Ohio Environmental Protection Agency

Biological and Water Quality Study of

Saint Marys River and Tributaries, 2015

Auglaize, Mercer, Shelby and Van Wert Counties

St. Marys River at river mile 61.5 east of the village of Rockford.

Ohio EPA Technical Report EAS/2018-11-01

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List of Acronyms

ALU	aquatic life use
CFR	Code of Federal regulations
cfs	cubic feet per second
cfu	colony forming units
CSO	combined sewer overflow
CWA	Clean Water Act
DC	direct current
DELT	deformities, erosions, lesions, tumors
D.O.	dissolved oxygen
ECBP	Eastern Corn Belt Plains
EPT	ephemeroptera, plecoptera, trichoptera
EWH	exceptional warmwater habitat
GIS	geographic information system
GPS	global positioning system
HHEI	headwater habitat evaluation index
HUC	hydrologic unit code
IBI	index of biotic integrity
ICI	invertebrate community index
IP	Interior Plateau
IPS	integrated prioritization system
LRAU	large river assessment unit
LRW	limited resource water
MGD	million gallons per day
MIwb	Modified Index of well-being
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
ORC	Ohio Revised Code
PAH	polycyclic aromatic hydrocarbons
PCR	primary contact recreation
PEC	probable effects concentration
QHEI	Qualitative Habitat Evaluation Index
RM	river mile
SCR	secondary contact recreation
SRV	sediment reference value
SSO	sanitary sewer overflow

TALU	tiered aquatic life use
TDS	total dissolved solids
TEC	threshold effects concentration
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TSS	total suspended solids
UAA	use attainability analysis
VOC	volatile organic compound
WAU	waterbody assessment unit
WQS	water quality standards
WWH	warmwater habitat
WWTP	wastewater treatment plant

Executive Summary

Rivers and streams in Ohio support a variety of uses, such as recreation, water supply and aquatic life. Ohio EPA evaluates streams to determine appropriate use designations and also to determine if uses are meeting the goals of the federal Clean Water Act. For this study, chemical, physical and biological sampling was conducted on 24 streams in the St. Marys River watershed. Aquatic life use (ALU) designations had been previously verified for five streams. The 2015 survey, however, represented the initial assessment of 18 of these streams. The study area involved 17 watershed assessment units, which are subwatersheds based on the United States Geological Survey's (USGS) 12-digit hydrologic unit code (HUC-12) system. The watershed assessment units are located in Shelby, Auglaize, Mercer and Van Wert counties. Sampling was conducted to provide an assessment of conditions within each watershed, and, for those waterbodies where the biological community was not meeting expectations, Ohio EPA identified causes and sources of impairment.

Waterways meeting the warmwater habitat (WWH) use possess habitat, chemical and hydrologic characteristics capable of maintaining healthy fish and macroinvertebrate communities in the absence of significant human impact. The modified warmwater habitat (MWH) use reflects the inability for a stream to meet the same characteristics of WWH due to irretrievable modifications to the physical habitat. During biological and water quality surveys, such as those conducted for the St. Marys watershed, Ohio EPA staff assess the appropriate use designation for every stream sampled. As a result of previous biological surveys, the St. Marys River and Kopp Creek are listed in the Ohio Water Quality Standards (WQS) with the WWH ALU designation; three streams (Black Creek, Blierdofer Ditch and Wierth Ditch) are listed as MWH. The WWH use was confirmed based on the 2015 survey results for 14 streams with previously unverified ALU designations. Additionally, the WWH use is recommended for the Twentyseven Mile Creek and the unnamed tributary to Twentyseven Mile Creek (RM 3.1). Based on this survey, a MWH ALU designation is recommended for two stream segments (Prairie Creek and the reach of Duck Creek upstream from RM 2.97) that previously were assigned an unverified WWH use.

Fifty-eight sites were sampled throughout the St. Marys River watershed (Figure 1). Designated or recommended ALUs fully met expectations at 34 sites. Compared to earlier investigations within the basin, the 59 percent ALU attainment demonstrated an improvement in overall condition and coincided with better wastewater treatment for the City of St. Marys and Village of New Bremen. Of the 41 percent of sites that were not meeting ALU expectations, excessive siltation/substrate embeddedness and habitat alteration were the most common causes of impairment (Table 1). Substrate embeddedness is a condition in which fine clay and silt particles fill in voids or spaces in between larger aggregate, such as cobble, along the bottom of the stream. This has a negative effect on the biology because there are fewer living spaces available to macroinvertebrates and fish for shelter and spawning. The primary sources of impairment were historical channelization and agricultural production. The second most common cause of impairment was organic enrichment, linked to both agricultural production (crop residue) and municipal point sources (nutrients resulting in algae growth/decay).

Of the sample locations on the St. Marys River mainstem, 75 percent were in full attainment of the WWH ALU designation. As suggested earlier, these scores reflect an overall improvement in watershed conditions since the previous assessment. However, the discharge of algae-rich water from the Miami and Erie Canal created unfavorable conditions in the St. Marys River for approximately three miles downstream. Algae contains organic matter which, in high enough levels, will deplete oxygen in the water column as the material decays. Low dissolved oxygen in the water column negatively affects fish and macroinvertebrates. Throughout the summer, Ohio EPA staff identified an increasing oxygen demand from the canal discharge.

As a result, non-attainment at three downstream sites (between RM 100.28 and 98.5) are attributed to these high organic loads (low dissolved oxygen). After the river recovered from the immediate effects of the canal discharge (downstream of RM 95), the aquatic life use was largely maintained.

Chemical water quality parameters were measured at 53 in-stream locations and five wastewater treatment plant discharges. In general, water quality conditions were typical of an agricultural watershed with high nutrient levels at many sites and periods of low dissolved oxygen throughout the watershed.

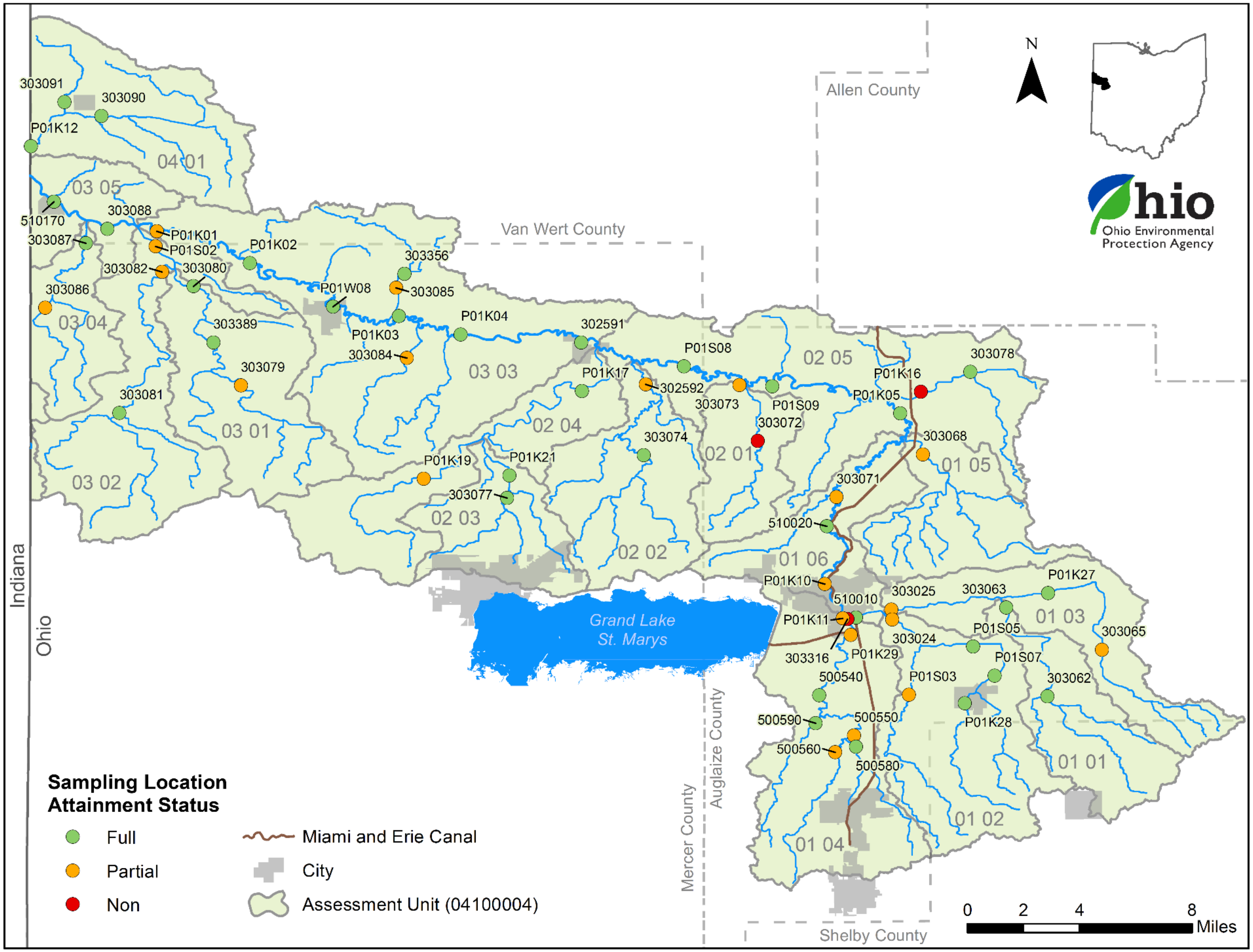

Figure 1 — Map of sampling locations and ALU attainment statuses in the St. Marys River basin based on data collected June-October 2015.

Table 1 — Aquatic life use attainment status for stations sampled in the St. Marys River basin based on data collected June-October 2015. The Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb) and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community. The table is organized by assessment unit (12-digit hydrologic unit code (HUC-12)). Sites with ALU changes recommended are evaluated using the biocriteria for the recommended use, not the current use.

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
04100004 01 01 – Muddy Creek											
303062	Muddy Creek @ Bay Rd.	ECBP/WWH	5.4[H]	9.3	38[ns]	--	G	57.0	FULL		
303063	Muddy Creek @ Washington Rd.	ECBP/WWH	0.45[H]	15.6	44	---	G	59.3	FULL		
04100004 01 02 – Center Branch											
P01K28	Center Branch @ New Knoxville @ end of Rd. near ponds (South St.)	ECBP/WWH	6.6[H]	5.9	38 [ns]	---	MG[ns]	56.3	FULL		
P01S07	Center Branch just upst. New Knoxville WWTP	ECBP/WWH	5.2[H]	10.4	44	--	MG[ns]	62.0	FULL		
P01S05	Center Branch @ Glynwood-New Knoxville Rd.	ECBP/WWH	3.22[H]	14.2	38[ns]	---	MG[ns]	52.0	FULL		
303024	Center Branch @ Plattner Pike	ECBP/WWH	0.34[W]	28.7	34*	7.8[ns]	48	50.0	PARTIAL	Direct habitat alterations; Low dissolved oxygen	Channelization; Agriculture
P01S03	Carter Creek W. of New Knoxville @ St. Rte. 219	ECBP/WWH	1.86[H]	7.8	46	--	F*	53.0	PARTIAL	Direct habitat alterations	Channelization
04100004 01 03 – East Branch											
303025	East Branch @ St. Rte. 29	ECBP/WWH	0.27[W]	37.1	32*	8.5	40	57.5	PARTIAL	Direct habitat alterations	Channelization
303065	Clear Creek @ Burr Oak Rd.	ECBP/WWH	5.4[H]	6.8	36[ns]	--	F*	62.8	PARTIAL	Direct habitat alterations	Channelization
P01K27	Clear Creek E. of St. Marys @ Bay Rd.	ECBP/WWH	1.32[H]	13.4	44	--	G	50.5	FULL		
04100004 01 04 – Kopp Creek											
500560	Kopp Creek N. of New Bremen @ Clover Four Rd.	ECBP/WWH	8.9[H]	4.6	38[ns]	--	F*	57.0	PARTIAL	Sedimentation/ siltation	Channelization

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
500550	Kopp Creek N. of New Bremen @ Lane off St. Rte. 66	ECBP/WWH	7.62^{H}	13.8	34*	--	MG^{ns}	55.5	PARTIAL	Nutrient/ eutrophication biological indicators; Low dissolved oxygen	Municipal point source; Agriculture
500540	Kopp Creek S. of St. Marys @ RR near CR 66A	ECBP/WWH	3.6^{W}	22.1	36^{ns}	8.5	38	61.8	FULL		
P01K29	Kopp Creek S. of St. Marys @ St. Rte. 66	ECBP/WWH	0.8^{W}	28.0	34*	7.4*	42	65.5	PARTIAL	Low dissolved oxygen	Municipal point source; Agriculture
500580	Wierth Ditch N. of New Bremen @ St. Rte. 66	ECBP/MWH	0.45^{H}	6.9	40	--	F	55.3	FULL		
500590	Trib. to Kopp Creek (RM 5.41) @ Piqua-St. Marys Rd.	ECBP/WWH	0.3^{H}	4.6	36^{ns}	--	MG^{ns}	53.8	FULL		
04100004 01 05 – Sixmile Creek											
303068	Sixmile Creek @ St. Marys-Kossuth Rd.	HELP/WWH	1.06^{H}	16.2	36	--	F*	48.8	PARTIAL	Sedimentation/ siltation	Channelization
04100004 01 06 – Fourmile Creek – Saint Marys River											
510010	St. Marys River @ St. Marys @ Aqueduct Rd.	ECBP/WWH	100.47^{W}	67.1	39^{ns}	8.1^{ns}	50	53.0	FULL		
303316	St. Marys River @ St. Marys, ust. Kopp Creek, @ Greenville Rd.	ECBP/WWH					0		(NON)	Organic enrichment biological indicators	Canal/pond discharge
P01K11	St. Marys River @ St. Marys, dst. Kopp Creek, @ Greenville Rd.	ECBP/WWH	100.12^{W}	101.0	37^{ns}	9.3	24*	51.8	PARTIAL	Organic enrichment biological indicators	Canal/pond discharge
P01K10	St. Marys River dst. St. Marys WWTP	ECBP/WWH	98.50^{W}	103.0	42	9.3	28*	63.3	PARTIAL	Organic enrichment biological indicators	Canal/pond discharge
510020	St. Marys River N. of St. Marys @ Glynwood Rd.	ECBP/WWH	95.12^{W}	106.0	36^{ns}	9.5	46	56.5	FULL		

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi²)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
303071	Fourmile Creek @ St. Marys River Rd.	ECBP/WWH	0.1[H]	5.6	36[ns]	--	F*	35.3	PARTIAL	Sedimentation/ siltation	Channelization
04100004 02 01 – Hussey Creek											
303072	Hussey Creek @ Salem-Noble Rd.	HELP/WWH	2.40[H]	6.8	32	--	P*	56.5	NON	Sedimentation/ siltation	Channelization
303073	Hussey Creek @ Hesse Rd.	HELP/WWH	0.10[H]	11.3	32	--	F*	46.3	PARTIAL	Sedimentation/ siltation	Channelization
04100004 02 02 – Eightmile Creek											
303074	Eightmile Creek @ Davis Rd.	HELP/WWH	6.55[H]	12.7	30	--	MG[ns]	55.8	FULL		
302592	Eightmile Creek SE of Mendon @ Mercer Rd.	HELP/WWH	1.22[W]	21.8	39	8.7	14*	45	PARTIAL	Other flow regime alterations	Natural sources
04100004 02 03 – Blierdofer Ditch											
303077	Blierdofer Ditch @ Morrow Rd.	HELP/MWH	2.50[H]	6.4	36	--	F	42.8	FULL		
P01K21	Blierdofer Ditch N. of Celina @ Oregon Rd.	HELP/MWH	1.70[H]	10.5	32	--	MG	28	FULL		
04100004 02 04 – Twelvemile Creek											
P01K19	Twelvemile Creek NW of Celina @ Hoenie Rd.	HELP/WWH	11.01[H]	11.6	32	--	F*	32	PARTIAL	Sedimentation/ siltation; Alteration in streamside covers	Channelization
P01K17	Twelvemile Creek S. of Mendon @ Celina-Mendon Rd.	HELP/WWH	1.80[W]	36.0	30[ns]	8.4	34	34.8	FULL		
04100004 02 05 – Prairie Creek – Saint Marys River											
P01K05	St. Marys River S. of Kossuth @ Barbara-Werner Rd.	HELP/WWH	87.8[B]	135.0	33[ns]	9.6	44	56.5	FULL		
P01S09	St. Marys River N. of St. Marys @ St. Rte. 116	HELP/WWH	80.51[B]	166.0	33[ns]	9.3	G	58.0	FULL		
P01S08	St. Marys River E. of Mendon @ Gallman Rd.	HELP/WWH	75.07[B]	184.0	32[ns]	9.1	46	53.3	FULL		
303078	Prairie Creek @ Eisley Rd.	HELP/MWH	2.75[H]	6.7	36	--	F*	25.0	FULL		

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi²)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
P01K16	Prairie Creek S. of Kossuth @ St. Rte. 197	HELP/MWH	1.02[H]	12.4	36	--	P*	22.8	NON	Organic enrichment	Crop production; Flooding
04100004 03 01 – Little Black Creek											
303079	Little Black Creek @ St. Rte. 707	HELP/WWH	6.85[H]	10.1	44	--	F*	42.8	PARTIAL	Sedimentation/ siltation; Alteration in streamside covers	Channelization
303389	Little Black Creek @ Wilson Rd.	HELP/WWH	3.95[W]	17.3	36	--	--	33.8	(FULL)		
303080	Little Black Creek @ Jordan Rd.	HELP/WWH	1.00[W]	23.6	34	7.4[ns]	MG[ns]	45.8	FULL		
04100004 03 02 – Black Creek											
303081	Black Creek @ Strable Rd.	HELP/MWH	10.70[H]	13.2	38	--	F	50.5	FULL		
303082	Black Creek @ Winkler Rd.	HELP/MWH	2.50[W]	25.0	43	9.6	16*	45.8	PARTIAL	Natural (flow or habitat)	Natural sources
P01S02	Black Creek SE of Willshire @ St. Rte. 33	HELP/MWH	0.90[W]	54.0	34	9.2	18*	40.8	PARTIAL	Natural (flow or habitat)	Natural sources
04100004 03 03 – Yankee Run – Saint Marys River											
302591	St. Marys River @ Mendon, Mendon-Celina Rd.	HELP/WWH	70.4[B]	251.0	36	9.2	48	56.5	FULL		
P01K04	St. Marys River N. of Mercer @ US 127	HELP/WWH	65.7[B]	261.0	35	9.6	42	49.0	FULL		
P01K03	St. Marys River E. of Rockford @ Frysinger Rd.	HELP/WWH	61.5[B]	279.0	36	9.5	34	54.8	FULL		
P01W08	St. Marys River @ Rockford @ St. Rte. 118	HELP/WWH	57.82[B]	295.0	36	10.1	30[ns]	63.0	FULL		
P01K02	St. Marys River dst. Rockford @ Townline Rd.	HELP/WWH	52.13[B]	303.0	31[ns]	9.3	40	58.5	FULL		
P01K01	St. Marys River SE of Willshire @ Harner Rd.	HELP/WWH	47.48[B]	309.0	37	9.2	24*	62.3	PARTIAL	Natural (flow or habitat)	Natural sources

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
303084	Yankee Run @ US 33	HELP/WWH	1.40[H]	6.1	42	--	F*	26.8	PARTIAL	Sedimentation/ siltation; Alteration in streamside covers	Channelization
303356	Town Run @ Frysinger Rd.	HELP/WWH	1.87[H]	5.6	32	--	--	38	(FULL)		
303085	Town Run @ St. Rte. 117	HELP/WWH	1.25[H]	7.1	34	--	F*	46.5	PARTIAL	Sedimentation/ siltation; Alteration in streamside covers	Channelization
04100004 03 04 – Duck Creek											
303086	Duck Creek @ Settler Rd.	HELP/MWH	4.70[H]	6.4	32	--	LF*	22.5	PARTIAL	Sedimentation/ siltation	Channelization; Natural sources
303087	Duck Creek dst. County Line	HELP/WWH	1.05[H]	15.6	38	--	MG[ns]	49	FULL		
04100004 03 05 – Town of Willshire – Saint Marys River											
303088	St. Marys River E. of Willshire, adj. to US 33	HELP/WWH	45.6[B]	366.7	34	9.3	MG[ns]	52.8	FULL		
510170	St. Marys River @ Willshire @ St. Rte. 81	HELP/WWH	43.48[B]	386.0	37	10.3	38	75.0	FULL		
04100004 04 01 – Twentyseven Mile Creek											
303090	Twentyseven Mile Creek @ Clayton Rd.	HELP/WWH	4.10[H]	14.0	36	--	MG[ns]	42.5	FULL		
P01K12	Twentyseven Mile Creek @ Ohio/Indiana state line	HELP/WWH	1.20[W]	28.2	44	9.1	30[ns]	55.3	FULL		
303091	Trib. to Twentyseven Mile Creek (RM 3.1) @ Wren-Landeck Rd.	HELP/WWH	0.40[H]	7.4	46	--	MG[ns]	56.3	FULL		

a River mile (RM) represents the point of record (POR) for the station, and may not be the actual sampling RM.
b MIwb is not applicable to headwater streams with drainage areas < 20 mi^2.
c A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional
ns Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).
* Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
H Headwater site (draining ≤20 $miles^2$)

W Wading site (non-boat site draining >20 miles^2)
B Boat site (large or deep waters, necessitating the use of boat sampling methods)
1 Level III Ecoregions: Eastern Corn Belt Plains (ECBP), Huron/Erie Lake Plains (HELP)
2 Aquatic life use (ALU) designations: exceptional warmwater habitat (EWH), warmwater habitat (WWH), modified warmwater habitat (MWH)

	Biological Criteria[3] - ECBP			Biological Criteria - HELP		
Index – Site Type	EWH	WWH	MWH	EWH	WWH	MWH
IBI – Headwaters	50	40	24	50	28	20
IBI – Wading	50	40	24	50	32	22
IBI – Boat	48	42	24	48	34	20
MIwb – Wading	9.4	8.3	6.2	9.4	7.3	5.6
MIwb – Boat	9.6	8.5	5.8	9.6	8.6	5.7
ICI	46	36	22	46	34	22

3 Biological criteria presented in OAC 3745-1-07, Table 7-1

Introduction

Ohio EPA evaluated 58 stream sampling locations in the St. Marys River watershed in Auglaize, Mercer, Shelby and Van Wert Counties in 2015 (Table 2). Fifteen sites on the St. Marys River mainstem were sampled as well as 33 sites on 11 tributary streams including: Kopp Creek; Fourmile Creek; Sixmile Creek; Prairie Creek; Hussey Creek; Eightmile Creek; Twelvemile Creek; Town Run; Black Creek; Duck Creek; and Twentyseven Mile Creek. Ten sites were sampled on two headwater streams, Center Branch and East Branch, and their tributaries, Muddy Creek, Clear Creek and Carter Creek. Three sites on the Miami-Erie canal were sampled where it discharges into the St. Marys River and into Sixmile Creek. A total of 20 National Pollutant Discharge Elimination System (NPDES)-permitted facilities discharge sanitary wastewater, industrial process water and/or industrial storm water into the St. Marys study area. Discharges from five of the municipal wastewater treatment plants were sampled during the study.

Figure 2 — Location of the St. Marys River watershed within the geopolitical boundaries of Ohio.

During 2015, Ohio EPA conducted a water resource assessment of 23 streams in the St. Marys River watershed using standard Ohio EPA protocols as described in Appendix A. Included in this study were assessments of the biological, surface water and recreation (bacterial) condition. A total of 58 biological, 57 water chemistry, six fish tissue and 29 bacterial stations were sampled in the St. Marys watershed. All of the biological, chemical and bacteria results can be downloaded from Ohio EPA's GIS interactive maps webpage at ***epa.ohio.gov/dsw/gis/index.aspx***.

Specific objectives of the evaluation were to:

- ascertain the present biological conditions in the St. Marys River watershed by evaluating fish and macroinvertebrate communities;
- identify the relative levels of organic, inorganic and nutrient parameters in the sediments and surface water;
- evaluate influences from NPDES outfall discharges;
- assess physical habitat influences on stream biotic integrity;
- determine recreation water quality;
- compare present results with historical conditions; and
- determine the attainment status and recommend changes if appropriate.

Table 2 — Sampling locations in the St. Marys watershed, 2015 (listed by stream name and stream code). *Red italics* text indicates wastewater effluent sampling.

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude
St. Marys River (04-500-000) WWH							
510010	At St. Marys @ Aqueduct Road	100.47	67.10	F2,MQ,C5,D,N	041000040106	40.535300	-84.377200
P01K11	At St. Marys, dst. Kopp Creek @ Greenville St.	100.12	101.00	F2,MQ,C,D,N,B	041000040106	40.534845	-84.383904
P01W12	*St. Marys WWTP outfall 001 to St. Marys River*	*98.60*	*102.00*	*C5,B*	*041000040106*	*40.550922*	*-84.392557*
P01K10	Downstream St. Marys WWTP	98.50	103.00	F2,MQ,C5,D,N,B,Sd	041000040106	40.552500	-84.393099
510020	North of St. Marys @ Glynwood Road	95.12	106.00	F2,MQ,C5,D,N,B,Sn,Sd	041000040106	40.582200	-84.392199
P01K05	South of Kossuth @ Barbara-Werner Road	87.80	135.00	F2,MQ,C,D,N,B	041000040205	40.640300	-84.354399
P01S09	North of St. Marys @ St. Rte. 116	80.51	166.00	F2,MQ,C5	041000040205	40.654400	-84.420299
P01S08	East of Mendon @ Gallman Road	75.07	184.00	F2,MQ,C5,D,N,B,Sn,Sd	041000040205	40.664700	-84.465599
302591	At Mendon @ Celina-Mendon Road	70.40	251.00	F2,MQ,C	041000040303	40.676827	-84.518683
303083	*Mendon WWTP outfall 001 to St. Marys River*	*70.25*	*251.30*	*C,B*	*041000040303*	*40.678052*	*-84.520401*
P01K04	North of Mercer @ US 127	65.70	261.00	F2,MQ,C	041000040303	40.681100	-84.580599
P01K03	East of Rockford @ Frysinger Road	61.50	279.00	F2,MQ,C,D,N,B	041000040303	40.690600	-84.612500
P01W07	*Rockford WWTP outfall 001 to St. Marys River*	*57.84*	*295.00*	*C,B*	*041000040303*	*40.695600*	*-84.645100*
P01W08	At St. Rte. 118	57.82	295.00	F2,MQ,C,D,N,B	041000040303	40.695400	-84.646400
P01K02	Downstream Rockford @ Townline Road	52.13	303.00	F2,MQ,C,D,N,B,Sn,Sd	041000040303	40.717800	-84.689400
P01K01	Southeast of Willshire @ Horner Road	47.48	309.00	F2,MQ,C	041000040303	40.734200	-84.737200
303088	St. Marys River adj. US 33 east of Willshire	45.60	366.68	F2,MQ,C,D,N	041000040305	40.735479	-84.762574
510170	At Willshire @ St. Rte. 81	43.48	386.00	F2,MQ,C,D,N,,Sn,Sd	041000040305	40.749400	-84.790299
303089	*Willshire WWTP outfall 001 to St. Marys River*	*43.12*	*388.23*	*C,B*	*041000040305*	*40.752260*	*-84.793800*
Muddy Creek (04-520-000) WWH*							
303062	Bay Road	5.40	9.33	F,Mq,C	041000040101	40.494644	-84.278557
303063	Washington Road	0.45	15.60	F,Mq,C,D,N,B	041000040101	40.540379	-84.299646
Center Branch (04-518-000) WWH*							
P01K28	At New Knoxville @ end of road near ponds	6.60	5.90	F,Mq,C	041000040102	40.491100	-84.321099
P01S07	Just upstream New Knoxville WWTP	5.20	12.40	F,Mq,C,D,N,B	041000040102	40.505300	-84.305600
303064	*New Knoxville WWTP outfall 001 to Center Branch*	*5.18*	*12.40*	*C,B*	*041000040102*	*40.506428*	*-84.304953*
P01S05	At Glynwood-New Knoxville Road	3.22	14.20	F,Mq,C,D,N,B	041000040102	40.521697	-84.316717
303024	At Plattner Pike	0.34	28.7	F2,MQ,C,D,N,B,Sn	041000040102	40.534027	-84.358237
Carter Creek (04-519-000) WWH*							
P01S03	West of New Knoxville @ St. Rte. 219	1.86	7.80	F,Mq,C	041000040102	40.495300	-84.349700
Clear Creek (04-517-000) WWH*							
303065	At Burr Oak Road	5.40	6.81	F,Mq,C	041000040103	40.518518	-84.250450
P01K27	East of St. Marys @ Bay Road	1.32	13.4	F,Mq,C,D,N,B	041000040103	40.547800	-84.278099
East Branch (04-500-006) Undesignated							
303025	East Branch @ St. Rte. 29	0.27	37.1	F2,MQ,C,D,N,B,Sn	041000040103	40.539323	-84.359130

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude
Kopp Creek (04-524-000) WWH							
500560	North of New Bremen @ Montezuma Road	8.88	4.60	F,Mq,C,B	041000040104	40.465800	-84.387800
500550	North of New Bremen @ lane off St. Rte. 66	7.62	13.8	F,Mq,C,D,N,B	041000040104	40.474400	-84.378100
500540	South of St. Marys @ St. Rte. 219	4.25	21.2	F2,MQ,C	041000040104	40.495972	-84.395849
P01K29	South of St. Marys @ St. Rte. 66	0.80	28.00	F2,MQ,C,D,N,B,Sn	041000040104	40.526100	-84.379700
Wierth Ditch (04-524-001) MWH							
303066	*New Bremen WWTP outfall 001 to Wierth Ditch*	*2.40*	*4.30*	*C,B*	*041000040104*	*40.442583*	*-84.379809*
500580	North of New Bremen @ St. Rte. 66	0.45	6.90	F,Mq,C,B	041000040104	40.468600	-84.377200
Unnamed Tributary to Kopp Creek @ RM 5.41 (04-524-002) WWH*							
500590	At Piqua-St. Marys Road	0.30	4.6	F,Mq,C	041000040104	40.480800	-84.397800
Miami-Erie Canal (04-500-999 and 04-500-004 (from Grand Lake)) MWH							
303070	Adjacent St. Rte. 66 @ Sixmile Creek aqueduct	17.00	n/a	C5,Sd	041000040105	40.626332	-84.346683
303092	Adj. Beech Rd. @ St. Marys River aqueduct	24.50	n/a	C5,Sd	041000040106	40.537778	-84.378213
302069	From Grand Lake, @ St. Marys, downstream St. Rte. 66	0.20	n/a	C5,Sd	041000040106	40.531994	-84.377038
Fourmile Creek (04-516-000) WWH*							
303071	At St. Marys River Road	0.10	5.56	F,Mq,C	041000040106	40.597197	-84.387133
Sixmile Creek (04-515-000) WWH*							
303068	At St. Marys-Kossuth Road	1.06	16.2	F,Mq,C,D,N,B	041000040105	40.619324	-84.342539
Prairie Creek (04-501-000) WWH*							
303078	At Eisley Road	2.75	6.7	F,Mq,C	041000040205	40.661666	-84.318082
P01K16	At St. Rte. 197	1.02	10.8	F,Mq,C,D,N,B	041000040205	40.651335	-84.343547
Hussey Creek (04-514-000) WWH*							
303072	At Salem-Noble Road	2.40	6.80	F,Mq,C	041000040201	40.626255	-84.427558
303073	At Hesse Road	0.10	11.30	F,Mq,C,D,N,B	041000040201	40.655022	-84.437122
Eightmile Creek (04-513-000) WWH*							
303074	At Davis Road	6.55	12.70	F,Mq,C	041000040202	40.618882	-84.486328
302592	Southeast of Mendon @ Mercer Road	1.22	21.80	F2,MQ,C,D,N,B,Sn	041000040202	40.655300	-84.485299
Twelvemile Creek (04-510-000) WWH*							
P01K19	Northwest of Celina @ Hoenie Road	11.01	11.60	F,Mq,C	041000040204	40.606700	-84.599700
P01K17	South of Mendon @ Celina-Mendon Road	2.31	35.9	F2,MQ	041000040204	40.655601	-84.510912
P01S01	Near Mendon @ Neptune-Mendon Rd.	0.70	37.50	C,D,N,B,Sn	041000040204	40.665600	-84.508300
Blierdofer Ditch (04-511-000) MWH							
303077	At Morrow Road	2.50	6.40	F,Mq,C	041000040203	40.596843	-84.556891
P01K21	North of Celina @ Oregon Road	1.70	10.50	F,Mq,C,D,N,B	041000040203	40.608300	-84.555600
Yankee Run (04-508-000) WWH*							
303084	At US 33	1.40	6.10	F,Mq,C	041000040303	40.668861	-84.608438

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude
Town Run (04-506-000) WWH*							
303356	At Frysinger Road	1.87	5.8	F,C,Sd	041000040303	40.7122	-84.609613
303085	At St. Rte. 117	1.25	7.10	F,Mq,C	041000040303	40.705059	-84.613882
Black Creek (04-503-000) MWH							
303081	At Strable Road	10.7	13.2	F,Mq,C	041000040302	40.640499	-84.756512
303082	At Winkler Road	2.50	25.00	F2,MQ,C,D,N,B	041000043024	40.713323	-84.734551
P01S02	Southeast of Willshire @ US 33	0.90	54.00	F2,MQ,C,D,N,B,Sn	041000040302	40.726400	-84.737799
Little Black Creek (04-504-000) WWH*							
303079	At St. Rte. 707	6.85	10.10	F,Mq,C	041000040301	40.654848	-84.693962
303389	At Wilson Road	3.95	17.3	F	041000040301	40.676889	-84.708064
303080	At Jordan Road	1.00	23.62	F2,MQ,C,D,N,B	041000040301	40.705829	-84.718230
Duck Creek (04-502-000) WWH*							
303086	At Settler Road	4.70	6.4	F,Mq,C	041000040304	40.694770	-84.794721
303087	Downstream County Line Road	1.05	15.6	F,Mq,C,D,N,B	041000040304	40.728118	-84.773742
Twentyseven Mile Creek (04-500-001) WWH*							
303090	At Clayton Road	4.10	14.00	F,Mq,C	041000040401	40.793588	-84.765754
P01K12	At OH/IN state line	1.20	28.20	F2,MQ,C,D,N,B,Sn	041000040401	40.778041	-84.801344
Unnamed Tributary to Twentyseven Mile Creek @ RM 3.1 (04-500-002) Undesignated							
303091	@ Wren-Landeck Rd.	0.40	7.40	F,Mq,C	041000040401	40.800842	-84.784911

*Unverified aquatic life use.

