Sinsinawa River Targeted Watershed Assessment: A Water Quality Report to Restore Wisconsin Watersheds, 2020

Galena River Watershed

(GP01)

HUC12: 070600050203

Monitored 2016

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

Sinsinawa River Riffle at Sinsinawa Road near Hazel Green, August 2016

Photo by: James Amrhein, South 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 Sinsinawa River at Explore Wisconsin's Waters Online! for more detail

WISCONSIN DEPT. OF NATURAL RESOURCES

EGAD # 3200-2020-03
Water Quality Bureau
Wisconsin DNR

Table of Contents

TABLE OF CONTENTS 2

FIGURES 3

TABLES 3

TARGETED WATERSHED ASSESSMENT STUDY SUMMARY 4

About the Watershed 4
Biological Communities and Water Quality 4
Recommendations 4

WISCONSIN WATER QUALITY MONITORING AND PLANNING 5

Basin/Watershed Partners 5
Report Acknowledgements 5
List of Abbreviations 6

WATER QUALITY PLAN GOALS 8

RESOURCES OVERVIEW 8

Land Use and Population 8
Ecological Landscapes 9
Hydrology 9

MONITORING PROJECT STUDY SUMMARY 10

Site Selection and Study Design 10
Methods, Equipment and Quality Assurance 11
Fish Assemblage *11*
Habitat Evaluation *11*
Macroinvertebrate Evaluation *11*
Continuous Temperature *11*

PROJECT RESULTS 12

Natural Community & Fish Assemblage 12
Qualitative Habitat Assessment 15
Macroinvertebrate Evaluation 17
Continuous Temperature 18

DISCUSSION 18

Fish Assemblage, Natural Communities and Habitat Analysis 18
Macroinvertebrate Data 19
Land Use and Stream Chemistry 20
Potential for Smallmouth Bass Fishery 21

STUDY CONCLUSIONS 22

MANAGEMENT RECOMMENDATIONS 23

Recommendations for work with Partners 23
Monitoring and Assessment Recommendations 23

APPENDIX A: REFERENCES 24

APPENDIX B: WATER NARRATIVES FOR WATERS IN THE STUDY 25

APPENDIX C: TEMPERATURE DATA, MODELED COMMUNITY, VERIFIED COMMUNITY 26

APPENDIX D: TEMPERATURE DATA 27

APPENDIX E: WATER QUALITY STANDARDS USE ASSESSMENT - FISH AND AQUATIC LIFE USE I 28
APPENDIX F: OUTSTANDING AND EXCEPTIONAL RESOURCE WATERS 31
APPENDIX G: IMPAIRED WATERS 31

Figures

Figure 1. The Sinsinawa TWA in the Galena Watershed (GP01). 8
Figure 2. Percent land use in the Sinsinawa River Watershed. 8
Figure 3. The Ecological landscapes in the Galena Watershed (GP01). 9
Figure 4. The Sinsinawa River just upstream of Sinsinawa Road. 9
Figure 5. Monitoring Stations Sinsinawa River TWA 10
Figure 6. Fish IBI Condition Values for the Sinsinawa TWA Project1 14
Figure 7. Fish Habitat Value Map for the Sinsinawa TWA 16
Figure 8. Macroinvertebrate IBI (mIBI) Condition Value Map for the Sinsinawa TWA 17
Figure 9. Stream classification temperature ranges from Lyons, et. al., 2009. 18
Figure 10. Unnamed Trib Kirkwood Road (Map Site ID 1) Macroinvertebrate Index of Biological Integrity results 19
Figure 11. Photo of agriculture-dominated landscape in the Sinsinawa watershed. 20
Figure 12. Sinsinawa River Total phosphorus concenrations - Louisberg Road 2014, 2015. 20
Figure 13: Stream biologist James Amrhein with smallmouth bass. 21
Figure 14. Sinsinawa River Smallmouth Bass Trend Analysis. 21
Figure 15. Cattle pasture adjacent to the Sinsinawa River. 22
Figure 16. Sinsinawa River upstream of Sinsinawa Road. 23
Figure 17. Sinsinawa River Riffles near Hazel Green, Wisconsin. Photo by James Amrhein, August 2016. 25
Figure 18. Sinsinawa River Landscape (2020 map) and Sinsinawa River at the Bridge 26

Tables

Table 1. Monitoring locations and the parameters measured during the Sinsinawa River Watershed study. 11
Table 2. Fish Natural Community, FIBI Used, FIBI Value & Fish Habitat Values for the Sinsinawa TWA 12
Table 3 Fish Assemblage, Natural Community, IBI Values for the Sinsinawa TWA [1] 13
Table 4. Fish Habitat Values for the Sinsinawa TWA Project 15
Table 5. Macroinvertebrate IBI (mIBI) condition values for the Sinsinawa TWA Project. 17
Table 6. Comparison of Temperature Data, Modeled Community and Verified Community 18
Table 7. Sinsinsawa River Total Phosphorus – at Louisberg Rd – 2014 and 2015 20
Table F1. Outstanding/Exceptional Resource Waters in the Galena River Watershed (GP01). 31
Table G1. Impaired waters in the Galena River Watershed (GP01).[1] 31

Targeted Watershed Assessment Study Summary

The primary purpose of this study was to assess the overall conditions of the Sinsinawa River and the Sinsinawa River subwatershed as a whole and potentially identify areas of management to help smallmouth bass and other non-game species thrive in this agriculture-dominated watershed. Historically the Sinsinawa River was known as a very productive smallmouth bass fishery with good habitat that has been subject to periodic fish kills. A secondary purpose was to determine if other streams in the watershed can serve as nursery streams for smallmouth bass and provide an important role in maintaining healthy smallmouth bass populations. In addition, this study provides data to examine total phosphorus data and determine if streams in this watershed exceed water quality standard criteria.

The following are key outcomes from this study:

- Streams in the watershed were monitored to understand their status.
- Condition of streams were assessed.
- Presence and sources of impairments were identified.
- Monitoring priorities for watershed were identified.
- Management recommendations were developed.
- Waters are subject of watershed planning.

About the Watershed

The Sinsinawa River watershed (HUC 12 = 070600050203) lies in extreme southeastern Grant County (Figure 1). This watershed extends into Jo Daviess County, IL. The Sinsinawa River itself is a 21.1-mile-long seepage and spring fed stream beginning 2 miles east of Louisburg in the township of Hazel Green. The river flows south approximately 10 miles into Illinois and another 10 miles toward the southwest where it joins the Mississippi River about 3 miles west of Galena, IL.

Biological Communities and Water Quality

Historically, the Sinsinawa River has had a good smallmouth bass fishery and in general has good smallmouth bass habitat. The smallmouth bass fishery, however, has periodically been affected by fish kills that can be attributed to manure spills and runoff events that lead to low dissolved oxygen levels (WDNR, 2001). Water quality and habitat best management practices (BMPs) were installed at some locations on the river as part of the Galena River Priority Watershed Project in the 1980's to mitigate impacts from the surrounding agriculture-dominated landscape. As with other streams in the watershed, water quality improvements due to the BMP installations has been less than successful due to the relative lack of participation by landowners, the scattered nature of implementation, and the masking of results by uncontrolled non-point pollution sources (Kroner et. al., 1992).

The entire length of the Sinsinawa River in Illinois is on the state's impaired waters (303(d)) list (IL EPA, 2014). In the 2018 Galena/Sinsinawa River Basin TMDL, the Galena River is explicitly listed for total suspended solids, and both the Galena and the Sinsinawa Rivers are listed for zinc, bacteria and total phosphorus (Il EPA, 2018).

The Sinsinawa River has historically had fair to poor macroinvertebrate index of biotic integrity (MIBI) ratings – a sign of significant riparian and watershed perturbations. The Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987) has shown "some" to "fairly significant" organic loading to the river. Documented fish kills were reported in 1978, 1988, 2009 and 2016. The river corridor is also intensively grazed. Despite these ecosystem pressures, smallmouth bass seem to do quite well in the river.

Recommendations

This study was designed to create an updated assessment of the overall conditions of the Sinsinawa River and the watershed and identify areas of management to help the smallmouth bass and other non-game species to thrive in this agriculturally dominated watershed. A secondary purpose was to determine if other streams in the watershed can serve as nursery streams for smallmouth bass and provide an important role in maintaining healthy smallmouth bass populations. The recommendations below reflect these goals.

- Proper manure management such as good housekeeping of barnyards and no spreading on steep slopes and during periods of ice and snow cover or prior to significant rain events would reduce the delivery of potentially deadly amounts of nutrients.
- Managed grazing would help protect streambanks and reduce sediment loads from bank erosion.
- Planting of cover crops would help prevent soil erosion during the vulnerable months.

Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state's Planning and Water Resources Monitoring programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act. Condition information and resource management recommendations support and guide program priorities for the plan area. This plan is approved by the Wisconsin DNR and is a formal update to the Grant – Platte 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.

Report Acknowledgements

- Jim Amrhein, Primary Author and Investigator, Southern District
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Basin/Watershed Partners

- Grant County Land Conservation Department

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List of 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.

FMDB: Fisheries 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. Therefore, biologists must review and confirm the natural community to use the correct fish IBI tool.

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

MIBI: **Macroinvertebrate Index of biological integrity.** The mIBI is the primary tool used to assess stream macroinvertebrate community 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.

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 except for fisheries taxonomy and habitat 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.

The landscape of the Sinsinawa Watershed near Hazel Green. Photo by James Amrhein, Water Quality Biologist, Department of Natural Resources. 2016.

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 Code. 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.

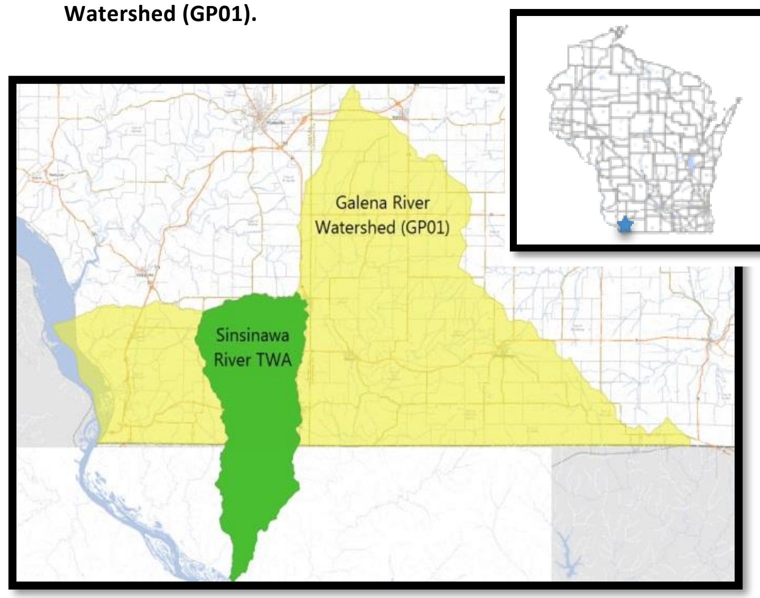
WSLH: Wisconsin State Laboratory of Hygiene– the state's certified laboratory that provides a wide range of analytical services including toxicology, chemistry, and data sharing.

