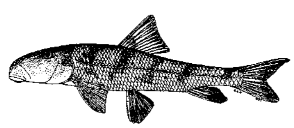
State of Ohio
Environmental Protection Agency

Division of Surface Water

Executive Summary
Biological and Water Quality Survey of the Wabash River Basin, 1999

Darke and Mercer Counties, Ohio



April 1, 2002
Revised August 12, 2008

Ted Strickland, Governor
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Ohio EPA Technical Report EAS/2002-4-4

State of Ohio Environmental Protection Agency
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NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents new publications by Ohio EPA have become available. The following publications should also be consulted as they represent the latest information and analyses used by Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

These documents and this report can be obtained from by writing to:

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125

FOREWORD

What is a Biological and Water Quality Survey?
A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 250-300 sampling sites.

Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1]), and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators
A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach is outlined in Figure 1 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation);

and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Uses
The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses.

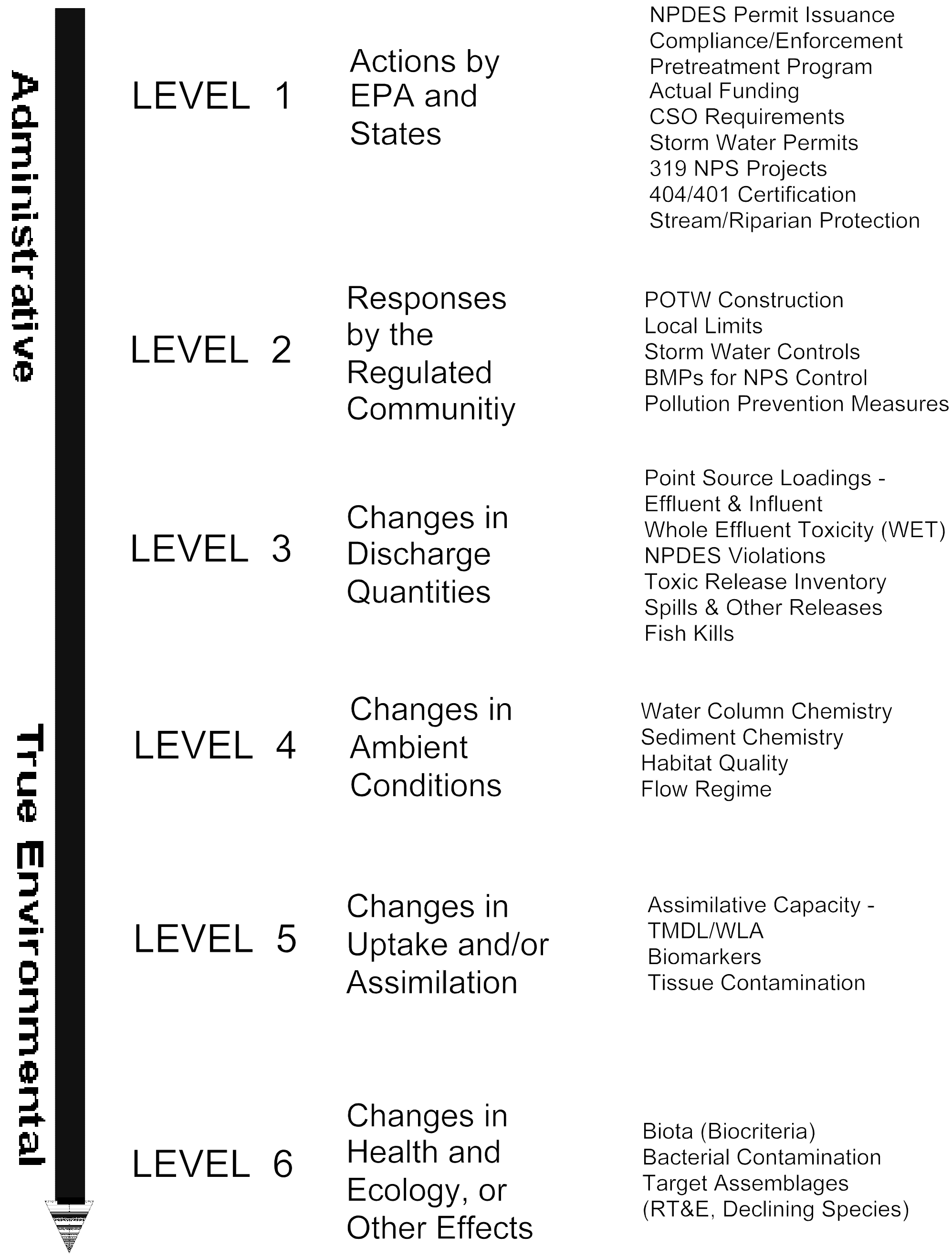

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the “typical” warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support “unusual and exceptional” assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio’s best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic “runs” of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi.^{2} drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a “tiered” approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, NH_3-N, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health are detailed in other documents.

INTRODUCTION

Biological, physical, surface water and sediment samples were collected from the Wabash River basin in 1999. The information gathered from this survey evaluates ambient conditions, existing environmental impacts from both point source discharges and nonpoint sources of pollution, and attainment of designated stream uses, and will be used, in part, to develop Water Quality Based Effluent Limits. Also, sources and causes of impairment identified in this study will help guide development of a Total Maximum Daily Load (TMDL) model for the basin. The primary areas sampled in this survey included the Wabash River mainstem, the Mississinewa River, Beaver Creek, Grand Lake St. Marys, Cold Creek, and any tributary or ditch named in the Ohio Water Quality Standards, as well as any unnamed tributaries with permanent flow or natural habitat features encountered during the survey.

Specific objectives of this study were to:

1) evaluate impacts to water quality and aquatic life from the following point source dischargers:

   Celina WWTP
   St. Henry WWTP
   Ft. Recovery WWTP

2) evaluate impacts to water quality and aquatic life from unsewered communities including: New Weston, Burkettsville, and Chickasaw;

3) evaluate possible water quality and aquatic life use impacts associated with Animal Feeding Operations (AFOs) and the land application of manure; and,

4) verify existing uses on designated streams and assign appropriate use designations to undesignated waters.

SUMMARY AND RECOMMENDATIONS

To facilitate agricultural crop production and prevent flooding, the Wabash basin is maintained to quickly convey rainfall downstream. Nearly all stream channels have been modified and an extensive tile drainage network has been installed. Riparian vegetation has been removed. Stream banks are engineered and pool or riffle areas have been converted into laminar glides. Natural stream habitats are essentially absent in the Wabash basin.