Key for Table 1 Sample Type column:

C	Chemistry site (6 rounds, base flow June - September), “Stream Survey” template
C5	Water column chemistry plus BOD5 site
N	Nutrient sites: water chemistry as listed above plus chlorophyll *a* and dissolved ortho P
B	*E. coli* bacteria assessment site (six rounds)
F	One-pass fish site
F2	Two-pass fish site (for reference sites and/or drainage area 20 sq. miles or greater)
Mq	Qualitative macroinvertebrate site
MQ	Hester-Dendy quantitative macroinvertebrate site
T	Fish tissue site
Sn	Sentinel Site: flow monitoring, chemistry April - October, plus 4 rounds water column organics (April – July)
D	Water quality sonde continuous data recorder site
Sd	Sediment sampling site

Study Area Description

Location and Scope

The St. Marys River starts east of the town of St. Marys where Center Branch and East Branch merge and then flows west into Indiana where it joins with the St. Joseph River at Ft. Wayne to form the Maumee River. A major Maumee River tributary, the St. Marys River drains 816.7 $miles^2$ of west-central Ohio and northeastern Indiana. The portion of the St. Marys River contained within Ohio constitutes just over 56 percent (458 $miles^2$) of the watershed. Here the river drains portions of Shelby, Auglaize, Mercer and Van Wert Counties. The St. Marys watershed drains 39.2 percent (201.7mi^2) of Mercer County, 26 percent (178 mi^2) of Auglaize County, 11.4 percent (121 mi^2) of Van Wert County and 5.9 percent (36.3 mi^2) of Shelby County. Between its headwaters and Ohio-Indiana state line, population centers within the study area are New Bremen, New Knoxville, St. Marys, Mendon, Rockford and Willshire. Predominant land uses in the watershed include forest and scrub (10.5 percent), cultivated crops (81.7 percent), pasture/hay production (5.7 percent) and developed [urban, suburban and industrial (1.5 percent) (Figure 3).

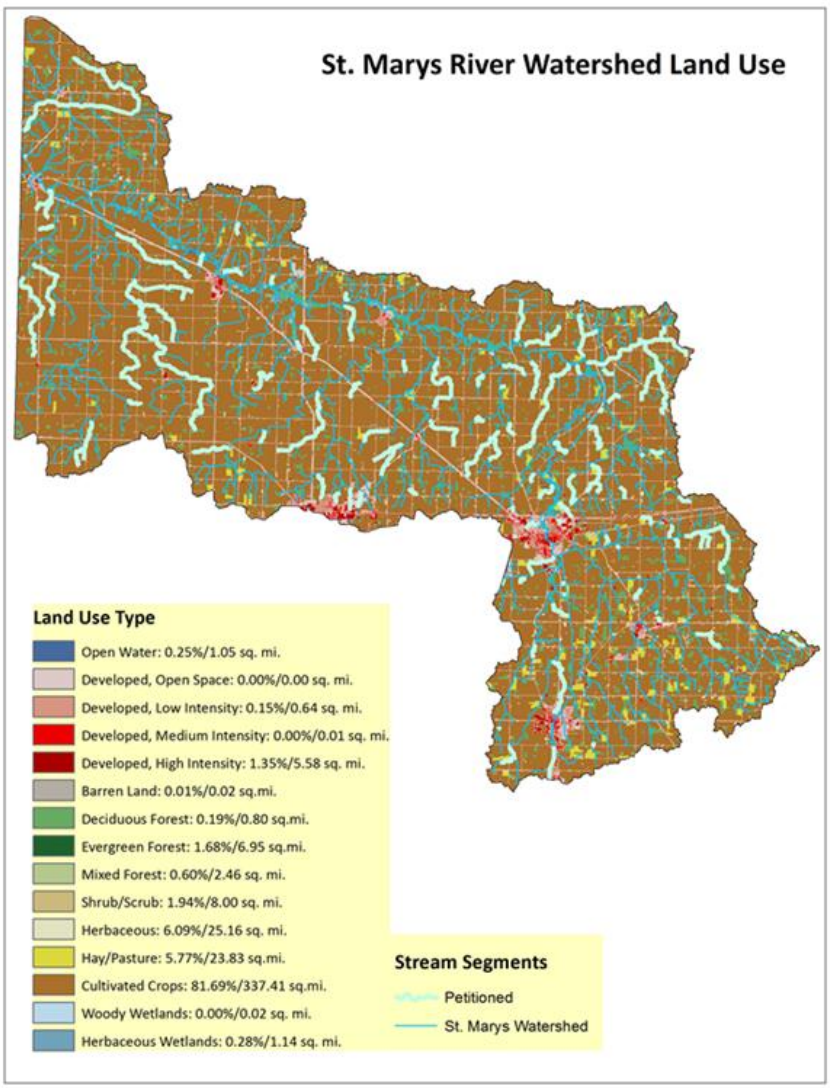

Figure 3 — Land use in the St. Marys River watershed, showing petitioned stream segments. Data courtesy of National Land Cover Dataset 2011 (Jin, et al. 2013) and Auglaize, Mercer, Shelby and Van Wert counties, Ohio.

Grand Lake St. Marys was built in the 1800s to supply water to a canal system that connected Lake Erie with the Ohio River. The lake now drains into Jennings Creek, a tributary of the Auglaize River, in Delphos, Ohio. However, the lake also feeds remnants of historic Miami-Erie Canal in the St. Marys watershed in Auglaize County. Canal aqueducts cross the St. Marys River mainstem and tributaries. The canals, controlled by Ohio Department of Natural Resources (ODNR), at times overflow from the aqueducts to the streams. The aqueducts were observed to be continuously flowing into the streams during the 2015 survey.

Beneficial Uses

Beneficial use designations assigned to the streams in the St. Marys River watershed include those for aquatic life, recreation and public water supply. The majority of the streams assessed in the St. Marys watershed have the current aquatic life use designation of WWH. Three streams - Black Creek, Blierdofer Ditch and Wierth Ditch - are designated as MWH.

These latter three streams were originally designated aquatic life uses in the 1978 Ohio Water Quality Standards. The techniques used then did not include standardized approaches to the collection of in-stream biological data or numerical biological criteria. This study used biological data to evaluate and update the aquatic life uses for these streams.

The current primary contact recreation (PCR) designations are Class A for the St. Marys River below the city of St. Marys and Class B for all other stream segments, except for Kopp Creek and Wierth Ditch which are designated as secondary contact recreation (SCR) waters. All designated streams in the St. Marys study area are designated as agricultural water supply (AWS) and industrial water supply (IWS). None of the streams are assigned public water supply (PWS).

Nonpoint Source Issues

The most common nonpoint sources negatively affecting water quality throughout the study area included fertilizer runoff, failing home sewage treatment systems, sedimentation from agricultural crop production, and urban storm water runoff. Agricultural practices may cause habitat and flow alteration impairments in headwater and small tributary streams. These practices include channelization and routine maintenance of streams and ditches and the drainage of farm fields through subsurface tiles.

Drainage alterations were also found where floodplains and wetlands were crossed by numerous highways and railroads, as well as in urban areas where development has encroached or filled in natural wetlands and floodplains. All of the counties in the study area have programs for drainage maintenance (ODAG 2008). Unsewered communities that exist in the watershed contribute to recreational use impairment due to the lack of centralized wastewater collection and treatment.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (for example, NPDES permits, Director's Orders, or the Ohio Water Quality Standards [OAC 3745-1] and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, Total Maximum Daily Loads (TMDLs) and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

Physiography and Ecoregions

The relationship between surface water quality and the landscape is best comprehended as the nexus between land use and stream physiography, as the first often dictates the latter. Being the dominant land use within the St. Marys River basin and the economic base of the region, agriculture has and continues to make significant demands upon landscape and associated surface waters. Key among these is drainage. Given the general low relief and poor natural drainage, much of the St. Marys watershed has been subjected to significant hydromodification beginning in mid-19th century, so as to bring land under cultivation, improve habitability, facilitate transportation and promote public health. Although full documentation of historical drainage improvements was not readily available and well beyond the scope of this report, multiple contemporary and historical sources attest to both the poor drainage common to much of the study area at the time of settlement and the substantial socioeconomic benefits realized following wide-spread drainage improvements (Sutton 1880, Slocum 1905, Scranton 1907, Trautman 1981, USDA 1979 and USDA 1981). In many important ways the degree and extent of hydromodification and its physiographic antecedents are the most consequential variables supporting the assessment of the competency of riverine habitats within the study area to support aquatic communities consistent with state and federal water quality goals.

Like all major Maumee River tributaries, the St. Marys River basin is defined by Wisconsin age glacial and associated post glacial features. The geology of the study area is dominated by the Teays River bedrock valley, deeply buried with unconsolidated deposits and without surface expression (GSA 1991). Remnants of the pre-glacial Teays River are carved into the bedrock of Auglaize and Mercer Counties. A 400-foot valley of the Teays is buried under Grand Lake St. Marys. Derived from the advance and retreat of the Erie ice lobe, the Fort Wayne, Wabash and St. John end moraines delimit all or portions of the northern and southern boundaries of the watershed (Figure 4). Originating in western Auglaize and northwestern Shelby counties, the St. Marys River collects its headwaters from the dissected north and south faces of the St. Johns and the Wabash moraines, respectively. Once off the moraines, these small waters gather drainage and course through the nearly level intermorainal till, eventually coalescing to form the principal headwaters of the St. Marys: Kopp Creek; East Branch; and Center Branch. Formed by the confluence of the East and Center Branches, the mainstem proceeds north after receiving Kopp Creek through the city of St. Marys and in so doing breaches the Wabash end moraine. From there the river continues north through the intermorainal till of northwestern Auglaize County. Upon meeting the Ft. Wayne moraine, the northerly course of the St. Marys River is abruptly diverted northwest and continues in that direction following closely the southern face of the moraine through north-central Mercer and southwestern Van Wert counties. Through its middle and lower reaches, nearly every St. Marys River tributary of consequence originates from the south, off the opposing face of the Wabash end moraine, flowing downgrade through low relief till before joining the mainstem. Exceptions to this include Town Run and Twentyseven Mile Creek. The St. Marys exits Ohio just west of the Village of Willshire in southern Van Wert County. Upon entering Indiana, the river flows an additional 42 miles until joining the St. Joseph River at the city of Ft. Wayne to form the Maumee River.

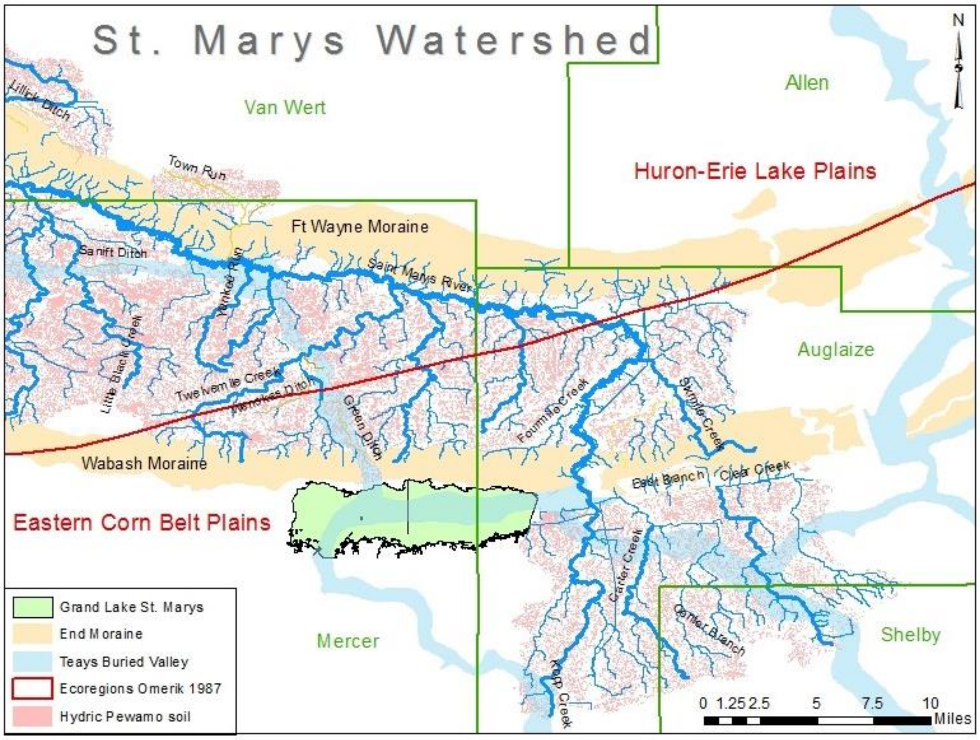

Figure 4 — Glacial features of the St. Marys River watershed.

Draining two of Ohio's five ecoregions, the St. Marys River is a trans-boundary system. The upper third of the watershed is contained within the Eastern Corn Belt Plains (ECBP) and remaining lower two-thirds are located within the Huron-Erie Lake Plain (HELP) (Omernik 1987, Omernick and Gallent 1988). In general terms, the ECBP is characterized by flat to gently rolling topography, primarily represented by ground moraine, with areas of higher relief defined by dissected end moraine, kames, outwash terraces and related landforms of glacial origin. Soils here are primarily derived from high lime glacial drift. Natural drainage can vary significantly, but soils are typically well- to moderately well-drained. The degree of hydromodification within the ECBP required to meet social or economic needs varies greatly, based upon subregional or local factors; however, in general the combination of naturally adequate drainage and moderate relief tends to obviate the need for extensive hydrological manipulation. This of course is not universal, and as stated previously, local or subregional conditions may necessitate drainage or other hydrological modification greater than commonly needed or observed throughout the region as a whole.

By comparison, the HELP ecoregion is characterized by a broad and nearly level lake plain, giving way to extensive lacustrine deposits of laminated clays and related still-water deposits in the heart of the region (Pavey et al. 1999, Omernik 1987, Omernick and Gallent 1988). Local relief is very low, with relic beach ridges providing nominal elevation above the plain. Soils are poorly drained, derived mainly from a mix of lacustrine deposits (clayey silts and sand) and lake-planed moraine.

Repeated glaciations have made this watershed flat as glacial till and repeated outwash depositions filled the valley. As the glacier left Ohio, meltwater formed Lake Maumee. This supersized precursor to Lake Erie defines the HELP, the ecoregion of the northern part of the watershed. The HELP ecoregion morphs into the ECBP ecoregion in the southern part of the watershed, as hydric Pewamo soils become less prominent (Table 3).

Table 3 — Hydric soils are the dominant soil type in the HELP and become less dominant in the ECBP ecoregion.

County	Percent hydric component of watershed	Predominant hydric soil
Van Wert	76.6%	89% Pewamo Silty Clay Loam
Mercer	87%	87% Pewamo Silty Clay Loam
Auglaize	33.6%	86% Pewamo Silty Clay Loam
Shelby	38%	98% Pewamo Silty Clay Loam

Given the low relief and the dominance of clayey soils, stream gradients are typically very low and adjacent uplands are naturally poorly drained. The remnants of Lake Maumee became the Great Black Swamp, known for its knee-deep mud and disease. This area was one of the last areas to be settled in Ohio until immigrants experienced with farming low lands and drainage technology began to drain the swamp. To facilitate human habitation, agriculture and other economic land uses, extensive drainage activities were undertaken within this region as early as the 1850s (ditching, dredging, field tiling, etc.).

In 1859, Ohio began to pass laws encouraging ditch digging to drain wetlands. The state legislature gave authority to boards of county commissioners to construct drainage improvements for groups of land owners. Landowners who needed improved drainage were required to petition commissioners in their county (ODAG 2008). Today a vast system of drainage tiles and ditches has made good farm land. More than 80 percent of the watershed is agricultural with 150 miles of petition ditches (Figure 4).

Over the following 160 years, nearly 70 percent of the stream networks draining the HELP have been, to varying degrees, directly channelized or otherwise hydrologically modified to receive and efficiently convey surface and subsurface drainage. The scale, pervasive nature and maintenance of these drainage improvements, coupled with prevalence of clayey soils and low stream power have rendered many of the associated waterways permanently debilitated in terms of riverine macrohabitat and associated ambient biological potential. In recognition of the innate physical limitations of the HELP ecoregion and the corresponding absence of least impacted wading and headwater reference conditions, biocriteria for the HELP ecoregion were derived from upper 10^{th} percentile reference data (Ohio EPA 1987b), to account for the overall lower biological potential of this region.

The above descriptions of the ECBP and HELP ecoregions are generalized and do not necessarily capture or adequately describe the conditions within the St. Marys watershed. Although the basin does physically encompass portions of both the ECBP and HELP ecoregions, much of the mainstem and its tributaries lie on or near the boundaries or are contained within the least typical or least representative portions of these regions. As a result, otherwise well-documented distinctions between the two regions regarding land form, land use, drainage, stream characteristics and associated ambient biological potential or demonstrated performance are not necessarily as sharp as they would otherwise be in the heart of ECBP or HELP. In fact, much of the watershed may be credibly viewed as being transitional in nature.

The extent of the HELP ecoregion within the St. Marys River study area is not strictly limited to Lake Plain province, but instead includes a significant portion of the adjacent glaciated Till Plains (Pavey et al. 1999), a physiography more commonly associated with the ECBP. The area of tills contained within the HELP extends from the relic beach ridges that demark the maximum extent of Lake Plain proper, south, into the St. Marys watershed, terminating at the Wabash moraine in west-central Mercer County, capturing a portion of the Central Ohio Clayey Till Plains subregion (Ohio DNR 1998). Soils here are generally fine, derived from Wisconsin-aged till and lacustrine deposits over carbonate bedrock. Relief is moderate to low, and at times locally very low. Elm-Ash swamp forest were originally well-represented in this area, concentrated mainly in present-day north-central Mercer county (Gordon 1966 and 1969), indicating prevalence of naturally hydric or otherwise poorly drained conditions. Outside of the morainal areas, this has necessitated extensive hydromodification of the uplands, drainages and associated waterways.

Similarly, the portion of the study area within the ECBP is not typical or otherwise representative of that region as a whole. Owing to its transitional nature, non-trivial portions of the watershed draining the ECBP contain significant post-glacial lacustrine features similar to, albeit not as well defined or pervasive as those of the HELP. Grand Lake St. Marys is a prime example of lake-plain type deposits within the ECBP. Pre-settlement vegetation of the site consisted of a mix of poorly drained wet prairie/marshlands and Elm-Ash swamp forests, these obviously predated by post glacial lacustrine deposits (Gordon 1966 and 1969). A review of the physiography and phytogeography of the study area identified other important examples of lacustrine deposits. Pockets of Elm-Ash swamp forest were dispersed within the headwaters of the St. Marys (East Branch and Center Branch), representing large areas of poorly drained, clayey soils. Likewise, the entire length of Prairie Creek and several miles of the St. Marys floodplain downstream from Prairie Creek are contained within a 14-mile swath of poorly drained lake-planed clayey till. Due to these and other factors, major soil associations of the lowlands are by and large moderately to poorly drained, with local areas waterlogged, hydric or otherwise regularly saturated. Together these conditions have necessitated extensive drainage improvements and other hydrological modification greater than commonly needed or observed throughout the ECBP at the state level. Furthermore, in many instances the frequency of hydromodification observed for the section of the ECBP within the study area was similar to that of the tributaries well within the HELP. The result of this is that in terms of channel form and ambient biological potential, many of these streams are functionally akin to those of the HELP, this being particularly true of those transitional waters at or near the ecoregion boundary.

Based upon a strict or narrow interpretations of ecoregion boundaries, the upper 16 miles of the St. Marys River mainstem, from its origin to approximately RM 85.0, is located within the ECBP. However, the lower seven miles of this segment, between RMs 92.0 and 85.0, are transitional in nature. The remaining lower 43 miles of the mainstem are contained within the HELP. A similar examination placed 14 direct or indirect St. Marys River tributaries within the ECBP, and 13 tributaries within the HELP. As with the mainstem, a number of streams or stream reaches are within the transitional area or otherwise very near the ecoregion boundary.

Although distinct biological conditions between ecoregions is well documented in Ohio (Whittier et al. 1987), the boundaries are not precise, and therefore do not necessarily represent abrupt changes in landform, biological potential or ambient biological performance. In recognition of this, Ohio EPA (1987b) provides guidance regarding the determination of the appropriate ecoregion for boundary waters or sites that lie near the ecoregion boundary and are on or in a trans-boundary system. Soils, drainage, upland slope, stream gradient, riparian vegetation, in-stream macrohabitat and biological performance are among the factors to be considered in selecting the appropriate ecoregion for transitional waters or monitoring stations described as such. These factors are aligned with transitional waters of the study area and are summarized in Figure 5 and Table 4, Table 5 and Table 6. Based upon a review and analysis of these factors, the following waters were found to be more closely affiliated with sites well within the HELP and are recommended to be classified as such: lower Sixmile Creek; Prairie Creek; Hussey Creek; upper Eightmile Creek; Blierdofer Ditch (tributary to Twelvemile Creek); and the St. Marys River at RM 87.9.

Table 4 — Landscape factors of transitional monitoring site or streams, within the St. Marys River basin.

St. Marys River	Soils: Defiance silty clay, frequently flooded
RMs 89.42-87.9	Slope Gradient: Dominant Component 1
Grade: 1.0 ft./mile	Drainage Class: Somewhat poorly drained
	Hydric Classification: Not hydric
	Quart. Geo: Holocene aged alluvium and alluvial terraces, deposited in present and former floodplains; ranges from silty clay in areas of fine-grained deposits to coarse sand, gravel or cobbles in areas of shallow bedrock.
Sixmile Creek	Soils: Shoals silt loam, occasionally flooded
RM 1.06	Slope Gradient: Dominant Component 1
Grade: 4.1 ft./mile	Drainage Class: Somewhat poorly drained
	Hydric Classification: Partially hydric (5%)
	Quart. Geo.: Late Wisconsin-aged ground moraine, flat to gently undulating.
Hussy Creek	Soils: Sloan silty clay loam
RM 2.4	Slope Gradient: Dominant Component 1
Grade: 8.5 ft./mile	Drainage Class: Very poorly drained
	Hydric Classification: All hydric (100%)
	Quart. Geo.: Late Wisconsin-aged ground moraine, flat to gently undulating.
	Soils: Millgrove clay loam
Prairie Creek	Slope Gradient: Dominant Component 1
RM 2.75	Drainage Class: Very poorly drained
Grade: 3.5 ft./mile	Hydric Classification: Partially hydric (90%)
	Quart. Geo: Late Wisconsin-aged Lake-planed moraine, very flat, planed by waves in glacial lakes; small patches of sand, silt or clay on the surface in many areas.
Prairie Creek	Soils: Defiance silty clay, frequently flooded
RM 1.02	Slope Gradient: Dominant Component 1
Grade: 1.4 ft./mile	Drainage Class: Somewhat poorly drained
	Hydric Classification: Not hydric
	Quart. Geo: Late Wisconsin-aged Lake-planed moraine, very flat, planed by waves in glacial lakes; small patches of sand, silt or clay on the surface in many areas.
Eightmile Creek	Soils: Sloan silty clay loam
RM 6.6	Slope Gradient: Dominant Component 1
Grade: 0.5 ft./mile	Drainage Class: Very poorly drained
	Hydric Classification: All hydric (100%)
	Quart. Geo.: Late Wisconsin-aged ground moraine, flat to gently undulating.
Blierdorfer Ditch	Soils: Montgomery silty clay
RMs 2.5-1.7	Slope Gradient: Dominant Component 1
Grade: 5.1-4.7 ft./mile	Drainage Class: Very poorly drained
	Hydric Classification: All hydric (100%)
	Quart. Geo.: Late Wisconsin-aged ground moraine, flat to gently undulating.

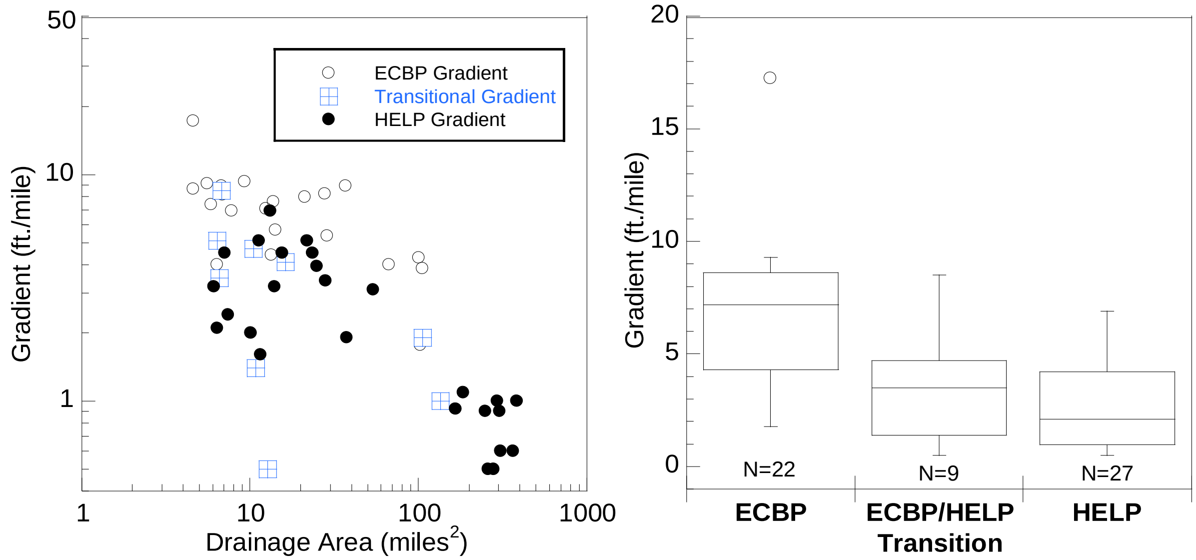

Figure 5 — Gradient scatter and box plots from St. Marys basin by ecoregion. Note similarity between transitional streams and HELP streams.

Table 5 — Nonparametric comparison of site gradients between ECBP, HELP and transitional areas (Wilcoxon-Mann-Whitney Rank Sum), St. Marys River basin.

	Group 1: ECBP Gradient Group 2: Trans. Gradient		Group 1: Trans. Gradient Group 2: HELP Gradient		Group 1: ECBP Gradient Group 2: HELP Gradient	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Count	22	9	9	27	22	27
Median	7.195	3.5	3.5	2.1	7.195	2.1
Median Difference	3.695		1.4		5.095	
Sum of Group 1 ranks	414		190.5		785.5	
Sum of Group 2 ranks	82		475.5		439.5	
Group1 U	161		145.5		532.5	
Group2 U	37		97.5		61.5	
P Value	0.007411		0.3898		<0.0001	

At p<0.05, note significant differences between ECBP and transitional sites, nonsignificant difference between transitional and HELP sites and significant difference between HELP and ECBP site.

Table 6 — Transitional sites between the ECBP and HELP ecoregions within the St. Marys River basin.

Code	Name	River Code	RM	Ecoregion
P01S10	St. Marys Salem-Noble Rd.[1]	04-500-000	89.42	ECBP to HELP
P01K05	St. Marys R. S of Kossuth @ Barber-Werner Rd.	04-500-000	87.8	ECBP to HELP
303068	Sixmile Creek @ St. Marys-Kossuth Rd.	04-515-000	1.06	ECBP to HELP
303078	Prairie Creek @ Eisley Rd.	04-501-000	2.75	ECBP to HELP
P01K16	Prairie Creek S of Kossuth @ St. Rte. 197	04-501-000	1.02	ECBP to HELP
303072	Hussey Creek @ Salem-Noble Rd.[2]	04-514-000	2.4	HELP
303074	Eightmile Creek @ Davis Rd.	04-513-000	6.55	ECBP to HELP
303077	Blierdofer Ditch @ Morrow Rd.	04-511-000	2.5	ECBP to HELP
P01K21	Blierdofer Ditch N of Celina @ Oregon Rd.	04-511-000	1.7	ECBP to HELP

1 St. Marys River, RM 89.42, chemical monitoring only in 2015, but bioassessment performed at this location in 1991, thus this site was included in gradient analysis.

2 Hussy Creek assigned to the HELP prior to the 2015 survey but was included in transitional analysis of 2015 data because of its proximity to other transitional waters.

Drainage Maintenance

Presently, about 20 percent of the linear stream miles that together constitutes the Ohio portion of the St. Marys River watershed are actively maintained as open drainage ways by county authorities (based on personal communication with the offices of Auglaize, Mercer and Van Wert county engineer). County maintenance efforts are largely limited to small headwaters, reaches generally draining less than five square miles, but selected larger streams are actively maintained as well. Streams so affected include all or portions of mainstem and/or selected tributaries of the following waterbodies: Clear Creek (East Branch tributary); upper Muddy Creek (East Branch tributary); Wierth Ditch (Kopp Creek tributary); Prairie Creek (entire length); upper Hussy Creek; Eightmile Creek; upper Twelvemile Creek; Black Creek; upper Little Black Creek; upper Duck Creek; Twentyseven Mile Creek (entire length); and numerous minor direct tributaries to the St. Marys River. Monitoring efforts on these actively maintained surface waters included nine sites on five streams: Clear Creek (RMs 5.4 and 1.3); Prairie Creek (RMs 2.8 and 1.0); Little Black Creek (RMs 10.1 and 3.95); Duck Creek (RM 4.7); and Twentyseven Mile Creek (RMs 4.1 and 1.2).

It is important to note that the 20 percent maintenance figure cited above does not include all historically channelized waters or drainages that are currently maintained through private efforts. In fact, excluding most of the St. Marys River mainstem, the channels of nearly all St. Marys River tributaries assessed as part of the 2015 survey appeared artificial, incised or otherwise modified at some point in the past. Although the age and extent modification and the degree of recovery varied significantly, it was clear that much of the tributary network within the study area has been physically altered to receive and convey surface and subsurface drainage.

Evidence of systematic channel modification on the St. Marys River mainstem appeared limited to the upper three to four miles, from its source through the city of St. Marys. Although not definitive, observations from monitoring sites on the middle and lower river did not offer evidence of widespread or systematic channelization, dredging or ditching, and instead found most of the meandering course of the St. Marys largely in a natural state, at least in terms of channel form.

NPDES-Permitted Facilities

A total of 20 National Pollutant Discharge Elimination System (NPDES)-permitted facilities discharge sanitary wastewater, industrial process water and/or industrial storm water into the St. Marys River watershed (04100004) within Auglaize, Mercer, Shelby and Van Wert Counties. Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in their NPDES permit and report results to Ohio EPA in a discharge monitoring report (DMR). Individual NPDES permits in the St. Marys River watershed are listed in Table 7. The city of St. Marys is considered a major discharger based on the volume (>1 MGD) and type of waste they discharge. All other individual NPDES-permitted facilities in the watershed are considered minor dischargers. Minor dischargers include eight activated sludge sewage treatment plants, four sewage lagoons, four package plants and two industrial storm water discharges.

General NPDES permits are a potential alternative for facilities that have a minimal effect on the environment, have similar operations and meet certain eligibility criteria. There are several different types of general permits, including, but not limited to, small sanitary sewer discharges, petroleum bulk storage and non-contact cooling water. A list of facilities covered under each type may be found at ***epa.ohio.gov/dsw/permits/NonStormgplist***. There are also several types of general permits specific to storm water, including, but not limited to, small MS4s, construction sites, industries and marinas. A list of facilities covered under each type may be found at ***epa.ohio.gov/dsw/permits/gplist***.

Table 7 — Facilities regulated by an individual NPDES permit for the St. Marys River Watershed Assessment Unit (04100004).

Permit No	Facility Name	Design Discharge (MGD)	Wastewater Type and Treatment System	Stream and RM at Discharge	County
041000040102 – Center Branch					
2IN00164	Thieman Stamping Company	0.002	Process Water/Sanitary Waste	Carter Creek (~4.7)	Auglaize
1PR00034	The Way International	0.05	Extended Aeration Package Plant	Center Branch (8.0)	Shelby
2PA00059	New Knoxville STP	0.35	Controlled Discharge Lagoon	Center Branch (5.18)	Auglaize
2PG00093	Sharlon Subdiv	0.0075	Extended Aeration Package Plant	Center Branch (2.3)	Auglaize
041000040103 – East Branch					
2PG00092	Pleasantview Estates Subdiv	0.02	Extended Aeration Package Plant	East Branch (0.9 from UT)	Auglaize
2PP00026	ODOT Rest Area 7-33	0.01	Extended Aeration Package Plant	RM 1.68 via UT via field tile	Auglaize
041000040104 – Kopp Creek					
2PB00034	New Bremen WWTP	0.9	Continuous Discharge Lagoon	Wierth Ditch (2.40)	Auglaize
2PG00105	Forest Lane Subdiv	0.01	Extended Aeration Package Plant	Wierth Ditch (1.25)	Auglaize
2IW00240	Saint Marys WTP		Softener/Filter Backwash Water	Armstrong Ditch (2.5)	Auglaize
041000040105 – Sixmile Creek					
2PR00178	Easy Campgrounds	0.00675	Package Plant	UT (3.1) to Ankerman Creek (0.9)	Auglaize
041000040106 – Fourmile Creek – St. Marys River					
2PD00026	Saint Marys STP	3	Oxidation Ditch	St. Marys River (98.60)	Auglaize
2IJ00082	CON-AG Inc	0.6697	Storm Water/Process Water	St. Marys River (~93.98)	Auglaize
041000040204 – Twelvemile Creek					
2PG00120	Country Time Subdiv WWTP	0.008	Extended Aeration Package Plant	Twelvemile Creek (8.5)	Mercer
041000040303 – Yankee Run – St. Marys River					
2PA00058	Mendon WWTP	0.1	Controlled Discharge Lagoon	St. Marys River (69.54)	Mercer
2IN00183	BP Amoco Oil Corp Bulk Plant Rockford		Storm Water/Process Water	St. Marys River (~58.65)	Mercer
2PG00119	Deerfield Subdiv WWTP	0.1	Extended Aeration Package Plant	St. Marys River (63.0)	Mercer
2PD00001	Rockford STP	0.25	Continuous Discharge Lagoon	St. Marys River (57.84)	Mercer
2IJ00041	Stoneco Rockford Quarry (Shelly Materials)	4.8	GW Removal/Storm Water/Wash Water	St. Marys River (54.5)	Mercer
041000040305 – Town of Willshire – St. Marys River					
2PA00013	Willshire WWTP	0.0665	Activated Sludge – Extended Aeration Package Plant	St. Marys River (43.15)	Van Wert
2IZ00132	Willshire WTP		Filter and RO Backwash Water	Bowen Ditch (to St. Marys R. at 43.2)	Van Wert

Facilities listed in Table 7 that potentially impact biological and water quality results in the study area because of their size or performance are discussed in detail below.

