facing bank where denser herbaceous vegetation establishment is difficult.

The macroinvertebrate data showed a consistent trend with M-IBI scores in the fair range. The HBI indicates that impacts from organic loading increase the further down in the watershed one travels. The macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). This is relationship was reaffirmed through Biologists' observations and comparison of the F-IBII, M-IBI, and the habitat scores within the watershed. It is evident that impacts from the watershed land cover and the riparian areas limit the aquatic life in these systems.

Growing season total phosphorous concentrations were very consistent between the 2 streams sites monitored in 2017 and the single station monitored in 2018. The Department's listing methodology for impaired waters (WDNR, 2013) recommends listing sites where the median phosphorus concentration exceeds 0.075 mg/l on wadeable streams and 0.1 mg/l on rivers. The impairment listing protocol uses a 90% confidence interval about the median for listing streams and rivers. The East River continues to be impaired by TP concentrations and the UNT to the Fox River exceeds the criteria which would indicate this stream is also likely impaired by TP. Total Suspended Solids and Orthophosphate concentrations were also collected at Mallard Road in the East River in 2018. Dissolved Orthophosphate is a form of phosphorous that is readily available for aquatic plant and algae uptake and spurs growth. It is important to note that the median DOP concentration in the East River in 2018 exceeded the total phosphorous standard by 5 times. This indicates that approximately 70% of the TP concentration in the Upper East River is readily available for plant and algae growth. Likely sources for DOP in the East River include agricultural tile line and or legacy sediment phosphorous release. The Lower Fox River TMDL sets a target for TSS in the Lower Fox at 18 mg/l.

The average and median concentration observed in the East River for Total Suspended solids is 31.8 mg/l. This would indicate that TSS is a concern in the East River and impacting aquatic life.

Management Actions

Management Goals

It is evident that signifincat impacts from non-point sources of pollution to the streams in the Upper East River continue to limit the aquatic life and threaten downstream waters. Starategies should continue to improve knowledge of soil helth principles in the watershed to reduce nutirient and sediment loads, increase infiltration and overall improve water quality conditions. Riparian corridors should be managed to promote native cover types with limited invasive species and dense herbaceous understories to stabilize eroding banks. Comprehensive bank stabilization projects should utilize strategies to establish natural stream morphology, contain a significant fish cover component, establish a sustainable rate of sediment transport, and re-develop a floodplain connectivity. Headwater areas should be protected by increasing buffer widths, installing grassed waterways, restoring functional wetlands, or otherwise protecting concentrated flow paths to the streams.

Recommendations

- Advance the understanding and use of Soil Health principles throughout the watershed.
- Develop a riparian corridor management strategy. The management strategy should promote the establishment of diverse, healthy forest cover types to improve infiltration, provide for nutrient and sediment sequestration, provide for stabile bank conditions, and increase cover for fish.
- Vegetative buffer widths should be increased in the headwaters and concentrated flow paths should be established into grassed waterways where possible.
- Identify opportunities for wetland restorations in the headwaters of the watersheds.
- Focused efforts on strategic bank stabilization should be taken to address watershed wide bank erosion and failures.
- Continue monitoring monthly growing season total phosphorus, orthophosphate and total suspended solids at Mallard Road on East River to track progress of BMP installation throughout the watersheds on water quality.
- Management of woody vegetation to prevent overgrowth along banks, to control regrowth and use management practices that avoid destabilization of banks.
- Within 5 years following the BMP implementation through Upper East River 9KE plan repeat monitoring at the 16 locations to evaluate contemporary conditions within the watershed.
- Continue to monitor monthly growing season TP, TSS, and DOP at the Mallard Road crossing to tacks trends in water quality and effects of BMP implementation on instream water quality conditions.

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Appendix B: Stream Narratives

East River

East River Mallard Road

The East River is a 42.25-mile long tributary stream to the Fox River. The segment of the East River within the Upper East River watershed is approximately 15.1-miles. Land-use in the watershed is predominantly agriculture changing to urban as the stream approaches the confluence with the Fox River. Agricultural land use along the East River corridor has significantly altered water quality and habitat throughout the upper portions of the watershed. The habitat scores rate good to fair along this entire segment of the East River and are maintained by intact riparian buffers, the width: depth ratio, and the diverse presence of riffles and bends. The overall habitat scores may seem acceptable, but segments of the East River continue to be heavily impacted by severe bank erosion, lack of fish habitat, and deposition of fine sediment. It was also noted that the quality of riparian areas were often times degraded, low quality forest cover types with little to no herbaceous understory and dominated by invasive species. Total Phosphorous concentrations near the pour point in 2017 and 2018 indicate Total Phosphorous concentrations exceed the State's water quality criteria for phosphorous and high suspended solids load continue to impair this stream. The East River originates and is verified as a warm headwater stream. As the stream flows north and picks up baseflow, it shifts to a cool-warm headwater. This general shift in natural community occurs within a zone between