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

Water Quality Plan Goals

The overall goal of this plan is to document water quality conditions and make recommendations to improve and protect water quality in the Sinsinawa subwatershed of the Grant-Platte Basin. This Targeted Watershed Assessment (TWA) monitoring project provided substantial data to analyze current conditions in the Sinsinawa subwatershed. This plan presents monitoring results, identifies issues in the area found during the project, and presents recommendations to improve or protect water quality, consistent with Clean Water Act guidelines and state water quality standards.

Figure 1. The Sinsinawa TWA in the Galena Watershed (GP01).



Resources Overview

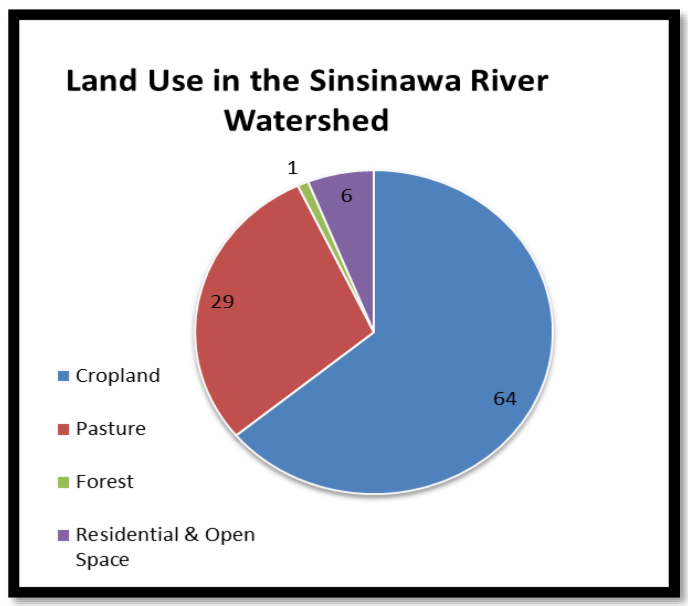
The Sinsinawa River watershed (HUC 12 = 070600050203) lies in extreme southeastern Grant County (Figure 1). This watershed extends into Jo Daviess County, IL. The Sinsinawa River itself is a 21.1-mile-long seepage and spring fed stream beginning 2 miles east of Louisburg in the township of Hazel Green. The river flows south approximately 10 miles into Illinois and another 10 miles toward the southwest where it joins the Mississippi River about 3 miles west of Galena, IL.

The Sinsinawa River is part of the larger Galena River Watershed (GP01) in southwestern Lafayette County and southern Grant County (Figure 1). The watershed is relatively large comprising 242 square miles. Of the 260 miles of streams in the watershed, 115 stream miles are classified as warm water sport fishery. Thirty-five miles of the Galena River are considered Exceptional Resource Water (ERW) under state administrative rules. The remaining 120 miles of smaller streams in the watershed have not yet had the biological use determined. Additional information about the waters in the Galena River Watershed can be found in Appendix I: Outstanding and Exceptional Resource Waters, and Appendix J: Impaired Waters.

Land Use and Population

The Wisconsin portion of the watershed encompasses 24.7 mi2 (21,190 acres). Several unnamed tributaries add flow to the main river along the way. The vast majority of the land use is in cropland or pasture, with scattered woodlands, open space, and residential making up the balance (Figure 2). The communities of Cuba City and Hazel Green both have portions of their boundaries in the watershed, but neither has a wastewater discharge to the watershed. Agriculture is the dominant land use in the smaller Sinsinawa subwatershed at 64% cropland and 29% pasture. Runoff from agricultural fields and barnyards are considered to be the major sources of non-point pollution. Another major non-point source pollution problem common in this and other watersheds, particularly in the Grant-Platte Basin, is overgrazing of stream banks.

Figure 2. Percent land use in the Sinsinawa River Watershed.



Ecological Landscapes

This Sinsinawa subwatershed is located in the Southwest Savanna Ecological Landscape which is in the far south-west part of the state (Figure 3). This area is characterized by deeply dissected topography, unglaciated for the last 2.4 million years, with broad open hilltops and river valleys, and steep wooded slopes. The climate is favorable for agriculture but the steep slopes limit the agriculture to hilltops and valley bottoms (WDNR, 2015b) .

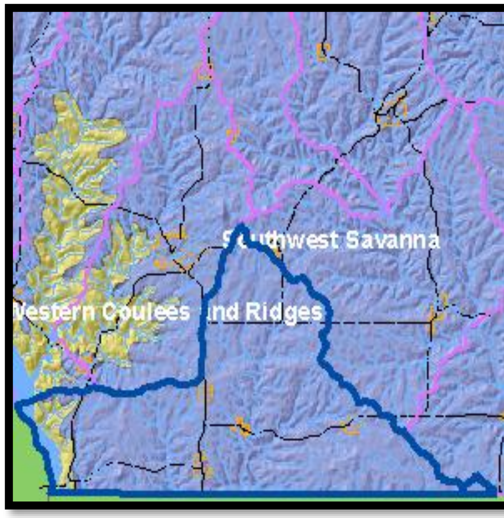


Figure 3. The Ecological landscapes in the Galena Watershed (GP01).

Soils are underlain with calcareous bedrock. Soils on hilltops are silty loams, sometimes of shallow depth over exposed bedrock and stony red clay subsoil. Some valley soils are alluvial sands, loams, and peats.

Some hilltops are almost treeless due to the thin soil while others have a deep silt loam cap. Historic vegetation consisted of tall prairie grasses and forbs with oak savannas and some wooded slopes of oak. Almost three-quarters of the current vegetation in the subwatershed is agricultural crops with lesser amounts of grasslands, barrens, and urban areas. The major forest types are oak-hickory and maple-basswood. High-quality prairie remnants occur on rocky hilltops and slopes that are not farmed. Some prairie pastures and oak savannas still exist. The grassland areas harbor many rare grassland birds, invertebrates, and other grassland species. Relict stands of pine occur on bedrock outcroppings along some stream systems.

Hydrology

The study area is located in the driftless area of the state and is characterized by dendritic stream systems among rolling hills and steeply graded valleys. Agricultural practices and hydrologic modifications have altered natural stream flows so that flashy hydro regimes are more common and historical springs, which once dotted the landscape, are much less common than they once were. Given the gradient in this area, the streams have always been flashy to some extent. However, today soils are less stable, so they now carry an increased sediment and nutrient load (Figure 4).

Figure 4. The Sinsinawa River just upstream of Sinsinawa Road.

Studies have been conducted to evaluate the effect of changing natural driftless floodplain systems to heavily agricultural land uses. In the larger Galena Watershed, the conversion from natural vegetation with freely evolving stream meanders to an agriculture-dominated landscape with constrained stream valleys and floodplains has encouraged development of more incised meander belts along streams draining between 10 and 200 km (DNR Ecological Landscapes, 20. These belts consist of alluvial terraces that confine flood flows to a relatively narrow portion of the valley. Researchers found that in systems where stream floodplains were constrained, peak flood flows were more dramatic, more intense, and yielded greater downstream erosion and sediment loads (ibid).

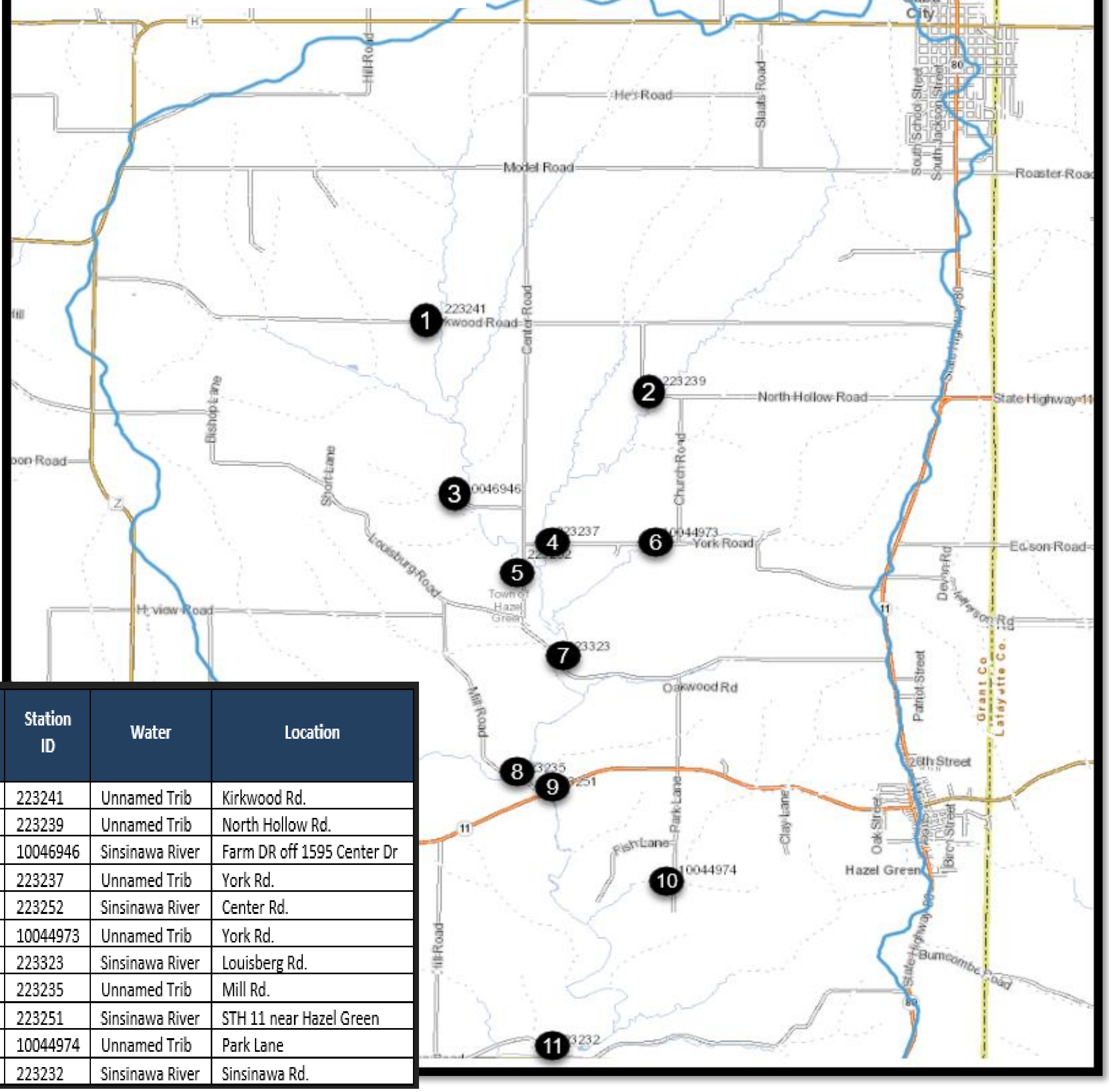
Monitoring Project Study Summary

The Sinsinawa River Targeted Watershed Assessment was conducted to assess the overall chemical, physical and biological condition of the River and its tributaries.

Site Selection and Study Design

This study involved the collection of fish community, macroinvertebrate, water chemistry, and qualitative habitat data at several sites in the watershed. The 2016 watershed survey was conducted by water resources biologists on 11 sites in the HUC 12 (Figure 5). Sites were selected to cover a variety of stream reaches predicted by the Targeted Watershed Site Selection Tool (TWSST) model (WDNR, 2015a). With this model, stream network homogeneity and heterogeneity are estimated based on-stream channel and landscape level physical characteristics. By this method, one can assess differing stream types within a watershed and predict the status of other similar streams in the watershed where little known information exists and without sampling each stream individually. A majority of stations selected were used for habitat and fish monitoring, while a select 6 were used for macroinvertebrate monitoring. Water chemistry, though monitored outside of this study period, took place at one station on the Sinsinawa River near Louisberg Road (Figure 5-7, Table 1).