City of St. Marys STP (Ohio EPA Permit # 2PD00026)

The city of St. Marys STP serves approximately 12,675 residents in the city of St. Marys and St. Marys Township. Sewer services for the city are provided by a municipal sanitary sewer wastewater treatment plant with an average daily design flow of 3.0 MGD. Sanitary waste from the village receives treatment through fine screening, grit removal, oxidation ditch, ferrous chloride addition for phosphorus removal, secondary clarification and ultraviolet disinfection. When influent flow exceeds 9.0 MG, wastewater is diverted to a 2.7 MG equalization (EQ) basin. The final treated effluent is discharged to the St. Marys River.

The sanitary sewer collection system for the city is made up of 100 percent separate sanitary sewers, however, sanitary sewer overflows directly to the St. Marys River (RM 98.60) occur during excessive flows in the system. A bypass exists that discharges to an equalization basin during high flow events. When the EQ basin becomes full, untreated wastewater is bypassed directly to the St. Marys River. During the sampling period for the stream survey, one bypass occurred from June 15-18, 2015 totaling 10 MG. Estimated inflow and infiltration rate to the system is 0.1 MGD.

Ohio EPA most recently conducted a compliance sampling inspection and bioassay at the St. Marys STP on May 5-6, 2014. The effluent from outfall 002 was not acutely toxic to *Pimephales promelas* or *Ceriodaphnia dubia*. Compliance history for the plant during the sampling period showed the facility obtained a 30-day concentration *E. coli* violation for the month of May 2015 and a 30-day limit violation for mercury for the month of July 2015. Facility staff considered these isolated violations since there were no similar issues at any other point in 2015. Ohio EPA staff concurred.

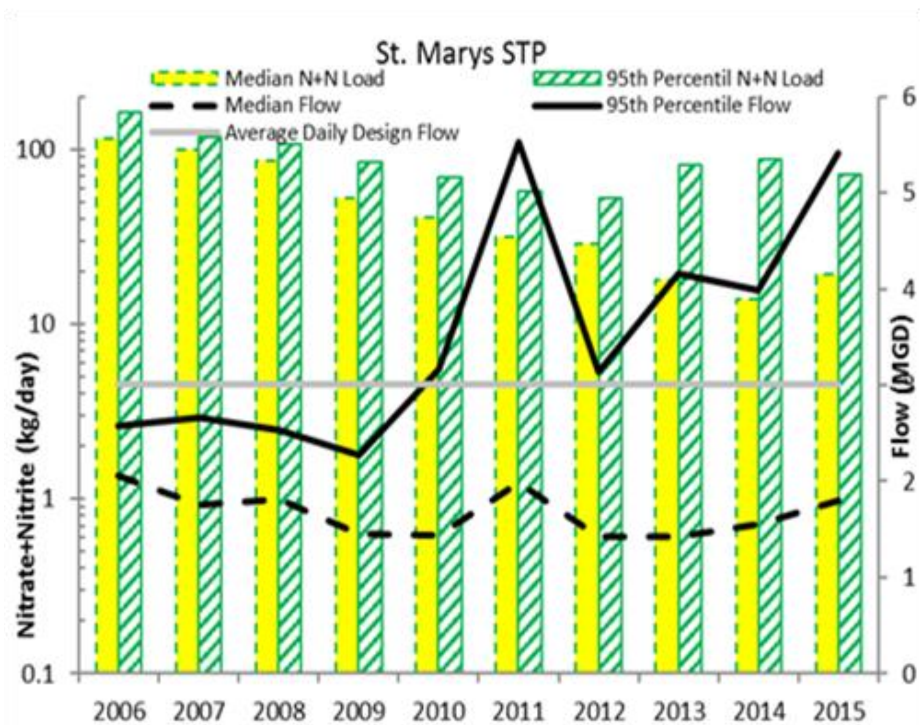

Figure 6 — Annual nitrate+nitrite loadings for the St. Marys STP from 2006-2015.

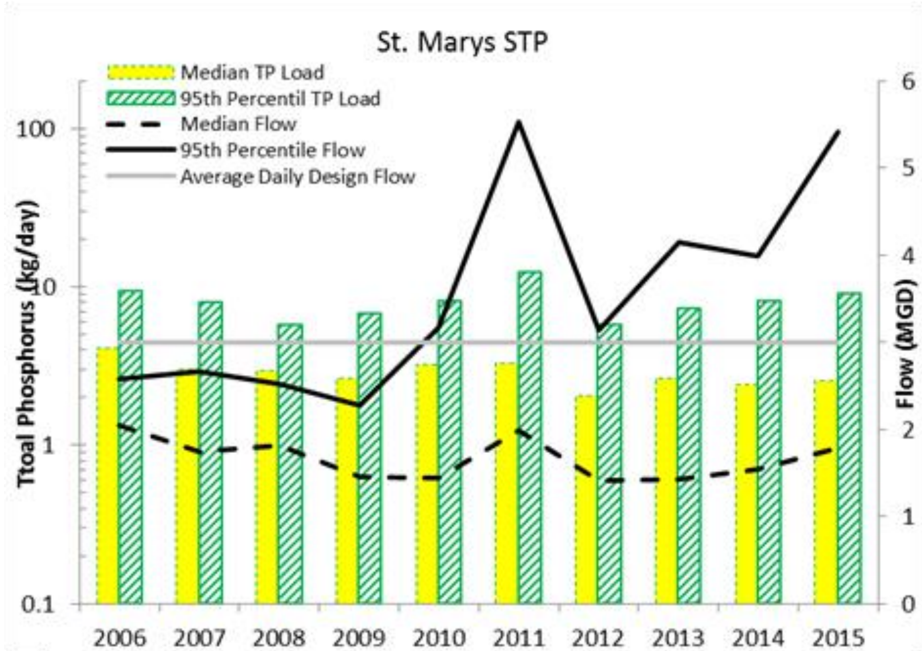

Figure 7 — Annual total phosphorus loadings for the St. Marys STP from 2006-2015.

Pollutant loadings from the city of St. Marys STP from 2006 through 2015 were evaluated and annual statistics for nitrate+nitrate-N and total phosphorus are depicted in Figure 6 and Figure 7. The plant discharged at a slightly increasing 95th percentile flow during the past 10 years. The annual nitrate+nitrite-N loadings have remained fairly steady, however, annual average discharge concentrations are high. 95th percentile phosphorus loads have remained steady over the past 10 years with an overall decrease in the median load for the past four years.

Village of New Knoxville STP (Ohio EPA Permit # 2PA00059)

The village of New Knoxville STP serves approximately 891 residents. Sewer services for the village are provided by a municipal sanitary sewage treatment plant with an average daily design flow of 0.35 MGD. The municipal wastewater treatment plant consists of a stabilization pond and total containment pond. Effluent discharges to the Center Branch at RM 5.18.

The sanitary sewer collection system for the village is made up of 100 percent separate sanitary sewers. During the sampling period (March through October) the facility had permit limit violations for pH, dissolved oxygen, oil and grease and total mercury. Permit violations are summarized in Table 8. Dissolved oxygen and pH permit limit violations have occurred more frequently since flow through the plant was low in 2012 and gradually started to increase starting in 2013.

Table 8 — New Knoxville STP permit limit compliance.

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
2PA00059*MD	April 2015	001	pH	1D Conc	9.0	9.01	4/28/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.19	6/30/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.32	6/29/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.39	6/26/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.31	6/25/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.4	6/24/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.22	6/23/2015
2PA00059*MD	June 2015	001	pH	1D Conc	9.0	9.06	6/22/2015
2PA00059*MD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.34	8/12/2015
2PA00059*MD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.1	8/11/2015
2PA00059*MD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.03	8/10/2015
2PA00059*MD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.83	8/7/2015
2PA00059*MD	August 2015	001	Oil and Grease	1D Conc	10	57.5	8/5/2015
2PA00059*MD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.8	8/3/2015
2PA00059*MD	August 2015	001	Mercury, Total (Low Level)	30D Conc	9.6	88.1	8/1/2015

Effluent was released from the controlled discharge lagoons to the Center Branch in April, June 22-30, August 3-13 and October 15-31, 2015.

The facility continued to report multiple pH and DO limit violations in 2016 and, through further investigation, facility staff determined the cause to be a faulty multi-meter. Since acquiring a new multi-meter, New Knoxville has not reported any violations for pH or DO.

Village of Rockford STP (Ohio EPA Permit # 2PD00001)

The village of Rockford sewage treatment plant provides sanitary wastewater treatment to approximately 1,119 people. The municipal wastewater treatment plant consists of continuous discharge lagoons including aeration with an average daily design flow of 0.25 MGD. The village's sanitary waste is 100 percent separated and discharges into the St. Marys River at RM 57.84.

The Rockford STP had permit limit violations for dissolved oxygen, CBOD 5, total suspended solids and pH during the sampling period (March through October). These permit limit exceedances are documented in Table 9. Dissolved oxygen permit limit violations have been a consistent issue for the facility since 2009.

Table 9 — Rockford STP permit limit compliance.

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
2PD00001*GD	May 2015	001	Dissolved Oxygen	1D Conc	5.0	3.7	5/28/2015
2PD00001*GD	May 2015	001	Dissolved Oxygen	1D Conc	5.0	4.1	5/12/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	4.1	6/29/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	4.9	6/23/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	3.1	6/22/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	2.6	6/19/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	2.2	6/18/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	2.3	6/17/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	4.8	6/16/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	4.8	6/15/2015
2PD00001*GD	June 2015	001	CBOD 5 day	7D Qty	38	43.149	6/15/2015
2PD00001*GD	June 2015	001	TSS	7D Qty	85	115.064	6/15/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	2.9	6/12/2015

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
2PD00001*GD	June 2015	001	pH	1D Conc	6.5	6.4	6/12/2015
2PD00001*GD	June 2015	001	Dissolved Oxygen	1D Conc	5.0	4.2	6/11/2015
2PD00001*GD	July 2015	001	Dissolved Oxygen	1D Conc	5.0	4.3	7/22/2015
2PD00001*GD	July 2015	001	Dissolved Oxygen	1D Conc	5.0	4.3	7/17/2015
2PD00001*GD	July 2015	001	Dissolved Oxygen	1D Conc	5.0	4.1	7/1/2015
2PD00001*GD	July 2015	001	TSS	7D Qty	85	104.163	7/1/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.9	8/26/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.5	8/25/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.7	8/24/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.3	8/21/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.	8/20/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.	8/19/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.9	8/18/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	3.4	8/17/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.4	8/13/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.5	8/7/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.2	8/6/2015
2PD00001*GD	August 2015	001	Dissolved Oxygen	1D Conc	5.0	4.6	8/3/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.7	9/30/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	2.3	9/29/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	4.6	9/28/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	4.9	9/24/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	4.3	9/23/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	4.8	9/18/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.1	9/17/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	2.6	9/16/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.1	9/14/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	2.5	9/11/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.7	9/9/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.	9/8/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.5	9/4/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	3.8	9/3/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	4.1	9/2/2015
2PD00001*GD	Sept 2015	001	Dissolved Oxygen	1D Conc	5.0	2.2	9/1/2015

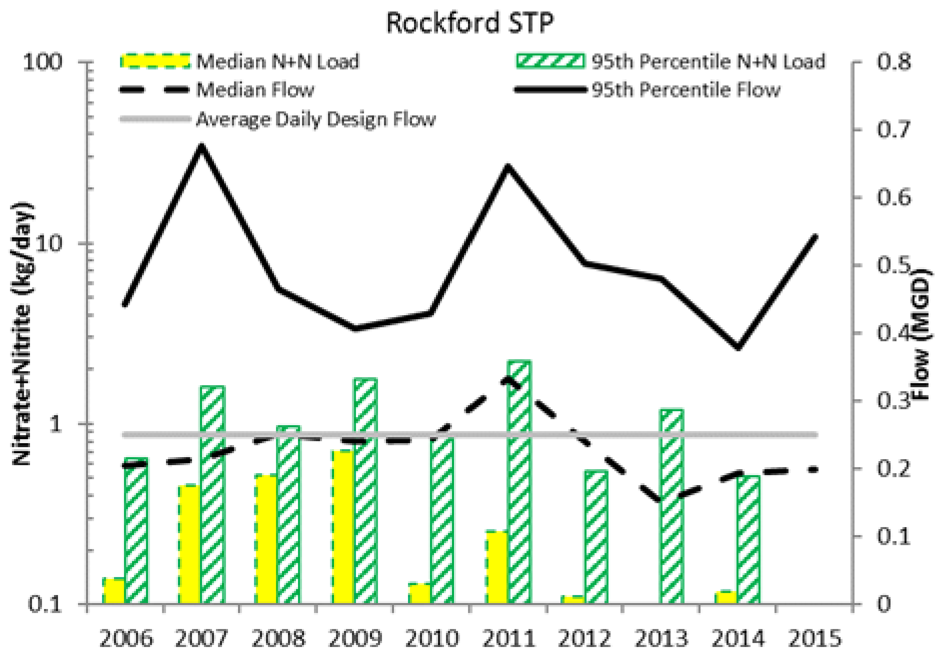

Figure 8 — Annual nitrate+nitrite loadings for the Rockford STP from 2006-2015.

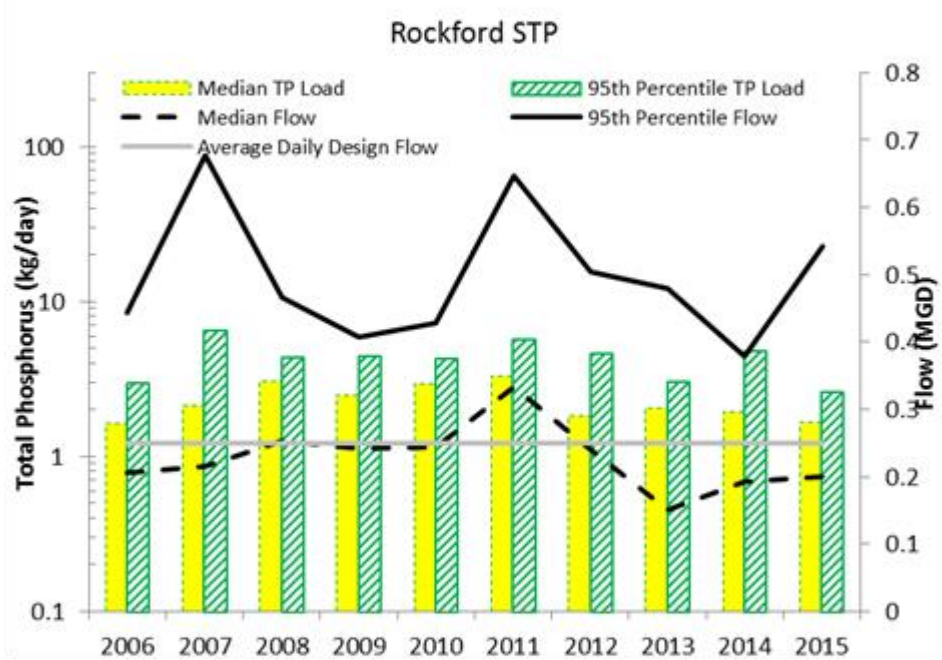

Figure 9 — Annual total phosphorus loadings for the Rockford STP from 2006-2015.

Pollutant loadings from the Village of Rockford STP between 2006 and 2015 were evaluated and annual statistics for nitrate+nitrate-N and total phosphorus loadings are displayed in Figure 8 and Figure 9. The nitrate+nitrite-N loadings have decreased significantly over the past 10 years. Phosphorus loads fluctuate but overall remained steady. The 95th percentile flow is significantly above the design flow of the plant. This potentially could be a result of inflow and infiltration (I&I) to the system. A Nov. 5, 2015 inspection of the plant documents that a permit-to-install for additional aeration to the existing lagoons to better treat current flows and a proposed increased load from industry was submitted to Ohio EPA. The PTI for plant upgrades was approved on Feb. 24, 2017. The permit (effective June 1, 2017) includes a compliance schedule that requires full compliance with the effluent limits within 18 months. As of the publication date of this report, the frequency of dissolved oxygen violations has significantly decreased.

Village of New Bremen WWTP (Ohio EPA Permit # 2PB00034)

The village of New Bremen wastewater treatment plant provides sanitary wastewater treatment to approximately 3,000 people. The municipal wastewater treatment plant consists of influent pumping, bar screen, rock filter and aerated lagoon (continuous discharge) with an average daily design flow of 0.9 MGD. The village's sanitary waste is 100 percent separated and discharges into Wierth Ditch at RM 2.4.

The New Bremen WWTP had permit limit violations for ammonia, CBOD 5, total suspended solids and oil and grease during the sampling period (March through October). These permit limit exceedances are documented in Table 10. For the past 10 years, ammonia violations have been consistently documented in the effluent from the New Bremen WWTP.

Table 10 — New Bremen WWTP permit limit compliance.

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
2PB00034*MD	March 2015	001	Nitrogen, Ammonia	7D Qty	65.0	74.2125	3/15/2015
2PB00034*MD	March 2015	001	CBOD 5 day	7D Qty	51.0	67.4581	3/8/2015
2PB00034*MD	March 2015	001	Nitrogen, Ammonia	7D Qty	65.0	74.8521	3/8/2015
2PB00034*MD	March 2015	001	CBOD 5 day	30D Qty	34.0	39.3095	3/1/2015
2PB00034*MD	March 2015	001	Nitrogen, Ammonia	30D Qty	44.0	52.2305	3/1/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Qty	10.2	24.8561	5/22/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Conc	3.0	14.5	5/22/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Qty	10.2	40.9815	5/15/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Conc	3.0	18.65	5/15/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Qty	10.2	46.3475	5/8/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Conc	3.0	17.65	5/8/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	30D Qty	6.8	29.7649	5/1/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	7D Conc	3.0	13.85	5/1/2015
2PB00034*MD	May 2015	001	Nitrogen, Ammonia	30D Conc	2.0	16.1625	5/1/2015
2PB00034*MD	June 2015	001	CBOD 5 day	7D Qty	51.0	82.3388	6/15/2015
2PB00034*MD	June 2015	001	TSS	7D Qty	102.0	216.316	6/15/2015
2PB00034*MD	June 2015	001	TSS	30D Qty	68.0	75.2798	6/1/2015
2PB00034*MD	August 2015	001	Oil and Grease, Hexane	1D Conc	10.0	28.1	8/5/2015

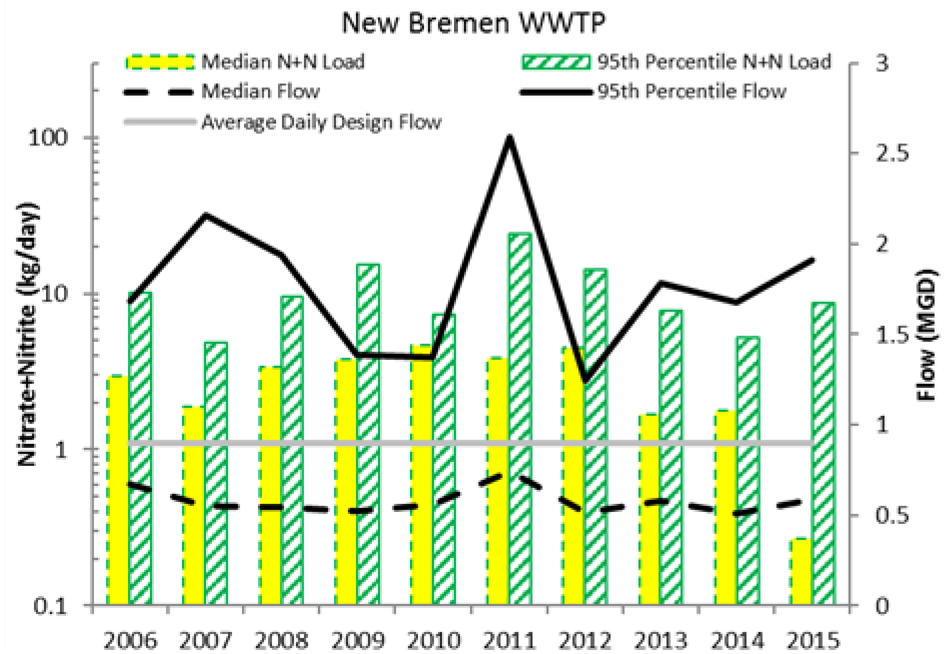

Figure 10 — Annual nitrate+nitrite loadings for the New Bremen WWTP from 2006-2015.

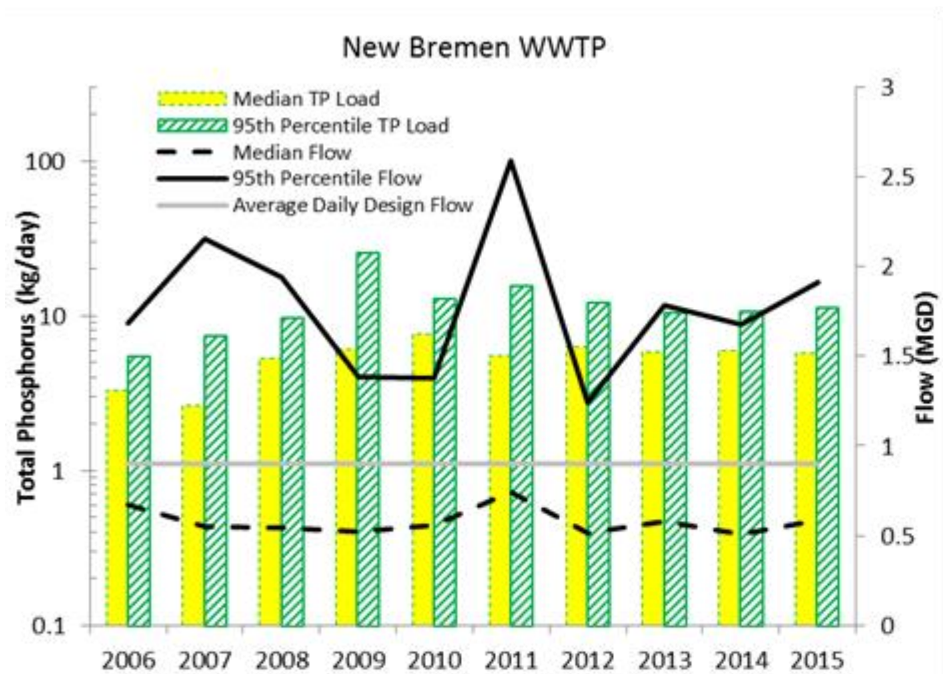

Figure 11 — Annual total phosphorus loadings for the New Bremen WWTP from 2006-2015.

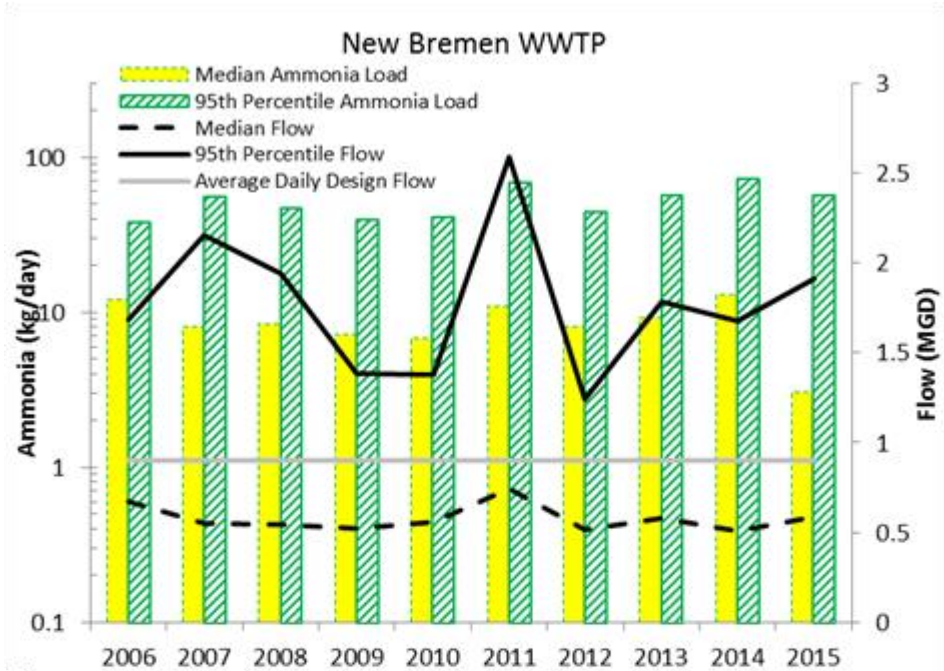

Figure 12 — Annual ammonia loadings for the New Bremen WWTP from 2006-2015.

Pollutant loadings from the Village of New Bremen WWTP between 2006 and 2015 were evaluated and annual statistics for nitrate+nitrate-N, total phosphorus and ammonia loadings (ammonia was added because of the facility's non-compliance history with ammonia) are displayed in Figure 10, Figure 11 and Figure 12.

The annual nitrate+nitrite-N loadings have fluctuated but remained on a steady trend. Phosphorus loads show an overall, slightly increasing trend. Ammonia loading from the plant has remained steady with a slightly increasing trend with the median load decreasing in 2015. As noted above, ammonia violations have been consistently reported in the facility effluent for at least the past 10 years.

A compliance review completed by Ohio EPA's Division of Surface Water staff documented that ammonia violations were a result of infiltration into the sanitary sewer system and issues with temperature and turnover in the lagoons. Infiltration into the system can be observed by the high 95th percentile flows in the associated figures.

To attempt to fix the ammonia violations, the facility is videotaping and smoke testing the sewer system to determine locations of infiltration and fixing problems as they turn up. In addition, solids were removed from the first lagoon cell in 2015 resulting in improved compliance for ammonia in 2016. As of the publication of this report, ammonia and CBOD violation frequency has decreased and the effluent quality has seen some improvement over the past year.

Village of Mendon WWTP (Ohio EPA Permit # 2PA00058)

The village of Mendon wastewater treatment plant provides sanitary wastewater treatment to approximately 638 people. The municipal wastewater treatment plant is a controlled discharge aerated lagoon with an average daily design flow of 0.1 MGD. The village's sanitary waste is 100 percent separated and discharges into the St. Marys River at RM 69.54.

Compliance history for the plant during the sampling period showed the facility obtained a 30-day concentration CBOD five-day violation for the month of April 2015.

The village discharged from the lagoons April 15-30 and Sept. 9-28. Because of the infrequent discharges, no pollutant loadings tables were prepared for this facility.

Results

Water Chemistry Results

Surface water chemistry samples were collected from the St. Marys River study area from April through October 2015 at 59 locations (Appendix G). Stations were established in free-flowing sections of the streams and samples were collected directly from the stream. Samples were alternatively collected from bridge crossings when high flows or other barriers made for unsafe wading conditions. Surface water samples were collected in appropriate containers, preserved and delivered to Ohio EPA's Environmental Services laboratory. Collected water was preserved using appropriate methods, as outlined in the *Ohio EPA Surface Water Field Sampling Manual*, July 31, 2015 (Ohio EPA, 2015).

USGS gage data from the St. Marys River at the town of Rockford on St. Rte. 118 was used to show flow trends in the St. Marys River watershed during the 2015 survey (Figure 13). Dates when water samples and bacteria samples were collected in the study area are noted on the graph. Flow conditions during the summer field season were above normal June through July. During the remainder of the summer the flow was either at or lower than the historic median. Water samples captured a variety of flow conditions in the study area during the field season. Bacteria samples were collected during the recreation use season (May 1 through October 31) and were typically collected during lower flows.

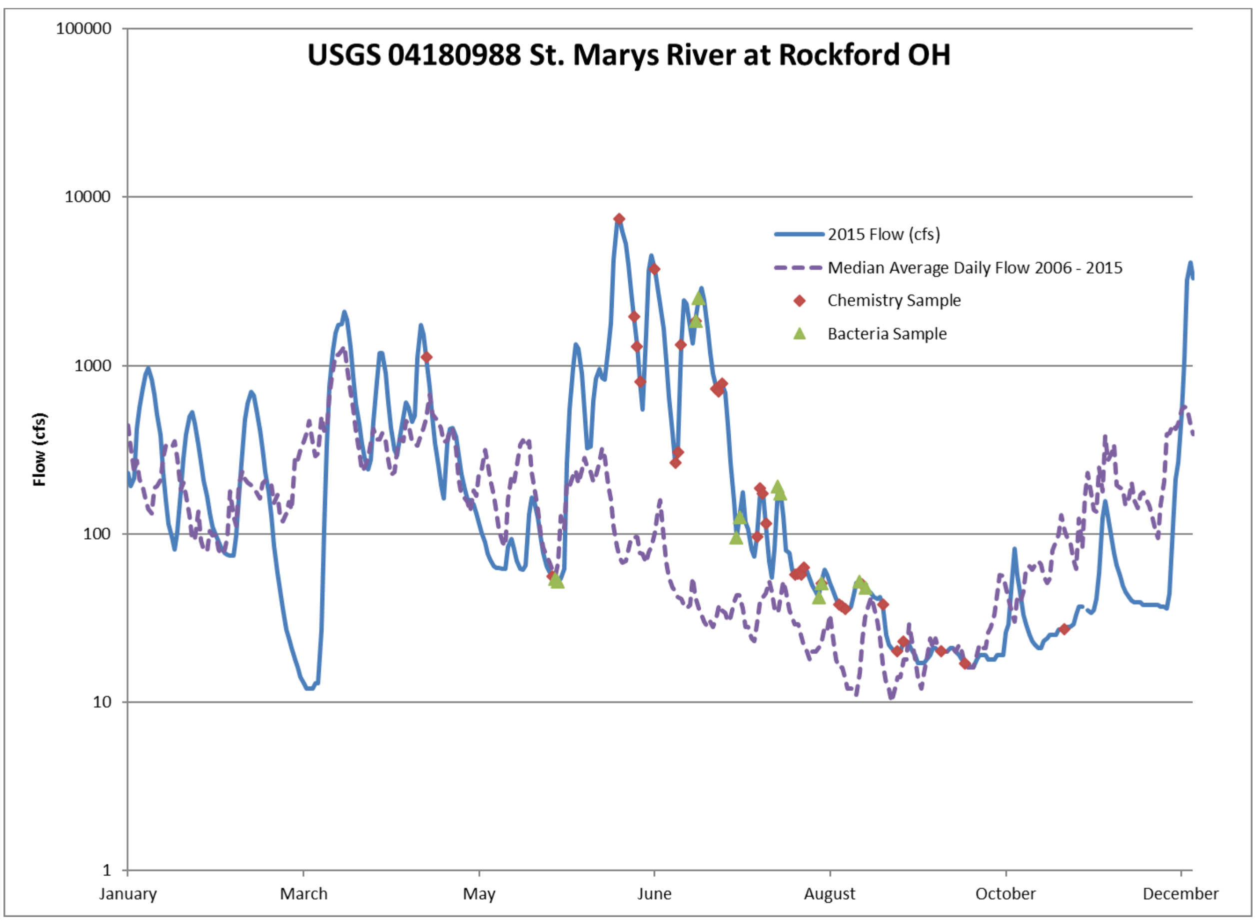

Figure 13 — Daily average flow conditions in the St. Marys River at the USGS gage at Rockford in 2015. (USGS, 2016).

Surface water samples were analyzed for metals, nutrients, semi-volatile organic compounds, herbicides, bacteria, pH, temperature, conductivity, dissolved oxygen (D.O.), percent D.O. saturation and suspended and dissolved solids (Appendices G, H and K). Parameters which exceeded the Ohio WQS criteria are reported in Table 11. Bacteriological samples were collected from 30 locations during the 2015 survey. The bacteriological results are reported in the Recreation Use section. Water quality sondes were placed at 30 locations to monitor hourly levels of D.O., pH, temperature and conductivity. Water quality exceedances observed with the sondes are reported in Table 15.

Field meter instantaneous D.O. readings levels were below the minimum water quality criteria at 31 sites a total of 63 times during the 2015 sampling season. Low D.O. levels were found throughout the watershed, throughout the summer, with a greater number later in the summer. Dissolved oxygen fluctuates in a stream due to biological activity, flow, reaeration, pollution and temperature. During summer months, flow is decreased, pollutant sources are less diluted, water temperatures are higher and biological activities are increased. These conditions result in generally lower D.O. in the stream and larger daily variability.

Eleven sites had temperatures exceeding water quality criteria. Of note, the exceedances occurred earlier in the season, in May. The stream temperatures in May, ranging from 20.1-24.1^{0}C, were not warmer than the rest of the summer; the exceedances resulted from temperature criteria being lower earlier in the year.

Metals were measured at the stream sampling locations in 2015 with 18 parameters tested (Appendix G). Iron exceeded the statewide water quality criteria for the protection of agricultural uses at eight sites in 2015 (Table 11). Aluminum exceeded criteria at five stations. These exceedances occurred during the sampling event on June 18, a day when a subset of 11 stations was sampled during a high flow event. That day the streams were muddy from surface runoff from preceding rainfall. All aluminum exceedances were concurrent with iron exceedances. The source of the iron and aluminum exceedances may have been suspended soil particles or sediment in the water. During water sample chemical analysis, metals in and on soil clay particles are released into solution, resulting in erroneously elevated metals concentrations in the water. No other metal exceedances were found in the study area in 2015.

Table 11 — Exceedances of Ohio EPA WQS criteria (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the St. Marys River study area, May-October 2015. Bacteria exceedances are presented in the Recreation Use section.