Confined animal feeding operations in Ohio are most numerous in the Wabash watershed. High fecal coliform bacteria concentrations are routine in area streams. Stream substrates are typically embedded and smothered by silt. Abundant algal growth, encouraged by universal nutrient enrichment, affords ample organic decomposition and confounds dissolved oxygen availability. In Ohio, fish kills resulting from pollutant spills and improper manure management are most numerous in the Wabash basin.

Due to habitat simplification and hydromodification, only the most pollution tolerant types of aquatic life reside in the watershed. The altered flow regime retards aquatic community performance especially in the watersheds uppermost reaches where the streams often become dry. Achievement of warmwater ecoregional biocriteria is not possible in the basin due to the pervasiveness of habitat disruption and the amount of pollutant loading. In short, water resource conditions in the Wabash River watershed are poor.

The Wabash River basin, including the Mississinewa River, Beaver Creek and all joining tributaries ranks among the ten most degraded watersheds in Ohio (Figure 2). Stream habitat destruction for agricultural drainage and its attendant hydrologic disruption pervades the entire watershed (Figure 3). Land applied animal manure from large animal feeding operations (AFOs) resulted in significant organic and nutrient enrichment throughout the watershed. The hypereutrophic conditions in Grand Lake St. Marys were an intrinsic aquatic life use impairment and resulted in water quality and aquatic life use impairment to the Wabash River mainstem downstream from its confluence with Beaver Creek (the outlet stream for Grand Lake St. Marys). Biological criteria scores, aquatic life use attainment status, and recommended aquatic life use designations for streams sampled in the Wabash basin are provided in Table 1. Exceedences and violations of Ohio Water Quality Standards criteria are tablulated in Table 2. Figures 4-9 depict results for various chemical, physical, and biological parameters collected from sites in the Wabash River basin during 1999.

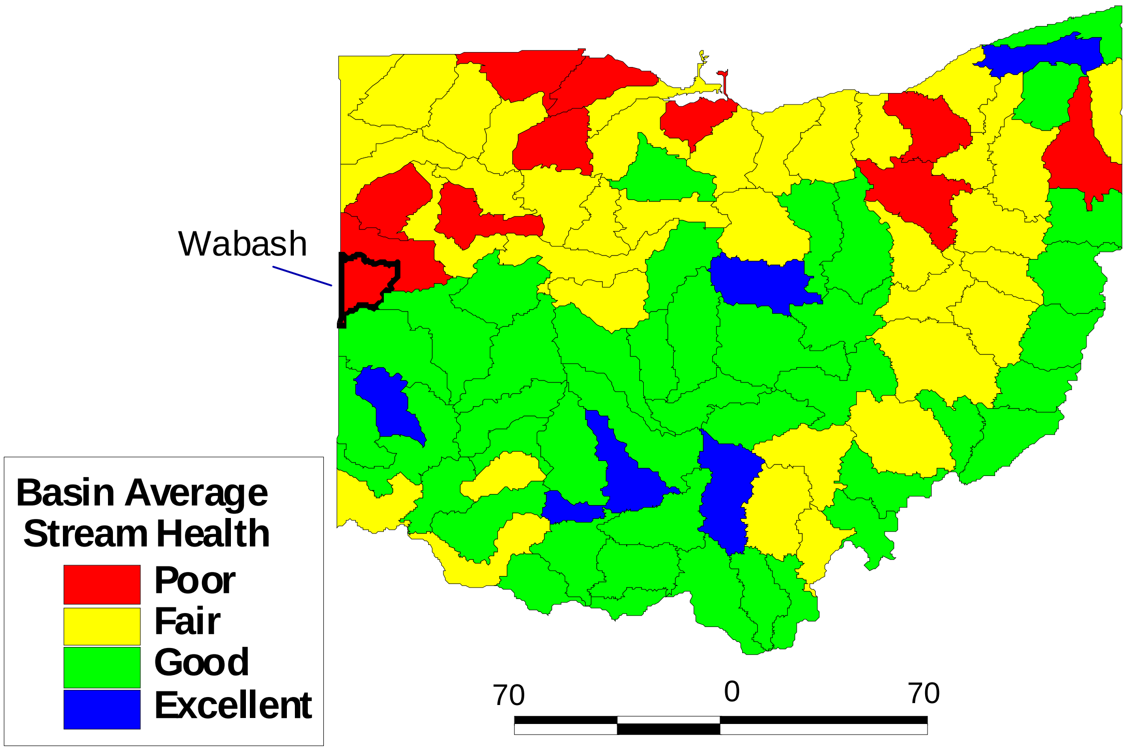

Figure 2. Location within Ohio of Wabash River basin and assessment of stream health.

Figure 3. Typical stream channel morphology in the Wabash River basin.

Table 1. Attainment of biological criteria for sites sampled in the Wabash River basin, 1999.

RIVER MILE Fish/Macro.	IBI	MIwb	ICI	QHEI	Attainment Status
		Wabash River (22-001)			
		Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)			
506.4	12*$_{flow}$	NA	VP*	30.5	NON/NON
504.5	12*$_{flow}$	NA	VP*	31.5	NON/NON
		Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)			
502.2	16*	NA	P*	52.0	NON/NON
494.3/494.4	28*	8.2^{ns}	20*	26.5	NON/Partial
489.9	21*	4.5*	14*	25.0	NON/NON
484.8/484.7	26*	7.0*	14*	33.0	NON/Partial
482.2	--	--	4*	--	NON/NON
482.0	14*	2.8*	VP*	42.5	NON/NON
		Eastern Cornbelt Plains WWH (Existing)			
480/480.1	32*	8.8	30*	61.5	Partial
476.2/476.0	29*	7.8^{ns}	38	45.0	Partial
469.5	30*	8.2^{ns}	MG	49.5	Partial
466.1	25*	7.2*	16*	43.0	NON
Hickory Branch (22-002)					
		Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)			
0.3	32*	NA	F*	32.0	NON/Partial
Crab Branch (22-004)					
		Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)			
0.5/0.4	22*	NA	VP*	37.0	NON/NON
Toti Creek (22-005)					
		Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)			
2.2/2.1	22*	NA	P*	26.0	NON/NON
0.3/0.2	30*	NA	F*	52.5	NON/Full
Stony Creek (22-006)					
		Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)			
0.2/0.1	22*	NA	F*	48.0	NON/deferred
Twomile Creek (22-007)					
		Eastern Cornbelt Plains WWH (Existing) /Primary Headwater (Recommended)			
1.7	20*	NA	VP*	48.5	NON/deferred
Threemile Creek (22-008)					
		Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)			
0.7	20*	NA	VP*	27.0	NON/NON
Ward Ditch (22-010)					
		Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)			
0.7	18*	NA	P*	27.0	NON/Full