Figure 5. Monitoring Stations Sinsinawa River TWA



Map No.	Station ID	Water	Location
1	223241	Unnamed Trib	Kirkwood Rd.
2	223239	Unnamed Trib	North Hollow Rd.
3	10046946	Sinsinawa River	Farm DR off 1595 Center Dr
4	223237	Unnamed Trib	York Rd.
5	223252	Sinsinawa River	Center Rd.
6	10044973	Unnamed Trib	York Rd.
7	223323	Sinsinawa River	Louisberg Rd.
8	223235	Unnamed Trib	Mill Rd.
9	223251	Sinsinawa River	STH 11 near Hazel Green
10	10044974	Unnamed Trib	Park Lane
11	223232	Sinsinawa River	Sinsinawa Rd.

Table 1. Monitoring locations and the parameters measured during the Sinsinawa River Watershed study.

Map No.	Station ID	Water	Location	WBIC	*Water Chem.	Water Temp.	Invertebrate	Qualitative Habitat	Fish
1	223241	Unnamed Trib	Kirkwood Rd.	941400				2016	2016
2	223239	Unnamed Trib	North Hollow Rd.	941100				2016	2016
3	10046946	Sinsinawa River	Farm DR off 1595 Center Dr	940200				2016	2016
4	223237	Unnamed Trib	York Rd.	941100			2016	2016	2016
5	223252	Sinsinawa River	Center Rd.	940200			2016	2016	2016
6	10044973	Unnamed Trib	York Rd.	941000				2016	2016
7	223323	Sinsinawa River	Louisberg Rd.	940200	2014-15	2016	2016	2016	2016
8	223235	Unnamed Trib	Mill Rd.	940800			2016	2016	2016
9	223251	Sinsinawa River	STH 11 near Hazel Green	940200				2016	2016
10	10044974	Unnamed Trib	Park Lane	940700			2016	2016	2016
11	223232	Sinsinawa River	Sinsinawa Rd.	940200		2016	2016	2016	2016

Methods, Equipment and Quality Assurance

Fish Assemblage

The fish survey was conducted by electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). A stream tow barge with a generator and two probes was used at most sites. A backpack shocker with a single probe was used at sites generally less than 2 meters wide. All fish were collected, identified, and counted. All gamefish were measured for length. At each site, qualitative notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were also recorded. A qualitative habitat survey (Simonson, et. al., 1994) was also performed at each site. The fisheries assemblage was collected using Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin.

Habitat Evaluation

At each site, qualitative notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were recorded. A qualitative habitat survey (Simonson, et. al., 1994) was performed at 10 sites in the Sinsinawa River and four unnamed tributaries (see also Guidelines for Qualitative Physical Habitat Evaluation of Wadeable Streams).

Macroinvertebrate Evaluation

Macroinvertebrate samples were obtained by kick sampling and collecting using a D-frame net at six sites in the Sinsinawa River and three unnamed tributaries in the watershed in fall, 2016 and sent to the University of Wisconsin-Stevens Point for analysis. Detailed procedures include: Guidelines for Collecting Macroinvertebrate Samples in Wadeable Streams.

Continuous Temperature

Continuous water temperature data loggers (HOBO brand) were placed at two sites on the Sinsinawa River at Louisberg Road and Sinsinawa Road from June to August 2016 and were programed to take hourly water temperature readings during this period. See also: Guidelines and Standard Procedures for Continuous Temperature Monitoring Wisconsin DNR May 2004 (Version 1) .

Rural, agricultural areas typify the Sinsinawa River Watershed.

Project Results

Natural Community & Fish Assemblage

The results of the fisheries surveys are summarized in Table 2. A total of 19 species were found in the watershed. Despite the natural community model predicting most of these systems to be "cool-cold" transitional streams, no stenothermal coldwater species were found in the watershed. Conversely, most of the species found were considered to be warmwater species (Lyons, et. al., 2009).

On the mainstem of the Sinsinawa River, 12 to 15 warm and transitional species were present and generally dominated by common shiner and white suckers. Common shiner and central stoneroller were the most widely distributed species in the watershed, followed by creek chubs, fantail darters, and johnny darters. The species assemblages of the unnamed tributaries were made up of a subset of the species found in the river. The number of species varied by size of stream and/or place in the watershed with larger streams (greater flow) containing enhanced numbers of species. Smallmouth bass were found at 3 of the 4 sites sampled on the Sinsinawa River and an individual was found at 1 site on a tributary. The numbers of smallmouth bass and associated catch per unit effort increased as one moved downstream on the Sinsinawa River.

Table 2. Fish Natural Community, FIBI Used, FIBI Value & Fish Habitat Values for the Sinsinawa TWA

Map No.	Station ID	WBIC	Water	Location	Modeled NC [1]	Best Fit NC	FIBI Used [2]	FIBI Value Condition	Habitat Condition
1	223241	941400	Unnamed Trib	Kirkwood Rd.	CCHW	CWMS	CC/CW IBI (Inter. IBI)	70/70 (Excellent) 80 (Good)	Fair
2	223239	941100	Unnamed Trib	North Hollow Rd.	CCHW	CWHW	CC/CW IBI (Inter. IBI)	70/70 (Excellent) 70 (Good)	Fair
3	10046946	940200	Sinsinawa River	Farm Dr off Center Dr	CCMS	CWMS	CC/CW IBI	100/100 (Excellent)	Good
4	223237	941100	Unnamed Trib	York Rd.	CCHW	CWMS	CC/CW IBI	100/100 (Excellent)	Fair
5	223252	940200	Sinsinawa River	Center Rd.	CCMS	CWMS	CC/CW IBI	90/70 (Excellent)	Fair
6	10044973	941000	Unnamed Trib	York Rd.	CCHW	WHW	CC/CW IBI (Inter. HW)	40/10 (Fair) 40 (Fair)	Poor
7	223323	940200	Sinsinawa River	Louisberg Rd.	CCMS	CWMS	CC/CW IBI	100/90 (Excellent)	Good
8	223235	940800	Unnamed Trib	Mill Rd.	CCHW	CWHW	CC/CW IBI (Inter. HW)	90/90 (Excellent) 100 (Excellent)	Good
9	223251	940200	Sinsinawa River	STH 11 near Hazel Green	CCMS	CWMS	CC/CW IBI	100/90 (Excellent)	Good
10	10044974	940700	Unnamed Trib	Park Lane	CCHW	CWHW	CC/CW IBI (Inter. HW)	50/60 (Good) 80 (Good)	Fair
11	223232	940200	Sinsinawa River	Sinsinawa Rd.	CCMS	CWMS	CC/CW IBI	90/90 (Excellent)	Good

[1] *CCHW – Cool Cold Headwater, CWHW – Cool Warm Headwater, CCMS – Cool Cold Mainstem, CWMS – Cool Warm Mainstem, WMS --- Warm Mainstem*

[2] *CC/CW IBI is Cool-Cold/Cool-Warm IBI – Coolwater IBI , Inter. IBI is Intermittent Headwater IBI*

Table 3 Fish Assemblage, Natural Community, IBI Values for the Sinsinawa TWA [1]

	Sinsinawa River				Unnamed (941100)		Unnamed (940800)	Unnamed (940700)	Unnamed (941000)	Unnamed (941400)
Species	Upstream of Center Rd	Louisberg Rd	STH 11	Sinsinawa Rd	North Hollow Rd	York Rd	Mill Rd	Park Lane	York Rd	Kirkwood Rd
Bigmouth Shiner	2								5	
Bluntnose Minnow	7	47	6			91	25		2	41
Central Stoneroller	2	29	35	41	3	120	13	2		1
Common Shiner	251	206	186	191		166	39	39	25	15
Creek Chub	40	10	38		18	116	25	49		18
Emerald Shiner			31	5						
Fantail Darter	3	197	85	31	30	297	108			74
Fathead Minnow	4							11	180	
Hornyhead Chub	5	91	145	48		158	3			
Johnny Darter	1	13			6	179	53	18	16	81
Longnose Dace		25	29	10	1	21	16			
Pumpkinseed				1						
Rosyface Shiner	1	24	18	13		32	1			
Shorthead Redhorse				3						
Smallmouth Bass		14	34	72		1				
Southern Redbelly Dace	20	15			12	265	3	1		40
Stonecat		6	15	2						
White Sucker	104	210	206	215	2	200	9			
Common Shiner x Rosyface Shiner		1								
Modelled Natural Community[1]	CCMS	CCMS	CCMS	CCMS	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW
Verified?	No	No	No	No	No	No	No	No	No	No
Verified Natural Community[2]	CWMS	CWMS	CWMS	CWMS	CWHW	CWMS	CWHW	CWHW	Warm HW	CWMS
Cool-cold/Cool-Warm IBI[3]	90/70	100/90	100/90	90/90	70/70	100/100	90/90	50/60	40/10	70/70
Other IBI (where appropriate)[4]					70 (Good)		100 (Excellent)	80 (Good)	40 (Fair)	80 (Good)

Tolerant Species
Intolerant Species
Species names in italics indicate warmwater species

1) Lyons, John. 2013. DRAFT Methodology for Using Field Data to Identify and Correct Wisconsin Stream "Natural Community" Misclassifications. Version 4. May 16, 2013
2) Natural Community suggested by the methodology cited above.
3) Coolwater IBI: Poor ≤ 20; Fair 21-40; Good 41-60; Excellent 61-100
4) Lyons, John. 2006. A Fish-Based Index of Biotic Integrity to Assess Intermittent Headwater Stream in Wisconsin, USA.