Stream (use designation[a]) 12-digit WAU[b]	River Mile	Parameter (value) (units are µg/l for metals, C° for temperature and mg/l for dissolved oxygen)
St. Marys River (WWH, PCR, AWS, IWS)		
01-06	100.47	none
01-06	100.12	Dissolved Oxygen (3.63[‡‡], 3.11[‡‡])
01-06	98.50	Dissolved Oxygen (3.30[‡‡])
01-06	95.12	Temperature (23.62**) Aluminum-T (4520[#]) Iron-T (6060[∞])
02-05	87.80	Dissolved Oxygen (3.19[‡‡])
02-05	80.51	none
02-05	75.07	Dissolved Oxygen (3.90[‡‡]) Temperature (21.90*)
03-03	70.40	none
03-03	65.70	none
03-03	61.50	Dissolved Oxygen (2.33[‡‡])
03-03	57.82	Dissolved Oxygen (2.82[‡‡])
03-03	52.13	Dissolved Oxygen (3.19[‡‡], 3.37[‡‡], 3.99[‡‡]) Temperature (21.83*) Iron-T (5350[∞])
03-03	47.48	Dissolved Oxygen (3.09[‡‡])
03-05	45.60	Dissolved Oxygen (3.53[‡‡])
03-05	43.48	Dissolved Oxygen (3.38[‡‡], 3.40[‡‡]) Temperature (21.22*) Aluminum-T (5370[#]) Iron-T (6550[∞])
Muddy Creek (WWH, PCR, AWS, IWS)		
01-01	5.40	Dissolved Oxygen (3.88[‡‡])
01-01	0.45	none
Center Branch (WWH, PCR, AWS, IWS)		
01-02	6.60	none
01-02	5.20	none
01-02	3.22	none
01-02	0.34	Dissolved Oxygen (0.02[‡‡]) Temperature (23.60**)
Carter Creek (WWH, PCR, AWS, IWS)		
01-02	1.86	none
Clear Creek (WWH, PCR, AWS, IWS)		
01-03	5.40	none
01-03	1.32	none
East Branch (Undesignated – recommended WWH, PCR, AWS, IWS)		
01-03	0.27	Dissolved Oxygen (3.92[‡‡]) Temperature (24.10**) Aluminum-T (4940[#]) Iron-T (6280[∞])
Kopp Creek (WWH, SCR, AWS, IWS)		
01-04	8.88	none
01-04	7.62	none

Stream (use designation[a]) 12-digit WAU[b]	River Mile	Parameter (value) (units are µg/l for metals, C° for temperature and mg/l for dissolved oxygen)
01-04	3.60	Dissolved Oxygen (3.79‡‡)
01-04	0.80	Temperature (22.90**)
Tributary to Kopp Creek (WWH, PCR, AWS, IWS)		
01-04	0.30	Dissolved Oxygen (1.54‡‡)
Wierth Ditch (MWH, SCR, AWS, IWS)		
01-04	0.45	pH (9.15Δ)
Miami-Erie Canal (MWH, PCR, AWS, IWS)		
01-05	17.00	Dissolved Oxygen (2.27‡‡) Iron-T (5240∞)
01-06	0.20	Dissolved Oxygen (2.30‡‡, 2.96‡‡, 1.97‡‡, 2.49‡‡, 2.99‡‡, 0.86‡‡)
01-06	24.50	Dissolved Oxygen (2.18‡‡, 2.56‡‡, 2.16‡‡, 1.02‡‡, 0.68‡‡) Iron-T (5210∞)
Sixmile Creek (WWH, PCR, AWS, IWS)		
01-05	1.06	Dissolved Oxygen (3.65‡‡, 3.06‡‡, 2.79‡‡, 3.09‡‡)
Fourmile Creek Creek (WWH, PCR, AWS, IWS)		
01-06	0.10	none
Hussey Creek (WWH, PCR, AWS, IWS)		
02-01	2.40	Dissolved Oxygen (3.23‡‡, 2.66‡‡)
02-01	0.10	Dissolved Oxygen (1.00‡‡, 3.52‡‡, 3.27‡‡, 3.77‡‡)
Eightmile Creek (WWH, PCR, AWS, IWS)		
02-02	6.55	none
02-02	1.22	Dissolved Oxygen (3.67‡‡, 3.79‡‡) Temperature (21.60*) Aluminum-T (4600#) Iron-T (5740∞, 5080∞)
Blierdofer Ditch (MWH, PCR, AWS, IWS)		
02-03	2.50	none
02-03	1.70	none
Twelvemile Creek (WWH, PCR, AWS, IWS)		
02-04	11.01	none
02-04	0.70	Dissolved Oxygen (3.54‡‡, 3.66‡‡, 2.37‡‡) Temperature (20.10*)
Prairie Creek (Undesignated – recommended MWH, PCR, AWS, IWS)		
02-05	2.75	Dissolved Oxygen (3.70‡‡)
02-05	1.02	Dissolved Oxygen (3.43‡‡, 3.93‡‡, 2.95‡‡, 2.93‡‡, 3.81‡‡, 1.19‡‡)
Little Black Creek (WWH, PCR, AWS, IWS)		
03-01	6.85	none
03-01	1.00	Dissolved Oxygen (3.63‡‡, 1.91‡‡)
Black Creek (MWH, PCR, AWS, IWS)		
03-02	10.70	none
03-02	2.50	none
03-02	0.90	Temperature (22.07*)
Town Run (WWH, PCR, AWS, IWS)		
03-03	1.87	none
03-03	1.25	Dissolved Oxygen (3.27‡‡)
Yankee Run (WWH, PCR, AWS, IWS)		
03-03	1.40	Dissolved Oxygen (2.88‡‡)
Duck Creek (WWH, PCR, AWS, IWS)		
03-04	4.70	Dissolved Oxygen (2.74‡‡, 2.96‡‡, 3.52‡‡)
03-04	1.05	Dissolved Oxygen (2.77‡‡)

Stream (use designation[a]) 12-digit WAU[b]	River Mile	Parameter (value) (units are µg/l for metals, C° for temperature and mg/l for dissolved oxygen)
Twentyseven Mile Creek (WWH, AWS, IWS, PCR)		
04-01	4.10	none
04-01	1.20	Dissolved Oxygen (3.24‡‡, 0.60‡‡) Temperature (21.10*) Aluminum-T (7240#) Iron-T (9060∞)
Tributary to Twentyseven Mile Creek (RM 3.1) (Undesignated – recommended WWH, PCR, AWS, IWS)		
04-01	0.40	none

a Use designations:

Aquatic Life Habitat	Water Supply	Recreation
MWH — modified warmwater habitat	IWS — industrial water supply	PCR — primary contact
WWH — warmwater habitat	AWS — agricultural water supply	SCR — secondary contact
LRW — limited resource water	PWS — public water supply	BWR — bathing water
Undesignated [WWH criteria apply to 'undesignated' surface waters.]		

b Watershed Assessment Unit within HUC8 04100004

‡‡ value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) or value is below the MWH minimum at any time D.O. criterion (3.0 mg/l – ECBP; 2.5 mg/l - HELP) as applicable.

** exceedance of OMZM (outside mixing zone maximum) numerical criteria for prevention of acute toxicity.

exceedance of numerical criteria for the protection of human health (non-drinking-protective of people against adverse exposure to chemicals via eating fish), derived in accordance with OAC 3745-1-38.

∞ exceedance of agricultural water supply criterion.

Δ exceedance of the pH criteria (6.5-9.0).

* exceedance of OMZA (outside mixing zone average) numerical criteria for prevention of chronic toxicity.

Organic parameters, including organochlorine pesticides, acid and chlorinated acid herbicides and glyphosate, were measured at 11 sampling locations, four in the St. Marys River mainstem and seven in tributaries (Appendix H). Organics were analyzed during four sampling events from April to July. The whole suite of pesticides were analyzed for in April, May and June. Only the acid herbicides were analyzed in July, as they appeared to be more prevalent in the watershed than the other types of pesticides according to earlier sampling events.

In the stream water analysis for organics, 19 pesticides were detected, six of which have established water quality criteria. Of that six, one pesticide, dieldrin, was detected above the water quality criteria (Table 12). Dieldrin was detected during the April sampling in Kopp Creek (RM 0.80) at 0.0025 µg/l, exceeding the water quality criteria for the protection of human health of 0.0065 ng/l (0.0000065 µg/l). Dieldrin is among the organochlorine pesticides that were banned for agricultural use in 1970; however, due to its persistence in soils and sediments, it remains ubiquitous in the environment (ATSDR 2002).

Three acid herbicides - atrazine, acetochlor and metolachlor - were among the most frequently detected (Figure 14). These herbicides are generally applied at planting which is reflected by the higher concentrations in the streams in May and June. An exception was the concentration spike in Eightmile Creek in July. Herbicide applications may have been occurring into July because of late soybean planting resulting from flooding in June. In the St. Marys River stations, concentrations were generally greater at the sites further downstream. Concentrations were generally lower in the smaller, headwater streams Kopp Creek, East Branch and Center Branch.

The herbicide with the greatest number of detections was metolachlor, with 35 detections in 44 samples over the watershed. The highest concentration was 4.60 µg/l, in Twelvemile Creek on May 26, 2015. There is no Ohio water quality standard for metolachlor, however, as a comparison, the sample concentration was less than the Illinois chronic aquatic life criteria for metolachlor of 30.4 µg/l. Similarly, for acetochlor, the highest concentration was 4.97 µg/l, in Twelvemile Creek on July 22, 2015, which was below the Illinois criteria for acetochlor of 12 µg/l. A water quality standard also does not exist for atrazine; however, as a comparison, none of the atrazine detections exceeded the drinking water MCL of 3.0 µg/l. A 1995 review of field studies suggested that effects from atrazine were "ecologically important" only at exposures of 50 µg/l or greater (Solomon et al. 1996). All samples were at least an order of magnitude below that level during the survey.

Nutrients were measured at each water sampling location, and included ammonia, nitrate+nitrite, total Kjeldahl nitrogen (TKN), total phosphorus and orthophosphate. In addition to nutrient monitoring, measurements are taken at a subset of locations to represent the algal biomass and associated dissolved oxygen production and consumption. These measurements are then evaluated along with the biological observations to determine the impact of nutrients on an assessment site. The purpose of the nutrient monitoring summarized in this report is to consider the effect of nutrients on the biological conditions in the local streams. There is considerable concern in the larger western Lake Erie Basin, which the St. Marys river is tributary to, about total annual and spring phosphorus loads. There are separate efforts being undertaken aimed at addressing these issues. While excess nutrients may be sourced from watersheds they are often effectively transported to the downstream water without causing local impairments.

Chlorophyll concentrations from benthic algae (attached to bottom substrates) are measured as a proxy for algal community biomass in wadeable streams and small rivers, while chlorophyll concentrations measured from sestonic algae (suspended in the water column) serve as a proxy for algal abundance in large rivers. Physical factors such as width-depth ratio, time of travel and longitudinal gradient may largely determine whether sestonic or benthic algae drive production and respiration. However, sestonic algae typically dominate streams defined as large rivers, and benthic algae typically dominate small streams. Miltner (2010) identified benthic chlorophyll levels that broadly demarcate enrichment status relative to Ohio. Streams with less than 90 mg/m^2 can be considered least disturbed and atypical for Ohio. Benthic chlorophyll levels between 90-183 mg/m^2 are typical for Ohio streams with modest amounts of agriculture or wastewater loadings. Levels between 183-320 mg/m^2 are typical of streams draining agricultural landscapes or that are effluent dominated. Chlorophyll levels exceeding 320 mg/m^2 characterize over-enrichment or nuisance conditions. A review of studies on sestonic chlorophyll-a by Dodds (2006), which included some Midwestern streams, suggest that concentrations of 40-100 µg/l sestonic chlorophyll-a identify eutrophic conditions while concentrations >100 µg/l indicate hyper-eutrophic conditions.

Ohio and other states have been developing nutrient reduction strategies in recent years to address cultural eutrophication (U.S. EPA 2015, Ohio EPA 2014a, Miltner 2010, Heiskary and Markus 2003). Wide diel (24-hour) D.O. ranges associated with eutrophication are caused by excessive photosynthesis (O_2 production) during daylight hours and respiration (O_2 consumption) at night. The most recent investigations by Ohio EPA have identified a diel D.O. range of 6.5 mg/l as a threshold generally protective of biological and stream quality; diel D.O. ranges greater than 6.5 mg/l are indicative of eutrophication in Ohio streams and are likely over-enriched (Ohio EPA 2014).

Total phosphorus and nitrate+nitrite-N usually represent the largest portion of these nutrients. The index period for nutrients impacting streams is May 1 – October 30. Ohio EPA compares the geometric means of samples in the index period to benchmarks based on reference conditions in Ohio streams (Ohio EPA 1999). Table 14 compares the geomeans for all sites sampled in the study area to these benchmarks. Geometric means that are higher in concentration than nutrient benchmarks are highlighted in yellow. Most locations sampled in 2015 yielded geometric means greater than benchmarks for nitrate+nitrite-N and/or total phosphorus.

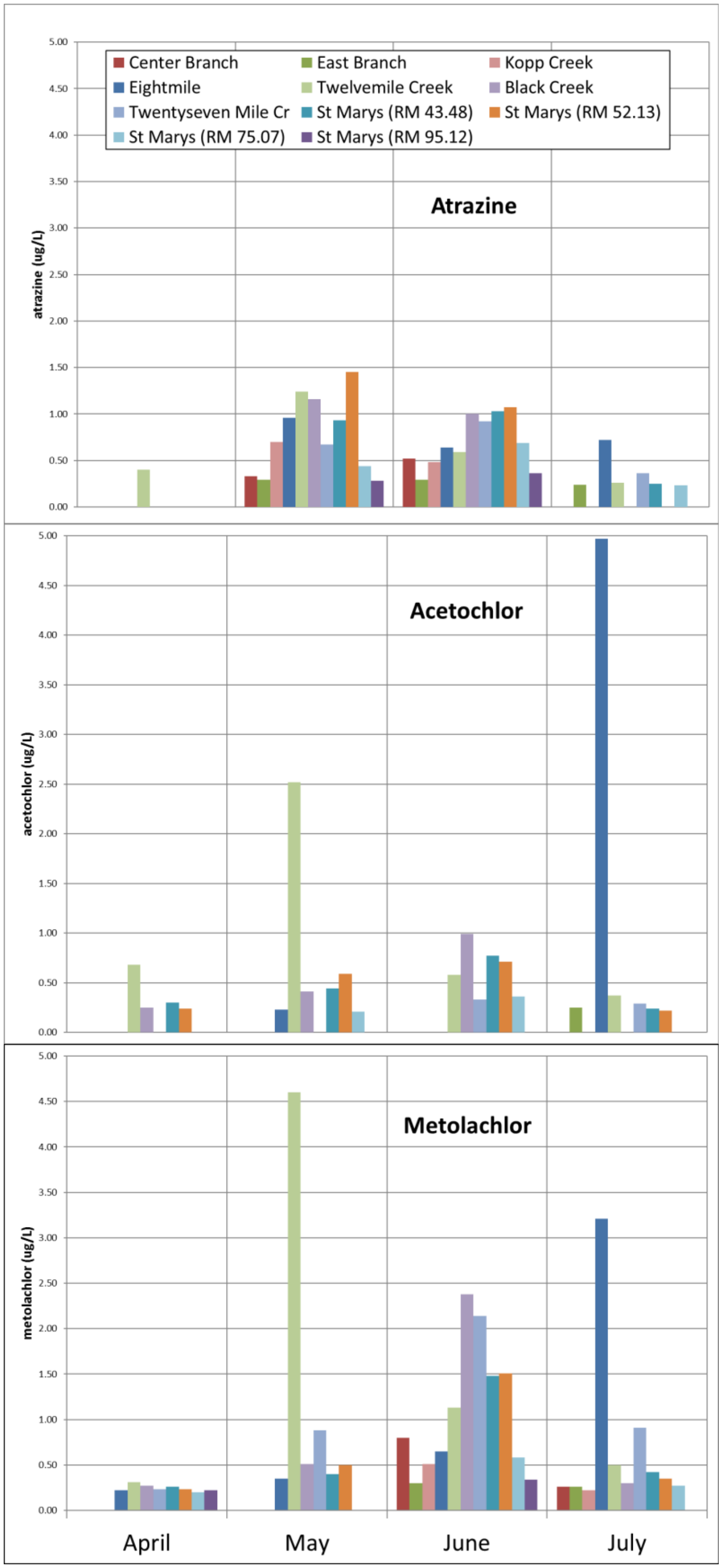

Figure 14 — Detections of selected herbicides in samples collected from the St. Marys River and tributaries, 2015.

Table 12 — Frequency of pesticides detected in stream water samples in the St. Marys River watershed during 2015 (number of water quality criteria exceedances/number of detections). [1]

		St. Marys River Watershed (WAU 04100004-__-__)							
		01-02	01-03	01-04	02-02	02-04	03-02	04-01	
Parameter	St. Marys River mainstem RMs 95.12, 75.07, 52.13, and 43.48	Center Branch RM 0.34	East Branch RM 0.27	Kopp Creek RM 0.80	Eightmile Creek RM 1.22	Twelvemile Creek RM 0.70	Black Creek RM 0.90	Twentyseven Mile Cr RM 1.20	TOTAL
α-Hexachlorocyclohexane	0/4	0/1	-	-	0/1	0/1	0/2	0/1	0/10
β-Hexachlorocyclohexane	0/2	-	-	-	-	-	0/1	-	0/3
δ-Hexachlorocyclohexane*	*/1	-	-	-	-	-	-	-	*/1
γ-Hexachlorocyclohexane (LIndane)	0/1	-	-	0/1	0/1	0/1	-	0/1	0/5
2,2-Dichloropropionic acid (Dalapon)*	-	-	-	-	-	-	*/1	-	*/1
4,4-DDE*	-	-	-	-	-	-	*/1	-	*/1
Acetochlor*	*/10	-	*/1	-	*/2	*/4	*/3	*/2	*/22
Alachlor*	-	-	-	-	-	-	*/1	-	*/1
Aldrin*	-	-	-	-	*/1	*/1	-	-	*/2
Atrazine*	*/11	*/2	*/3	*/2	*/3	*/4	*/2	*/3	*/30
Benzo(a)pyrene	1/1	-	-	-	-	-	-	-	1/1
Di(2-Ethylhexyl)adipate*	*/3	*/1	*/1	-	-	-	*/1	-	*/6
Bis(2-Ethylhexyl)phthalate	0/10	0/1	0/1	0/4	0/2	0/2	0/2	0/1	0/23
Butachlor*	*/1	-	-	-	-	-	*/1	-	*/2
Dieldrin	-	-	-	1/1	-	-	-	-	1/1
α-Endosulfan*	*/1	-	-	-	-	*/1	-	-	*/2
Heptachlor epoxide*	*/1	*/1	*/1	-	-	-	*/1	-	*/4
Metolachlor*	*/13	*/2	*/2	*/2	*/4	*/4	*/4	*/4	*/35
Simazine*	-	-	-	-	-	-	*/1	-	*/1
TOTAL	**1/59**	**0/8**	**0/9**	**1/10**	**0/14**	**0/18**	**0/21**	**0/12**	**2/151**

1 Water samples for pesticides analysis were collected in April, May, June and July.
* Parameter was detected but no applicable water quality criteria are available.

Figure 15 shows a longitudinal representation of the nutrient assessment data collected on the St. Marys mainstem. Both nitrate+nitrite-N and total phosphorus geometric means decrease very slightly as you progress downstream in the St. Marys mainstem. Only four stations did not have nutrient concentrations greater than benchmark values, these stations were located downstream on the St. Marys River at RM 47.48 at Harner Rd., at RM 43.48 at St. Rte. 81 in Willshire and at the downstream Black Creek stations (RM 2.5 at Winkler Rd. and at RM 0.9 at US 33). The diel range of dissolved oxygen was above the threshold at three sites during the August water quality sonde survey. The benthic chlorophyll-a data indicated low benthic algal biomass, however, sestonic chlorophyll-a values were high. The sestonic algae concentrations initially increased downstream of the canal discharge at the St. Marys aqueduct at RM 100.45, but then increased, eventually reaching the high threshold near RM 75.

Figure 16 is a representation of the nutrient assessment data collected on tributaries to the St. Marys River. Both nitrate+nitrite-N and total phosphorus were almost ubiquitously elevated when compared to the benchmark values. The highest concentrations of total phosphorus were observed on Kopp Creek at RM 7.62 downstream of the New Bremen WWTP discharge and declined but remained elevated above other sites in the survey when moving downstream. Nine of 20 of the sites that had diel dissolved oxygen ranges monitored had values above the threshold of 6.5 mg/l. The highest values observed were in headwater tributaries of the St. Marys River in the ECBP ecoregion, including: Center Branch; Clear Creek; and Kopp Creek. At these same sites benthic chlorophyll-a was typically in the moderate range, however, on Kopp Creek at RM 7.62 the benthic chlorophyll-a measurement reached 734 µg/l, well into the high range.

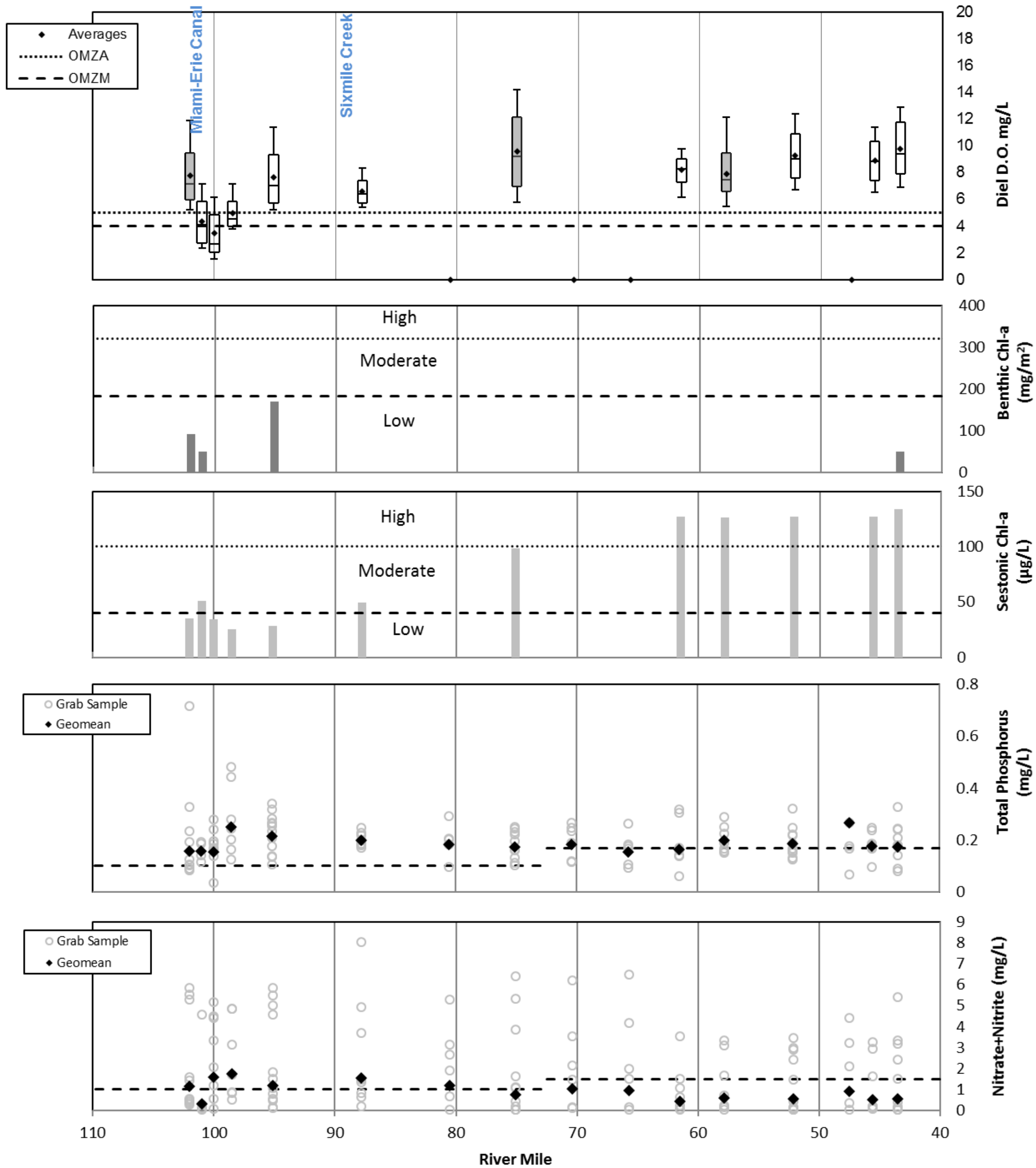

Figure 15 — Longitudinal representation of diel D.O., benthic/sestonic chlorophyll-a, TP and nitrate+nitrite-N used to evaluate the impact of nutrients on the St. Marys River. Relevant standards for D.O. and benchmarks for chlorophyll-a and nutrient concentrations (Dodds 2006, Miltner 2010, Ohio EPA 2014) are presented within their respective plots. The diel dissolved oxygen and chlorophyll data were collected from Aug. 18–21, 2015. Chemistry grab samples are from the period of May 1 – Oct. 31, 2015.

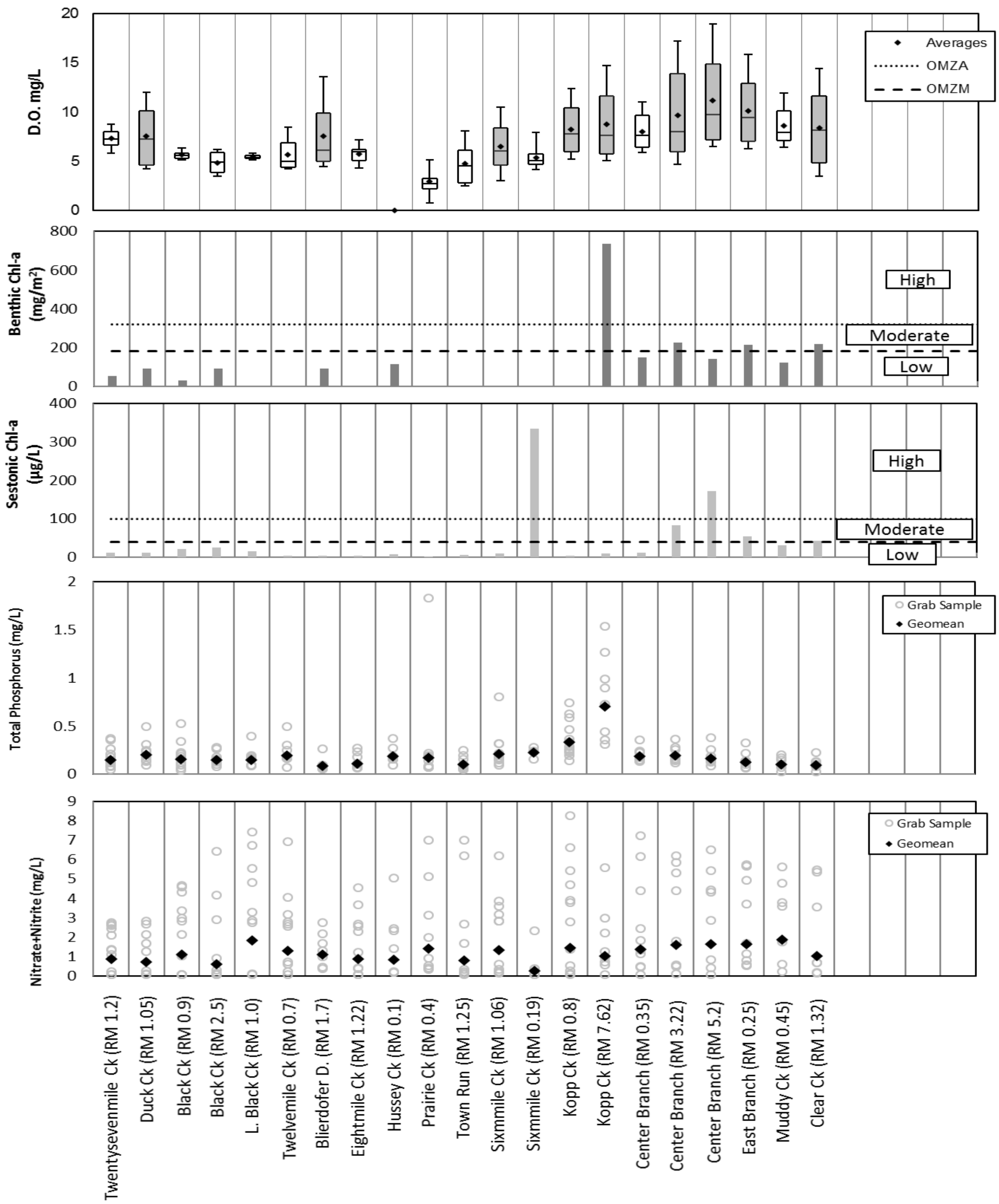

Figure 16 — Representation of diel D.O., benthic/sestonic chlorophyll-a, TP and nitrate+nitrite used to evaluate the impact of nutrients on tributaries to the St. Marys River. Benchmarks for chlorophyll-a (Dodds 2006, Miltner 2010, Ohio EPA 2014) are presented within their respective plots but D.O. standards and nutrient benchmarks are excluded because they change based on the designated use and stream size. The dissolved oxygen and chlorophyll data were collected on two surveys from Aug. 18–21, 2015 and Sept. 16–21, 2015. Chemistry grab samples are from the period of May 1 – Oct. 31, 2015.

The ammonia water quality standard was not exceeded in any of the samples at any of the sampling stations during the 2015 sampling season.

Chemistry data was collected to evaluate the impact of NPDES dischargers on stream water quality. Effluent samples were collected from five municipalities' wastewater treatment plants (WWTPs) within the study area: city of St. Marys; New Knoxville; Rockford; New Bremen; and Willshire. Mendon's WWTP was planned to be part of the study but the plant's controlled discharge aerated lagoon system did not discharge during the study period so effluent samples were not collected. New Knoxville's WWTP also has a controlled discharge lagoon system, but it did discharge during two periods within the survey sampling timeframe, from June 22-30, and from August 3-13. The WWTPs are discussed in more detail in the NPDES-Permitted Facilities section.

The WWTPs all discharged nutrients to streams at average phosphorus levels greater than benchmark concentrations for the streams (Table 13). The New Bremen WWTP which discharges to Wierth Ditch, may contribute to adverse conditions in Kopp Creek. Two stations in Kopp Creek downstream of the confluence with Wierth Ditch were found to be in partial attainment of the warm water habitat (WWH) aquatic life use (ALU). The other minor WWTPs - New Knoxville STP which discharges to Center Branch, and Rockford STP which discharges to the St. Marys River at RM 57.84 - do not appear to have overall adverse effect on the streams. During the study, the stream sampling locations downstream of those plants were found to be in full attainment of their assigned aquatic life use (Table 1).

The city of St. Marys WWTP is a major discharger with an average daily design flow of 3.0 MGD. The St. Marys River downstream of the WWTP discharge showed to be in partial attainment of the WWH ALU. However, upstream of the wastewater treatment plant discharge, the St. Marys River is also in partial attainment, which is linked to a discharge from the Miami and Erie Canal at the St. Marys aqueduct.

Upstream of the St. Marys aqueduct canal discharge, the St. Marys River is in full attainment. Measures of organic and nutrient enrichment were elevated in the canal when compared to the river upstream. Total phosphorus, biological oxygen demand (BOD5) and sestonic (water column) chlorophyll-a were all elevated in the water discharged from the canal. The geometric mean of total phosphorus discharged from the canal was 0.31 mg/l, nearly three times concentration in the river just upstream of 0.13 mg/l (Table 14). Throughout the sampling season, the canal was a bright green color from algae. The canal discharge had an order of magnitude higher sestonic chlorophyll-a than was observed in the upstream background conditions. Concurrent with the chlorophyll-a concentrations observed in the canal discharge, the BOD5 samples were similarly an order of magnitude higher. These two measures serve together as an indication of organic loading from the canal discharge that was largely derived from sestonic algae. The visual impact of this load is shown in the photos below (Figure 17 and Figure 18). The canal discharge contributed more flow than the upstream watershed when three of the four canal discharge measurements made during common, low-flow periods in the St. Marys River.

A second location, at RM 0.42 on Sixmile Creek, received a discharge from the Miami and Erie canal. The flow at this discharge point was more than twice that observed at the St. Marys aqueduct. However, the sampling at this location was limited to assessing the potential effects on the St. Marys River because biological sampling only occurred upstream. The total phosphorus from the canal discharge was not greater than the upstream waters of Sixmile Creek. However, the organic loading from the canal (algae-derived), indicated by high BOD5 and sestonic chlorophyll-a, was reflected in the conditions observed downstream of the discharge. Further, sestonic chlorophyll-a became more elevated in the St. Marys River downstream of the confluence with Sixmile Creek at RM 89.12 (Figure 18).

Table 13 — Summary of water quality grab samples for BOD5, chlorophyll-a and total phosphorus around two discharge points of the Miami and Erie Canal to the St. Marys River watershed. Averages are for four sampling events at the St. Marys aqueduct and six sampling events at the Sixmile Creek aqueduct.

	St. Marys Aqueduct			Sixmile Creek Aqueduct		
Stream Name	St. Marys	Canal	St. Marys	Sixmile Creek	Canal	Sixmile Creek
Location	RM 100.47		RM 100.28	RM 1.06		RM 0.19
BOD5 (mg/l)	1.0	9.3	5.7	1.75	8.8	9.3
Chlorophyll-a (µg/l)	12.8	75.5	67.2	6.6	210.9	192.2
Total Phosphorus (mg/l)	0.16	0.29	0.16	0.18	0.16	0.26
Average Canal Discharge	Four measurements: 3.86 cfs			Two measurements: 9.69 cfs		

Figure 17 — Photo of Miami-Erie canal discharge to the St. Marys River (photo taken July 24, 2015).

Figure 18 — Photo of Miami-Erie canal discharge to the St. Marys River (photo taken Aug. 3, 2015).

The influence of the canal is also observed in the biological oxygen demand throughout the St. Marys River. Figure 19 shows BOD concentrations measured in the St. Marys River during the 1991 and 2015 stream surveys. In general, BOD levels were lower in the 2015 survey than the 1991 survey. In 1991, the highest BOD concentrations were downstream of the St. Marys STP at RM 98.09, where the geometric mean BOD was 6.79 mg/l. The maximum 1991 BOD concentration of 11 mg/l was detected a little further downstream at RM 95.12, at Glynwood Road. In 2015, the BOD concentrations were lower downstream of the St. Marys STP than upstream. Of six STP effluent samples during the summer survey, only one had detectable BOD, at 2.1 mg/l. After the initial drop with the St. Marys STP discharge, the 2015 BOD concentrations do appear to increase downstream of the RM 89.12 confluence with the canal-influenced Sixmile Creek.

The improvement in the St. Marys STP discharge is likely due to a major upgrade to the plant in 2009 which increased the flow capacity and added additional treatment components such as an oxidation ditch and an equalization basin.