RIVER MILE Fish/Macro.	IBI	MIwb	ICI	QHEI	Attainment Status
Bear Creek (22-011)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
1.8	12*	NA	VP*	16.0	NON/NON
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
0.1	24*	NA	VP*	12.0	NON/NON
Trib.to Toti Creek (22-014)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
1.2	12*	NA	VP*	18.0	NON/NON
Henry Ditch (22-015)					
	Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)				
1.5	12*	NA	VP*	50.0	NON/deferred
Fort Creek (22-016)					
	Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)				
1.5	--$_{flow}$	NA	VP*	--	NON/deferred
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
0.1	18*	NA	VP*	34.0	NON/NON
Trib.to Fort Creek (22-017)					
	Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)				
0.1	16*	NA	VP*	51.5	NON/deferred
Trib to Wabash489.32 (22-018)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
0.4/0.5	12*	NA	VP*	32.5	NON/NON
Trib to Wabash 491.06 (22-019)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
0.2	16*	NA	VP*	26.0	NON/NON
Trib to Wabash 492.03 (22-020)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
1.1	12*$_{flow}$	NA	VP*	22.0	NON/NON
Trib to Wabash 492.95 (22-021)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
1.2/1.1	12*	NA	VP*	24.0	NON/NON
Beaver Creek (22-100)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
10.4	34*	10.0	4*	62.5	NON
9.7	30*	9.0	10*	36.5	NON/Partial
7.6/6.5	22*	6.5*	10*	25.0	NON
2.6/2.5	20*	5.4*	12*	25.0	NON

RIVER MILE Fish/Macro.	IBI	MIwb	ICI	QHEI	Attainment Status
Big Run (22-101)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
0.1	28*	NA	F*	28.0	NON/Full
Little Beaver Creek (22-103)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
4.7	24*	NA	F*	41.0	NON/Partial
Little Bear Creek (22-104)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
0.1	<u>18</u>*	NA	<u>P</u>*	34.5	NON/NON
Hardin Creek (22-106)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
3.2	<u>20</u>*	NA	F*	41.0	NON/NON
1.0	<u>26</u>*	NA	F*	26.5	NON/Full
Coldwater Creek (22-107)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
8.2	<u>20</u>*	NA	F*	32.5	NON/Partial
7.5	<u>18</u>*	NA	<u>P</u>*	32.0	NON/NON
5.2	<u>18</u>*	NA	<u>P</u>*	32.5	NON/NON
2.4/2.3	28*	NA	F*	42.5	NON/Partial
0.6[A]/0.3	<u>21</u>*	8.9	<u>VP</u>*	44.0	NON/NON
Burntwood Creek (22-108)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
3/3.1	<u>20</u>*	NA	<u>P</u>*	29.0	NON/NON
Beaver Creek (22-109)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
4.4/4.5	<u>20</u>*	NA	<u>P</u>*	48.5	NON/NON
3.5	<u>22</u>*	NA	<u>VP</u>*	40.5	NON/NON
0.7[A]/1.5	28*	8.4[ns]	<u>VP</u>*	40.5	NON/NON
Prairie Creek [Beaver] (22-111)					
	Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)				
3.1	<u>12</u>*$_{flow}$	NA	<u>VP</u>*	14.0	NON/NON
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
0.1	<u>16</u>*	NA	F*	28.0	NON/NON
Prairie Creek [Lake] (22-112)					
	Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)				
1.6[A]	32*	8.9	<u>VP</u>*	46.0	NON/NON

RIVER MILE Fish/Macro.	IBI	MIwb	ICI	QHEI	Attainment Status
Mississinewa River					
Eastern Cornbelt Plains MWH (Existing)					
114.9/114.8	28	NA	P*	32.0	Partial
113.8/114.2	36	NA	P*	29.0	Partial
111.5	40	NA	P*	34.0	Partial
108.5	28	5.9	22	31.5	Full
Jordan Ditch (22-201)					
Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)					
4.2	20*	NA	VP*	43.0	NON/deferred
Grays Branch (22-202)					
Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)					
3.2	26*	NA	MG	40.5	Partial/deferred
Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)					
0.6	30*	NA	MG	29.0	Partial/Full
Trib to Mississinewa (22-203)					
Eastern Cornbelt Plains WWH (Existing)/LRW (Recommended)					
0.3	12*$_{flow}$	NA	F	25.0	NON/Full
Grand Lake St. Marys (22-999)					
Eastern Cornbelt Plains EWH (Existing)					
17.7	31	9.2	VP	44.0	No applicable criteria
16.7	32	8.6	VP	46.0	No applicable criteria
15.6	29	6.5	VP	51.5	No applicable criteria
15.1	30	8.5	VP	53.5	No applicable criteria
Barnes Creek (04-535)					
Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)					
0.5	--$_{flow}$	--	P*	--	(NON/NON)
Little Chickasaw Creek (04-521)					
Eastern Cornbelt Plains WWH (Existing)LRW (Recommended)					
2.2	--$_{flow}$	--	VP*	--	NON/NON
Eastern Cornbelt Plains MWH (Existing)					
0.2/0.5^{A}	27*	8.1^{ns}	VP*	46.5	NON
Chickasaw Creek 04-522					
Eastern Cornbelt Plains WWH (Existing)/MWH (Recommended)					
5.4	20*	NA	F*	28.5	NON/NON
4.2	22*	NA	F*	35.5	NON/Partial
1.3^{A}	29*	7.9^{ns}	VP*	24.5	NON/NON

RIVER MILE Fish/Macro.	IBI	MIwb	ICI	QHEI	Attainment Status
East Fork Chickasaw Creek (04-521)					
Eastern Cornbelt Plains WWH (Existing)/Primary Headwater (Recommended)					
0.2	24*	NA	F*	34.0	NON/deferred

a The Modified Index of Well-being is not applicable (NA) to headwater site types.
b A qualitative narrative evaluation was used when quantitative data were not available or unreliable. (P = Poor, F = Fair, MG = Marginally Good, G = Good, VG = Very Good, E = Exceptional).
c Use attainment status based on one organism group is parenthetically expressed.
A Boat sampling method.
* Indicates significant departure from applicable WWH biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
ns Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).
flow Performance limited by lack of water.