[1] *IBI Values reflect verified natural communities.*

Reference Tables

(Cool-Warm Transition IBI for Warm Transition

Condition (Rating) Categories for Cool-Warm Mainstem Fish Index of Biotic Integrity (fIBI)

fIBI	Condition
61-100	excellent
41-60	good
21-40	fair
0-20	poor

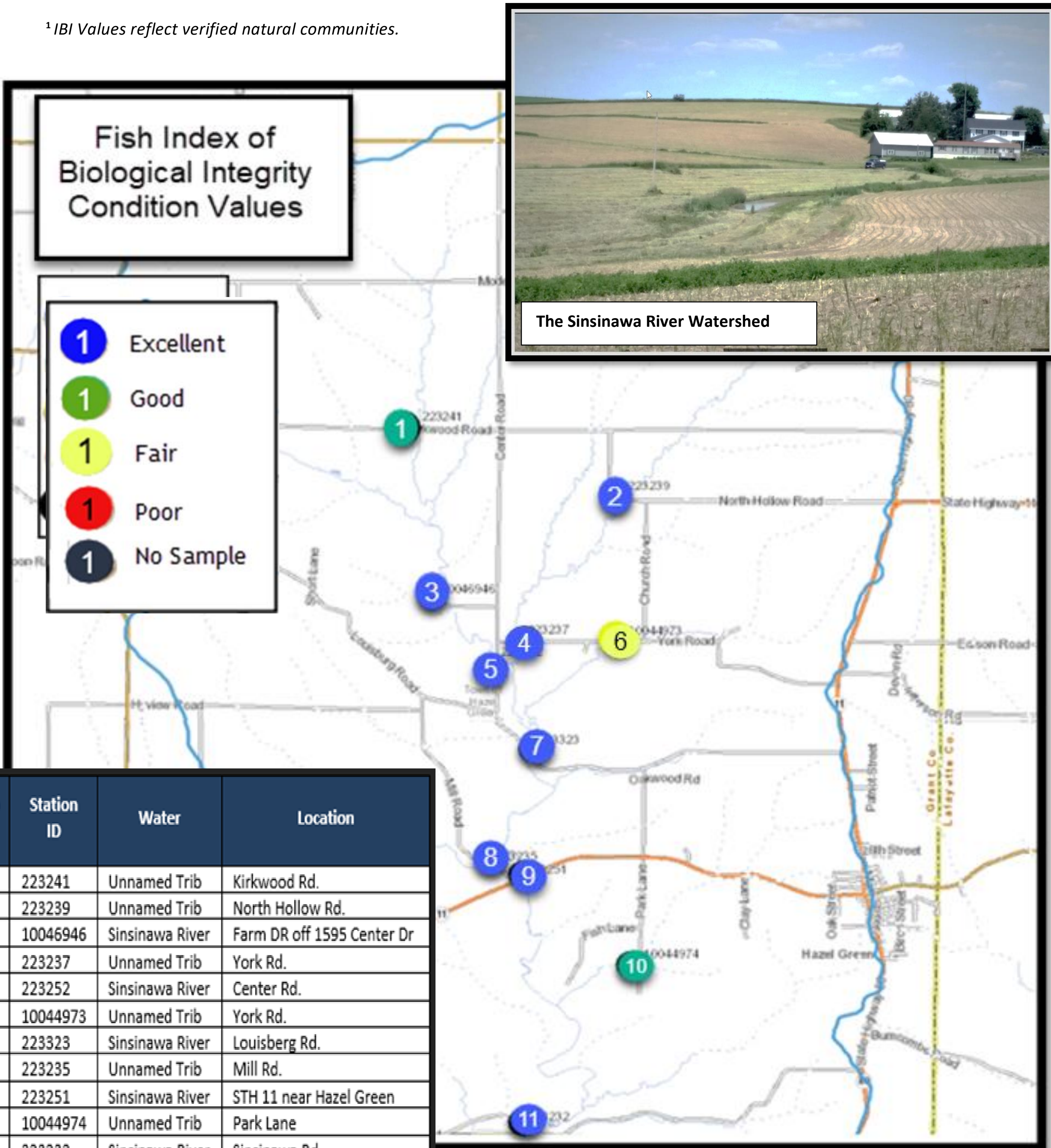
(Small stream IBI for Warm Transition Headwaters)

Condition (Rating) Categories for Small Stream Fish Index of Biotic Integrity (fIBI)

fIBI	Condition
91-100	excellent
61-90	good
31-60	fair
0-30	poor

Figure 6. Fish IBI Condition Values for the Sinsinawa TWA Project1

[1] *IBI Values reflect verified natural communities.*



Map No.	Station ID	Water	Location
1	223241	Unnamed Trib	Kirkwood Rd.
2	223239	Unnamed Trib	North Hollow Rd.
3	10046946	Sinsinawa River	Farm DR off 1595 Center Dr
4	223237	Unnamed Trib	York Rd.
5	223252	Sinsinawa River	Center Rd.
6	10044973	Unnamed Trib	York Rd.
7	223323	Sinsinawa River	Louisberg Rd.
8	223235	Unnamed Trib	Mill Rd.
9	223251	Sinsinawa River	STH 11 near Hazel Green
10	10044974	Unnamed Trib	Park Lane
11	223232	Sinsinawa River	Sinsinawa Rd.

Qualitative Habitat Assessment

Qualitative habitat surveys showed overall habitat to be “fair” to “good” at most sites (Table 4, Figure 7). The site on unnamed tributary 941000 had an overall habitat score of 20 or “poor”. The overall scores were buoyed by the width-to-depth ratio, riffle/bend, and fine sediment scores. The lack of a riparian buffer and lack of pools tended to depress the scores. Bank erosion and fish cover varied by site.

Condition (Rating) Categories for Qualitative Habitat

Score	Condition
>75	excellent
50-75	good
25-49	fair
< 25	poor

Table 4. Fish Habitat Values for the Sinsinawa TWA Project

WBIC	Station Name		Date	Flow (cfs)	Stream Width (m)	Ave Stream Depth (m)	Riparian Buffer Score	Bank Erosion Score	Pool Area Score	Width Depth Score	Riffle Bend Score	Fine Sediments Score	Fish Cover Score	Overall Score	Rating
940200	Sinsinawa River off Center Drive	5	03-Aug-16	-	6	0.4	0	0	0	10	5	5	5	25	Fair
940200	Sinsinawa River - Louisburg Rd	7	03-Aug-16	16.4	6	0.4	0	15	0	10	10	10	10	55	Good
940200	Sinisinawa River - STH 11, near Hazel Green WI	9	16-Aug-16	-	6	0.4	0	10	0	10	10	15	15	60	Good
940200	Sinsinawa River - Sinsinawa Rd. (Bi)	11	16-Aug-16	-	8	0.75	0	5	3	10	15	15	15	63	Good
940700	Unnamed Trib (940700) to Sinsinawa R at Park Lane	10	06-Jun-16	-	3	0.2	0	10	0	5	5	15	5	40	Fair
940800	Unnamed Trib (940800) to Sinsinawa River - Mill Rd.Bi	8	27-Jun-16	-	6	0.5	10	5	7	10	10	10	10	62	Good
941000	Unnamed Trib (941000) to Sinsinawa R at York Rd	6	06-Jun-16	-	3.5	0.25	0	5	0	10	5	0	0	20	Poor
941100	Unnamed Trib (941100) to Sinsinawa River - North Hollow	2	06-Jun-16	-	4.5	0.3	0	10	0	10	5	10	5	40	Fair
941100	Unnamed Trib (941100) to Sinsinawa R - York Rd	4	22-Aug-16	7.9	4	0.4	0	5	0	10	10	10	10	45	Fair
941400	Unnamed Trib (941400) - Kirkwood Rd	1	27-Jun-16	-	2	0.3	0	5	0	10	10	0	5	30	Fair

Station Name	Comments
Sinsinawa River off Center Drive	HEAVILY PASTURED. OVERLY WIDE AND SHALLOW. LOTS OF SEDIMENT.
Sinsinawa River - Louisburg Rd	-
Sinisinawa River - STH 11, near Hazel Green WI	LOTS OF HISTORIC RIP-RAP.
Sinsinawa River - Sinsinawa Rd. (Bi)	PASTURED, BUT GOOD NATURAL HABITAT. EXCELLENT RIFFLE/RUN COMPLEXES. GOOD DEPTH IN RUNS
Unnamed Trib (940700) to Sinsinawa R at Park Lane	RUBBLE COBLE BOTTOM. IN A PASTURE. ABUNDANCE FILAMENTOUS ALGAE
Unnamed Trib (940800) to Sinsinawa River - Mill Rd.Bi	WOODED CORRIDOR (MUCH OF STREAM IN PASTURE W/PATCHES OF WOODLAND). PERCHED CULVERT AT MILL RD. FILAMENTOUS ALGAE ON ROCKS
Unnamed Trib (941000) to Sinsinawa R at York Rd	VERY HEAVY SEDIMENT, POTENTIAL 303 CANDIDATE
Unnamed Trib (941100) to Sinsinawa River - North Hollow Rd	GRAVEL AND RUBBLE/COBBLE BOTTOM. HEAVY MATS OF FLIMANTOUS ALGAE, PRESENCE OF ASSELLUS. 100% HORSE PASTURE
Unnamed Trib (941100) to Sinsinawa R - York Rd	GOOD FLOW, MUST BE GOOD WATER SOURCE UPSTREAM.
Unnamed Trib (941400) - Kirkwood Rd	SEDIMENT WAS MODERATE TO HIGH FOR SUCH A HIGH GRADIENT STREAM.

Reference Tables

Map No.	Station ID	Water	Location
1	223241	Unnamed Trib	Kirkwood Rd.
2	223239	Unnamed Trib	North Hollow Rd.
3	10046946	Sinsinawa River	Farm DR off 1595 Center Dr
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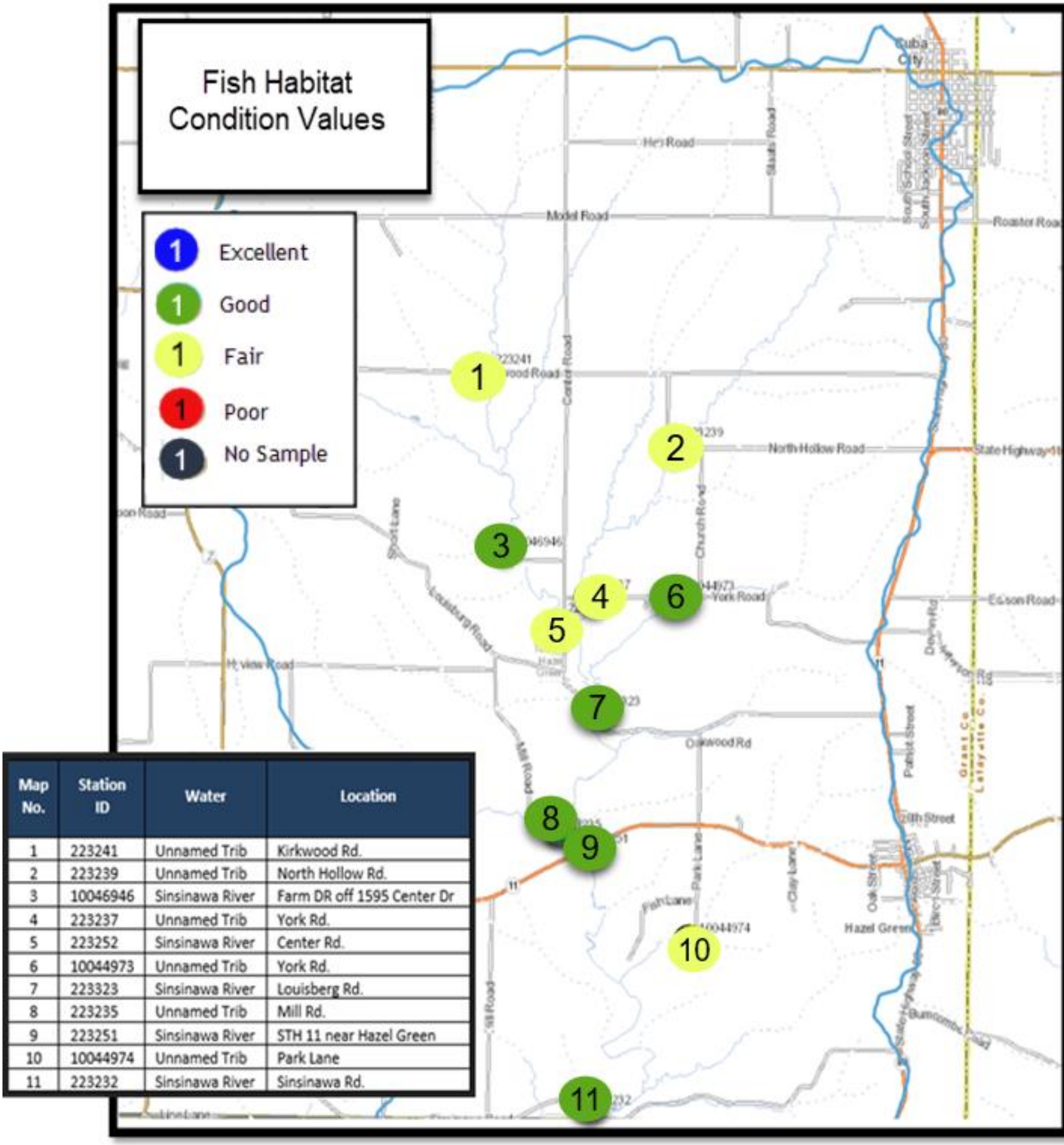
7	223323	Sinsinawa River	Louisberg Rd.
8	223235	Unnamed Trib	Mill Rd.
9	223251	Sinsinawa River	STH 11 near Hazel Green
10	10044974	Unnamed Trib	Park Lane
11	223232	Sinsinawa River	Sinsinawa Rd.