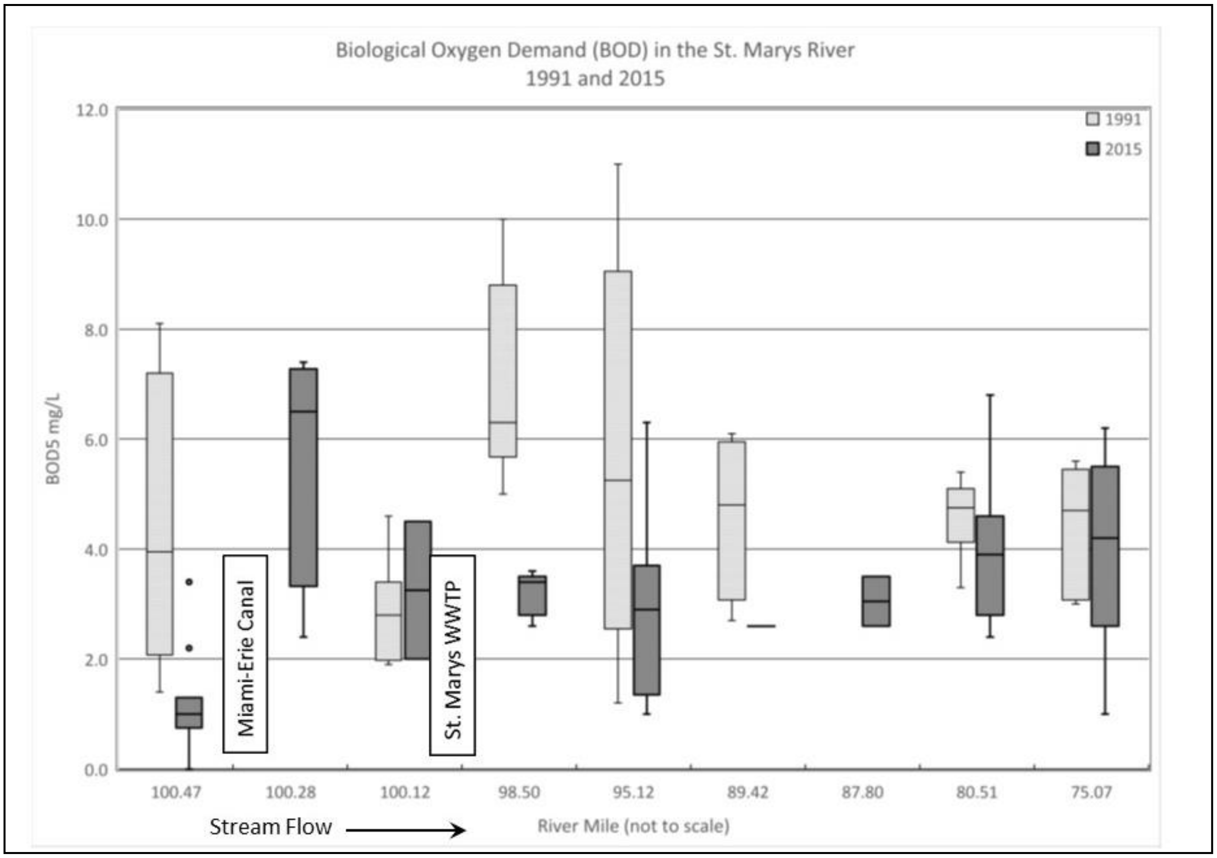

Figure 19 — Biological Oxygen Demand (BOD) in the St. Marys River, 1991 and 2015.

Table 14 — Nutrient sampling results in St. Marys River, summer (May-October) 2015. The seasonal geometric mean for each site was measured against nutrient benchmark values developed and published in *Association Between Nutrients, Habitat and the Aquatic Biota in Ohio Rivers and Streams, 1999* (Ohio EPA Technical Bulletin MAS/1999-1-1). Please note the degree to which seasonal geometric means exceed or fall below the nutrient benchmark values do not directly translate to cause/source determinations for aquatic life use impairment. Rather, this data serves as one of many lines of evidence in the cause/source determination-process. However, this information does give one a general sense of how individual site-nutrient levels compare to statewide data. Geometric means greater than the benchmark are highlighted in yellow.

Stream (aquatic life use designation[a])					Nitrate+nitrite-N (mg/l)		Phosphorus-T (mg/l)	
RM	AU[b]	Location	Drainage Area (mi²)	Samples (#)	Geometric Mean[c]	Benchmark*	Geometric Mean[c]	Benchmark*
St. Marys River *(WWH)*								
100.47	01-06	Aqueduct Rd.	67.10	10	1.30	1.0	0.13	0.10
100.45	**01-06**	**Miami-Erie Canal at St. Marys adj. Beech Rd.**	**0.00**	**10**	**0.11**		**0.31**	
100.45	**01-06**	**Miami-Erie Canal (from Grand Lake) at St. Marys, dst. St. Rte. 66**	**45.00**	**10**	**0.10**		**0.26**	
100.28	01-06	Upst. Kopp Cr. at Greenville St.	67.10	4	0.30	1.0	0.16	0.10
100.12	01-06	Dst. Kopp Cr. at Greenville St.	101.00	8	1.24	1.0	0.19	0.10
98.60	*01-06*	*St. Marys WWTP final effluent*	*102.00*	*6*	*3.15*		*0.40*	
98.50	01-06	Dst. St. Marys WWTP	103.00	7	1.75	1.0	0.26	0.10
95.12	01-06	Glynwood Rd.	106.00	12	1.28	1.0	0.20	0.10
87.80	02-05	Barber-Werner Rd.	135.00	8	1.45	1.0	0.20	0.10
80.51	02-05	St. Rte. 116	166.00	6	1.18	1.0	0.21	0.10
75.07	02-05	Gallman Rd.	184.00	10	0.78	1.0	0.19	0.10
70.40	03-03	Celina-Mendon Rd.	251.00	6	1.01	1.5	0.22	0.17
70.25	*03-03*	*Mendon WWTP final effluent*	*251.30*	---	---		---	
65.70	03-03	U.S. 127	261.00	6	0.88	1.5	0.18	0.17
61.50	03-03	Frysinger Rd.	279.00	7	0.56	1.5	0.20	0.17
57.84	*03-03*	*Rockford WWTP final effluent*	*295.00*	*6*	*0.08*		*1.99*	
57.82	03-03	St. Rte. 118	295.00	7	0.54	1.5	0.20	0.17
52.13	03-03	Townline Rd.	303.00	10	0.56	1.5	0.19	0.17
47.48	03-03	Harner Rd.	309.00	5	0.37	1.5	0.16	0.17
45.60	03-05	Adj. US Rt. 33 east of Willshire	366.68	7	0.74	1.5	0.19	0.17
43.48	03-05	St. Rte. 81	386.00	9	0.60	1.5	0.17	0.17
43.12	*03-05*	*Willshire WWTP final effluent*	*388.23*	*6*	*13.50*		*3.62*	
Muddy Creek *(WWH)*								
5.40	01-01	Bay Rd.	9.33	6	0.87	1.0	0.16	0.08
0.45	01-01	Washington Rd.	15.60	7	1.12	1.0	0.10	0.08
Carter Creek *(WWH)*								

RM	AU[b]	Location	Drainage Area (mi²)	Samples (#)	Nitrate+nitrite-N (mg/l) Geometric Mean[c]	Nitrate+nitrite-N (mg/l) Benchmark*	Phosphorus-T (mg/l) Geometric Mean[c]	Phosphorus-T (mg/l) Benchmark*
Stream (aquatic life use designation[a])								
1.86	01-02	St. Rte. 219	7.80	6	3.24	1.0	0.25	0.08
Center Branch *(WWH)*								
6.60	01-02	At New Knoxville at end of Walnut St.	5.90	6	2.86	1.0	0.32	0.08
5.20	01-02	Just upst. New Knoxville WWTP	12.40	8	1.49	1.0	0.17	0.08
5.18	*01-02*	*New Knoxville WWTP final effluent*	*12.40*	*6*	*0.26*		*0.95*	
3.22	01-02	Glynwood-New Knoxville Rd.	14.20	8	1.42	1.0	0.21	0.08
0.35	01-02	Plattner Rd.	28.65	10	1.24	1.0	0.19	0.10
Clear Creek *(WWH)*								
5.40	01-03	Burr Oak Rd.	6.81	6	1.07	1.0	0.11	0.08
1.32	01-03	Bay Rd.	13.40	7	0.86	1.0	0.10	0.08
East Branch *(Undesignated)*								
0.25	01-03	St. Rte. 29	37.12	10	1.54	1.0	0.13	0.10
Kopp Creek *(WWH)*								
8.88	01-04	Montezuma Rd.	4.60	6	1.59	1.0	0.16	0.08
7.62	01-04	At lane off St. Rte. 66	13.80	8	0.65	1.0	0.80	0.08
4.10	01-04	Dst. St. Rte. 219	21.16	6	2.41	1.0	0.34	0.10
0.80	01-04	St. Rte. 66	28.00	12	1.22	1.0	0.33	0.10
Tributary to Kopp Creek (5.41) *(WWH)*								
0.30	01-04	Piqua-St. Marys Rd.	4.60	6	2.72	1.0	0.10	0.08
Wierth Ditch *(MWH)*								
2.40	*01-04*	*New Bremen WWTP final effluent*	*4.30*	*6*	*0.34*		*2.61*	
0.45	01-04	St. Rte. 66	6.90	6	0.77	1.0	0.70	0.10
Sixmile Creek *(WWH)*								
0.42	**01-05**	**Miami-Erie Canal at Sixmile Creek Aqueduct**	**0.00**	**10**	**0.17**		**0.15**	
1.06	01-05	St. Marys-Kossuth Rd.	16.20	10	0.20	1.0	0.22	0.08
Fourmile Creek *(WWH)*								
0.10	01-06	St. Marys River Rd.	5.56	6	1.60	1.0	0.26	0.08
Hussey Creek *(WWH)*								
2.40	02-01	Salem-Noble Rd.	6.80	6	0.88	1.0	0.12	0.08
0.10	02-01	Hesse Rd.	11.30	7	0.73	1.0	0.21	0.08
Eightmile Creek *(WWH)*								
6.55	02-02	Davis Rd.	12.70	7	1.32	1.0	0.09	0.08
1.22	02-02	Mercer Rd.	21.80	10	0.77	1.0	0.12	0.10
Blierdofer Ditch *(MWH)*								

RM	AU[b]	Location	Drainage Area (mi^2)	Samples (#)	Nitrate+nitrite-N (mg/l) Geometric Mean[c]	Nitrate+nitrite-N (mg/l) Benchmark*	Phosphorus-T (mg/l) Geometric Mean[c]	Phosphorus-T (mg/l) Benchmark*
Stream (aquatic life use designation[a])								
2.50	02-03	Morrow Rd.	6.40	6	1.48	1.0	0.06	0.34
1.70	02-03	Oregon Rd.	10.50	7	1.01	1.0	0.08	0.34
Twelvemile Creek *(WWH)*								
11.01	02-04	Hoenie Rd.	11.60	6	1.29	1.0	0.16	0.08
0.70	02-04	Neptune-Mendon Rd.	37.50	10	1.06	1.0	0.20	0.10
Prairie Creek *(Undesignated – recommended MWH)*								
2.75	02-05	Eisley Rd.	6.65	6	1.17	1.0	0.11	0.08
0.40	02-05	St. Rte. 197	10.80	8	0.68	1.0	0.18	0.08
Little Black Creek *(WWH)*								
6.85	03-01	St. Rte. 707	10.10	6	2.71	1.0	0.07	0.08
1.00	03-01	Jordan Rd.	23.62	9	1.54	1.0	0.16	0.10
Black Creek *(MWH)*								
10.70	03-02	Strable Rd.	13.19	6	1.58	1.0	0.10	0.34
2.5	03-02	Winkler Rd.	25	8	0.54	1.6	0.15	0.28
0.90	03-02	U.S. Rte. 33	54.00	11	0.95	1.6	0.16	0.28
Town Run *(WWH)*								
1.25	03-03	St. Rte. 117	7.10	8	0.76	1.0	0.09	0.08
Yankee Run *(WWH)*								
1.40	03-03	U.S. Rte. 33	6.10	6	1.52	1.0	0.09	0.08
Duck Creek *(WWH)*								
4.70	03-04	Settler Rd.	6.44	7	0.48	1.0	0.39	0.08
1.05	03-04	Dst. County Line Rd.	15.62	8	0.58	1.0	0.21	0.08
Twentyseven Mile Creek *(WWH*)*								
4.10	04-01	Clayton Rd.	14.00	6	1.28	1.0	0.12	0.08
1.20	04-01	Ohio/Indiana State Line	28.20	11	0.72	1.0	0.14	0.10
Tributary to Twentyseven Mile Creek (RM 3.1) (Undesignated)								
0.40	04-01	Wren-Landeck Rd.	7.40	6	1.28	1.0	0.14	0.08

Values from wastewater treatment plants (final effluent) are italicized in *red*. Values from canals are bold in **green**. Values above applicable reference values (benchmarks) are highlighted in yellow.

a Use designations (aquatic life) — MWH – modified warmwater habitat; WWH – warmwater habitat; EWH – exceptional warmwater habitat; Undesignated (WWH criteria apply to 'undesignated' surface waters); LRW – limited resource water (WWH criteria used for evaluation)

b WAU – Assessment Unit within 8-digit watershed assessment unit 04100004

c Geometric mean calculated from data collected between May 1 – Oct. 31, 2015.

* Benchmark values per *Association Between Nutrients, Habitat and the Aquatic Biota in Ohio Rivers and Streams* –Tables 1 and 2, (Ohio EPA Technical Bulletin MAS/1999-1-1).

Statewide	Headwater (<20 mi^2)			Wadeable (20 mi^2 <200 mi^2)			Small River (200 mi^2 <1000 mi^2)			Large River (>1000 mi^2)		
	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH

NO_3-NO_2-N (mg/l)	1.0	0.5	1.0	1.0	0.5	1.6	1.5	1.0	2.2	2.0	1.5	2.4
Phosphorus-T (mg/l)	0.08	0.05	0.34	0.10	0.05	0.28	0.17	0.10	0.25	0.30	0.15	0.32

A subset of the sites that were sampled for chemistry were also sampled with water quality sondes that monitor temperature, dissolved oxygen (D.O.), pH and specific conductance (conductivity). Temperature, D.O. and pH are influenced by diel (24-hour) patterns. These diel patterns have the greatest impact on streams during a critical condition that includes stable, low streamflow. Specific conductance is not influenced by the same diel triggers but is monitored because it is a strong indicator of changes in streamflow. The water quality sondes collect readings hourly to monitor these parameters throughout the diel cycle. Grab readings differ because they only represent one point on the diel cycle. While they are effective at characterizing water quality parameters that change based on hydrologic regime or season, they can miss or not fully characterize parameters that exhibit diel patterns.

Critical conditions for temperature and D.O. are times when flows are low, temperatures are high and daylight is long. These are the times that streams are most sensitive to organic and nutrient enrichment. To capture these conditions, sondes are typically deployed during low-flow conditions from June to September. Two deployments occurred in the St. Marys watershed. The first was from Aug. 14-21, 2015; 16 tributary sites were sampled during the first four days and the equipment was moved to sites on the mainstem for the remainder of the survey. This allowed the slow receding mainstem additional time to recover from the most recent rain event. Some of the tributaries received enough rain during the deployment to result in conditions that were not optimal but did not have an appreciable effect on the mainstem. Therefore, a second deployment took place at 11 tributary sites from September 16-21, 2015. Figure 20 shows these dates relative to the air temperature and streamflow. The figure shows that flows were elevated slightly above normal but were representative of summer, low-flow conditions. The air temperatures during the surveys were slightly above normal which is an important component of the critical conditions. Summary plots of all data collected are included in Appendix J of this document. The plots are of hourly readings taken for temperature, D.O., pH and specific conductance.

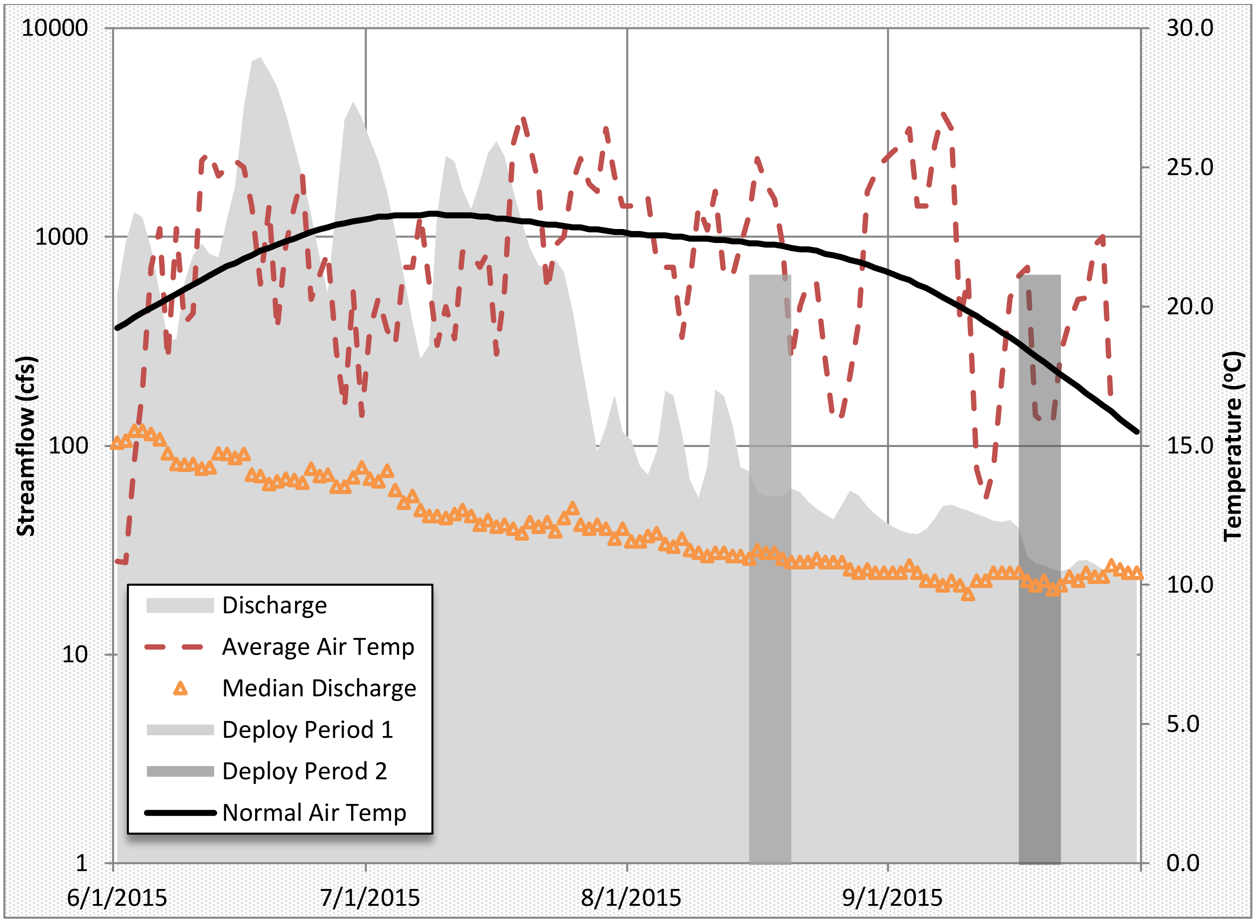

Figure 20 — Graph of average daily streamflow (USGS 04180988 – St. Marys River at Rockford, OH) relative to the median streamflow (Area weighted USGS 04186500 – Auglaize River near Fort Jennings, OH) including the average and normal daily air temperature (NOAA - GHCND:USC00338609) for the sampling season. Stream gage in the St. Marys study area did not have an adequate period of record for the median statistic.

The data collected during the sonde deployments are sufficient to evaluate exceedances of the standards for the protection of aquatic life for: maximum daily temperature; minimum D.O.; 24-hour average D.O.; pH; and specific conductivity. Absolute minima or maxima exceedances are compared directly to hourly readings reported from the water quality sondes. The 24-hour average for D.O. is calculated as a rolling 24-hour average of the hourly data. A summary of the exceedances is presented in Table 15.

Table 15 — Exceedances of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical and physical parameters derived from diel monitoring. Sondes were deployed at 30 sites and a subset of the sites was sampled twice. The first deployment was 8/14-21/2015 and 45-78 hours of data were collected at 30 sites. The second was 9/16-21/2015 resulting in an additional 119-123 hours of data collection at 11 sites. Sites that were sampled on both deployments are indicated in bold on the table. Sonde water quality monitors record hourly readings for the duration of the deployment. Consequently, exceedances can be presented as both a measure of magnitude and duration. Rolling 24-hour averages were calculated using the hourly readings for comparison against the average D.O. criteria. The duration is the count of consecutive hours that exceeded the criteria. The magnitude of an exceedance is presented as the most extreme value measured that exceeds the criteria and is presented in parenthesis after the duration. Applicable water quality criteria include: minimum D.O.[a], average D.O.[b], maximum temperature[c], pH[d] and specific conductance[e].

RM	Location	Parameter (D.O. in mg/l, Temp in ^oC, pH in SU and Sp. Cond. In µS /cm)	Comments
St. Marys River		***HELP/ECBP - Warmwater Habitat***	
100.47	@ Aqueduct Rd.	None	
100.28	@ Greenville St upst. Kopp Creek	D.O. min.: 5(3.6); 14(2.4)	Signature of organic enrichment
		D.O. avg.: 14(4.2)	Signature of organic enrichment
100.12	@ Greenville St dst. Kopp Creek	D.O. min.: 14(1.8); 13(1.5)	Signature of organic enrichment
		D.O. avg.: 24(3.4)	Signature of organic enrichment
98.50	Dst. St. Marys WWTP	D.O. min.: 1(3.9); 5(3.7)	Signature of organic enrichment
		D.O. avg.: 2(4.9)	
95.12	@ Glynwood Rd.	None	
87.80	@Barbara-Werner Rd.	None	
75.07	@ Gallman Rd.	None	
61.50	@ Frysinger Rd.	None	
57.82	@ St. Rte. 118	None	
52.13	@ Townline Rd.	None	
45.60	Adj U.S. Rte. 33	None	
43.48	@ St. Rte. 81	None	
Muddy Creek		***ECBP - Warmwater Habitat***	
0.45	@ Bay Rd.	None	
Center Branch		***ECBP - Warmwater Habitat***	
5.20	Just upst. New Knoxville WWTP	None	
4.75	@ Co. Rd. 103A	None	
3.22	@ Glynwood- New Knoxville Rd.	D.O. min.: 3(2.9)	Typical trend of primary production
0.35	@ Plattner Rd.	None	
Clear Creek		***ECBP - Warmwater Habitat***	
1.32	@ Bay Rd.	D.O. min.: 3(3.5); 7(3.0); 7(2.4)	Typical trend of primary production
East Branch		***ECBP – Undesignated***	
0.29	@ St. Rte. 29	None	
Kopp Creek		***ECBP - Warmwater Habitat***	
7.62	@ lane off St. Rte. 66	D.O. min.:	
		Sp. Cond.: *48(2628)*	
0.80	@ St. Rte. 66	D.O. min.: *1(3.9); 4(3.7); 6(3.2)*	
		D.O. avg.: *55(4.3)*	
Sixmile Creek		***HELP - Warmwater Habitat***	
1.06	@ St. Marys-Kossuth Rd.	D.O. min.: 12(2.5);	
		D.O. avg.: 25(4.1)	
0.19	@ Co. Rd. 66A	D.O. min.: *4(2.8);*	Typical trend of organic enrichment

RM	Location	Parameter (D.O. in mg/l, Temp in °C, pH in SU and Sp. Cond. In µS /cm)	Comments
		Temp. max.: 2(29.8)	Discharge from Miami and Erie Canal
Hussey Creek	***HELP - Warmwater Habitat***		
0.10	@ Hesse Rd.	None	Note the D.O. sensor failed for this sonde
Eightmile Creek	***HELP - Warmwater Habitat***		
1.22	@ Mercer Rd.	None	
Blierdofer Ditch	***HELP – Modified Warmwater Habitat***		
1.70	@ Oregon Rd.	None	
Twelvemile Creek	***HELP - Warmwater Habitat***		
0.70	@ Neptune-Mendon Rd.	None	
Prairie Creek	***HELP - Warmwater Habitat (Modified Recommended)***		
0.40	@ St. Rte. 197	D.O. min.: 4(1.1); 3(2.7); 5(3.2); 14(0.8); 15(0.6); *1(3.9); 1(2.5); 3(3.6); 7(2.6); 10(2.9); 1(3.0); 2(2.8)*	Typical trends of primary production with times of organic enrichment
		D.O. avg.: 7(4.3); 28(2.6)	Identifies signatures of organic enrichment
Little Black Creek	***HELP - Warmwater Habitat***		
1.00	@ Jordan Rd.	D.O. min.: 3(3.3); *9(2.7); 1(3.78); 10(2.8); 11(2.9); 20(0.9); 21(1.3)*	Heavy detrital debris noted in channel; signature of organic enrichment
		D.O. avg.: *98(2.1)*	Signature of organic enrichment
Black Creek		***HELP – Modified Warmwater Habitat***	
2.50	@ Winkler Rd.	None	
0.90	@ U.S. Rt. 33	D. O. avg.: 24(3.6)	Signature of organic enrichment
Town Run		***HELP – Warmwater Habitat***	
1.25	@ St. Rte. 117	D.O. min.: *4(2.8); 6(2.5); 1(3.9); 1(3.8); 6(3.0); 10(2.5)*	
		D.O. avg.: *12(4.7)*	
Duck Creek		***HELP – Warmwater Habitat***	
1.05	Dst. County Line Rd.	Temp. max.: 1(29.5)	Lack of riparian shading
		D.O. min.: *2(3.1); 1(3.3); 1(3.5)*	Typical trends of primary production
Twentyseven Mile Creek		***HELP – Warmwater Habitat***	
1.20	@ OH-IN State Line	None	

Notes: HELP - Huron Erie Lake Plain; ECBP – Eastern Corn Belt Plains

a The General Lake Erie basin daily maximum temperature criteria apply; See OAC 3745-1-35, Table 35-11(G).

b Applicable minimum 24-hour average D.O. criterion - WWH: 5.0 mg/l; MWH: 4.0 mg/l

c Applicable minimum D.O. criterion - WWH: 4.0 mg/l MWH-HELP: 2.5 mg/l

d The criteria for pH is 6.5-9.0 S.U.

e The criteria for specific conductivity is 2,400 µS/cm.

Within the sonde data, temperature exceedances of the general Lake Erie standards only occurred in two streams: Duck Creek (RM 1.05) and Sixmile Creek (RM 0.19). The riparian area along Duck Creek is maintained without trees causing the exceedance. Exceedances are frequently observed in these modified systems but do not typically describe impairment or reflect a specific source of thermal pollution. The site on Sixmile Creek is within a shaded reach of the stream, however during this time period the streamflow was dominated by a discharge from the Miami-Erie Canal at the Sixmile Creek Aqueduct. The exceedance at this site is reflective of the water quality in the canal. The two exceedances observed reflect the stream habitat and an external source, respectively.

The mainstem of the St. Marys River was assessed at 12 sites from the OH/IN state line (RM 43.48) to near its origination just downstream (RM 100.47) of the confluence of East Branch and Center Branch. Sites were placed densely around the city of St. Marys to capture the array of sources near the City including: headwater tributaries; overflows from the Miami-Erie Canal; Kopp Creek (New Bremen wastewater); and St. Marys wastewater. Downstream of the city, the landscape is largely in row crop agriculture with few small wastewater discharges. In this reach sondes were spaced further apart. The only exceedances of water quality standards were observed in the vicinity of the city of St. Marys; specifically, downstream of the overflow from the Miami-Erie Canal. Three sites downstream from the overflow (RM 100.28, 100.12 and 98.5) exceeded the minimum and average D.O. water quality criteria. The nature of these exceedances is indicative of organic enrichment from an external source, in this case the discharge from the Miami-Erie Canal.

One group of tributaries to the St. Marys River is located within the ECBP ecoregion. These tributaries include: Clear Creek; Muddy Creek; East Branch; Center Branch; and Kopp Creek. They were likely modified to improve drainage historically but had some indications of channel recovery and areas where a narrow but wooded riparian corridor has developed. Coarse substrates were also noted at many of the sites with few notes of decaying organic material within the channels. Also, commonly noted was clear water with little turbidity. These streams all exhibited strong diel fluctuations in D.O. and at several sites minimum D.O. exceedances in the early morning hours resulted. Kopp Creek (RM 0.8 and 7.62), Center Branch (RM 3.22) and Clear Creek (RM 1.32) all had minimum D.O. exceedances captured. With the exception of Kopp Creek (RM 0.8) these minimum exceedances are linked primarily to diel fluctuations from primary production. Kopp Creek (RM 0.8) also had an average D.O. criterion exceedance which identifies organic-loading stress in addition to diel fluctuations caused by primary production.

The second group of tributaries is located within the HELP ecoregion. These tributaries include: Twentyseven Mile Creek; Duck Creek; Black Creek; Little Black Creek; Prairie Creek; Sixmile Creek; Town Run; Hussey Creek; Eightmile Creek; Twelvemile Creek; and Blierdofer Ditch. These streams are more commonly in active maintenance for drainage enhancement, have generally lower gradients, finer substrates (including retained detrital material) and the water column was often described as more turbid. Most sites in this ecoregion that were monitored in the September sonde survey demonstrated minimum D.O. exceedances and several had D.O. average criterion exceedances. Sites with short duration minimum exceedances in the early morning hours are linked to diel D.O. trends reflecting algal growth. These included sites on Prairie and Duck creeks. The remaining sites that had exceedances exhibited both minimum and average exceedances, indicative of organic enrichment. Notes of detrital material of agricultural origin were common at these sites.

Specific conductance generally met the water quality standards. However, exceedances of the water quality standard (2,400 µS/cm) were observed at one site on Kopp Creek (RM 7.62). The conductivity remained elevated downstream at RM 0.8 but was not observed to exceed the water quality standard. The New Bremen WWTP discharge is upstream of this site and had high specific conductivity at times during the survey season.

Sediment Chemistry Results

Sediment samples were collected from nine locations within the study area on Sept. 23 and Sept. 29, 2015, employing methods and procedures specified in the *Ohio EPA Sediment Sampling Guide and Methodologies*, 3rd Edition (2012) and *Ohio EPA Sediment Sampling Data Quality Objectives for Biological and Water Quality Studies* (2014). The sediment sampling sites include three locations on the Miami-Erie Canal to characterize potential impacts from the canal to the St. Marys River, five locations on the St. Marys main stem to evaluate long-term trends and one location on Town Run.

Sediment collection involved looking for freshly deposited sediment in the stream bed with a bias toward fine-grained material (<60 microns, silt, clay, muck). Sand particles have a low surface area and are not chemically or biologically reactive. Clay particles have a high surface area and possess charged surfaces that attract and hold compounds. If few pollutants are bound to the sediment, it's not likely that levels will be above evaluation guidelines.

Fine-grained depositional areas were not a predominant substrate type at any of the sampling locations; however, fine substrates were common along the river margins. For this reason, depositional zones on both sides of the stream channel were sampled in an attempt to collect a composite sample representative of the stream segment. Samples were collected with a stainless steel scoop, with the exception of the canal samples which were collected with a Petite Ponar®, and then composited in a stainless steel bucket. From the bucket, the samples were transferred to the appropriate containers and then stored in a cooler at <6^{0}C until arriving at the laboratory (within 24 hours of sample collection).

Pollutant levels in the Miami-Erie Canal and the St. Marys main stem sediment samples were reviewed based upon the Ohio EPA 2010 *Guidance on Evaluating Sediment Contaminant Results* document. This document outlines an ecological impact screening protocol where contaminant concentrations are first compared to published guidelines from *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald, et. al. 2000) and Ohio EPA Sediment Reference Values (Ohio EPA 2008), and further risk assessment is carried out if those guidelines are exceeded. Not every pollutant type is included in each of these studies, while some pollutant types are included in more than one study. Furthermore, because nutrients are not included in this protocol, nutrient parameters were compared separately to thresholds published by the Ontario Ministry for the Environment (Persaud et al. 1993).

Following is a brief explanation of the ecological sediment quality guidelines which specifically apply to contaminants found in the St. Marys River study.

Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC)

This concentration level is the more conservative of a two-level set of guidelines developed by MacDonald, et al. (2000) to describe levels of contaminants based on the probability of ecological effects that arise from a given concentration. The TEC ". . . were intended to identify contaminant concentrations below which harmful effects on sediment dwelling organisms were not expected." Whereas the PEC are those where "…effects on sediment dwelling organisms were expected to occur."

The sample taken at the Miami-Erie Canal at St. Marys adjacent to Beech Road contained organic compounds that exceeded the PEC reference values. No other sites had sediment chemistry results that exceeded PEC reference values.

Ohio EPA Sediment Reference Values (SRV)

These values were developed for sediment metals using the same set of statewide ecoregion-based reference sites that were used in the development of Ohio EPA tiered aquatic life use biocriteria. The sediment reference values that were generated from this study are considered a screening tool; however, contaminants at lower concentrations than an ecoregion-specific SRV can be considered unlikely to cause deleterious aquatic life impact. Only the location at St. Marys River east of Mendon at Gallman Road was slightly above the SRV for cadmium (sample result - 0.912mg/kg, SRV value - 0.9mg/kg).

Ecological Screening Levels (ESL)

The ESLs represent a protective benchmark (for example, water quality criteria, sediment quality guidelines/criteria and chronic no adverse effect levels) for 223 contaminants (based on the RCRA 40 CFR 264 Appendix IX list of hazardous substances) and four environmental media (air, water, sediment and soil). They are used for screening purposes only, to determine if additional investigations are required. No samples in the St. Marys study showed results above the ESLs.

Summary

Metals, semi-volatile organic compounds and PCBs above screening benchmarks are presented in Table 16. Only one of the five St. Marys River sediment sampling locations showed levels above sediment-chemistry guidelines. St. Marys River east of Mendon at Gallman Road had slightly elevated levels of arsenic, cadmium and iron. Full attainment for aquatic life use was met at this site. All three locations along the Miami-Erie Canal showed at least some level of contamination. The Miami-Erie Canal adjacent to Rt. 66 at Sixmile Creek Aqueduct and at St. Marys River downstream St. Rte. 66 both had results above the TEC.

The sampling performed at the Miami-Erie Canal at St. Marys adjacent to Beech Rd. showed almost 50 percent of the constituents analyzed were above sediment-chemistry guidelines. Highly elevated levels of polycyclic aromatic hydrocarbons (PAHs) were found in six of the sample results. PAHs are found commonly in urban and suburban environments. Some sources of PAHs are incomplete combustion (gas and diesel engine exhaust and coal incinerators), road runoff, asphalt sealants used on parking lots and wastewater treatment effluent. Industrial processes are also major contributors to the distribution of PAHs. PAHs readily attach to sediment particles, leading to elevated concentrations in sediments. Most PAHs are insoluble in water, leading to limited mobility in the environment. There were several chemical compounds exceeding TEC and PEC levels at the Miami-Erie Canal at St. Marys adjacent to Beech Rd. However, the only water chemistry exceedances in the canal were dissolved oxygen, and no biology was sampled at these locations.

Sediment Nutrients

The sediment ammonia guideline is the Ontario open water disposal guideline equivalent to the lowest effect level (100 mg/kg) (Persuad 1993). The sediment phosphorus guidelines are the Ontario open water disposal guideline lowest effect level (600 mg/kg) and severe effect level (2000 mg/kg) causing disturbances in the benthic community. These guidelines were developed for harbors and are used only for reference in this document. The comparison of lake sediment toxicity to river sediment toxicity is not equivalent but is still used in lieu of any criterion established for stream sediment.