Narrative ranges and WWH biocriteria (bold) for Ohio ecoregions. Exceptional (EWH biocriteria), very good (EWH nonsignificant departure), poor and very poor evaluations are common statewide. For WWH, the ranges of marginally good and nonsignificant departure are the same (except in HELP).

IBI			MIwb		ICI	Narrative Evaluation
Headwater	Wading	Boat	Wading	Boat	All	
50-60	50-60	48-60	≥9.4	≥9.6	46-60	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	42-44	Very Good
Eastern Corn Belt Plains						
40-45	**40**-45	**42**-43	**8.3**-8.8	**8.5**-9.0	**36**-40	Good
36-39	36-39	38-41	7.8-8.2	8.0-8.4	32-34	Marginally Good
28-35	28-35	26-37	5.9-7.7	6.4-7.9	14-30	Fair
18-27	18-27	16-25	4.5-5.8	5.0-6.3	8-12	Poor
12-17	12-17	12-15	0-4.4	0-4.9	≤6	Very Poor

Biocriteria for LRW and MWH (channel modified and impounded) aquatic life uses.

IBI			MIwb		ICI	Type
Headwater	Wading	Boat	Wading	Boat	All	
All ecoregions						
18	**18**	**16**	**4.5**	**5.0**	**8**	Limited Resource Water
All ecoregions except HELP						
24	**24**	**24**	**6.2**	**5.8**	**22**	Channel Modified
--	**--**	**30**	**--**	**6.6**	**--**	Impounded

Table 2. Violations (maximum-minimum criteria) and exceedences (average criteria) of Ohio EPA Water Quality Standards which were documented at sites in the Wabash River basin study area, 1999. Values are evaluated based on both Ohio River Basin[1] criteria and statewide[2] criteria that are linked to assigned use designations[3]. Units are mg/l for dissolved oxygen (D.O.), ammonia, dissolved solids (TDS), iron (Fe), and manganese (Mn), °C for temperature (T), standard units for pH, # colonies/100 ml for fecal coliforms, and µg/l for heavy metals.

RM	Parameter (value)
Wabash River (WWH, PCR, AWS)	
504.47	D.O. (4.2 †, 1.6 ††)
494.26	Fe (6500 aws); fecal coliform (51000 ‡‡, 4900 ‡‡, 1500 ‡)
489.90	ammonia (0.41 †, 0.68 †, 0.29 †, 0.21 †); T (31.3 ††, 29.2 †, 30.3 ††, 28.5 †); pH (9.12 ††, 9.74 ††, 9.33 ††); fecal coliform (>200000 ‡‡)
484.73	fecal coliform (11000 ‡‡)
482.15	D.O. (2.8 ††, 3.8 ††, 4.4 †); ammonia (0.77 †); fecal coliform (11000 ‡‡, >10000 ‡‡)
479.99	fecal coliform (9500 ‡‡, 6500 ‡‡)
476.05	fecal coliform (4400 ‡‡, 2400 ‡‡)
469.53	fecal coliform (5000 ‡‡)
466.10	fecal coliform (6800 ‡‡, 2000 ‡‡)
Mississinewa River (MWH, SCR, AWS)	
114.24	Zn (431 ***); Cu (21 *); Fe (21000 ws); fecal coliform (>200000 ‡‡)
111.53	D.O. (1.9 ††, 3.2 †); ammonia (7.92 †, 4.42 †)
Gray Branch (WWH, PCR, AWS)	
3.21	fecal coliform (4400 ‡‡)
0.57	D.O. (3.2 ††, 1.6 ††, 1.6 ††)
Bear Creek (WWH, PCR, AWS)	
1.84	D.O. (2.7 ††, 0.5 ††, 3.7 ††, 4.0 †, 4.0 †, 1.8 ††); ammonia (5.90 †, 5.28 †, 7.58 †, 10.2 †, 6.97 †); TDS (2580 ††, 3720 ††, 1650 ††, 4920 ††); Fe (6680 aws); fecal coliform (>200000 ‡‡, 3200 ‡‡, 8900 ‡‡)

Table 2. continued.

RM	Parameter (value)
Bear Creek (WWH, PCR, AWS)	
0.01	D.O. (4.6 [†]); ammonia (5.82 [†], 1.11 [†]); T (28.2 [†]); fecal coliform (3300 [‡‡], 2900 [‡‡]); Fe (7730 [aws], 11200 [aws], 9800 [aws], 7320 [aws], 6080 [aws])
Fort Creek	
1.54	D.O. (0.2 [††], 1.2 [††]); TDS (5160 [††], 4460 [††]); fecal coliform (11000 [‡‡‡])
0.02	D.O. (2.2 [†])
Stony Creek (WWH, PCR, AWS)	
0.05	D.O. (3.4 [††], 2.9 [††], 3.4 [††], 2.9 [††], 2.5 [††])
Toti Creek (WWH, PCR, AWS)	
2.11	D.O. (4.9 [†], 3.9 [††], 4.2 [†]); fecal coliform (7000 [‡‡])
0.24	fecal coliform (4400 [‡‡])
Crab Branch (WWH, PCR, AWS)	
0.45	D.O. (3.2 [††], 1.3 [††], 4.8 , 2.0 [††]); ammonia (15.4 [††], 9.67 [†], 16.4 [††], 6.81 [†], 24.6 [††]); TDS (1840 [††], 2110 [††], 2080 [††]); fecal coliform (56000 [‡‡], 1600 [‡], 35000 [‡‡])
Hickory Branch (WWH, PCR, AWS)	
0.29	Fe (6910 [aws]); fecal coliform (8400 [‡‡])
Beaver Creek (WWH, PCR, AWS)	
10.30	T (28.8 [†]); fecal coliform (1800 [‡])
9.65	fecal coliform (2100 [‡‡], 1200 [‡], 1700 [‡])
7.49	T (28.5 [†], 28.5 [†]); pH (9.03 [††]); fecal coliform (1400 [‡])
2.65	T (28.2 [†]); fecal coliform (1300 [‡], 1200 [‡])

Table 2. continued.