Figure 7. Fish Habitat Value Map for the Sinsinawa TWA



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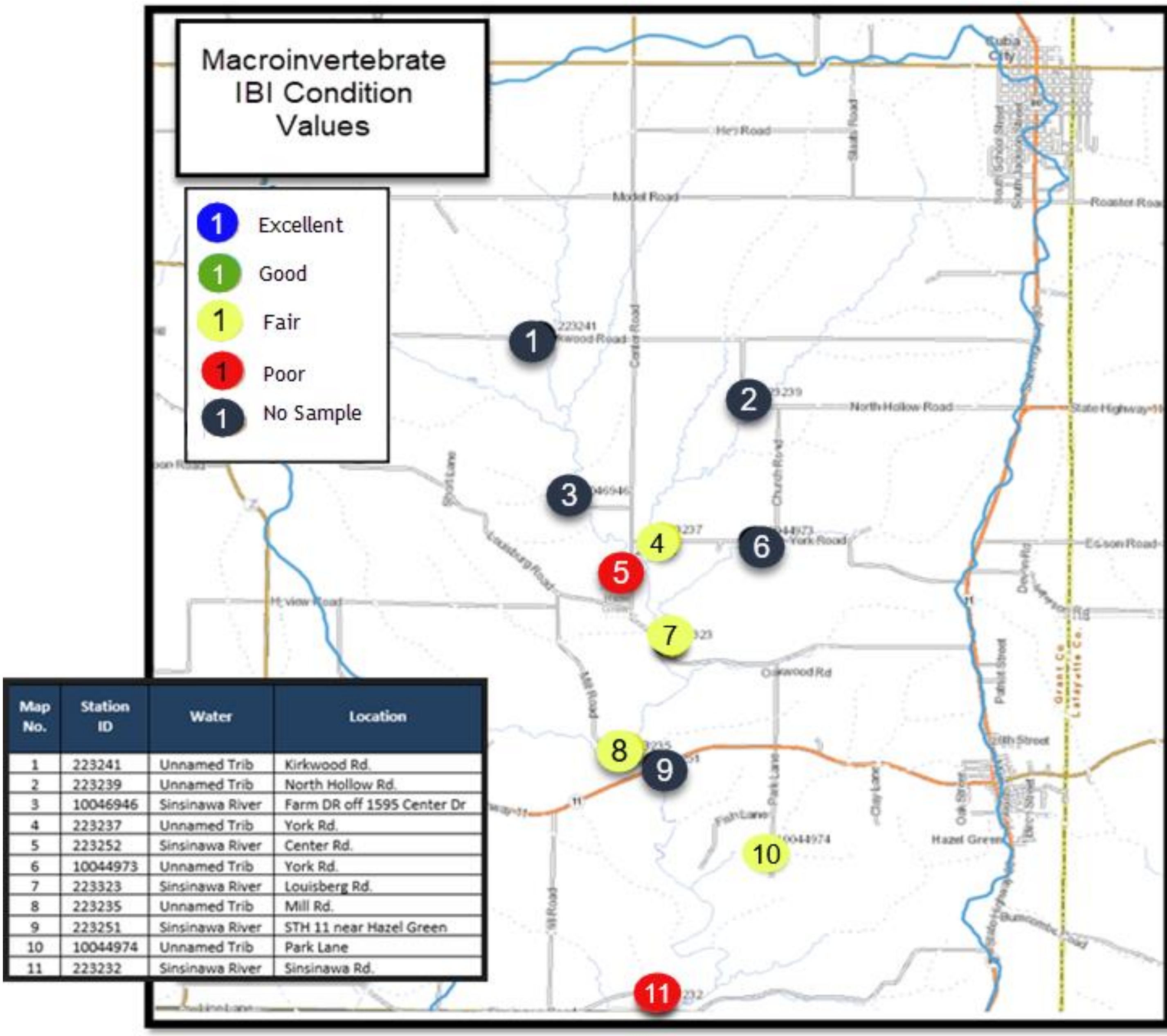
Macroinvertebrate Evaluation

Macroinvertebrate data was collected on 3 sites on the mainstem of the Sinsinawa River and on 3 unnamed tributaries in the fall of 2016 (Table 5, Figure 8). The macroinvertebrate IBI (mIBI) as developed by Weigel (2003) shows the main branch of the Sinsinawa River to be “poor” to low “fair”, while the 3 tributaries are in the “fair” category. HBI varied between “good” and “fair”, indicating there is some organic loading reaching the streams. One site on unnamed tributary 940700 showed a “poor” score, indicating that there is significant organic loading to that system.

Table 5. Macroinvertebrate IBI (mIBI) condition values for the Sinsinawa TWA Project.

Water Name	Map #	WBIC	Station ID	Station Name	MIBI	Condition
Unnamed Tributary	4	9411000	223237	Unnamed Trib (9411000) to Sinsinawa R at York Rd	3.13	Fair
Sinsinawa River	5	940200	223252	Galena River (Sinsinawa River) - Center Rd	1.61	Poor
Sinsinawa River	7	940200	223323	Sinsinawa River – Louisberg Rd.	2.70	Fair
Unnamed Tributary	8	940800	223235	Unnamed Trib (940800) – Mill Rd.	4.16	Fair
Unnamed Tributary	10	940700	10044974	Unnamed Trib (940700) to Sinsinawa R at Park Lane	3.90	Fair
Sinsinawa River	11	940200	223232	Sinsinawa River – Sinsinawa Rd.	1.45	Poor

Figure 8. Macroinvertebrate IBI (mIBI) Condition Value Map for the Sinsinawa TWA



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11	223232	Sinsinawa River	Sinsinawa Rd.

Continuous Temperature

Temperature data was collected hourly from June to October on the Sinsinawa River at Louisberg Road and Sinsinawa Road. As defined in Lyons et. al. (2009), temperatures at Louisberg Road closely resembled a cool-warm transitional stream in that the maximum daily mean, summer (June – August) mean, and July mean were all within the ranges for that temperature subclass (Table 6). Further downstream at Sinsinawa Road, temperatures for these same periods more closely resembled a warmwater system.

Table 6. Comparison of Temperature Data, Modeled Community and Verified Community

Station (SWIMS ID)	June-August Mean	July Mean	Maximum Daily Mean	Thermal Regime	Modelled Natural Community	Verified Community (Fish Assemblage Based)
Louisberg Rd. (223323)	19.78	19.92	23.03	Cool-Warm	Cool-Cold	Cool-Warm
Sinsinawa Rd. (223232)	21.65	21.78	24.70	Warm	Cool-Cold	Cool-Warm

Figure 9. Stream classification temperature ranges from Lyons, et. al., 2009.

Class and/or Subclass	June-Aug Mean	July Mean	Maximum Daily Mean
Coldwater	< 17.0	< 17.5	< 20.7
(Coolwater) Cold transition	17.0 - 18.7	17.5 - 19.5	20.7 - 22.6
(Coolwater) Warm transition	18.7 - 20.5	19.5 - 21.0	22.6 - 24.6
Warmwater	> 20.5	> 21.0	> 24.6

Discussion

Fish Assemblage, Natural Communities and Habitat Analysis

Most of the streams in this HUC 12 are modelled to be cool-cold transitional headwaters or mainstems (Lyons, 2008). The department recently developed a draft method to determine whether or not the modeled natural community is accurate based on the fishery assemblage and climate conditions (Lyons, 2015). There were no coldwater species found in the watershed, which immediately disqualifies the systems from being cold or cool-cold communities based on the department's method. A majority of species found in these streams are considered to be warmwater species (Lyons, 2012). These species, combined with several transitional species also found in these streams, showed the streams to more closely resemble cool-warm systems. As reflected in Table 6, water temperature and the verified natural community match up better than the modeled community.

Environmental degradation can sometimes explain the discrepancy between the modeled and actual community where there is a lack of intolerant species and a dominance of tolerant ones (Lyons, 2015). For most systems in this HUC 12, the percentage of tolerant fish fall within expected ranges for cool-cold transitional systems, and therefore a degraded community is not the principle reason for the discrepancy. The discrepancy between the temperature data, the modeled community and the actual fishery community can happen for several other reasons: either the year of the thermal measurement wasn't representative of the long-term average, the modeled thermal values were inaccurate, or both (Lyons, personal communication). In this case, air temperatures during the 2016 "summer" season over which the thermistors were deployed, while above the respective monthly averages for the period, were not considered abnormal as air temperatures were within the lower 10th and upper 90th percentile. The fishery is a long-term gauge of conditions in the stream and is therefore most important for bioassessment. That's not to say measured water temperatures or the modeled community aren't useful, but for natural community determination and IBI purposes, and in the absence of moderate to severe environmental perturbation, the fishery assemblage trumps water temperature data or the model (Ibid).

Stream biologic health as indicated by the fishery IBI varies by site, but generally shows good to excellent quality. As discussed earlier and shown in **Table 2,** the fishery assemblages show the natural communities to be cool-warm transitional at all but one site. The IBIs for these systems range from 10-100. According to WisCALM (WDNR, 2013), streams that are considered headwaters (90th percentile exceedance flow < 3 cubic feet per second) should be evaluated using the "Small and Intermittent Stream IBI" (Lyons, 2006). When this is applied to the streams where the verified community is confirmed as a headwater, sites are between 40 (fair) and 100 (excellent).

The fishery IBI reflects better environmental health than indicated by the qualitative habitat. The full set of qualitative habitat metrics can be found in Table 4. These habitat metrics were reflective of the nature of the streams in the watershed in that they had high gradient and shallow depth to bedrock, lending themselves to hard substrate, numerous riffles (See Figure 18) and lack of sediment due to scouring. The shallow depth to bedrock tended to limit the presence of pools, and the extensive grazing of the riparian corridors was reflected in the buffer metric and the bank erosion metric to some extent. It is often times more indicative to look at individual metrics within the habitat rating rather than the overall scores to get a better picture of the factors affecting stream habitat. While overall habitat scores can be "fair" or even "good", lack of buffers, the presence of bank erosion, and lack of fish cover can greatly affect the presence/absence of fish species.