Elevated ammonia above the Ontario open water sediment disposal guideline of 100 mg/kg was present in the samples collected from the Miami-Erie Canal. In the canal, concentrations ranged from 150 mg/kg at the Sixmile Creek aqueduct to 380 mg/kg in the canal at St. Marys downstream of St. Rte. 66 which receives water from Grand Lake St. Marys. In the St. Marys River sediments, ammonia averaged 61 mg/kg, with the highest concentration of 79 mg/kg at the sampling location downstream of the St. Marys WWTP.

Phosphorus concentrations ranged from 548 to 998 mg/kg with the highest concentrations in the Miami-Erie Canal and in the St. Marys River downstream of wastewater treatment plants. Sediment phosphorus results did not exceed the Ontario open water disposal guideline of 2,000 mg/kg at any of the sediment sampling locations. However, phosphorus concentrations exceeded the lowest effect level guideline (600 mg/kg) at all sites except at the St. Marys River at Willshire sampling location (548 mg/kg).

Table 16 — Chemical parameters measured above screening levels in samples collected by Ohio EPA from surficial sediments in the St. Marys River during sampling September 2015. Contamination levels were determined for parameters using Ohio Sediment Reference Values (SRVs, 2008), consensus-based sediment quality guidelines (MacDonald, et.al. 2000) and ecological screening levels (U.S. EPA 2003). Shaded numbers indicate values above the following: SRVs (blue); threshold effect concentration – TEC (yellow); probable effect concentration – PEC (red); and ecological screening levels – ESL (orange).

Parameter	St. Marys River dst. St. Marys WWTP	St. Marys River N of St. Marys @ Glynwood Rd.	St. Marys River E of Mendon @ Gallman Rd.	St. Marys River dst. Rockford @ Townline Rd.	St. Marys River @ Willshire @ St. Rte. 81	Town Run @ Frysinger Rd.	Miami-Erie Canal adj. St. Rte. 66 @ Sixmile Cr. Aqueduct	Miami-Erie Canal @ St. Marys adj. Beech Rd.	Miami-Erie Canal (From Grand Lake) @ St. Marys, dst. St. Rte. 66
Aluminum (mg/kg)	4,380	4,510	10,500	9,790	5,090	8,240	9,890	14,400	15,000
Arsenic (mg/kg)	4.98	5.82	10.4	5.95	6.47	7.29	9.89	9.63	10.7
Barium (mg/kg)	40.5	44.9	87.5	74.2	79.2	69.3	72.3	115	128
Calcium (mg/kg)	47,400	39,200	21,000	16,200	21,700	16,400	19,500	22,800	23,000
Cadmium (mg/kg)	0.615	0.504	0.912	0.749	0.520	0.644	0.793	1.06	1.27
Chromium (mg/kg)	8.19	8.21	13.4	12.8	10.4	10.6	14.2	18.8	22.3
Copper (mg/kg)	16.2	11.4	17.2	17.0	11.0	16.3	21.6	31.3	43.7
Iron (mg/kg)	12,200	12,700	24,100	19,300	14,400	20,700	23,000	27,400	30,100
Lead (mg/kg)	17.8	12.2	15.1	12.1	24.4	13.7	16.3	22.7	27.0
Magnesium (mg/kg)	17,200	13,000	7,200	7,970	5,430	4,900	7,560	13,500	13,300
Manganese (mg/kg)	211	370	446	402	337	332	494	204	224
Mercury (mg/kg)	0.06	0.075	<0.041	0.051	<0.032	<0.037	0.051	<0.083	<0.116
Nickel (mg/kg)	12.4	12.6	20.7	17.1	13.1	17.4	21.2	29.7	36.7
Potassium (mg/kg)	<1,300	<1,250	1,620	1,450	<1,220	<1,270	<1,960	<3,390	<4,350
Selenium (mg/kg)	<1.30	<1.25	<1.47	<1.40	<1.22	<1.27	<1.96	<3.39	<4.35
Sodium (mg/kg)	<3,260	<3,140	<3,670	<3,500	<3,040	<3,180	<4,910	<8,480	<10,900
Strontium (mg/kg)	123	109	119	121	70	36	67	65	84
Zinc (mg/kg)	63.7	59.7	95.9	73.7	52.2	78.1	85.5	147	160
2-Acetylamino fluorine (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	<1.50	<1.97
4, 4’-DDD (µg/kg)	<6.4	<6.0	<6.7	<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
4,4'-DDE (µg/kg)	<6.4	<6.0	<6.7	<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
4,4’-DDT (µg/kg)	<6.4	<6.0	<6.7	<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
Alpha-Chlordane (µg/kg)	<6.4	<6.0	<6.7	<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
Benz[a] anthracene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	2.63	<1.97

Parameter	St. Marys River dst. St. Marys WWTP	St. Marys River N of St. Marys @ Glynwood Rd.	St. Marys River E of Mendon @ Gallman Rd.	St. Marys River dst. Rockford @ Townline Rd.	St. Marys River @ Willshire @ St. Rte. 81	Town Run @ Frysinger Rd.	Miami-Erie Canal adj. St. Rte. 66 @ Sixmile Cr. Aqueduct	Miami-Erie Canal @ St. Marys adj. Beech Rd.	Miami-Erie Canal (From Grand Lake) @ St. Marys, dst. St. Rte. 66
Benzo[b] fluoranthene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	2.73	<1.97
Benzo[a] pyrene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	2.14	<1.97
Benzo[b] fluoranthene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	2.73	<1.97
Benzo[g,h,i] perylene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	1.60	<1.97
Benzo[k] fluoranthene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	1.85	<1.97
Chrysene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	3.31	<1.97
Dieldrin (µg/kg)	<6.4	<6.0		<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
Fluoranthene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	0.85	<0.87	9.17	<1.97
Gamma- Chlordane (µg/kg)	<6.4	<6.0	<6.7	<7.9	<6.3	<6.1	<8.7	<15.0	<19.9
Indeno[1,2,3-cd]pyrene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	1.82	<1.97
Penta chlorophenol (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	<1.50	<1.97
Phenanthrene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	<0.60	<0.87	6.87	<1.97
Pyrene (mg/kg)	<0.64	<0.61	<0.67	<0.79	<0.63	0.66	<0.87	6.06	<1.97
PCB-1254 (µg/kg)	<32.1	<30.2	<33.5	<39.5	<31.3	<30.3	<43.7	<75.0	<99.3
PCB-1260 (µg/kg)	<32.1	<30.2	<33.5	<39.5	<31.3	<30.3	<43.7	<75.0	<99.3
Ammonia-N mg/kg	79	48	70	72	38	60	150	290	380
TOC (%)	2.8	2.2	2.4	2.3	2.7	1.5	2.2	4.9	9.0
pH (SU)	8.0	8.0	7.9	7.69	7.8	7.4	7.8	8.0	8.2
Phosphorus-T mg/kg	921	772	893	998	548	715	921	966	902
% Solids	57.2	61.9	53.8	52.0	58.7	62.1	38.6	23.0	17.7

Physical Habitat for Aquatic Life

Macrohabitat Quality

The assessment of the influence of physical stream features and riparian conditions on ambient biological performance for the St. Marys River will take two basic forms: longitudinal (upstream to downstream) and aggregate. The discussion of tributaries will either be treated in the aggregate, or if sufficiently large, tributaries or sub-basins will be broken out separately for discussion. In addition, standardized habitat measures analysis will also consider consequential regional and sub-regional factors (physiography, geology, drainage practices, land use and soils, etc.).

The St. Marys River study area included a 59-mile segment of the mainstem, from its formation at the confluence of the East and Center Branches, downstream to the state line and all tributaries of consequence attendant to this reach. In total, 57 sampling stations were distributed among 23 named and unnamed waterbodies, yielding a cumulative assessment of approximately 140 linear stream miles.

For rivers, streams or segments thereof, draining an area greater than 20 miles^2, mean QHEI values equal to or greater than 60 generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the typical WWH aquatic life use designation. Average or aggregated values at or greater than 75 are generally considered adequate to support fully exceptional warmwater habitat (EWH) communities (Rankin 1989, Rankin 1995). Values between 55 and 45 indicate that limiting components of physical habitat are present and may exert a negative influence upon ambient biological performance. However, due to the potential for compensatory stream features (for example, strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily exclude WWH or even EWH assemblages. Values below 45 indicate a higher probability of habitat-derived aquatic life use impairment but should not be viewed as determinant.

For waters draining less than 20 square miles (headwaters), associated habitat narratives and aquatic life potential, as measured and appraised by the QHEI, vary slightly from those established for larger waters (Ohio EPA 2009). Exceptional conditions are generally indicated by QHEI values greater than 70. Macrohabitat quality ranked as good or otherwise associated with WWH communities ranges between 70 and 55. QHEI scores below this range down to 43 are considered fair, indicating limiting factors are present and will likely exert a negative influence upon aquatic communities. Values below this range indicate macrohabitat in the poor to very poor range. The accrual of multiple high influence negative features typical of waters so characterized, indicates significant habitat deficit and an associated higher probability of habitat-related aquatic life use impairment, in the absence of compensatory features.

St. Marys River Mainstem

As part of the 2015 fish sampling effort, the quality of near and in-steam microhabitats of the St. Marys River mainstem were evaluated at 15 sampling locations, assessing approximately 59 miles of the mainstem. A matrix of QHEI scores and macrohabitat features, by station and ecoregion, are presented in Table 17. Longitudinal performance of the QHEI for the St. Marys River is presented in Figure 21. Performance of the QHEI, by stream, sub-basin or other aggregations are presented in Figure 22 and Figure 23.

QHEI values from the St. Marys River mainstem ranged between 49 and 74, with a mean score of 57.6 (±12.47, two SD). Narratively, these statistics describe a range of macrohabitat quality from very good to fair-poor, and typical conditions as being fair-marginally good. Although decidedly subpar, aggregate channel, substrate and riparian features on the St. Marys River did not appear profoundly degraded. St. Marys River is in many ways habitat constrained, and the associated deficits undoubtedly influence the competency of the system to consistently support diverse aquatic communities; however, the dominant condition or central tendency would not predict wide-spread use impairment, or necessarily preclude WWH communities.

Table 17 — A matrix of QHEI scores and macrohabitat features of river and streams contained within the St. Marys River study area, 2015.

Key QHEI Components

			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
River Mile	QHEI	Grade. (ft./mile)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Mod. Influence Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
04-500-000 St. Marys River ECBP																																		
100.5	53.0	4.00									X		1				X		1	X	X			X	X			X	X	X	X	8	1.50	5.00
100.1	51.7	4.30		X							X		2				X		1	X	X			X	X			X	X		X	7	1.00	3.00
98.5	63.3	1.77		X							X	X	3				X		1	X	X			X	X			X	X	X		7	0.75	2.25
95.1	56.5	3.85		X		X	X	X	X		X		6				X		1	X	X			X	X		X		X	X		7	0.43	1.14
		HELP																																
87.8	56.5	1.00	X	X			X	X			X		5				X		1		X			X				X	X		X	5	0.33	1.00
80.5	58.0	0.92	X	X			X	X			X		5		X		X		2		X			X	X			X	X		X	6	0.50	1.17
75.1	53.3	1.09	X	X				X			X		4		X		X		2		X			X	X			X	X		X	6	0.60	1.40
70.4	56.5	0.90	X				X	X			X		4				X		1		X	X		X				X	X		X	6	0.40	1.40
65.7	49.0	0.50	X								X		2		X		X		2		X			X	X			X	X		X	6	1.00	2.67
61.5	54.7	0.50	X				X	X			X		4		X				1		X			X	X			X	X		X	6	0.40	1.60
57.8	63.0	1.00	X	X			X	X			X		5						0		X			X				X	X		X	5	0.17	1.17
52.1	58.5	0.90	X	X			X	X			X		5		X				1		X			X	X			X	X		X	6	0.33	1.33
47.5	62.3	0.60	X	X		X	X	X	X		X		7				X		1		X			X	X				X		X	5	0.25	0.88
45.6	52.8	0.60	X								X		2				X		1		X			X	X			X	X		X	6	0.67	2.67
43.5	75.0	1.00	X	X		X	X	X			X		6						0		X			X	X			X	X	X		6	0.14	1.14
04-500-006 East Branch ECBP																																		
0.3	57.5	8.92		X					X		X	X	4				X		1	X	X			X	X		X		X	X	X	8	0.60	2.00
04-517-000 Clear Creek ECBP																																		
5.4	62.8	8.96		X			X	X		X	X	X	6				X		1	X	X			X	X			X	X			6	0.43	1.14
1.3	50.5	4.42									X	X	2	X			X		2	X	X			X	X		X	X	X	X	X	9	1.00	3.67
04-520-000 Muddy Creek ECBP																																		
5.4	57.0	9.30		X						X		X	3				X	X	2	X				X	X			X	X		X	6	1.00	2.00
0.5	59.3	9.43		X	X		X	X		X		X	6				X	X	2	X				X	X			X	X	X	X	7	0.57	1.29
04-518-000 Center Branch ECBP																																		
6.6	56.3	7.35		X						X	X	X	4				X		1	X				X	X		X	X	X		X	7	0.60	1.80
5.2	62.0	7.04		X				X		X	X	X	5				X		1	X	X			X	X		X	X	X	X	X	9	0.50	1.83
3.2	52.0	5.68		X									1				X	X	2	X				X	X			X	X	X	X	7	2.00	4.50
0.3	50.0	5.35		X							X		2				X		1	X	X			X	X		X	X	X	X	X	9	1.00	3.67
04-519-000 Carter Creek ECBP																																		
1.9	53.0	6.94		X				X					2				X	X	2	X	X			X	X			X	X	X	X	8	1.33	3.33

Key QHEI Components

			WWH Attributes											MWH Attributes: *High Influence*						MWH Attributes: *Moderate Influence*														
River Mile	**QHEI**	**Grade. (ft./mile)**	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Mod. Influence Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
04-524-000 Kopp Creek ECBP																																		
8.9	57.0	17.24		X			X			X		X	4				X	X	2	X				X	X			X			X	5	0.80	1.40
7.6	55.5	7.58		X						X	X	X	4				X		1	X	X			X	X		X	X	X	X	X	9	0.60	2.20
4.3	61.8	7.94	X				X				X		3				X		1	X				X	X			X	X	X		6	0.75	2.00
0.8	65.5	8.20		X							X	X	3				X		1	X	X			X	X			X	X		X	7	0.75	2.25
04-524-001 Wierth Ditch ECBP																																		
0.5	55.3	8.06		X						X	X	X	4	X			X		2	X				X	X			X			X	5	0.60	1.40
04-524-002 UN Kopp Trib. @ RM 5.4 ECBP																																		
0.3	53.8	8.62		X				X					2				X	X	2	X	X			X	X			X	X	X	X	8	1.33	3.33
04-516-001 Fourmile Creek ECBP																																		
0.1	35.3	9.09											0			X	X	X	3	X	X			X	X			X	X	X	X	8	5.00	9.00
04-515-000 Sixmile Creek HELP																																		
1.1	48.8	4.10						X			X		2	X			X		2	X	X			X	X			X	X		X	7	1.00	3.00
04-501-000 Prairie Creek HELP																																		
2.8	25.0	3.50											0	X	X		X	X	4	X	X			X	X			X	X		X	7	5.00	8.00
1.0	22.8	1.40									X		1	X	X	X	X		4		X			X			X	X	X		X	6	2.50	3.50
04-514-000 Hussey Creek HELP																																		
2.4	56.5	8.50	X				X	X		X	X	X	6						0		X		X	X	X			X				5	0.14	0.86
0.1	46.3	4.00						X		X	X		3			X			1	X	X		X	X	X			X	X		X	8	0.75	2.25
04-513-000 Eightmile Creek HELP																																		
6.6	55.8	0.50	X					X		X	X	X	5	X					1		X			X	X			X				4	0.33	1.00
1.2	45.0	5.10						X			X		2	X	X		X		3	X	X			X	X			X	X		X	7	1.33	2.67
04-510-000 Twelvemile Creek HELP																																		
11.0	32.0	1.61											0	X	X	X	X	X	5	X	X			X	X			X	X	X	X	8	6.00	10.00
1.8	34.8	1.92									X		1	X	X	X	X		4		X			X	X		X	X	X	X		7	2.50	4.00
04-511-000 Blierdorfer Ditch HELP																																		
2.5	42.7	5.10											0				X	X	2	X	X		X	X	X			X	X	X	X	9	4.00	10.00
1.7	28.0	4.72											0	X	X	X	X	X	5		X		X	X	X	X		X	X		X	8	6.00	9.00
04-508-000 Yankee Run HELP																																		
1.4	26.8	3.25									X		1	X	X	X	X		4		X			X	X	X	X	X	X		X	8	2.50	5.00
04-506-000 Town Run HELP																																		
2.1	38.0	4.50					X				X		2		X		X		2	X	X			X	X			X	X		X	7	1.33	3.00
1.3	46.5	4.50						X			X		2		X				1	X	X		X	X	X			X	X		X	8	1.00	3.33

Key QHEI Components

			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
River Mile	QHEI	Grade. (ft./mile)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Mod. Influence Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
04-503-000 Black Creek HELP																																		
10.7	50.5	6.90											0				X	X	2	X	X			X	X			X	X		X	7	4.00	9.00
2.5	45.8	3.92					X	X		X	X		4				X		1	X	X			X			X	X	X		X	7	0.60	1.80
0.9	40.8	3.10									X		1	X	X		X		3	X	X			X	X		X	X	X		X	8	2.00	5.00
04-504-000 Little Black Creek HELP																																		
6.9	42.8	2.00									X		1	X			X		2	X	X			X	X		X	X	X	X	X	9	1.50	5.50
4.0	33.8	2.60					X				X		2		X		X		2	X	X			X	X		X	X	X		X	8	1.33	3.33
1.0	45.8	4.50		X			X	X			X		4		X		X		2	X	X		X	X	X			X	X		X	8	0.80	1.80
04-502-000 Duck Creek HELP																																		
4.7	22.5	2.10											0	X	X	X	X	X	5		X		X	X		X		X	X		X	7	6.00	9.00
1.1	49.0	4.50		X							X	X	3				X		1	X	X		X	X	X		X	X	X	X	X	10	0.75	3.00
04-500-001 Twentysevenmile Creek HELP																																		
4.1	42.5	3.20										X	1	X			X	X	3	X	X			X	X			X	X	X	X	8	2.00	5.00
1.2	55.3	3.40									X		1				X		1	X	X		X	X	X			X	X	X	X	9	1.50	5.50
04-500-002 UN Twentysevenmile Trib. @ RM 3.1 HELP																																		
0.4	56.3	2.38	X	X			X	X			X		5				X		1	X	X			X	X			X	X	X	X	8	0.50	1.67

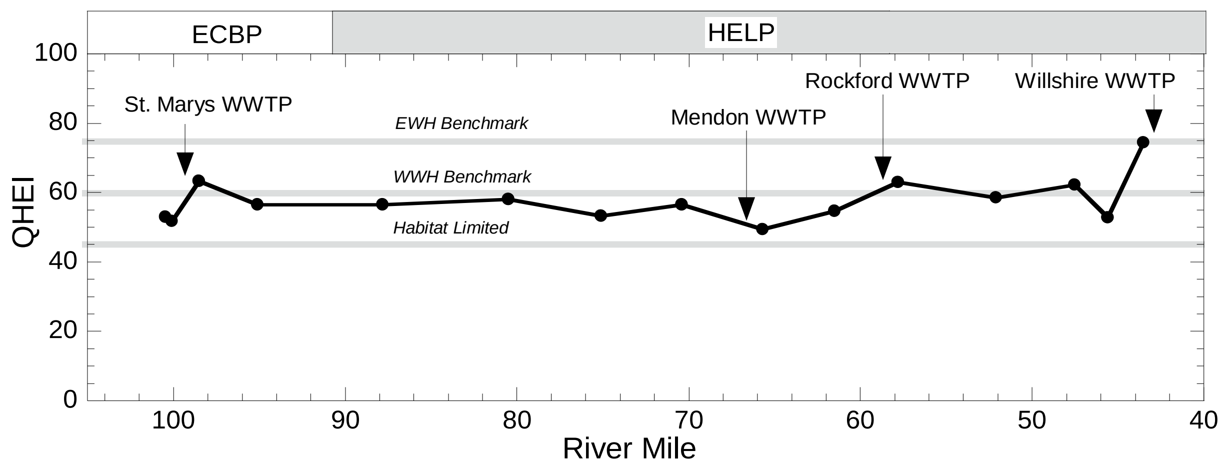

Figure 21— Longitudinal performance of the QHEI, St. Marys River mainstem, 2015. Horizontal grey-scale lines identify EWH and WWH benchmarks, and index scores typical of significantly deficient or otherwise potentially limiting macrohabitat (Rankin 1989, Rankin 1995 and Ohio EPA 2006). The St. Marys River is a transboundary system, draining portions of both the ECBP and HELP ecoregions (Omernik 1987 and Omernik and Gallant 1988).

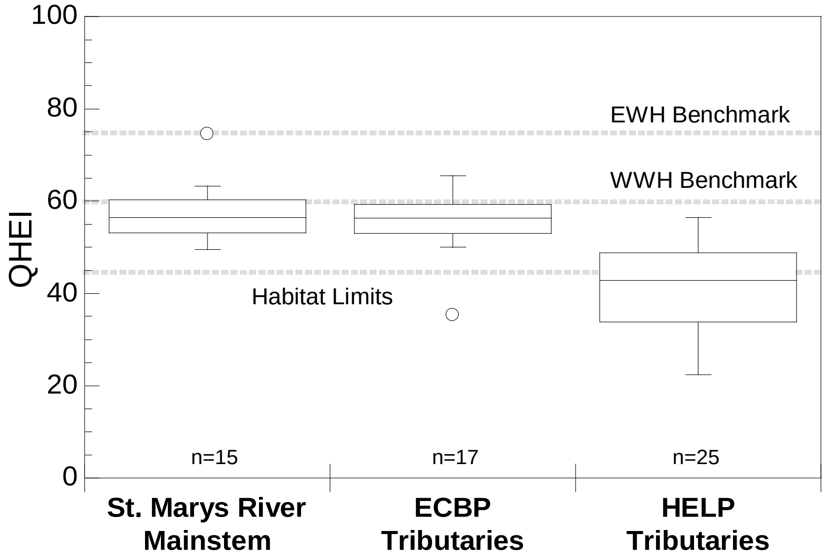

Figure 22 — Performance of the QHEI, for the St. Marys River study area, 2015: mainstem and tributaries within the ECBP and HELP ecoregions (Omernik 1987 and Omernik and Gallant 1988). Horizontal dashed lines EWH and WWH benchmarks, and index scores typical of significantly deficient or otherwise potentially limiting macrohabitat (Rankin 1989, Rankin 1995 and Ohio EPA 2006).

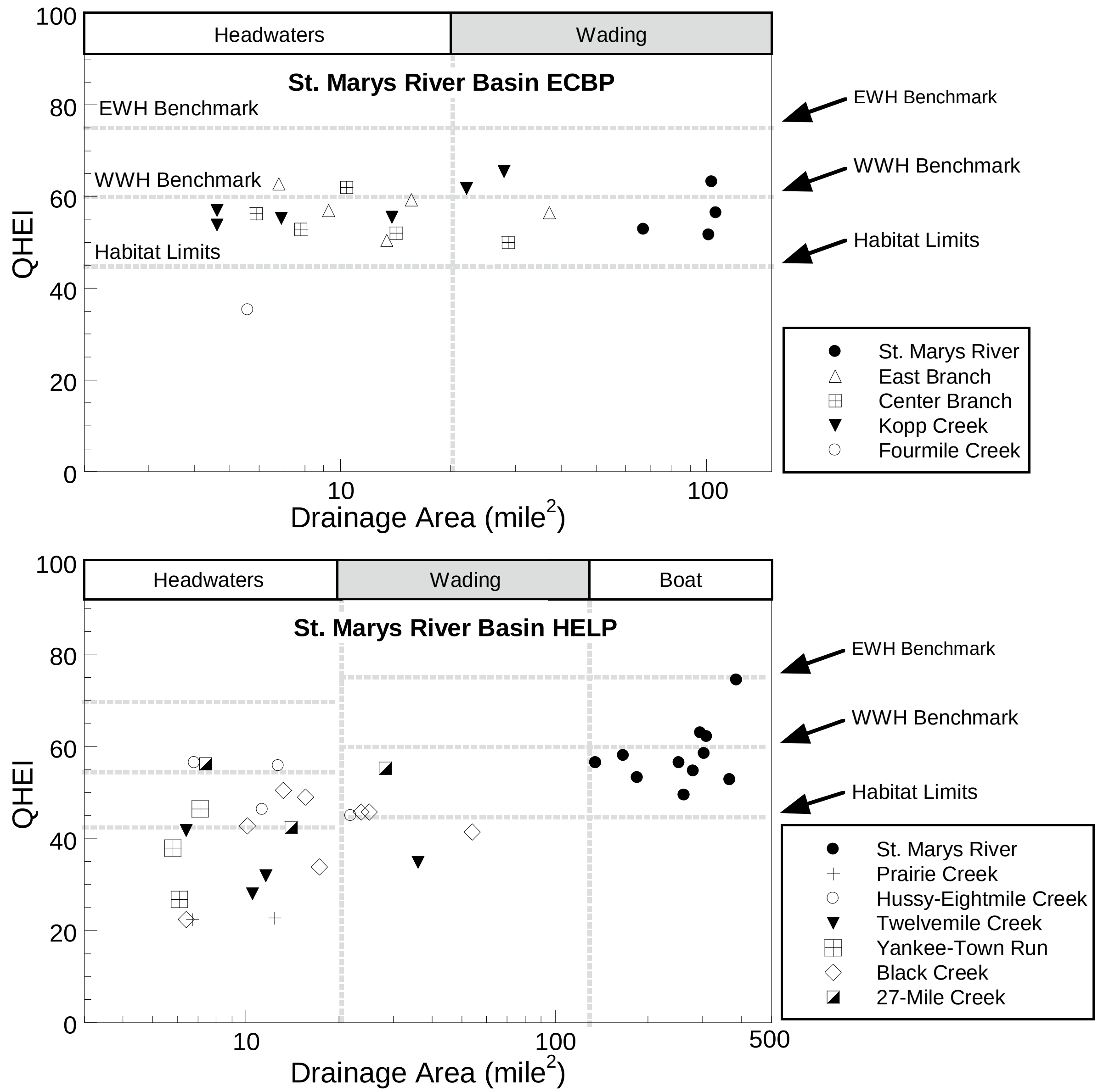

Figure 23 — Distributions of QHEI scores from the entire St. Marys River by stream size (drainage area). Upper and lower figures display the results from sites within ECBP and HELP ecoregions, respectively (Omernik 1987 and Omernik and Gallant 1988). Vertical dashed line represents the threshold between headwaters (≤20 mi²) and wading (>20 mi²) sites. From top to bottom, horizontal dashed lines indicate EWH and WWH benchmarks and a threshold at or below which macrohabitat is likely to be limiting (Rankin 1989, Rankin 1995 and Ohio EPA 2006).

Of the 15 mainstem sampling stations, only four yielded QHEI values equal to or greater than WWH benchmark. Areas of better quality habitat included a portion of the upper river, between RMs 98.5 and 95.1 (downstream from St. Marys), where the Wabash end moraine is breached, thus charging the bedload with coarse material, resulting in locally improved substrate conditions. Selected stations through the lower 15 miles of the study area, between the villages of Rockford and Willshire, also offered pockets of generally good macrohabitat. Of particular note were high quality conditions identified at the lowest mainstem site at RM 43.5. Here the St. Marys River has cut down to dolomite bedrock, over which coarse alluvium has been generously deposited. Sinuosity and channel development were modest, but adequate to permit the formation of a functional riffle-run complex composed of cobble, gravel and boulders — an uncommon feature on the St. Marys River. Substrates types here were diverse, generally coarse and largely free of excessive deposits of clayey silt. However, due to the resistant nature of bedrock, erosive forces are dissipated through lateral scour, resulting in an overabundance of shallow glide habitat and a general paucity of well-defined pools, particularly the type commonly associated with the cut bank (outside bend).

Macrohabitat quality at the remaining 11 stations, representing more than 70 percent of the mainstem, was middling in nature. The most consequential habitat deficit common to these sites, and to a lesser extent at better reaches as well, was sedimentation. Taxa richness, recruitment and the over-arching structure and function of lotic communities are closely linked to the particle size of streambed sediments. The most immediate and consequential effect of excessive sedimentation upon riverine habitat is the smothering or embedding of coarse bed material and various types of instream structure by sand and clayey silts, resulting in loss or diminution of substrate interstices and functional deterioration of in-stream cover. It is through the associated loss or degradation of living space (critical feeding and breeding substrates and necessary cover) that aquatic communities are negatively affected by sediment (Fajen and Layzer 1993, Waters 1995). Given the low stream power of the St. Marys River (due to very low gradient) the system has entrained vast quantities of fine sediment, delivered over multiple decades from the extensively hydrologically modified tributaries and associated uplands which they drain.

Sedimentation and its attending effects were more acute within portions of the St. Marys River draining HELP ecoregion. For reasons described previously, biocriteria here are significantly lower than any other parts of the state (Ohio EPA 1987b). As such, QHEI scores that would predict or otherwise suggest habitat-related use impairment outside of the HELP may in fact be compatible with the regional calibrated (significantly lower) HELP biocriteria.

St. Marys River Tributaries

The 2015 sampling effort included 22 direct and indirect St. Marys River tributaries. In total, 42 sampling stations where deployed to these waters, yielding a cumulative assessment of approximately 81 linear stream miles. Including the final determinations regarding the placement of transitional streams referenced previously, nine tributaries are located within the ECBP ecoregion, and the remaining 13 drain the HELP ecoregion. Given the physical and biological disparities between these areas, the assessment of tributary macrohabitat quality shall be divided by ecoregion. Performance of the QHEI, by stream, sub-basin or other aggregations are presented in Figure 21, Figure 22 and Figure 23. The ratio of negative and positive habitat attributes by ecoregion are presented in Figure 24 and Figure 25.

ECBP Tributaries

Assessed St. Marys River tributaries contained within the ECBP ecoregion included the entire headwaters of the St. Marys River (East Branch, Center Branch and Kopp Creek sub-basins) and Fourmile Creek (Table 17). Seventeen monitoring stations were deployed to these waters. QHEI scores ranged between 35.3 and 65.5, with a mean value of 55.5 (±13.61, 2 SD). Eight of the 17 corn-belt sites (47.1 percent) yielded QHEI values equal to or greater than the minimum headwater or wading WWH benchmarks, 55 and 60, respectively (Ohio EPA 2006).

To varying degrees, all ECBP tributaries bore evidence of previous channel modification, the effects of which were manifested in attending habitat deficits. Associated limiting channel and substrate features commonly encountered included: channel incision; fair-poor development; low functional sinuosity; and sparse in-stream cover, with selected stations showing heavy-moderate siltation and a moderate degree substrate embeddedness. Despite these limiting characteristics, most sites also contained a compliment of positive features. By and large, substrates were coarse (gravel or sand, or both) and in most instances, were not excessively embedded by clayey silts. Although modified, considerable channel recovery was observed, this due to natural fluvial processes, incidentally facilitated by the lack of aggressive channel maintenance by local authorities. The combination of adequate stream power (gradient and flow) and abundant glacial till and outwash within the uplands (bedload source material) has allowed for the redevelopment of modest meanders and other rudimentary features through active bank erosion and the conveyance, sorting and redeposition of bedload sediment.

At the station or reach scale, streams that showed the greatest degree of recovery (best quality habitat) were upper Clear Creek (RM 5.4), middle Center Branch (RM 5.2) and lower Kopp Creek (RMs 4.3 and 0.8), where QHEI values consistently exceeded 60. At similar scales, habitat deficit likely to preclude WWH communities or otherwise limit ambient biological performance were observed on the following streams: lower Clear Creek (RM 1.3) and lower Center Branch (RMs 3.2 and 0.3). Among these waters QHEI scores were within the low-fair to very poor range.

Habitat quality of the remaining corn-belt sites was reflective of partial or incomplete physical recovery. Taken together, QHEI scores from these sites did not suggest or predict widespread use impairment derived solely from deficient habitat, nor did they indicate an absence of structural habitat limitations among these waters, and instead reflected middling conditions, not optimal, but not profoundly degraded either.

HELP Tributaries

St. Marys River tributaries contained within the HELP ecoregion included all direct tributaries and larger tributary sub-basins draining to the St. Marys River from the mouth of Sixmile Creek (RM 89.12), downstream to Twentyseven Mile Creek (Indiana-Ohio Stateline). Together these waters represented 13 named and unnamed streams. Twenty-five monitoring stations were deployed to evaluate these waters. QHEI score ranged between 22.5 and 56.5, with a mean value of 41.25 (±21.62, 2 SD).

Narratively, these statistics describe a range of macrohabitat quality from good-fair to very poor, and typical conditions as being fair-poor. All sites contained ample evidence of extensive past modification. The channels were often trapezoidal in cross-section, deeply incised and monotonous in form. Dominant substrates were largely fine, often a mix of the clayey silts and muck. If present, coarser bed material was often heavily embedded by or with clayey silts. Diversity and abundance of instream cover were low and sparse, respectively, and riparian vegetation at most sites was patchy or lacking altogether.

Of 25 HELP tributaries sites, only four yielded QHEI scores equal to or greater than the headwater or wading WWH benchmarks. Nearly 50 percent yielded QHEI scores below these thresholds, with the vast majorities of these well within the poor range. The remaining sites were intermediate in nature, but, to varying degrees labored under the same habitat deficits stemming from channelization and sedimentation. Best conditions were observed on upper Hussy Creek, upper Eightmile Creek and lower Twentyseven Mile Creek and its principal Ohio tributary. Significantly deficit habitat was observed on all or portions of Fourmile Creek, Prairie Creek, Twelvemile Creek, Blierdorfer Ditch, Yankee Run, Town Run, Little Black Creek and Duck Creek. In the absence of compensatory features, QHEI scores and attribute ratios from these streams suggest a high probability of habitat-related use impairment.

The range of conditions and central tendency of these streams stands in stark contrast to those observed within the ECBP. Compared against corn-belt tributaries, the average HELP QHEI score was more than 10 units lower, significantly fewer HELP sites meet or exceeded the wading and headwater WWH thresholds, and the number of waterbodies yielding habitat evaluations in the poor range was nearly 10 times greater. Despite both ECBP and HELP tributaries having been subjected to extensive hydromodification, most HELP tributaries have failed to recover or reestablish a suite of rudimentary positive stream features, this is due to low stream power (gradient and flow) and the composition of the upland soils associated with the HELP. More aggressive channel maintenance by local authorities may have contributed to this observation, but its effects would be circumscribed, as all or portions of only four HELP tributaries evaluated in 2015 are formally maintained as open ditches as provided for by Ohio drainage law. Streams so described would include all or portions of Prairie Creek, Little Black Creek, Duck Creek and Twentyseven Mile Creek. It is important to reiterate that many more waterways are maintained for drainage purposes, however, they are generally very small and situated well upstream from the stream reaches evaluated in 2015.