RM	Parameter (value)
Hardin Creek (WWH, PCR, AWS)	
3.25	TDS (1680 ††, 1580 ††); fecal coliform (1100 ‡, 1900 ‡)
1.01	D.O. (4.9 †, 4.0 †); pH (9.07); fecal coliform (1200 ‡)
Little Beaver Creek (WWH, PCR, AWS)	
4.70	fecal coliform (3000 ‡‡, 3400 ‡‡)
Little Bear Creek (WWH, PCR, AWS)	
0.07	D.O. (3.9 ††, 3.7 ††, 3.1 ††, 3.8 ††); ammonia (5.52 †, 2.72 †); TDS (1550 ††, 1540 ††, 1610 ††, 1820 ††); fecal coliform (1300 ‡, >10000 ‡‡)
Big Run (WWH, PCR, AWS)	
0.12	T (28.9 †); fecal coliform (1600 ‡)
Prairie Creek	
3.07	ammonia (8.22 ††); pH (9.13 ††); TDS (1590 ††)
0.10	fecal coliform (>10000 ‡‡‡, >10000 ‡‡‡)
Coldwater Creek (WWH, PCR, AWS)	
9.33	TDS (1710 ††); fecal coliform (>10000 ‡‡, 2200 ‡‡, 1200 ‡)
8.54	ammonia (1.06 †); TDS (1810 ††); fecal coliform (>10000 ‡‡, 5000 ‡‡)
6.42	ammonia (3.54 †); TDS (1700 ††, 1810 ††, 2220 ††); fecal coliform (>10000 ‡‡, 5300 ‡‡)
3.51	D.O. (3.1 ††, 2.5 ††, 3.9 ††, 3.3 ††, 4.2 † , 4.2 †); ammonia (2.43 †); TDS (1880 ††, 2200 ††); fecal coliform (>10000 ‡‡, 1300 ‡, 3400 ‡‡)
Burntwood Creek (WWH, PCR, AWS)	
3.08	TDS (2400 ††); fecal coliform (2300 ‡‡, 2000 ‡, 2100 ‡‡)

Table 2. continued.

RM	Parameter (value)
Beaver Creek (WWH, PCR, AWS)	
6.87	D.O. (3.7 [††], 3.2 [††], 3.7 [††]); TDS (1510 [††], 1600 [††]); fecal coliform (1200 [‡])
5.91	D.O. (4.1 [†], 3.7 [††], 4.7 [†]); fecal coliform (1500 [‡])
Chickasaw Creek	
6.50	fecal coliform (>10000 [‡‡‡])
5.28	fecal coliform (>10000 [‡‡‡])
East Fork Chickasaw Creek	
0.16	pH (9.10 [††]); fecal coliform (6900 [‡‡‡])
Grand Lake St. Marys- Offshore (EWH, PCR, PWS, AWS)	
L1-S	pH (9.30 [††]); Fe (1760 [pws], 326 [pws]); Mn (134 [pws], 93 [pws], 119 [pws])
L1-B	D.O. (5.8 [†]); Fe (1650 [pws], 360 [pws]); Mn (128 [pws], 105 [pws], 120 [pws])
L2-S	Fe (1440 [pws], 402 [pws]); Mn (147 [pws], 122 [pws], 137 [pws])
L2-B	Fe (1370 [pws], 344 [pws], 390 [pws]); Mn (141 [pws], 129 [pws], 136 [pws])
L3-S	pH (9.36 [††]); Fe (1670 [pws], 346 [pws], 695 [pws]); Mn (125 [pws], 98 [pws], 119 [pws])
L3-B	pH (9.17 [††], 9.03 [††]); Fe (1710 [pws], 425 [pws], 717 [pws]); Mn (129 [pws], 104 [pws], 119 [pws])
Grand Lake St. Marys- Nearshore [4] (EWH, PCR, PWS, AWS)	
NS-1	pH (9.13 [††]); Fe (1190 [pws], 702 [pws], 899 [pws]); Mn (91 [pws], 103 [pws], 125 [pws])
NS-2	D.O. (5.6 [†], 4.9 [††]); pH (9.07 [††]); Fe (2200 [pws], 2780 [pws], 648 [pws]); Mn (146 [pws], 188 [pws], 124 [pws])
NS-3	pH (9.11 [††], 9.09 [††]); Fe (1910 [pws], 3200 [pws], 2710 [pws]); Mn (139 [pws], 192 [pws], 199 [pws])
NS-4	Fe (1260 [pws], 2510 [pws], 1840 [pws]); Mn (134 [pws], 166 [pws], 181 [pws])
NS-5	T (28.2 [†]); pH (9.11 [††], 9.40 [††], 9.37 [††]); Fe (1200 [pws], 857 [pws], 852 [pws]); Mn (118 [pws], 112 [pws], 116 [pws])
NS-6	T (28.5 [†]); Fe (1480 [pws], 1590 [pws], 915 [pws]); Mn (140 [pws], 140 [pws], 136 [pws])
NS-7	T (29.3 [†]); Fe (907 [pws], 1070 [pws], 788 [pws]); Mn (126 [pws], 146 [pws], 136 [pws])

Table 2. continued.

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[1] Ohio River Basin Aquatic Life Criteria

*** violation of maximum criteria established to prevent lethal toxicity (FAV).
** violation of maximum criteria established to prevent acute toxicity (AAC).
* exceedence of average criteria established to prevent chronic toxicity (CAC).

[2] Statewide Aquatic Life, Recreation, and Water Supply Criteria

†† violation of minimum or maximum criteria established to protect aquatic life uses.
† exceedence of average criteria established to protect aquatic life uses.
‡‡‡ violation of maximum criteria established to protect public health.
‡‡ violation of maximum criteria established to protect recreation uses.
‡ exceedence of average criteria established to protect recreation uses.
aws exceedence of average criteria established to protect agricultural water uses.
pws exceedence of average criteria established to protect drinking water uses.

[3] Aquatic life, recreation, and water supply use designations: exceptional warmwater habitat (EWH), warmwater habitat (WWH), modified warmwater habitat (MWH), limited resource water (LRW), primary contact recreation (PCR), secondary contact recreation (SCR), agricultural water supply (AWS), and public water supply (PWS).

[4] Grand Lake St. Marys nearshore sites: Northwood Subdivision (NS-1), Coldwater Creek (NS-2), Beaver Creek (NS-3), Prairie Creek (NS-4), Chickasaw Creek (NS-5), Little Chickasaw Creek (NS-6), and Barnes Creek (NS-7).

Figure 4. Potential effect of ammonia-nitrogen at sites in the Wabash River basin, 1999.