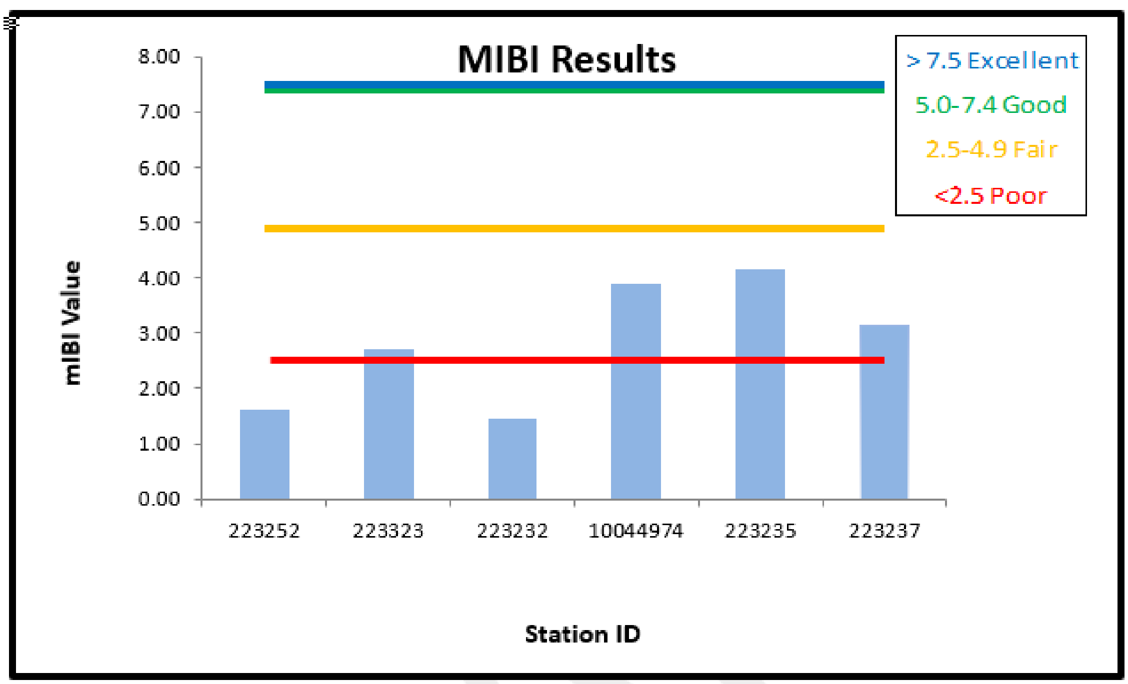
In this watershed, there were few buffers because most of the stream valleys are in pasture, which also exacerbates bank erosion. While the width-to-depth ratios were generally good, the shallow depth to bedrock limits depth. The bank erosion caused by pasturing lends itself to widening of the stream, reducing width-to-depth ratios. While depth, in and of itself, can be a form of fish cover, overall fish cover (i.e. overhanging vegetation, submerged macrophytes, boulders, or woody debris) was lacking in most of the tributary streams (See Figure 7), but very good in most of the sites surveyed on the Sinsinawa River itself.

Macroinvertebrate Data

Based on the 2014 Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) guidance (WDNR, 2013), the fishery IBI scores indicating a non-impaired status are in contrast to the macroinvertebrate community which indicate an impaired status for all or parts of many streams in this watershed. The macroinvertebrate community, as seen in Table 5, tends to reflect the land use and to some extent the overall habitat score. All of the MIBI scores are in the "poor" to "fair" range Figures 8 and 10).

The macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). While watershed and local variables explain a significant portion of variance among sites, Weigel found that in the driftless region, localized stressors were of greater importance to explain the IBI than in other parts of the state. Livestock grazing measured disturbance intensity and indicated its proximity to the stream. A majority of stream sites had poor buffer scores due to the prevalence of pasturing in stream valleys throughout the watershed. Overall, macroinvertebrate scores were typical of streams in the driftless area south of the Military Ridge, which tend to be depressed. This is likely a reflection of the intensity of agriculture in the region combined with a vulnerable landscape (i.e. steep slopes, shallow soils, and highly erodible land). The HBI scores varied but show there is organic loading to these systems. Potential sources of this include unfettered cattle access to streams, and runoff from barnyards and loafing areas. Historic macroinvertebrate data suggests this is of a chronic issue (WDNR, unpublished data).

Figure 10. Unnamed Trib Kirkwood Road (Map Site ID 1) Macroinvertebrate Index of Biological Integrity results



Land Use and Stream Chemistry

Over 90 percent of the land use in these watersheds is in agriculture, either row crops or grazing. Intense grazing in the riparian stream corridors is fairly common. Spring melt and early season rains, especially before crops are of sufficient size to reduce rain impact, or in fall after crops are harvested, can greatly increase the amount of sediment and nutrients reaching the streams.

Figure 11. Photo of agriculture-dominated landscape in the Sinsinawa watershed.

Nutrient enrichment has been a problem in this watershed. Periodic fish kills, at least two of which happened during summer months, appear to be caused by excessive nutrient loading from cumulative barnyard runoff throughout the watershed that lead to low dissolved oxygen levels (Mason, et. al., 1993, WDNR, 2003, WDNR, 2016).

In addition to lending itself to reduced oxygen levels, the nutrient loads enhance algal and periphyton growth, which then enhances available food for grazers and this pattern is repeated up the food chain. Contrary to the conventional thinking that more fish equates to a healthier system, the enhanced abundance of fish, particularly omnivores, is actually a sign of nonpoint source pollution impact. While these streams may not necessarily be considered as impaired, it does indicate excessive eutrophication of these systems.

May-2014	0.108	0.0501	
Jun-2014	0.0877	0.0873	
Jul-2014	0.0925	0.0877	
Aug-2014	0.0873	0.0925	
Sep-2014	0.0973	0.0973	
Oct-2014	0.0501	0.0991	Median
		0.108	0.104
May-2015	0.0991	0.11	
Jun-2015	0.117	0.117	
Jul-2015	0.136	0.126	
Aug-2015	0.126	0.136	
Sep-2015	0.438	0.438	
Oct-2015	0.11	0.13 Average	

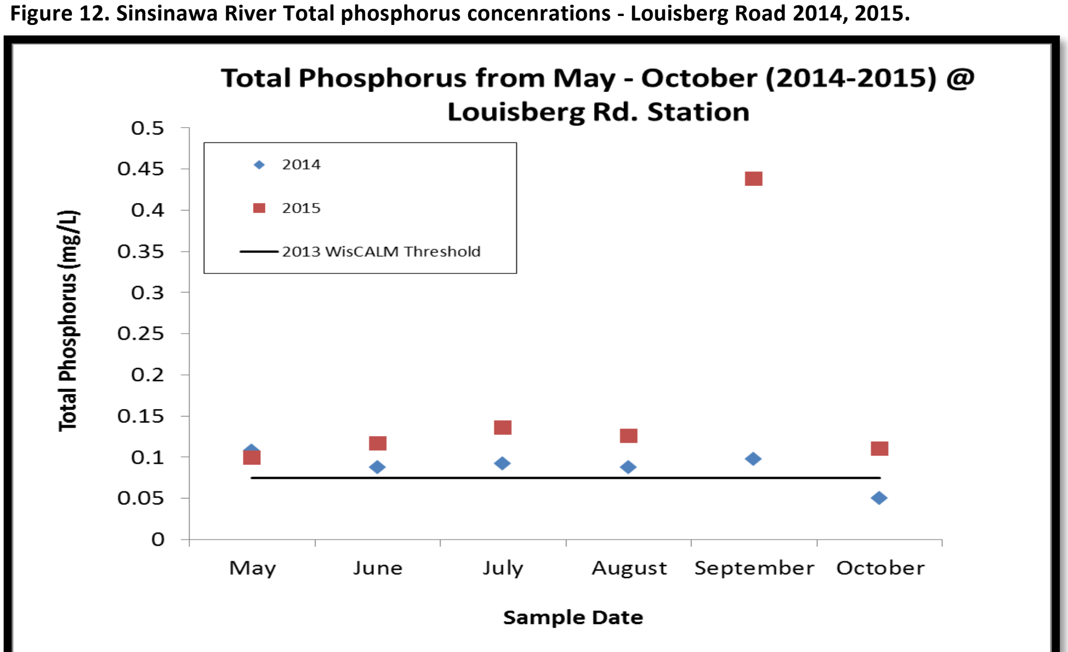
All values in mg/L

Table 7. Sinsinsawa River Total Phosphorus – at Louisberg Rd – 2014 and 2015

Although not a part of this particular study, total phosphorus data was collected during the growing season (May to October) in 2014 and 2015 as part as a follow-up to an impairment decision (WDNR, 2013). Grab samples were collected monthly at Louisberg Road by volunteer monitors (Table 7 and Figure 12).

For phosphorus, the department's listing methodology for impaired waters lists waters where the median concentration exceeds 0.075 mg/l on wadable streams and 0.1 mg/l on rivers (WDNR, 2017). Although Sinsinawa is named a "river", by definition, it is considered a stream as the 90th percentile exceedance flow is less than 110 ft3/second (Lyons, 2008). Thus, it is subject to the 0.075 mg/l phosphorus criterion that is applied to streams (WDNR, 2013). Based on the 2 years of monitoring, in addition to the median concentration being 0.104 mg/l, the lower 95th percentile of 0.087 mg/l exceeded the criteria as well.

Figure 12. Sinsinawa River Total phosphorus concenrations - Louisberg Road 2014, 2015.



Potential for Smallmouth Bass Fishery

One of the most important aspects of the Sinsinawa River is that it supports a fishable population of smallmouth bass. In fact, portions of the river contain some of the highest catch per unit effort populations for wadable systems in the state (Bradd Sims, personal communication). One reason for this 2016 survey was to determine if other streams in the watershed can serve as nursery streams for smallmouth bass and provide an important role in maintaining healthy smallmouth bass populations. Only one of the several small unnamed headwater streams, which are primarily spring and seepage fed, contained a single fish. The lack of smallmouth in these tributaries is unknown but may be related to: 1) the small size of the tributaries and corresponding lack of flow and habitat, 2) recent weather events which rendered them undesirable for smallmouth bass or, 3) because of a decrease in overall numbers during the sample period, or a combination of the three.

Figure 13: Stream biologist James Amrhein with smallmouth bass.

For the past two decades, the department's Fisheries and Habitat Research section has been conducting annual surveys of smallmouth bass population structure on streams in the driftless region, including a site on the Sinsinawa River between Sinsinawa Road and STH 11 (Lyons and Kanehl, 2016). They have found that, even with adequate habitat and good water quality, populations fluctuate widely because of annual variations in weather - particularly droughts and floods (Figure 14). This is a feature of riverine smallmouth bass populations throughout the region. During favorable weather conditions, such as those that occurred in 2012 which was a drought year with reduced runoff, the populations often explode with good populations augmented by large numbers of young-of-year smallmouth bass. Even in unfavorable weather years, the populations never are eliminated by bad weather; there's always some level of reproduction and a fair number of adults (John Lyons, personal communication).

However, the runoff issues in the southwest have more severe effects than weather. Polluted runoff can eliminate a population in a matter of hours or days. For example, Otter Creek in Lafayette County has suffered from multiple fish kills over a relatively short period of time. The stream has essentially no smallmouth bass population despite reasonable habitat and a history of stocking (Lyons and Kanehl, 2016). During the 1970's and 80's nearly all the SMB streams in southwest Wisconsin had depressed or near absent smallmouth bass populations from polluted runoff. Many, such as Rattlesnake Creek in Grant County, have recovered due to implementation of best management practices such as feedlot and manure management. Thus, continued good land and manure management is essential to maintaining SMB in these streams (John Lyons, personal communication).