Habitat deficits and limitations described above are common to waterbodies draining the HELP ecoregion as a whole. For reasons described previously, biocriteria for this region are significantly lower than any other part of the state (Ohio EPA 1987b). As such, QHEI scores that would predict or otherwise suggest habitat-related use impairment outside of the HELP may in fact be compatible with the regional calibrated (significantly lower) HELP biocriteria.

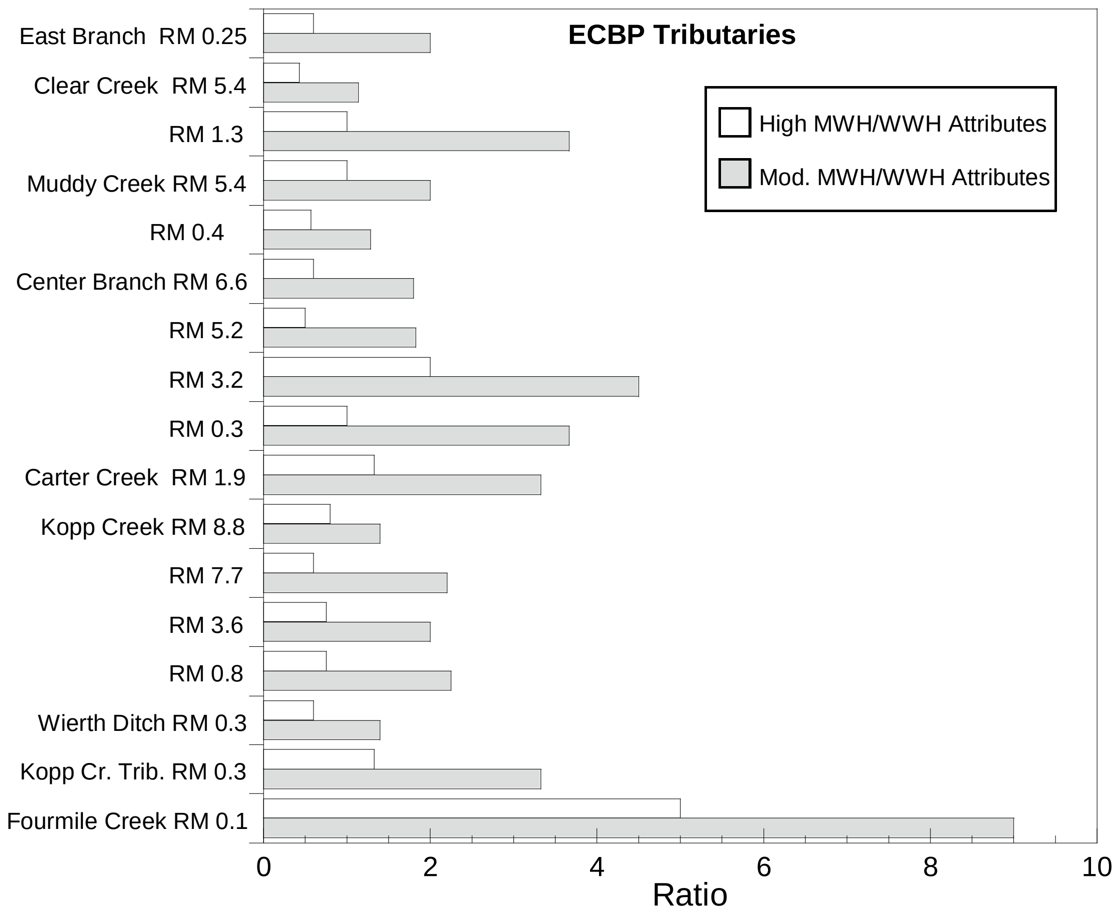

Figure 24 — Ratios of moderate/high influence (negative) macrohabitat attributes and WWH (positive) macrohabitat attributes per Rankin (1989) and Rankin (1995) for St. Marys River tributaries within the ECBP ecoregion (Omernik 1987 and Omernik and Gallant 1988). Ratios of moderate and high influence attributes ≥2.0 and 3.0, respectively, are indicative of habitat limitations.

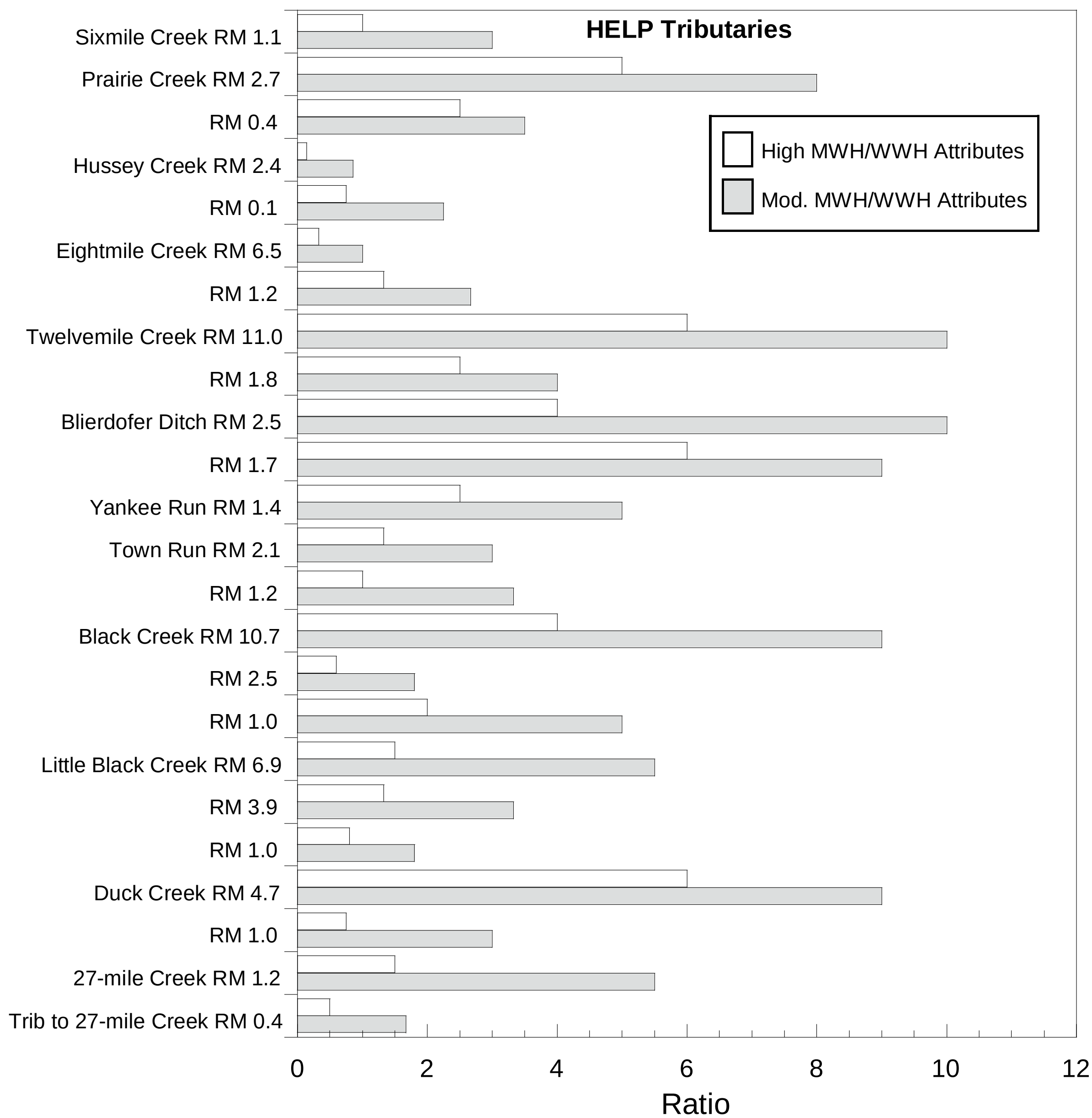

Figure 25 — Ratios of moderate/high influence (negative) macrohabitat attributes and WWH (positive) macrohabitat attributes per Rankin (1989) and Rankin (1995) for St. Marys River tributaries within the HELP ecoregion (Omernik 1987 and Omernik and Gallant 1988). Ratios of moderate and high influence attributes ≥2.0 and 3.0, respectively, are indicative of habitat limitations. In comparison with ECBP tributaries, note the very high frequency of ratios above the afore mentioned ranges.

Macrohabitat Trends

A review of historical monitoring data provides an excellent opportunity to evaluate the environmental conditions of the St. Marys River basin through time. Prior to the 2015 systematic survey, water quality investigations of the St. Marys River were largely piece meal in nature. The mainstem was surveyed and assessed in 1991, but this effort was limited to only the upper 25 miles (Ohio EPA 1992). Between 1981 and 1999, many tributaries were surveyed, but these efforts were disseminated or otherwise limited in scope, supporting various water quality management activities over the intervening 18 years (for example, 401 certifications, NPDES permitting, stream regionalization, use designation, reference site monitoring).

The assessment of macrohabitat trends within the St. Marys River basin is based upon on a comparison between tributaries, monitoring stations or stream reaches common to both, the historical efforts and the 2015 basin-wide survey. Although not ideal, in that the historical information from which comparisons will be drawn spans an 18-year period, these data did permit a coarse or general appraisal of gross habitat conditions through time. Common waters included seven named streams, draining both the ECBP and HELP ecoregions. QHEI score and the performance of important index metrics are summarized in Figure 26.

Among the selected St. Marys River tributaries subjected to a trend analysis, macrohabitat complexity and its overall competency to support a diverse and well-organized aquatic communities appeared to have increased though the period of record. This was manifest in the aggregated scores, as well as most of the habitat metrics that combine to form the QHEI. Either singularly or in combination, parametric and nonparametric tests found strong statistical differences ($p<0.05$) between historical data and the 2015 survey results for the QHEI and most metrics (cover, channel form and riffle development). Although not statistically significant, the substrate metric generally performed better in 2015 (for example, higher median, upper and lower quartiles and range).

These improvements reflect a combination of a gradual physical recovery and modern soil conservation efforts aimed at reducing sedimentation, and together represent a beneficial, self-reinforcing phenomenon. Improved channel form and complexity not only raises the ambient biological potential of a given stream reach, but also enhances its ability to process sediment and assimilate diffuse pollutant loads. Improved substrate conditions would similarly advance the ambient potential and assimilative capacity through a coarsening of the streambed. Furthermore, albeit to a lesser extent, these findings regarding reduced soil loss and a lessoning of in-stream sedimentation mirror or are otherwise consistent with larger trends. At national and regional scales, the broad adoption of modern tillage practices has reduced gross erosion since the late-1970s (NRCS 2007). Studies within the Maumee River basin and other smaller watersheds affirm the national assessment and have gone further to demonstrate linkages between agricultural best practices, reduced soil loss, reduced in-stream sedimentation and a concurrent positive response of the ambient biology (Barton and Farmer 1997, Meyers and Metzger 2000, Yoder et al. 2004, Richards et al. 2009, Tessler and Gottgens 2012 and Miltner 2016). Over the past 15 years, Ohio EPA has observed state-wide the reestablishment of not only formerly imperiled, substrate sensitive fish species (for example, bigeye chub and sand darter), but also broad community shifts toward lithophilic and specialist insectivorous species (substrate-dependent taxa), with a corresponding decline in ecological generalists (for example, common carp).

It is important to note that these results from the St. Marys River basin did not indicate full recovery or complete restoration of lost riverine habitat, as many of these tributaries still labor under the effects of sedimentation and hydromodification. Instead, these data show that significant improvements to macrohabitat quality have occurred over the past 20 to 30 years, and that commensurate improvement in the aquatic community performance is anticipated. Furthermore, although incomplete, these improvements are consistent with state, regional and national trends.

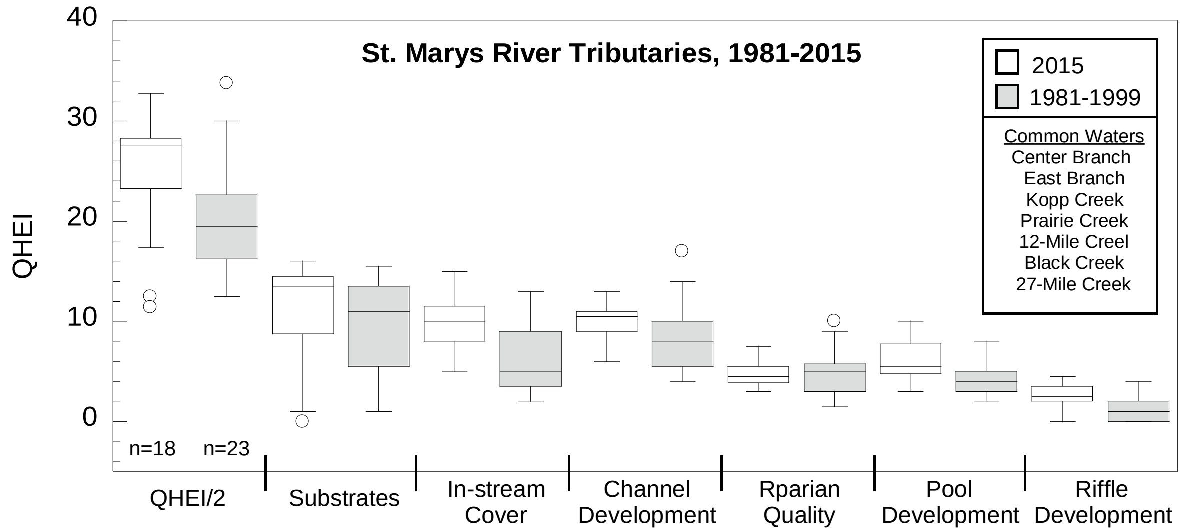

Figure 26 — Box plots of the QHEI and metric from St. Marys River tributaries common to both, the 2015 survey and previous investigations. Note improvements in site scores (QHEI) most other subcomponents (QHEI metrics).

Biological Quality and Environmental Stressor Gradients

Biological attainment status was determined for 58 locations in the study area. Sampling locations were evaluated using WWH biocriteria with the exception of the sites of Prairie Creek, a portion of Duck Creek, Black Creek, Blierdorfer Ditch and Wierth Ditch which are designated or recommended as MWH. Both fish and macroinvertebrate community condition were considered at each location with a few exceptions. The fish community was not sampled in the St. Marys River upstream from Kopp Creek (RM 110.28). Macroinvertebrates were not sampled in Town Run at Frysinger Rd. (RM 1.87) or Little Black Creek at Wilson Rd. (RM 3.95). Relative numbers of fish species collected per location are presented in Appendix D. Index of Biotic Integrity (IBI) and Modified Index of wellbeing (MIwb) scores are presented in Table 18. IBI metric breakdowns can be found in Appendix E.

Qualitative macroinvertebrate sampling was conducted at 56 locations (Table 19). Additionally, 25 of the sites on St. Marys River and eight tributaries were evaluated with quantitative sampling protocols where drainage areas exceeded 20 sq. miles. Supplementary sampling was conducted at three St. Marys River locations in 2016. The St. Marys River sites at US 127 (RM 65.70) and at Frysinger Road (RM 61.50) were resampled due problems with evaluating the sites when high water levels were encountered the previous year. Macroinvertebrate sampling was conducted in 2016 upstream from Kopp Creek, adjacent Greenville Road (RM 100.28) to ascertain the impact of the Miami-Erie canal discharge on the St. Marys River. Macroinvertebrate collection results by station and ICI metric scoring are presented in Appendices B and C, respectively.

Statistical methods used to group sites based on macroinvertebrate assemblages and to assess the relationships between those groups and environmental stressors are found in Appendix L. The hierarchical clustering groups determined by these methods are illustrated below in a modified attainment table (Table 20), boxplots of environmental variables ordered by site grouping (Figure 27), and a map of the St. Marys biological site locations (Figure 28). Insights from the analysis are included throughout the biological discussion. Some sites monitored during the survey were not included in the statistical analysis due to insufficient data, and they will not be included in any related tables or figures.

Table 18 — Attributes of fish samples collected from the St. Marys River study area, 2015.

River/ Stream River Mile	Drain. Area (miles²)	Cumulative Species	Mean Native Species	Relative Weight (kg/km)[a]	Relative Number (no./km)[a]	QHEI	IBI	MIwb[b]	Narrative
St. Marys River 04-500-000 ECBP WWH									
100.47[W]	67.1	32	24	4.3	1,056.8	53.0	39[ns]	8.1[ns]	M. Good
100.12[W]	101.0	34	25.5	92.3	349.0	51.8	37[ns]	9.3	M. Good-V. Good
98.50[W]	103.0	37	28.5	33.1	643.5	63.3	42	9.3	Good-V. Good
95.12[W]	106.0	30	25.5	33.7	1,136.3	56.5	36[ns]	9.5	M. Good-Except.
HELP WWH									
87.8[B, 1]	135.0	33	25.5	166.6	614.0	56.5	33[ns]	9.6	Fair-Except.
80.51[B]	166.0	35	26	62.2	823.0	58.0	33[ns]	9.3	Fair-V. Good
75.07[B]	184.0	37	26	69.4	846.0	53.3	32[ns]	9.1	Fair-Good
70.4[B]	251.0	31	24.5	103.8	736.0	56.5	36	9.2	M. Good-V. Good
65.7[B]	261.0	33	22	229.0	512.0	49.0	35	9.6	M. Good-Except.
61.5[B]	279.0	34	24.5	84.2	758.2	54.8	36	9.5	M. Good-V. Good
57.82[B]	295.0	38	26.5	137.9	833.0	63.0	36	10.1	M. Good-Except.
52.13[B]	303.0	31	23.5	143.3	698.0	58.5	31[ns]	9.3	Fair-V. Good
47.48[B]	309.0	35	24.5	83.4	728.0	62.3	37	9.2	M. Good-V. Good
45.6[B]	366.7	31	22.5	124.7	690.0	52.8	34	9.3	M. Good-V. Good
43.48[B]	386.0	35	27	183.2	1,100.2	75.0	37	10.3	M. Good-Except.
East Branch 04-500-006 ECBP WWH+									
0.27[W]	37.1	32	24.5	7.7	1,168.3	57.5	32*	8.5	Fair-Good
Clear Creek ECBP 04-517-000 WWH+									
5.4[H]	6.8	18	18	--	2,101.5	62.8	36[ns]	--	M. Good
1.32[H]	13.4	24	23	--	1,687.5	50.5	44	--	Good
Muddy Creek 04-520-000 ECBP WWH+									
5.4[H]	9.3	13	13	--	1,612.0	57.0	38[ns]	--	M. Good
0.45[H]	15.6	22	22	--	1,749.0	59.3	44	---	Good
Center Branch 04-518-000 ECBP WWH+									
6.6[H]	5.9	16	16	--	2,780.0	56.3	38[ns]	---	M. Good
5.2[H]	10.4	19	19	--	1,968.0	62.0	44	--	Good
3.22[H]	14.2	18	18	--	2,271.0	52.0	38[ns]	---	M. Good
0.34[W]	28.7	23	20.5	2.6	1,203.0	50.0	34*	7.8[ns]	Fair-M. Good
Carter Creek 04-519-000 ECBP WWH+									
1.86[H]	7.8	21	21	--	1,612.0	53.0	46	--	V. Good
Kopp Creek 04-524-000 ECBP WWH									
8.9[H]	4.6	14	14	--	1,804.0	57.0	38[ns]	--	M. Good
7.62[H]	13.8	20	19	--	2,136.0	55.5	34*	--	Fair
3.6[W]	22.1	24	20.5	3.2	1,877.3	61.8	36[ns]	8.5	M. Good-Good
0.8[W]	28.0	24	19	3.2	1,741.5	65.5	34*	7.4*	Fair-Fair
Wierth Ditch 04-524-000 ECBP MWH									
0.45[H]	6.9	21	20	--	764.0	55.3	40	--	Good
Trib. to Kopp Creek 04-524-002 ECBP WWH+									
0.3[H]	4.6	19	18	--	2,948.0	53.8	36[ns]	--	M. Good
Fourmile Creek 04-516-000 ECBP WWH+									
0.1[H]	5.6	16	15	--	764.0	35.3	36[ns]	--	M. Good
Sixmile Creek 04-515-000 HELP[1] WWH+									
1.06[H]	16.2	25	21	--	656.6	48.8	36	--	M. Good
Prairie Creek 04-501-00 HELP[1] MWH+									
2.75[H]	6.7	19	17	--	1,286.7	25.0	36	--	M. Good
1.02[H]	12.4	26	25	--	1,324.0	22.8	36	--	M. Good

River/ Stream River Mile	Drain. Area (miles²)	Cumulative Species	Mean Native Species	Relative Weight (kg/km)[a]	Relative Number (no./km)[a]	QHEI	IBI	MIwb[b]	Narrative
Hussy Creek 04-514-000 HELP[1] WWH+									
2.40[H]	6.8	23	22	--	1,438.5	56.5	32	--	Fair
0.10[H]	11.3	18	17	--	742.2	46.3	32	--	Fair
Eightmile Creek 04-513-000 HELP[1] WWH+									
6.55[H]	12.7	22	20	--	1,041.0	55.8	30	--	Fair
1.22[W]	21.8	26	21.5	--	349.5	45.0	39	8.7	Good-Good
Twelvemile Creek 04-510-000 HELP WWH									
11.01[H]	11.6	18	17	--	1,880.0	32.0	32	--	Fair
1.80[W]	36.0	27	21.5	6.1	3,413.2	34.8	30[ns]	8.4	Fair-M. Good
Blierdofer Ditch 04-511-000 HELP[1] MWH									
2.50[H]	6.4	19	18	--	1,776.0	42.8	36	--	M. Good
1.70[H]	10.5	16	15	--	540.0	28.0	32	--	Fair
Yankee Run 04-508-000 HELP WWH+									
1.40[H]	6.1	26	24	--	2,254.0	26.8	42	--	Good
Town Run 04-506-000 HELP WWH+									
1.87[H]	5.6	24	22	--	2,162.0	38.0	32	--	Fair
1.25[H]	7.1	25	23	--	1,242.0	46.5	34	--	Fair
Black Creek 04-503-000 HELP MWH									
10.70[H]	13.2	20	19	--	3,902.0	50.5	38	--	M. Good
2.50[W]	25.0	34	25.5	8.8	2,287.5	45.8	43	9.6	Good-Except.
0.90[W]	54.0	29	24.5	9.7	1,866.0	41.4	34	9.2	M. Good-V. Good
Little Black Creek 04-504-000 HELP WWH+									
6.85[H]	10.1	24	22	--	2,316.0	42.8	44	--	Good
3.95[W]	17.3	23	21	--	2,716.5	33.8	36	--	M. Good
1.00[W]	23.6	24	19.5	2.2	895.5	45.8	34	7.4[ns]	Fair-M. Good
Duck Creek 04-502-000 HELP MWH+									
4.70[H]	6.4	16	14	--	602.0	22.5	32	--	Fair
1.05[H]	15.6	27	25	--	1,575.0	49.0	38	--	M. Good
Twentyseven Mile Creek 04-500-001 HELP WWH+									
4.10[H]	14.0	22	19	--	1,658.0	42.5	36	--	M. Good
1.20[W]	28.2	27	25	5.9	1,399.5	55.3	44	9.1	Good-V. Good
Trib. to Twentyseven Mile (RM 3.1) 04-500-002 HELP WWH+									
0.40[H]	7.4	20	20	--	2,110.0	56.3	46	--	V. Good

a Relative abundance and relative weight estimates standardized to 0.3 km for wading and headwater sites and 1.0 km for boat sites, respectively.
b MIwb applicable to waters greater than 20 miles² (i.e., non-headwaters)
W Wadable streams: sites draining areas > 20 miles².
ns Non-significant departure from the bio criteria (≤4 IBI units or ≤0.5 MIwb units).
B Boat sites: large or deep waters, necessitating the use of Boat sampling methods.
1 Sites so identified are located within the transitional boundary between ECBP and HELP ecoregions. Based upon biotic and abiotic factors these sites were assigned to the HELP, as provided for in Ohio EPA (1987b).
+ Aquatic life use designation field verified by previous investigation(s).
* Significant departure from the biocriteria (>4 IBI units or >0.5 MIwb units).
H Headwaters: sites draining areas ≤ 20 miles².

Ecoregional Criteria (OAC 3745-1-07, Table 7-15)						
	Eastern Corn Belt Plain (ECBP)			Huron-Lake Erie Plain (HELP)		
Index – Site Type	EWH	WWH	MWH[c]	EWH	WWH	MWH[c]
IBI - Headwaters	40	50	24	28	50	20
IBI - Wading	40	50	24	32	50	22
MIwb -Wading	8.3	9.4	6.2	7.3	9.4	5.6
IBI - Boat	42	48	24	34	48	20
MIwb - Boat	8.5	9.6	5.8	8.6	9.6	5.7

c Modified Warmwater Habitat (MWH) for channel modified or impounded areas.

Table 19 — Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the St. Marys River study area, June to October 2015-2016.

River Mile	Drain. Area (miles^2)	Total Taxa	Quant Taxa	Qual Taxa	Qual EPT[a]	Qual Sens.	Qual Tolerant	Density #/sq ft	Narr. /ICI[b]	Current (fps)	Predominant Taxa[c]
St. Marys River 04-500-000											
100.47	67.1	82	45	63	15	10	16	619	50	0.45	Mayflies (F), Caddisflies (F), Midges (F, MT)
100.28 (2016)	67.1	30	10	26	4	1	20	24,948	0*	0.6	Aquatic worms (T), Midges (MT)
100.12	101	63	31	52	10	3	27	5,621	24*	1.0	Flatworms (F), Aquatic worms (T), Midges (MT)
98.50	103	66	36	53	10	3	23	4,121	28*	0.4	Aquatic worms (T), Midges (F)
95.12	106	75	40	56	13	11	18	1,267	46	0.8	Baetid mayflies (F), Caddisflies (F), Midges (F)
87.80	135	77	36	60	13	11	22	1,669	44	0.46	Mayflies (F), Caddisflies (F), Midges (F)
80.51	166	66	34	48	12	9	21	367	G	0.13	Mayflies (F), Midges (MT)
75.07	184	63	31	47	14	10	16	620	46	0.9	Mayflies (F), Caddisflies (F)
70.40	251	65	45	49	9	8	17	555	48	0.45	Mayflies (F), Caddisflies (F)
65.70 (2016)	261	51	26	39	8	5	16	839	42	1.3	Mayflies (F), Caddisflies (F)
61.50 (2016)	279	46	26	38	8	6	11	842	34	0.6	Mayflies (F), Caddisflies (MI, F), Midges (F, MT)
57.82	295	45	28	33	7	3	14	636	30[ns]	0.13	Mayflies (F), Caddisflies (MI, F), Midges (F, MT)
52.13	303	63	33	47	9	11	16	557	40	0.64	Mayflies (F), Caddisflies (MI, F), Midges (F)
47.48	309	44	26	32	6	5	14	695	24*	0.1	Midges (F, MT)
45.60	366.7	59	31	47	9	8	15	506	MG[ns]	0.4	Mayflies (F), Caddisflies (MI, F), Midges (F, T)
43.48	386	59	31	41	11	8	14	1,006	38	0.4	Mayflies (F), Caddisflies (MI, F), Midges (F)
East Branch 04-500-006											
0.27	37.1	80	49	62	11	2	20	1,055	40	0.2	Amphipods (F, MT), Mayflies (F), Caddisflies (F), Midges (F, MT, T)
Clear Creek 04-517-000											
5.40	6.8	35		35	6	1	13		F*		Baetid mayflies (F), Midges (F, T)
1.32	13.4	57		57	16	8	18		G		Turbellaria (F), Mayflies (F), Caddisflies (F), Snails (T), Midges (F, T)
Muddy Creek 04-520-000											
5.40	9.3	46		46	12	5	15		G		Mayflies (F), Caddisflies (F), Midges (F, T)
0.45	15.6	55		55	15	9	17		G		Mayflies (F), Caddisflies (F), Midges (F, T)
Center Branch 04-518-000											
6.60	5.9	34		34	8	2	11		MG[ns]		Isopods (MT), Mayflies (F)
5.20	10.4	31		31	9	3	6		MG[ns]		Turbellaria (F), Mayflies (F), Midges (F, T)

River Mile	Drain. Area (miles^2)	Total Taxa	Quant Taxa	Qual Taxa	Qual EPT[a]	Qual Sens.	Qual Tolerant	Density #/sq ft	Narr. /ICI[b]	Current (fps)	Predominant Taxa[c]
3.22	14.2	40		40	8	4	13		MG[ns]		Turbellaria (F), Isopods (MT), Mayflies (F), Caddisflies (F), Midges (F, T)
0.34	28.7	66	42	47	12	4	13	539	48	0.2	Mayflies (F), Caddisflies (F), Midges (F)
Carter Creek 04-519-000											
1.86	7.8	31		31	7	0	14		F*		Isopods (MT), Mayflies (F), Caddisflies (F)
Kopp Creek 04-524-000											
8.88	4.6	33		33	6	1	14		F*		Turbellaria (F), Amphipods (MT), Isopods (MT), Caddisflies (F)
7.62	13.8	49		49	9	3	13		MG[ns]		Turbellaria (F), Caenid Mayflies (F), Caddisflies (MI)
3.60	22.1	63	30	54	12	7	11	659	38	0.0	Turbellaria (F), Caddisflies (MI), Damselflies (F)
0.80	28	62	43	44	10	3	10	653	42	0.2	Caddisflies (F), Riffle beetles (F), Limpets (F), Midges (F)
Wierth Ditch 04-524-000											
0.45	6.9	30		30	4	2	13		F		Turbellaria (F), Leeches (MT, T), Caddisflies (F), Midges (F, T)
Trib. to Kopp Creek 04-524-002											
0.30	4.6	41		41	11	1	15		MG[ns]		Turbellaria (F), Amphipods (F), Caenid mayflies (F), Beetles (MT)
Fourmile Creek 04-516-000											
0.10	5.6	23		23	5	0	8		F*		Isopods (MT), Caddisflies (F), Midges (F, T)
Sixmile Creek 04-515-000											
1.06	16.2	37		37	5	2	17		F*		Beetle (F, MT), Mosquitoes (F), Midges (T)
Prairie Creek 04-501-000											
2.75	6.7	36		36	5	0	21		F*		Leeches(MT), Snails (T), Midges (T)
1.02	12.4	27		27	2	1	20		P*		Isopods (MT), Corixids (MT), Snails (T), Midges (T)
Hussy Creek 04-514-000											
2.40	6.8	24		24	1	0	17		P		Isopods (MT), Fingernail clams (F)
0.10	11.3	40		40	4	1	23		F		Isopods (MT, T), Corixids (MT), Snails (T), Midges (T)
Eightmile Creek 04-513-000											
6.55	12.7	46		46	7	1	17		MG[ns]		Water mites (F), Caddisflies (F), Riffle beetles (F), Midges (F, T)
1.22	21.8	43	24	26	1	0	17	318	14		Isopods (MT), Damselflies (F, T), Corixids, Midges (T)
Twelvemile Creek 04-510-000											
11.01	11.6	39		39	6	1	17		F*		Beetles (MT), Snails (T), Midges (F, T)

River Mile	Drain. Area (miles^2)	Total Taxa	Quant Taxa	Qual Taxa	Qual EPT[a]	Qual Sens.	Qual Tolerant	Density #/sq ft	Narr. /ICI[b]	Current (fps)	Predominant Taxa[c]
1.80	36	67	45	43	8	3	15	560	34		Caddisflies (F), Damselflies (F), Fingernail Clams (F), Midges (F)
Blierdofer Ditch 04-511-000											
2.50	6.4	37		37	6	0	13		F		Turbellaria (F), Caddisflies (F), Beetles (F, MT), Midges (F, T)
1.70	10.5	43		43	8	2	13		MG		Bryozoan (F), Isopods (T), Mayflies (F), Midges (F, T)
Yankee Run 04-508-000											
1.40	6.1	56		56	6	1	*27*		F*		Corixids (MT)
Town Run 04-506-000											
1.25	7.1	38		38	4	1	19		F*		Corixids (MT), Midges (F, MT, T)
Black Creek 04-503-000											
10.70	13.2	44		44	7	3	17		F		Turbellaria (F), Beetles (F, MT, T)
2.50	25	49	26	37	3	1	15	61	16*	0.0	Caddisflies (F), Midges (F, MT, T)
0.90	54	37	19	27	3	0	15	34	18*	0.0	Isopods (MT), Damselflies (F), Midges (F, MT, T)
Little Black Creek 04-504-000											
6.85	10.1	40		40	7	1	18		F*		Turbellaria (F), Damselflies (F, T), Beetles (F, MT), Midges(F, T)
1.00	23.6	36		36	6	2	14		MG[ns]		Caenid mayflies (F), Midges (MI, F, T)
Duck Creek 04-502-000											
4.70	6.4	39		39	3	0	24		LF*		Corixids (MT), Midges (F, T)
1.05	15.6	55		55	9	3	19		MG[ns]		Caddisflies (MI, F), Midges (F, M)
Twentyseven Mile Creek 04-500-001											
4.10	14	51		51	9	4	21		MG[ns]		Beetles (F, MT), Baetid mayflies (MT)
1.20	28.2	51	26	41	10	4	9	458	30[ns]		Mayflies (F), Fingernail clams (F), Midges (F)
Trib. to Twentyseven Mile (RM 3.1) 04-500-002											
0.40	7.4	43		43	6	0	17		MG[ns]		Midges (F, T)

a Qual. EPT=Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.
b Narrative assessment used in lieu of ICI score based on qualitative sampling data when no quantitative data are collected: VG-very good; G-good; MG-marginally good; F-fair; P-poor.
c Tolerance Categories: VT=Very Tolerant; T=Tolerant; MT=Moderately Tolerant; F=Facultative; MI=Moderately Intolerant; I=Intolerant.
ns Nonsignificant departure from applicable biocriterion.
* Significant departure from applicable biocriterion; poor and very poor results are underlined.

Ecoregion Biocriterion						
	Eastern Corn Belt Plains (ECBP)			Huron-Erie Lake Plain (HELP)		
INDEX	MWH	WWH	EWH	MWH	WWH	EWH
ICI	22	36	46	22	34	46

Table 20 — Modified attainment table with associated hierarchical clustering groups.