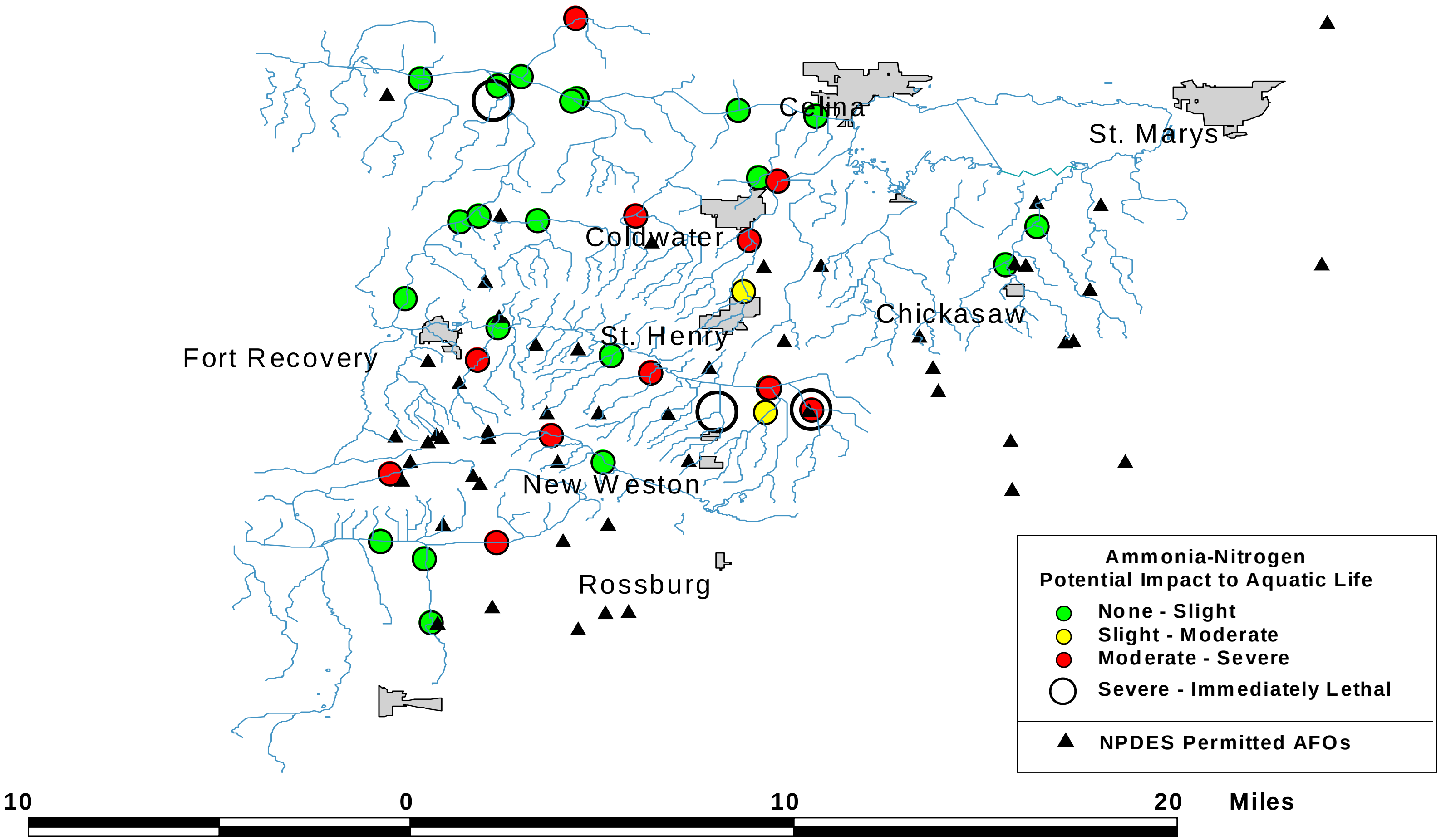

Figure 5. Levels of fecal coliform bacteria at sites in the Wabash River basin, 1999.