Lamer-Clancy and Mill Road. The Fish IBI scores throughout the entire segment were within the good to Fair range with one excellent score observed. A shift in stream condition was noticeable near the change in natural community as noted by the biologist. Fewer fish species and the overall number of fish that were captured declined even though the scores and ratings were maintained. It was also noted that water clarity, bottom substrate composition, and bank condition all sharply declined near the Lamers-Clancy and Mill Road crossings. These observed changes are likely more than coincidental with a change in natural community and are linked to an increase in agricultural influences on water quality. The M-IBI scores were all within the fair range except for Mallard Road which was poor. It was consistent for the HBI scores that further downstream sites were impacted greater by organic loading and agricultural impacts which subsequently yielded scores in the fair to poor range.

East River- Mill Road

East River Man-Cal Road

UNT to East River (120500)

The Unnamed Tributary to the East River is a 10-mile long tributary to the East River. This is the second largest stream in this sub-watershed behind the East River. This stream originates within the Holland Wildlife Area and Holland Red Maple Swamp State Natural Area. It immediately begins to flow through extensive agricultural land use prior to the confluence with the East River. Adequate buffers appear to be maintained along this stream however smaller tributaries and drainages to this stream have inadequately or no maintained buffers. The natural community classification for this stream has been verified as a cool-warm headwater however the assemblage at 2 stations is dominated by tolerant species so the natural community of a warm headwater has been retained at these 2 stations. Both a cool-warm headwater and warm headwater applies the small stream IBI to calculate a F-IBI. These stations all scored in the good to excellent range with the furthest upstream station having the greatest catch rate of any other stream station during surveys in 2017. The quality in this stream is maintained by the extensive natural wetland as the origin of this stream with a protected land use. The upstream station that scored excellent benefits from protected buffers, stable banks, balanced stream features of riffles, runs and pools, and cover for fish. The other stations on this stream have depressed scores from these same metrics.

UNT to East River (120900)

The Unnamed Tributary to the East River is a 6.66-mile long tributary to the East River. The headwaters of this tributary originate as surface water flow and is fed by a few additional small tributaries as it flows north towards the East River. In places this stream is well buffered as it flows through small woodlots and in other places, minimum buffers exist within agricultural fields to protect the waterway. The habitat in this stream scores fair and is severely impacted by bank erosion, lack of pool habitat, homogenous habitat, extensive deposits of fines, lack of cover for fish. The F-IBI scored a low fair and was dominated by tolerant headwater species. The MIBI and HBI rated as fair is impacted by organic loading and land use. During the field season of 2017, an unreported manure spill was discovered at the fair road crossing. This stream is limited during periods of flow during dry, warm parts of the year may experience unknown, unreported manure spills that have led to poor aquatic life conditions.

Unreported manure spill, UNT to East River- Fair Road 2017

UNT to East River (121000)

The Unnamed Tributary to the East River is a 4.18-mile long tributary to the East River. The headwaters of this tributary originate as a series of high gradient channels coming down across the Niagara escarpment through agricultural land use. Limited buffers exist in this location and agricultural land uses are likely contributing to impacts observed in the stream. As it flows west and north and approaches the confluence with the East River the gradient decreases and the small sinuous stream

exists. The fish community is dominated by species tolerant to environmental degradation the FIBI rated poor and overall habitat scored good. Lack of pools, deposition of fines, and lack of fish habitat is present within this reach.

UNT to East River (121300)

The Unnamed Tributary to the East River is a 2.61-mile long tributary to the East River. The headwaters of this tributary originate as a series of high gradient channels coming down across the Niagara escarpment through agricultural land use. Limited buffers exist in this location and agricultural land uses are likely contributing to impacts observed in the stream. As it flows west and north and approaches the confluence with the East River the gradient decreases and a small sinuous stream exists. The FIBI rated excellent and overall habitat scored good. Lack of pools, deposition of fines, and lack of fish habitat is present within this reach and depressed the overall score. In locations, adequate buffers widths from the stream exist, however the condition of the buffers could be improved upon and a comprehensive strategy to provide stable bank conditions should be developed.

UNT to East River (5021240)

The Unnamed Tributary to the East River is a 3.18-mile long tributary to the East River. The headwaters of this tributary originate as a series of high gradient channels coming down across the Niagara escarpment through agricultural land use. Limited buffers exist in this location and agricultural land uses are likely contributing to impacts observed in the stream. As it flows west and north and approaches the confluence with the East River the gradient decreases and the small sinuous stream exists. The FIBI rated good and overall habitat scored fair. Lack of pools, deposition of fines, bank erosion, and lack of fish habitat is present within this reach and depressed the overall score.