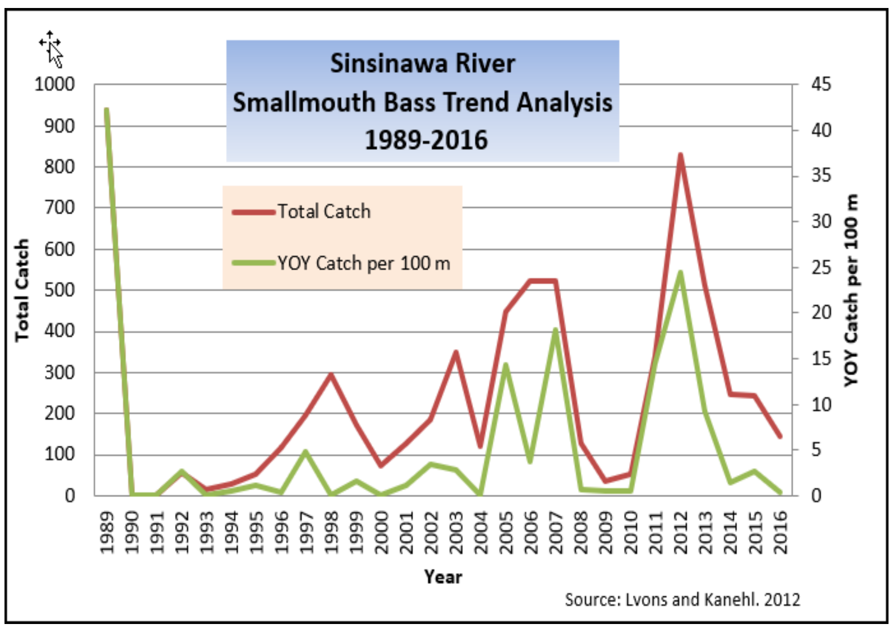


Figure 14. Sinsinawa River Smallmouth Bass Trend Analysis.

The potential for a catastrophic event is enhanced because it does not appear as if the feeder streams to the Sinsinawa River serve as nursery streams. Therefore, a kill on the river itself can greatly affect the population of the river – particularly if it affects adult smallmouth bass of reproducing age. Known kills have occurred in 1978, 1988, and in 2009. Coincidentally, a fish kill was reported on the Sinsinawa River while biologists were conducting a survey in

August 2016. The investigation found hundreds of dead non-game fish, mostly white sucker and common shiner and several (1+ year old) smallmouth bass in a reach upstream of Louisberg Road. Investigation of sites downstream of Louisberg Road did not reveal any dead fish. As was the case with previous kills, because the kill was reported days after it occurred, the source was never determined.

Study Conclusions

The Sinsinawa River flows through a highly agricultural watershed which results in phosphorus loading in excess of the criteria and a biological impact in the form of a depressed macroinvertebrate community. While the Sinsinawa River is on the Illinois list of impaired waters due to sedimentation and siltation, the high gradient of the river in Wisconsin allows adequate scouring of sediment. However, this does not mean there are not high loads of sediment reaching the streams in the watershed. Habitat scores are depressed by the extensive grazing which occurs in the riparian stream corridors. On the other hand, fish communities of the Sinsinawa watershed have shown themselves to be resilient as indicated by the fish IBI. This is not to say that the fishery is not impacted. Periodic fish kills affect the stream and could limit what could potentially be an exceptional smallmouth bass fishery.

Controlling sediment and nutrient - particularly manure - runoff will 1) enhance spawning habitat and prevent valuable spawning areas from becoming covered in silt; 2) maintain good pool depth so that older fish can seek refuge in winter or in periods of low flow; and 3) prevent potentially fatal dissolved oxygen sags or ammonia induced toxicity. The department should continue to work with the Grant County Land Conservation Department (LCD) and landowners to encourage best management practices in this watershed to enhance water quality and protect a valuable fishery. BMPs to promote include:

- Proper manure management such good housekeeping of barnyards and no spreading on steep slopes and during periods of ice and snow cover or prior to significant rain events to reduce the delivery of potentially deadly amounts of nutrients.
- Managed grazing to help protect streambanks and reduce sediment loads from bank erosion.
- The planting of cover crops to help prevent soil erosion during the vulnerable months.

The department and Grant County LCD should explore ways to educate landowners on the valuable resources of the Sinsinawa River and to gain consensus and interest in ways to increase profitability of farms while protecting and enhancing water quality of the watershed potentially through farmer-led programs and/or demonstration areas.

Figure 15. Cattle pasture adjacent to the Sinsinawa River.

Management Recommendations

Resource Goals

Water quality goals for the Sinsinawa River watershed include:

- Work with partners to minimize the impact of agricultural runoff in rural areas.
- Protect and enhance smallmouth bass populations
- Encourage best management practices to enhance water quality and protect a valuable fishery.

Recommendations for work with Partners

- The department should continue to work with the Grant County Land Conservation Department (LCD) and landowners to encourage best management practices in this watershed to enhance water quality and protect a valuable fishery. BMPs to promote include:
    - Proper manure management such good housekeeping of barnyards and no spreading on steep slopes and during periods of ice and snow cover or prior to significant rain events to reduce the delivery of potentially deadly amounts of nutrients.
    - Managed grazing to help protect streambanks and reduce sediment loads from bank erosion.
    - The planting of cover crops to help prevent soil erosion during the vulnerable months.
- The department and Grant County LCD should explore ways to educate landowners on the valuable resources of the Sinsinawa River and to gain consensus and interest in ways to increase profitability of farms while protecting and enhancing water quality of the watershed potentially through farmer-led programs and/or demonstration areas.

Monitoring and Assessment Recommendations

- Expand monitoring efforts as needed to measure potential changes in water quality as best practices are implemented.
- Natural Community updates based on fish species found in recent surveys:
    - Station 10021757, Sinsinawa River off Center Drive was modeled as a Cool-Cold Headwater but is recommended as a Cool-Warm Headwater based on the 2017 Natural Community temperature evaluation analysis tool.
    - Station 223323, Sinsinawa River Louisberg Rd. was modeled as a Cool-Cold Headwater but is recommended as a Cool-Warm Headwater based on the 2017 Natural Community temperature evaluation analysis tool.
    - Station 223251, Sinsinawa River STH 11, near Hazel Green WI was modeled as a Cool-Cold Headwater but is recommended as a Cool-Warm Headwater based on the 2017 Natural Community temperature evaluation analysis tool.
    - Station 223232, Sinsinawa River Sinsinawa Rd. was modeled as a Cool-Cold Headwater but is recommended as a Cool-Warm Headwater based on the 2017 Natural Community temperature evaluation analysis tool.
- The department should update the natural community classification for the Sinsinawa River from cool-cold to cool-warm using the guidance provided by Lyons (2015).

Figure 16. Sinsinawa River upstream of Sinsinawa Road.

Appendix A: References

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Appendix B: Water Narratives for Waters in the Study

Sinsinawa River WBIC: 94020


Figure 17. Sinsinawa River Riffles near Hazel Green, Wisconsin. Photo by James Amrhein, August 2016.

The Sinsinawa River rises in south central Grant County and flows into Illinois. Historically, it has had a good smallmouth bass fishery. In general, the river has good smallmouth bass habitat (WDNR, 1990). The smallmouth bass fishery, however, has periodically been affected by fish kills that can be attributed to manure spills and runoff events that lead to low dissolved oxygen levels (Mason et.al, 1993). DNR fish surveys, conducted annually between 1989 and 1997 on an 1800-meter reach of the river, have found that the smallmouth bass population can be extremely variable. The greatest evidence of this can be seen by looking at the 1989 to 1991 data. In 1989, 445 smallmouth bass were collected at this site. In 1990 and 1991, however, zero smallmouth bass were found at the same site.

Since the population crash in the early 1990's, the smallmouth bass population in the Sinsinawa has been slowly recovering and recent field observations indicate the smallmouth bass fishery has improved (Wang, et.al., 1997, Kerr, 1998). Water quality and habitat best management practices were installed at some locations on the river as part of the priority watershed project in the 1980's. As with other streams in the watershed, water quality improvements due to the BMP installations has been masked by uncontrolled non-point pollution sources. Macroinvertebrate sampling over the years have shown that the Sinsinawa's Hilsenhoff biotic index (HBI) ranges from good to fairly poor (Kroner et.al., 1992; Lillie and Schlesser, 1993). The fair and poor HBI ratings indicate significant water quality impairment due to agricultural non-point sources of pollution.

Fish IBI values on this stream in the current study were largely "excellent" condition, while habitat was a mix of fair to good.

Unnamed Tributary WBIC: 941100

Unnamed Tributary to Sinsinawa River (941100) is a 5.93-mile river that falls in Grant County. This river is managed for fishing and swimming. It was assessed during the 2016 listing cycle; the regional biologist recommended listing for degraded biological community based on current and historical Poor mIBI scores. This water was considered impaired and not meeting its Fish and Aquatic Life use.

Unnamed Tributary WBIC: 941400

Unnamed Tributary 941400 is a 3.43-mile river that falls in Grant County. This river is managed for fishing and swimming and is currently not considered impaired. It was assessed during the 2018 listing cycle; new biological (fish Index of Biotic Integrity (IBI) scores) sample data were clearly below the 2018 WisCALM listing thresholds for the Fish and Aquatic Life use. This water was meeting this designated use and was not considered impaired.

Appendix C: Temperature Data, Modeled Community, Verified Community

Site	June-Aug Mean	July Mean	Maximum Daily Mean	Thermal Regime (Based on Water Temperature Data)	Modelled Natural Community	Verified Community (Fish Assemblage Based)
Sinsinawa River - Louisberg Road	19.78	19.92	23.03	Cool-Warm	Cool-Cold	Cool-Warm
Sinsinawa River - Sinsinawa Road	21.65	21.78	24.70	Warm	Cool-Cold	Cool-Warm

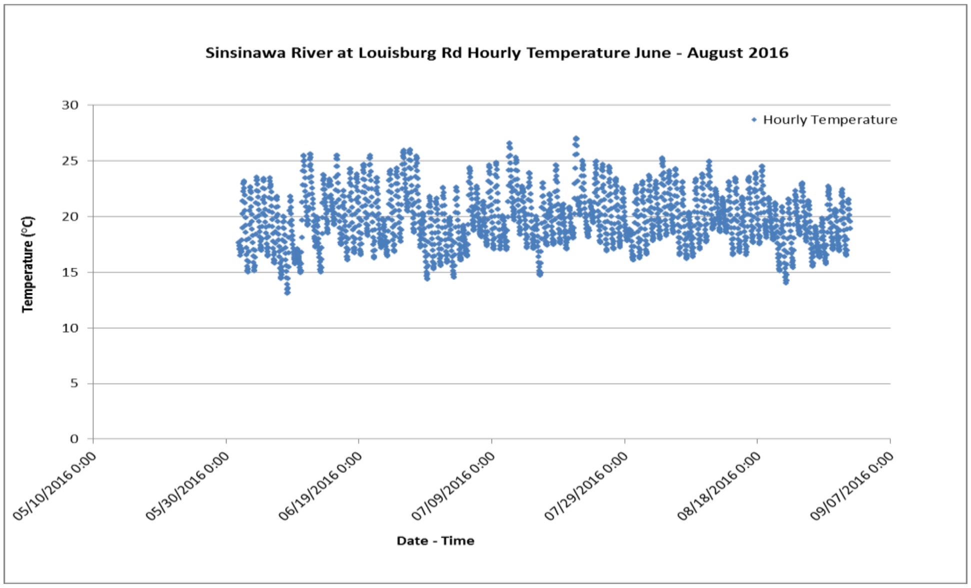
Class and/or Subclass	June-Aug Mean	July Mean	Maximum Daily Mean
Coldwater	< 17.0	< 17.5	< 20.7
(Coolwater) Cold transition	17.0 - 18.7	17.5 - 19.5	20.7 - 22.6
(Coolwater) Warm transition	18.7 - 20.5	19.5 - 21.0	22.6 - 24.6
Warmwater	> 20.5	> 21.0	> 24.6