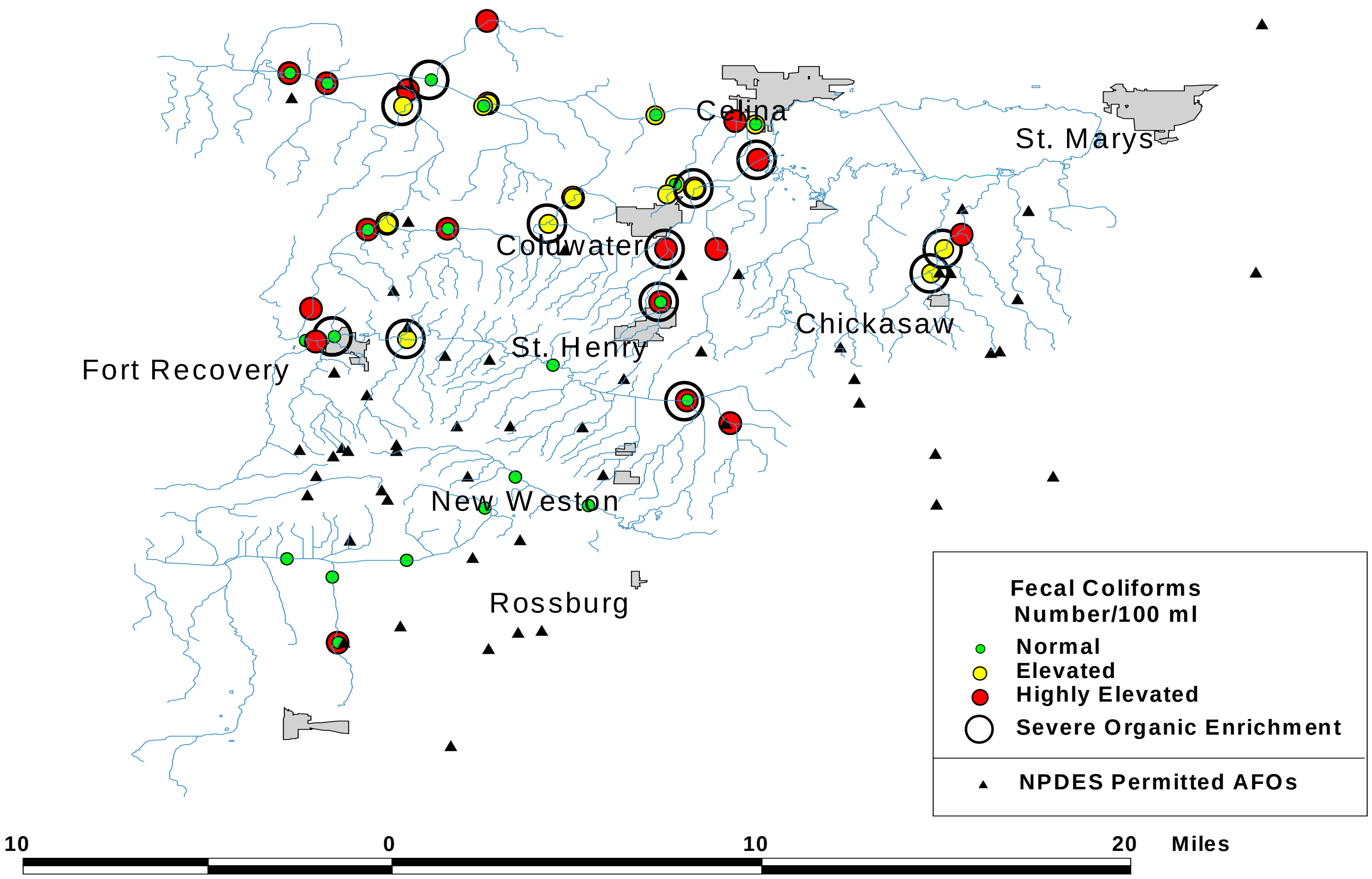

Figure 6. Levels of organic enrichment at sites in the Wabash River basin, 1999.

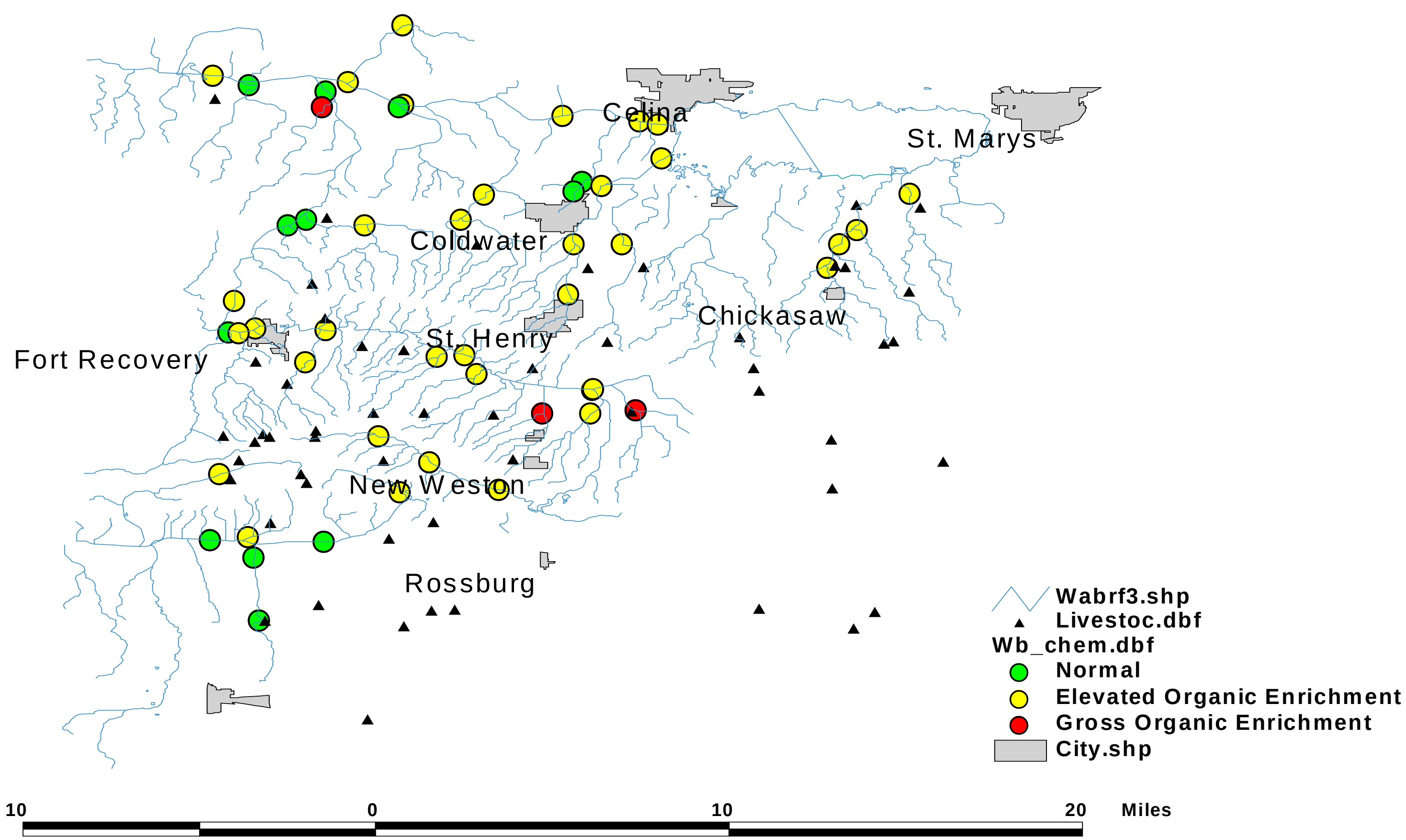

Figure 7. Concentrations of dissolved oxygen at sites in the Wabash River basin, 1999.