Appendix C: Fisheries, Habitat, Macroinvertebrate Tables 2016

Stream - Site	East River #1 Mallard Road	East River #3 Fair Road	UNT to East River #4 Fair Road	UNT to East River #5 STH 96	East Rvier #6 STH 96	UNT to UNT to East River #7 Old Hwy 57	UNT to East River #8 STH 96	UNT to East River #9 STH 96	UNT to East River #10 Bunker Hill Road	East River #11 Mill Rd	UNT to East River #12 Mill Road	East River #13 Lamers Clancy Rd	UNT to East River #14 Lamers Clancy Rd	East River #15 CTH Z	East River #16 Wayside Rd	East River #17 ManCal Rd	Totals
Stream Order	5	4	4	2	4	3	3	3	3	4	2	4	3	3	3	3	
Mean Stream Width	5	7.0	4	4	5	2	3	2.50	3	5.00	2	5	1	5.0	4	4	
Station Length	175	295	140	180	175	100	105	100	100	175	100	175	100	175	140	140	
Nat. Comm. Classification	CWHW	CWHW	CWHW	MACRO	CWHW	MACRO	WHW	MACRO	WHW	CWHW	MACRO	WHW	MACRO	WHW	WHW	WHW	
V. Natural Community	CWHW	CWHW	WHW	CWHW	CWHW	CWHW	CWHW	CWHW	WHW	CWHW	MACRO	WHW	CWHW	WHW	WHW	WHW	
Fish Species																	
Black Bullhead		1															1
Black Crappie		1															1
Black Sided Darter									2								2
Brook Stickleback	10	20	4	5	16	46	1	37	1	160	7	15	12	34	2	5	375
Central Mudminnow	27	23	12	4	7	4	26	426	53	6		4	1	5	4	9	611
Common Shiner	1									1		17		5		1	25
Creek Chub	30	10	93	14	2	2	63	10	42	84		172	64	292	72	180	1130
Fathead Minnow	31			2	1							9	1	1		19	64
Golden Shiner	1	2															3
Green Sunfish	2	4				1			1	1			1	8			18
Johnny Darter	10		46			4	37		9	22		25	49	54	16	32	304
Largemouth Bass		4										1					5
Northern Pearl Dace							1	101				1		8	5	4	120
Northern Redbelly Dace								4					4				8
Northern Pike										1							1
Southern Redbelly Dace							1							16	2	4	23
Western Blacknose Dace			9			7	24	21	9			15	1	2	9	1	98
White Sucker			7		1		9			26		20		16	1	2	82
Totals	112	65	171	25	27	64	162	599	117	301	7	279	133	441	111	257	2871
# species	8	8	6	4	5	6	8	6	7	8	1	10	8	11	8	10	
18 Total Species																	
IBI Score																	
Coldwater																	
Cool-Cold(CC)																	
Cool-Warm (CW)																	
Warmwater																	
Small Stream (Intermittent)	40	50	90	30	50	30	50	100	50	70	10	70	90	100	80	80	

Stream - Site	East River Mallard Road	East River Fair Road	UNT to East River Fair Road	UNT to East River - 8 STH 96	UNT to East River - 9 STH 96	East River Mill Road	East River Lamers Clancy Road	UNT to East River Lamers Clancy Road	East River CTH Z	East River ManCal Road
Stream Order	5	4	4	3	3	4	4	3	3	3
Mean Stream Width	5	7.0	4	3	2.50	5.00	5	1	5.0	4
Station Length	175	295	140	105	100	175	175	100	175	140
Nat. Comm.	CWHW	CWHW	CWHW	WHW	MAC	CWHW	WHW	MAC	WHW	WHW
HBI Rating [1]	Fairly Poor	Poor	Fair	Fair	Fair	Good	Fairly Poor	Fairly Poor	Good	Good
HBI Score [1]	7.49	7.51	5.54	6.06	5.87	5.04	6.76	6.74	4.73	4.7
MIBI Rating [2]	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
MIBI Score [2]	2.14	2.92	3.28	4.47	4.22	3.25	4	3.2	3.98	4.09

1) E= Excellent (0-3.5)
VG= Very Good (3.51-4.50)
G= Good (4.51-5.50)
F= Fair (5.51-6.50)
FP= Fairly Poor (6.51-7.50)
P= Poor (7.51-8.50)
VP= Very Poor (8.51-10)

2) E= Excellent (7.5-10)
G= Good (5.0- 7.49)
F= Fair (2.51- 4.99)
P= Poor (0- 2.5)

Appendix D: Water Quality Standards Attainment Report