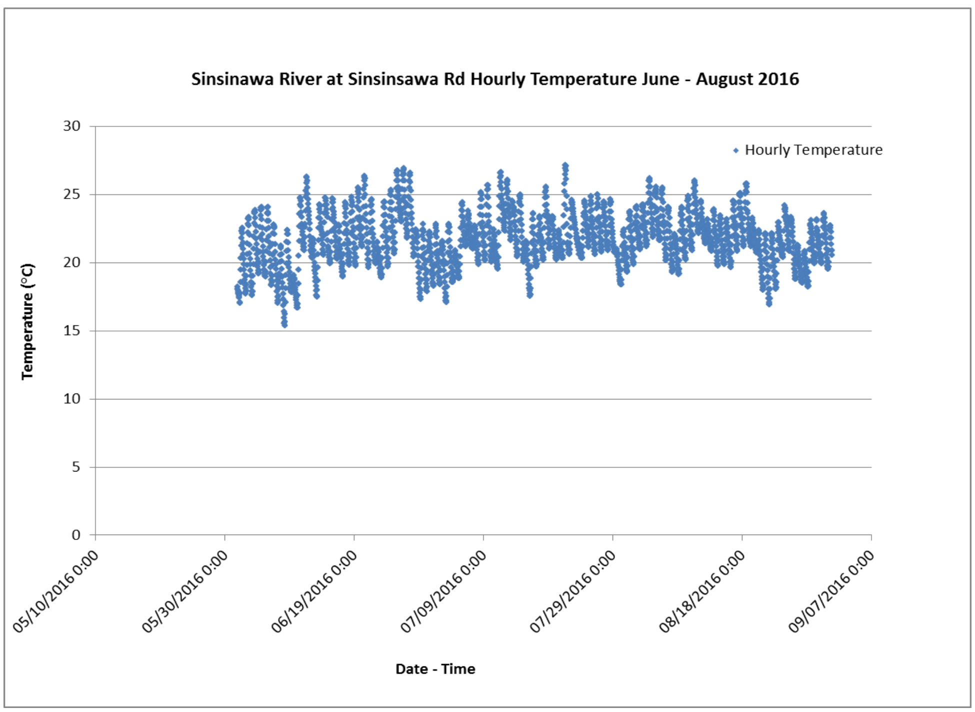
Temperature ranges from Lyons, et. al., 2009

Figure 18. Sinsinawa River Landscape (2020 map) and Sinsinawa River at the Bridge

Photo by James Amrhein Water Quality Biologist South District. Photo taken August 2016.

Appendix D: Temperature Data





Appendix E: Water Quality Standards Use Assessment - Fish and Aquatic Life Use [i]

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Use	Designated Use	Impairments	Sources	Assessment
721000	Mississippi (Reach 6) Apple-Plum LD 11 to Wisconsin State Line (upper Pool 12)	580.8	583	WWSF	WWSF	Not Supporting	Default FAL	Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored
721000	Mississippi (Reach 5) Grant-Maquoketa Wisconsin River to LD 11 (mid Pool 10 to LD 12)	583	630.7	WWSF	WWSF	Not Supporting	Default FAL	Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored
721200	O'Leary Lake	0	7.39	Small	FAL	Supporting	Default FAL	NA	NA	Not Assessed
933500	Apple River	0	5.7	WWSF	WWSF	Supporting	Default FAL	NA	NA	Monitored
934200	Kentucky Creek	0	1.73	FAL	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File
935300	Unnamed Trib to Apple R	0	3.84	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed
935500	Galena River	0	3	WWSF	WWSF	Fully Supporting	Default FAL	NA	NA	Monitored
935500	Galena River	3	35.66	WWSF	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored
935600	East Fork Galena River	0	13.49	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed
936300	Scrabble Creek	0	5.36	WWSF	WWSF	Not Assessed	Default FAL	NA	NA	No Assessment on File
936400	Bull Branch	0	3.75	LFF	WWFF	Not Supporting	Default FAL	Chronic Aquatic Toxicity, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban), Surface Mining	Monitored
936500	Coon Branch	0	5.21	WWSF	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored
936500	Coon Branch	5.21	6.56	LFF	FAL	Not Supporting	LFF	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment
936500	Coon Branch	6.56	7.83	LAL	FAL	Not Supporting	LAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored
936500	Coon Branch	7.83	8.8	FAL	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File
936600	Kelsey Br	0	2	WWSF	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored
936600	Kelsey Br	2	6.73	WWFF	WWFF	Supporting	WWFF	NA	NA	Monitored
936800	Diggings Creek	0	5.43	WWFF	WWFF	Not Supporting	FAL Warmwater	Chronic Aquatic Toxicity, Degraded Biological Community, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban)	Monitored
936900	Ellis Branch	0.01	5.26	FAL	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File
937000	Shullsburg Creek	0	13.58	WWSF	WWSF	Supporting	WWSF	NA	NA	Monitored
937200	Spring Br	0	6.14	FAL	WWSF	Supporting	Default FAL	NA	NA	Monitored
937700	Shullsburg Trib	0	4.18	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed
937800	Un Tr To Shullsburg Br	0	4.3	WWFF	Cold	Not Supporting	Default FAL	Chronic Aquatic Toxicity, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban)	Monitored
939100	Madden Br	0	7.69	WWSF	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source	Monitored
939800	Pats Creek	0	8.97	WWSF	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (	Monitored
940100	Un Trib To Galena River	0	6	FAL	WWSF	Not Assessed	Default FAL	NA	NA	No Assessment
940200	Sinsinawa River	10.31	21.13	FAL	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored
940700	Unnamed Trib to Sinsinawa R	0	2.54	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored
940800	Unnamed Trib to Sinsinawa River	0	1.42	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored
941000	Unnamed Trib to Sinsinawa River	0	3.86	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored
941100	Un Trib To Sinsinawa River	0	5.93	FAL	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source	Monitored

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment
941500	Little Menominee R -Wi-Il-Bd	0	5	WWFF	WWFF	Not Assessed	WWFF	NA	NA	No Assessment on File
941700	Menominee R -Wi-Il Bd	5.55	10.4	WWSF	WWSF	Not Supporting	WWSF	Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored
941700	Menominee River	10.4	11.23	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed
941800	Tributary to Menomonee River	0	0.94	FAL	FAL	Not Assessed	LAL	NA	NA	No Assessment
942700	Fair Play Creek	0.01	3.34	WWFF	WWFF	Not Assessed	Default FAL	NA	NA	No Assessment
942800	Hollow Branch	0	3.99	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed
943100	Kieler Cr	0	4.43	WWSF	WWSF	Supporting	Default FAL	NA	NA	Monitored
943200	Sinnipee Cr	0	2.5	WWSF	WWSF	Not Assessed	Default FAL	NA	NA	No Assessment
3000630	Tributary to Shullsburg	0	0.83	FAL	FAL	Supporting	LAL	NA	NA	Monitored
5041408	Trib to Kieler Creek	0	1.38	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed

[t]This water quality standards 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.

Appendix F: Outstanding and Exceptional Resource Waters

Wisconsin has designated many of the state's highest quality waters as Outstanding Resource Waters (ORWs) or Exceptional Resource Waters (ERWs). Waters designated as ORW or ERW provide recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. One segment of the Galena River is designated as an ERW (Table F1).

Table F1. Outstanding/Exceptional Resource Waters in the Galena River Watershed (GP01).

Local Waterbody Name	WBIC	ORW/ERW	Start Mile	End Mile
Galena River	935500	ERW	3.0	35.66

Appendix G: Impaired Waters

Section 303(d) of the Clean Water Act requires states to publish a list of waters that do not meet water quality standards. This "Impaired Waters List" reflects waters that are newly added or removed based on new information. Impaired waters in this watershed are impaired due to continued effects from mining waste piles and habitat loss due to sedimentation from non-point sources (Table 2). The entire length of the Sinsinawa River in Illinois is on the Illinois 303(d) list of impaired waters for total phosphorus, zinc and bacteria; total suspended solids is listed as a contributing factor for the aquatic life use impairment (IL EPA, 2014, 2017, 2018).

Table G1. Impaired waters in the Galena River Watershed (GP01).[1]

Local Name	WBIC	*Start Mile*	*End Mile*	Pollutant	Impairment	Sources
Bull Branch	939100	0	3.75	Zinc, Sediment/Total Suspended Solids	Chronic Aquatic Toxicity, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban), Surface Mining
Coon Branch	939800	0	5.21	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Coon Branch	940200	5.21	6.56	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Coon Branch	941100	6.56	7.83	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Diggings Creek	936800	0	5.43	Lead, Zinc, Unknown Pollutant, Sediment/Total Suspended Solids	Chronic Aquatic Toxicity, Degraded Biological Community, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban)
Galena River	936600	3	35.66	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Kelsey Branch	943000	0	2	Total Phosphorus	Biological Community	Non-Point Source (Rural or Urban)
Louisberg Creek*	94300	0	5.26	Total Suspended Solids	Degraded Habitat	Livestock, Non-irrigated Crop Production, Streambank Modifications/destabilization
Madden Branch	939100	0	7.69	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Menominee River	941700	5.55	10.4	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)
Mississippi (Reach 5) Grant-Maquoketa Wisconsin River to LD 11 (mid Pool 10 to LD 12)	721000	583	630.7	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)
Mississippi (Reach 6) Apple-Plum LD 11 to Wisconsin State Line (upper Pool 12)	721000	580.8	583	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)
Pats Creek	939800	0	8.97	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)
Sinsinawa River* [2]	940200	10.31	21.13	Total Phosphorus	Biological Community	Non-Point Source (Rural or Urban)
Unnamed Tributary to Shullsburg Branch	937800	0	4.3	Lead, Zinc, Sediment/Total Suspended Solids	Chronic Aquatic Toxicity, Degraded Habitat	Mine Tailings, Non-Point Source (Rural or Urban)
Unnamed Tributary to Sinsinawa River*	941100	0	5.93	Unknown Pollutant	Biological Community	Non-Point Source (Rural or Urban)

[1] *Waters with asterisks (*) are located in the study area.*

[2] *In Illinois, the Sinsinawa River is listed for bacteria, zinc, and phosphorus for the entire stretch of the river in Wisconsin's neighboring state. These TMDLs were addressed in a TMDL Approval by USEPA in 2018 (IL EPA, 2018).*