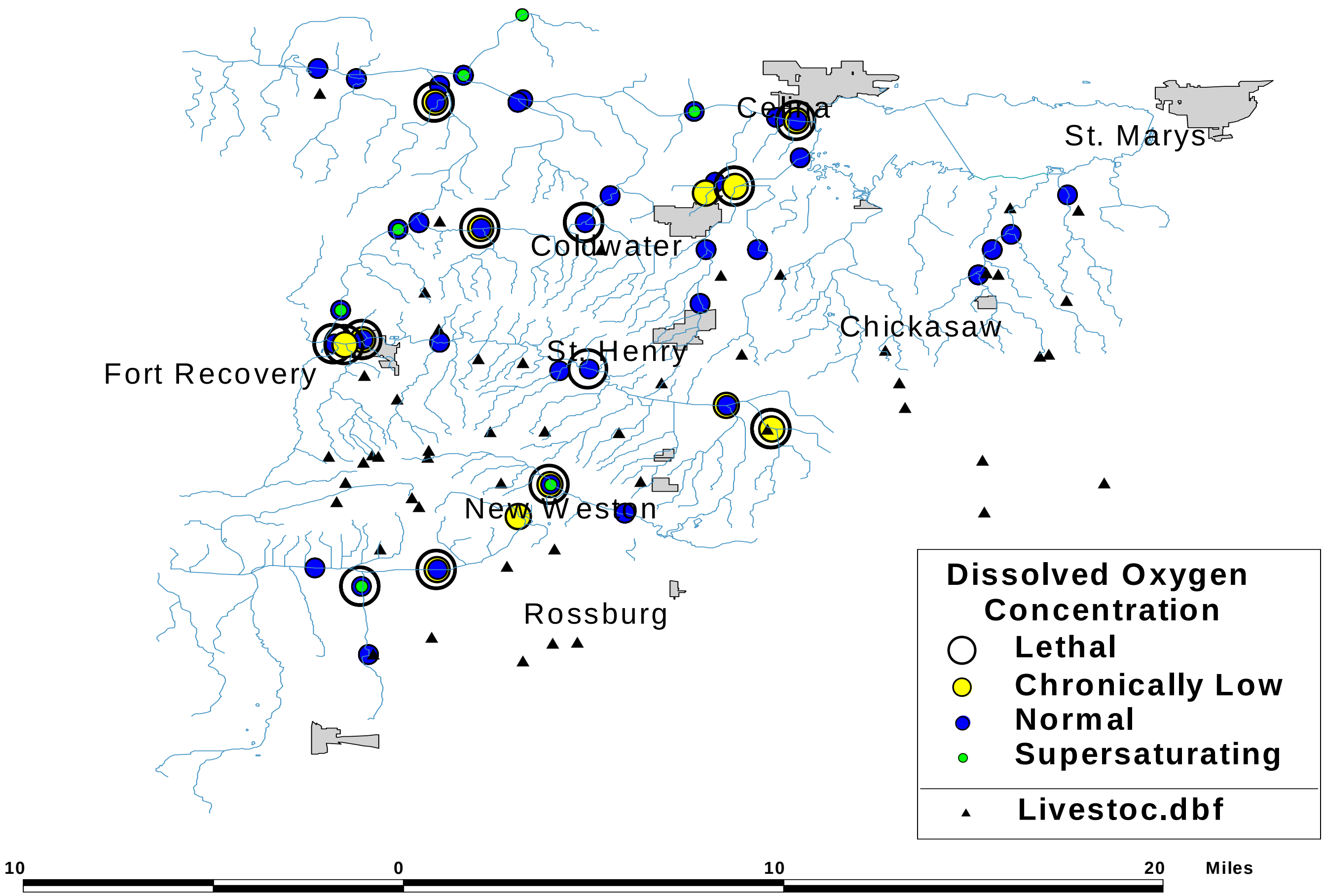

Figure 8. Macroinvertebrate community quality at sites in the Wabash River basin, 1999.

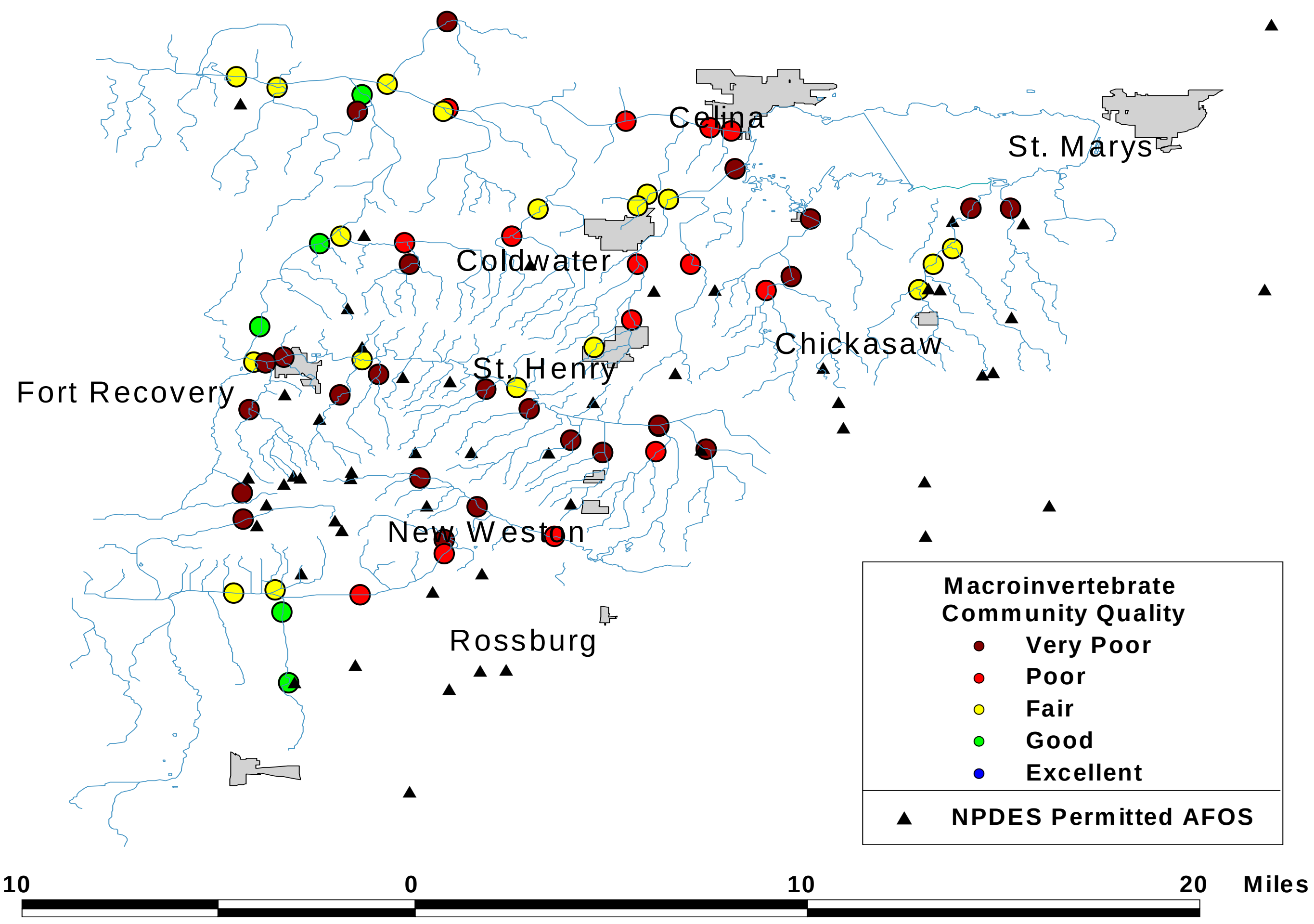

Figure 9. Fish community quality at sites in the Wabash River basin, 1999.