Location	River Mile (Station ID)	Drain. Area (miles²)	Attain.	Causes	Sources	Groups[1]
St. Marys River 04-500-000 ECBP WWH						
St. Marys River at St. Marys @ Aqueduct Rd.	100.47 (510010)	67.1	FULL			3
St. Marys River at St. Marys, dst. Kopp Creek, @ Greenville Rd.	100.12 (P01K11)	101.0	**PARTIAL**	Organic enrichment biological indicators	Canal/Pond discharge	8
St. Marys River dst. St. Marys WWTP	98.50 (P01K10)	103.0	**PARTIAL**	Organic enrichment biological indicators	Canal/Pond discharge	8
St. Marys N. of St. Marys @ Glynwood Rd.	95.12 (510020)	106.0	FULL			3
HELP WWH						
St. Marys River S. of Kossuth @ Barbara-Werner Rd.	87.8 (P01K05)	135.0	FULL			1
St. Marys River N. of St. Marys @ St. Rte. 116	80.51 (P01S09)	166.0	FULL			1
St. Marys River E. of Mendon @ Gallman Rd.	75.07 (P01S08)	184.0	FULL			1
St. Marys River at Mendon, Mendon-Celina Rd.	70.40 (302591)	251.0	FULL			1
St. Marys River N. of Mercer @ US 127	65.70 (P01K04)	261.0	FULL			1
St. Marys River E. of Rockford @ Frysinger Rd.	61.50 (P01K03)	279.0	FULL			1
St. Marys River at Rockford @ St. Rte. 118	57.82 (P01W08)	295.0	FULL			1
St. Marys River dst. Rockford @ Townline Rd.	52.13 (P01K02)	303.0	FULL			1
St. Marys River SE of Willshire @ Harner Rd.	47.48 (P01K01)	309.0	**PARTIAL**	Natural (flow or habitat)	Natural sources	1
St. Marys River E. of Willshire, adj. to US 33	45.60 (303088)	366.7	FULL			1
St. Marys River at Willshire @ St. Rte. 81	43.48 (510170)	386.0	FULL			1
East Branch 04-500-006 ECBP WWH+						
East Branch @ St. Rte. 29	0.27 (303025)	37.1	**PARTIAL**	Direct habitat alterations	Channelization	3
Clear Creek ECBP 04-517-000 WWH+						
Clear Creek @ Burr Oak Rd.	5.4 (303065)	6.8	**PARTIAL**	Direct habitat alterations	Channelization	4
Clear Creek E. of St. Marys @ Bay Rd.	1.32 (P01K27)	13.4	FULL			4
Muddy Creek 04-520-000 ECBP WWH+						
Muddy Creek at Bay Rd.	5.4 (303062)	9.3	FULL			4
Muddy Creek at Washington Rd.	0.45 (303063)	15.6	FULL			5
Center Branch 04-518-000 ECBP WWH+						
Center Branch at New Knoxville at end of road near ponds (South Street)	6.60 (P01K28)	5.9	FULL			4
Center Branch just upst. New Knoxville WWTP	5.20 (P01S07)	10.4	FULL			4
Center Branch @ Glynwood-New Knoxville Rd.	3.22 (P01S05)	14.2	FULL			4

Location	River Mile (Station ID)	Drain. Area (miles²)	Attain.	Causes	Sources	Groups[1]
Center Branch at Plattner Pike	0.34 (303024)	28.7	**PARTIAL**	Direct habitat alterations and low dissolved oxygen	Channelization and Agriculture	3
Carter Creek 04-519-000 ECBP WWH+						
Carter Creek W. of New Knoxville @ St. Rte. 219	1.86 (P01S03)	7.8	**PARTIAL**	Direct habitat alterations	Channelization	4
Kopp Creek 04-524-000 ECBP WWH						
Kopp Creek N. of New Bremen @ Clover Four Rd.	8.9 (500560)	4.6	**PARTIAL**	Sedimentation/siltation	Channelization	4
Kopp Creek N. of New Bremen @ Lane off St. Rte. 66	7.62 (500550)	13.8	**PARTIAL**	Nutrient/eutrophication biological indicators and low dissolved oxygen	Municipal point source and Agriculture	6
Kopp Creek S. of St. Marys @ RR near CR 66A	3.6 (500540)	22.1	FULL			6
Kopp Creek S. of St. Marys @ St. Rte. 66	0.8 (P01K29)	28.0	**PARTIAL**	Low dissolved oxygen	Municipal point source and Agriculture	3
Wierth Ditch 04-524-000 ECBP MWH6						
Wierth Ditch N. of New Bremen @ St. Rte. 66	0.45 (500580)	6.9	FULL			6
Trib. to Kopp Creek 04-524-002 ECBP WWH+						
Trib. to Kopp Creek (5.41) @ Piqua-St. Marys Rd.	0.3 (500590)	4.6	FULL			4
Fourmile Creek 04-516-000 ECBP WWH+						
Fourmile Creek @ St. Marys River Rd.	0.1 (303071)	5.6	**PARTIAL**	Sedimentation/siltation	Channelization	5
Sixmile Creek 04-515-000 HELP WWH+						
Sixmile Creek @ St. Marys-Kossuth Rd.	1.06 (303068)	16.2	**PARTIAL**	Sedimentation/siltation	Channelization	6
Prairie Creek 04-501-00 HELP MWH+						
Prairie Creek @ Eisley Rd.	2.75 (303078)	6.7	**FULL**			7
Prairie Creek S. of Kossuth @ St. Rte. 197	1.02 (P01K16)	12.4	**NON**	Organic enrichment	Crop production and Flooding	7
Hussy Creek 04-514-000 HELP WWH+						
Hussey Creek @ Salem-Noble Rd.	2.40 (303072)	6.8	**NON**	Sedimentation/siltation	Channelization	7
Hussey Creek @ Hesse Rd.	0.10 (303073)	11.3	**PARTIAL**	Sedimentation/siltation	Channelization	5
Eightmile Creek 04-513-000 HELP WWH+						
Eightmile Creek @ Davis Rd.	6.55 (303074)	12.7	FULL			6
Eightmile Creek SE of Mendon @ Mercer Rd.	1.22 (302592)	21.8	**PARTIAL**	Other flow regime alterations	Natural sources	2
Twelvemile Creek 04-510-000 HELP WWH						
Twelvemile Creek NW of Celina @ Hoenie Rd.	11.01 (P01K19)	11.6	**PARTIAL**	Sedimentation/siltation, Alteration in streamside covers	Channelization	5

Location	River Mile (Station ID)	Drain. Area (miles^2)	Attain.	Causes	Sources	Groups[1]
Blierdofer Ditch 04-511-000 HELP MWH						
Blierdofer Ditch @ Morrow Rd.	2.50 (303077)	6.4	FULL			4
Blierdofer Ditch N. of Celina @ Oregon Rd.	1.70 (P01K21)	10.5	FULL			6
Yankee Run 04-508-000 HELP WWH+						
Yankee Run @ US 33	1.40 (303084)	6.1	**PARTIAL**	Sedimentation/siltation; Alteration in streamside covers	Channelization	5
Town Run 04-506-000 HELP WWH+						
Town Run @ St. Rte. 117	1.25 (303085)	7.1	**PARTIAL**	Sedimentation/siltation; Alteration in streamside covers	Channelization	8
Black Creek 04-503-000 HELP MWH						
Black Creek @ Strable Rd.	10.70 (303081)	13.2	FULL			5
Black Creek @ Winkler Rd.	2.50 (303082)	25.0	**PARTIAL**	Natural (flow or habitat)	Natural sources	2
Black Creek SE of Willshire @ St. Rte. 33	0.90 (P01S02)	54.0	**PARTIAL**	Natural (flow or habitat)	Natural sources	2
Little Black Creek 04-504-000 HELP WWH+						
Little Black Creek @ St. Rte. 707	6.85 (303079)	10.1	**PARTIAL**	Sedimentation/siltation; Alteration in streamside covers	Channelization	6
Little Black Creek @ Jordan Rd.	1.00 (303080)	23.6	**FULL**			5
Duck Creek 04-502-000 HELP MWH+						
Duck Creek @ Settler Rd.	4.70 (303086)	6.4	**PARTIAL**	Sedimentation/siltation	Channelization; Natural sources	8
Duck Creek 04-502-000 HELP WWH+						
Duck Creek dst. County Line	1.05 (303087)	15.6	FULL			5
Twentyseven Mile Creek 04-500-001 HELP WWH+						
Twentyseven Mile Creek @Clayton Rd.	4.10 (303090)	14.0	FULL			6
Twentyseven Mile Creek @Ohio/Indiana state line	1.20 (P01K12)	28.2	FULL			5
Trib. to Twentyseven Mile (RM 3.1) 04-500-002 HELP WWH+						
Trib. to Twentyseven Mile (RM 3.1) @ Wren-Landeck Rd.	0.40 (303091)	7.4	FULL			6

[1] Methods used to determine hierarchical clustering groups are included in Appendix L. Background colors coordinate with statistical groupings and are used as a visual aid across figures and tables.

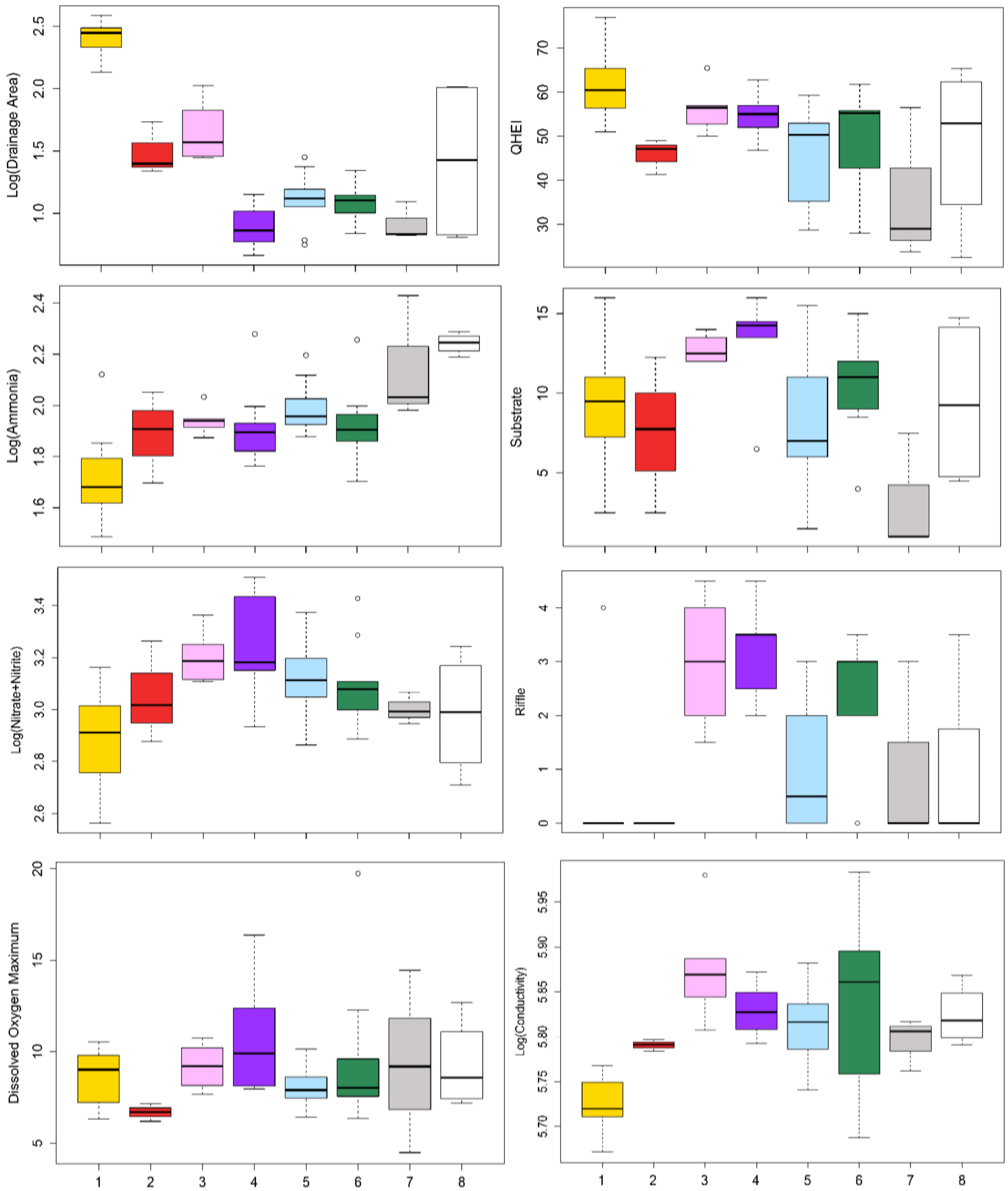

Figure 27 — Boxplots of select environmental variables by hierarchical clustering group.

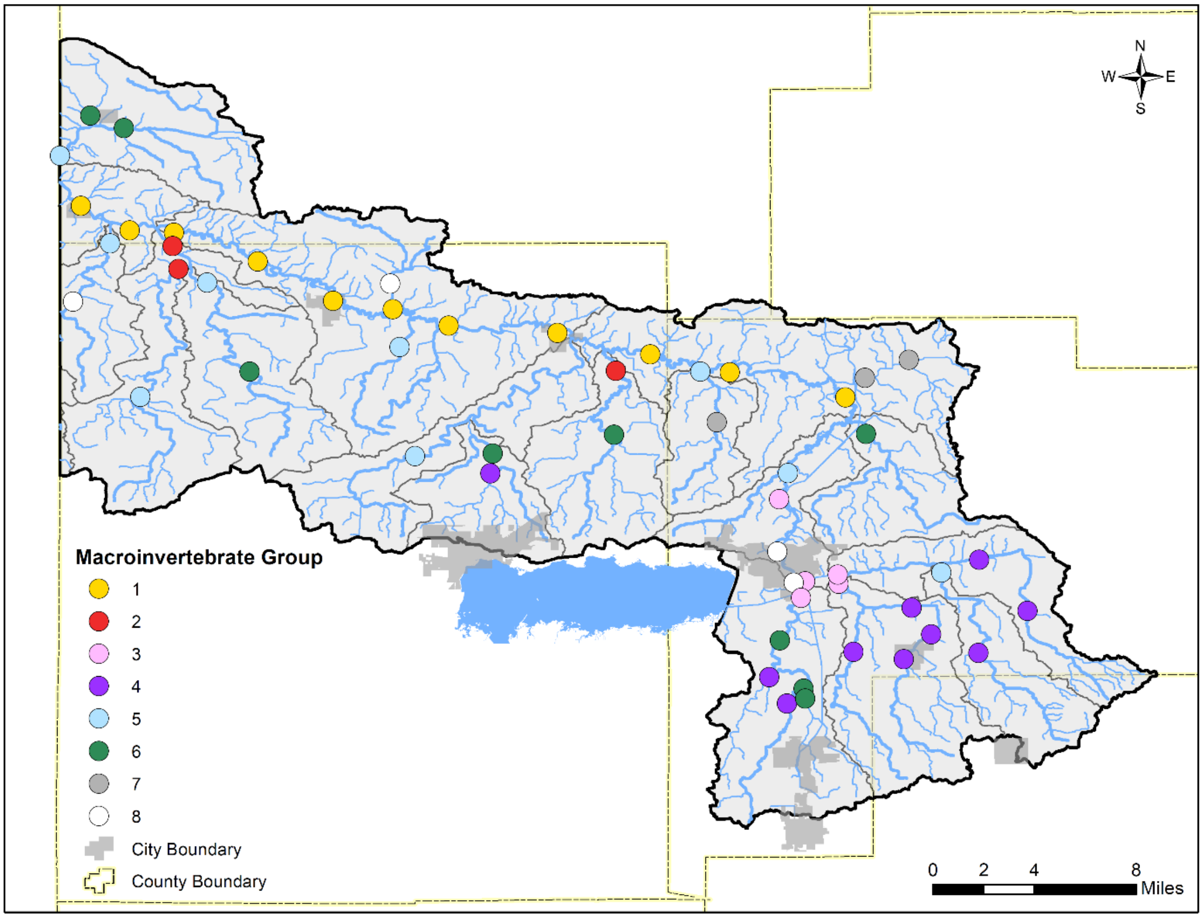

Figure 28 — Map of St. Marys River biological sites by hierarchical clustering group.

Discussion

The St. Marys River mainstem demonstrated full attainment of the WWH ALU at 12 of 16 sites (Figure 29). The fish community at least marginally met ecoregional expectations but the limited occurrence of round bodied suckers and simple lithophilic fish species that require clean gravel substrates negatively reflected on the accumulation of fine-grained sediments within the channel of the mainstem. As a result, many of the IBI scores were within or scored just above the range of nonsignificant departure of ecoregional expectation. MIwb scores fared somewhat better and reflected an appropriately even distribution of numbers and biomass within the fish community. Partial and non-attainment of the ALU in the St. Mary River mainstem occurred where the macroinvertebrate community reflected environmental stress.

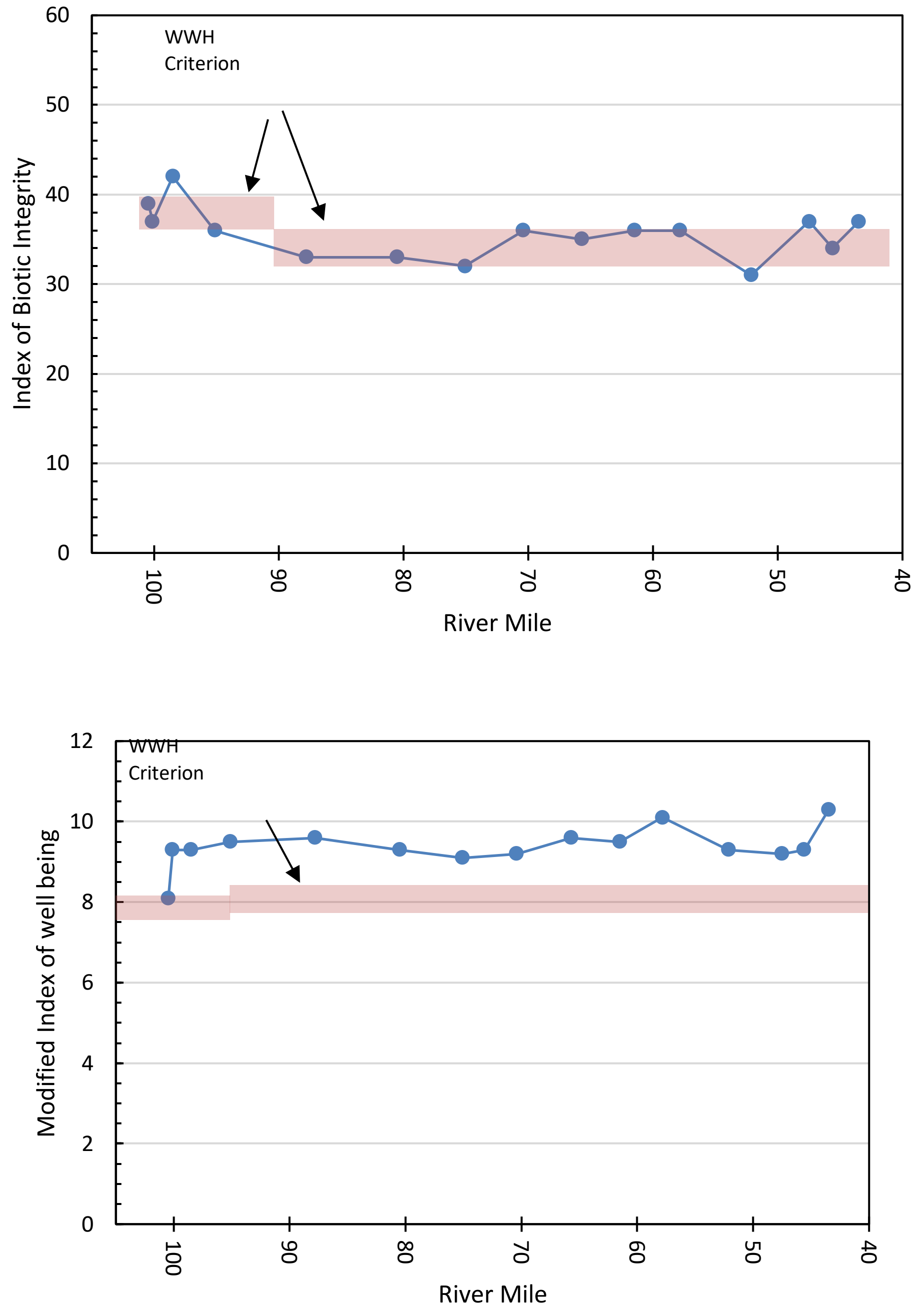

Figure 29 — Longitudinal performance of Index of Biotic Integrity and Modified Index scores in the St. Marys River, 2015.

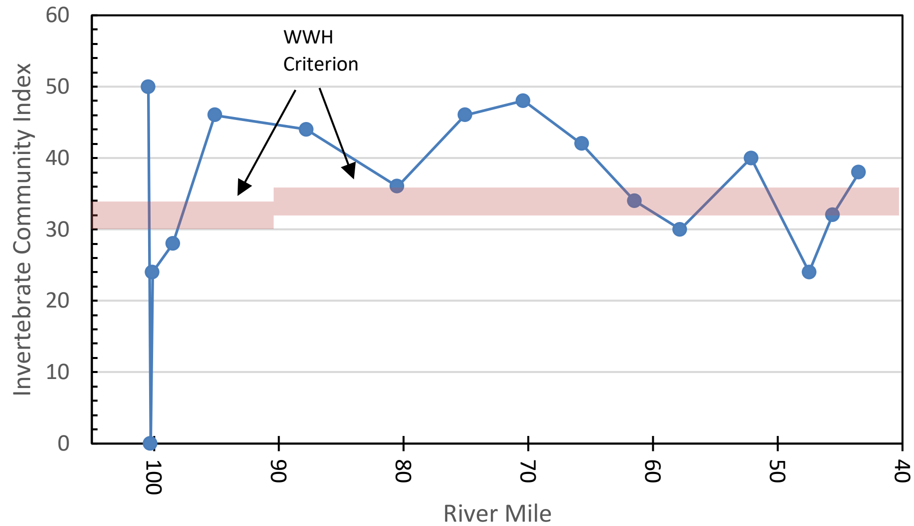

Figure 30 — Longitudinal performance of ICI scores for the St. Marys River RM 100.47 to RM 43.48. The ICI is estimated where quantitative data are not available.

After sampling was completed in 2015, an investigation of macroinvertebrate community condition was conducted the following summer at RM 100.28, downstream from the point where the St. Marys River receives substantial flow from the Miami-Erie Canal. In 2016, the city of St. Marys experienced strong noxious odors attributed to water quality of the canal that drew media attention (Dayton Daily News, July 27, 2016, St. Mary's Lake problems spill over to canal, Thomas Gnau, staff writer) and macroinvertebrate diversity in the river was severely impacted by the Miami-Erie Canal discharge. The canal carries nutrient- and algae-rich water from Grand Lake St. Marys. Septic conditions resulted in the St. Marys River following the introduction of the canal water. The macroinvertebrate community was greatly predominated by tolerant midges and aquatic worms. Rarely is the macroinvertebrate community so severely impacted as to result in ICI score of zero as was the case at RM 100.28. ICI scores in the fair range at the next two sites were reflective of continued degraded water quality due to the canal discharge downstream to, at least, RM 98.50 (Figure 30). The fully-assessed mainstem sites downstream of the canal, at RMs 100.12 and 98.5, were grouped separately from the other mainstem sites during hierarchical clustering, further evidence of the canal influence. Notable environmental signatures for those sites (Group 8) include high ammonia (Figure 27) and BOD, both indicators of local sources of highly organic material. Due to the overriding influence of the canal discharge, potential effects could be attributed to additional nutrient loading from Kopp Creek or the St. Marys WWTP. The fish community within this reach generated index scores in the marginally good to very good range.

Full attainment of the WWH ALU was observed in the St. Marys River beginning at RM 95.10 and was largely maintained for more than 51 miles downstream to the terminus of the study area at RM 43.48. All mainstem sites downstream of RM 95 clustered into Group 1, where the performance of biological communities and environmental factors were controlled by the larger drainage area. The only occasion where ecoregional expectations were not met occurred at RM 47.48. Fish community index scores were in the good range. A fair macroinvertebrate community result was attributed to the physical habitat at the site, particularly the slow current velocity present under low flow conditions. As a result, taxa commonly encountered in flowing waters such as hydropsychid caddisflies and baetid mayflies were absent.

Conditions at the site appeared to be the naturally occurring result of low stream gradient which consequently allowed for settling of fine-grained sediment and silt.

Headwater sites—those less than 20 mi^2—generally separated into four groups (4-7). Group 4—almost exclusively sites in the southeastern part of the watershed—was characterized by high substrate, riffle and gradient scores; high strontium and nitrate+nitrite; and low metals. These common factors reflect coarser stream bed, greater channel diversity and ground water inflow, all features associated with the ECBP ecoregion in this part of the state. Three southeastern headwater sites did not cluster in Group 4 but instead in Group 6, including sites on Kopp Creek at RMs 3.6 and 7.62 and Wierth Ditch at RM 0.45. These three sites were downstream of the New Bremen WWTP, the effects of which (high ammonia, nitrate+nitrite, conductivity, etc.) caused them to act more like and be grouped with sites in the HELP.

The remaining headwater groups, Groups 5 and 7, were spread throughout the watershed and displayed a wide range of chemical and environmental values. However, sites in both groups were characterized by poor QHEI metrics and their effects. Group 7 sites (Prairie and Hussey Creeks) were all impaired for macroinvertebrates and had the lowest substrate metric scores in the watershed, in addition to low minimum dissolved oxygen and high ammonia. Group 5 had a range of biological scores, but those with impairment had very poor substrate and riffle metric scores.

As implied by the poor QHEI metrics, sedimentation and channelization in support of rural drainage was the predominate source of impairment for headwater sites. Twelve of 14 sites with partial or non-attainment of their respective ALU were impacted by channelization. Macroinvertebrate assemblages typically included low EPT and pollution-sensitive taxa diversity (Table 19). The macroinvertebrate communities of these sites were most affected by habitat alteration and sedimentation. Straightening and removal of in-stream and riparian cover from watercourses results in alteration of the natural flow regime and a monotonous channel. Increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosion process. Additionally, sediment is then confined within the stream channel rather than being transferred to the adjacent flood plain during high flow events. Siltation/sedimentation primarily affects the aquatic insects by burying larger substrates and filling interstitial spaces, thereby limiting the amount and type of livable area. It can also limit the macroinvertebrate diversity further by directly inhibiting respiration of many insect species. Streams which showed impairment at headwater sites included: Clear Creek; Carter Creek; Kopp Creek; Fourmile Creek; Sixmile Creek; Hussey Creek; Twelvemile Creek; Yankee Run; Town Run; Little Black Creek; and Duck Creek.

The only headwater site in which the fish showed impairment was Kopp Creek at RM 7.62 and, unlike the previous sites, was impacted by wastewater effluent from the New Bremen WWTP along with agricultural sources. The uppermost site on Kopp Creek (RM 8. 88) produced a marginally good IBI score (IBI= 38). The IBI declined to 34 at RM 7.62. The fish assemblages were largely similar, but darter species diversity was not sufficiently increased as expected with an increase in drainage area and the proportion of tolerant taxa increased modestly but was enough to lower the score. An increase in the incidence of significant disease or other gross external anomalies (DELTs) at RM 7.62 was not sufficient to depress or otherwise affect the IBI. Nonetheless, the modest upsurge in DELTs provided evidence of chronic sublethal stress.

Prairie Creek at St. Rte. 197 (RM 1.02) produced a marginally good fish assemblage but the macroinvertebrate community was in poor condition. Flooding rains had deposited an accumulation of cornstalks into the stream. Decomposition of this material likely imposed a significant oxygen demand on the stream and, as a result, qualitative sampling produced just two EPT taxa and a single pollution sensitive taxon.

Black Creek at RMs 2.50 and 0.90 and Eightmile Creek at RM 1.22 clustered on their own during statistical analysis (Group 2). While they are similar in drainage area, the most distinguishing characteristic is that they all received riffle metric scores of zero. Black Creek is designated a channelized MWH stream. The macroinvertebrate community at RMs 2.50 and 0.90 was limited below what is typically encountered, even given the limitations of the ALU. The depressed communities at both sites were attributed to naturally occurring hydrologic dynamics. A lack of sufficient rainfall resulted in a lowering of the water table and a nearly interstitial flow condition at RM 2.50 which limited macroinvertebrate organism diversity. Black Creek at RM 0.90 was in a stream segment where low gradient in combination with proximity to the confluence with the St. Marys River created a pooled condition. A total of four EPT taxa were collected at the site but no sensitive taxa were recorded. Eightmile Creek at RM 1.22 is designated WWH but was similarly affected by low gradient and proximity with the mainstem. ICI scores at all three sites, while not directly applicable given the lack of current, were consistent with sampling of the natural substrates and were in the low-fair range. The lack of water movement likely contributed to documented occasions when D.O. measurements fell below the minimum criterion at all three sites, but fish index scores performed in the good to very good range for the HELP ecoregion.

The downstream sites on Kopp Creek at RM 0.80, Center Branch St. Marys at RM 0.34 and East Branch St. Marys at RM 0.27 all demonstrated impairment in the fish community. They also clustered together for macroinvertebrates in Group 3, however this seemed primarily driven by their physiography aspects and size. These were sites near the confluence with the mainstem that apparently reflected the combined influence of modest, yet pervasive, habitat deficits and high background pollutant load.

The East Branch at RM 0.27 failed to support fully WWH when the IBI fell short of the prescribed criteria, driven by poor performance of the following metrics: low number of intolerant species; high proportion of tolerant and generalist taxa; and low proportion of species within sensitive/specialized breeding and guilds. Stream size here required multiple pass biomonitoring over the course of the 2015 sampling season. Examination of the results from each sampling event found that the aforementioned metrics performed similarly or were otherwise comparable. Conditions here, however, were not profoundly degraded, and instead represented only a modest departure from the WWH criteria. Compared against its upstream tributaries, East Branch showed a four-fold increase in the proportion of generalist species, a doubling of the proportion of tolerant species, and a failure to accrue darter species, despite a significant increase in drainage area.

Species richness in Kopp Creek was generally good through the sub-basin but declined slightly near the mouth (RM 0.80). Fully 70 percent of the fish assemblage was composed of tolerant species. Although well-represented throughout Kopp Creek, tolerant species reached their highest proportions at this location. Impairment identified on lower Kopp Creek likely reflected the combined influence of modest, yet pervasive, habitat deficits within the sub-basin and high background pollutant load, the latter derived from diffuse and permitted sources. As the final outlet for the entire sub-basin, lower Kopp Creek must assimilate or otherwise process much of the nutrients, ammonia, sediment and algal biomass exported from the catchment. Use impairment here coincided with stimulated instream algal growth, mid-season and depressed D.O., late season, the latter reflective of cumulative respiration greater than primary productivity as the growing season waned. As measured by chlorophyll-a, RM 7.62 was found to support the highest benthic algal concentrations observed within the study area. Further, the larger algal biomass resulted in wide diel D.O. swings well in excess of the 6.5 mg/l threshold (approaching 10mg/l). Further, the increased algal growth was represented with D.O. 24-hour ranges being higher than the threshold of 6.5 mg/l at both RM 0.80 and 7.62.

Use impairment delineated by fish community performance within the Center Branch sub-basin was limited to the lowest station on the mainstem (RM 0.34). Impaired status was driven by the IBI. Departure from the WWH criteria was slight, with the station average IBI short of the minimum criterion by two index units. Stream size here required multiple pass biomonitoring. A comparison of the results for each sampling event from this station revealed minor, but consequential differences in the performance of the IBI between passes; one pass met the minimum criterion (IBI=36) and the other fell just short (IBI=32). Regarding the latter, two metrics under-performed: percent intolerant species and relative abundance (less tolerant species). A comparison of these metrics did not reveal strong absolute differences, rather, they were at or near IBI scoring break-points, so even modest disparities resulted in a full four-unit shortfall, ultimately bringing the station average below the minimum WWH criterion. Impairment identified on lower Center Branch most likely reflected the combined influence of modest, yet pervasive, habitat deficits and high background pollutant load, the latter derived largely from diffuse sources. As the final outlet for the entire sub-basin, lower Center Branch must assimilate or otherwise process much of the nutrient, ammonia and sediment loads generated within the catchment.

Trends

The 2015 St. Marys River fish indices from sites between RM 100.47 and RM 75.07 showed improvement compared with scores from 1991 (Figure 31). Fish community indices scores were largely in the fair to poor range in 1991. The principle causes of degradation were attributed to organic and inorganic loadings from CSOs and inadequate sewage treatment from the city of St. Marys, excessive sedimentation, monotonous habitat and elevated sediment metals. IBI and MIWb scores were in the fair to excellent range and at least marginally met WWH expectations throughout the stream reach in 2015. The improved fish scores reflected reduced pollutant loadings owing to improved effluent quality from the St. Marys WWTP. Sediment contaminant levels were also reduced in 2015. Although reduced, excessive sedimentation and other habitat deficits remain sources of stress on the fish community that was reflected in the numerous marginally attaining IBI scores seen in 2015.

A review of historical survey results provides an opportunity to assess status and trends of Kopp Creek through time. The entire Kopp Creek basin was first evaluated in 1981 (Ohio EPA 1982) and the 2015 survey marks the first reassessment of the sub-basin since that time. A comparison of these data clearly indicates significant improvement in the environmental conditions of Kopp Creek have occurred over the intervening 34 years. Notable water quality improvements included a significant reduction in oxygen-demanding wastes, ammonia and phosphorus within Wierth Ditch and affected portions of Kopp Creek. Concurrent biological improvements were also documented. Fish and macroinvertebrate community performance narratives ranged between poor and very poor in 1981. These conditions represented a high degree of use impairment. The 2015 results found species richness to have increased significantly, as each site now supports between 14-20 native fish taxa, with commensurate improvements in community structure and functional organization and 4-10 EPT taxa. Even sites not affected by the basin's only consequential permitted point source (New Bremen WWTP), showed similar improvement. Presently, three of the six sites evaluated in 2015 support biological communities fully consistent with the WWH biocriteria. Where the fish community failed to meet WWH (two sites), scores were just shy of the prescribed biocriteria. Even though the macroinvertebrate remained impaired upstream from the New Bremen WWTP, six EPT taxa were collected in 2015 where none were recorded in 1981.

As observed throughout the St. Marys River study area, system-wide improvements throughout Kopp Creek appeared as a result of multiple factors. First among these is the recovery of physical habitat lost to the debilitating effects of gross sedimentation and historical channelization, attributable to the positive effects of modern soil conservation practices (reduced sedimentation) and naturally directed channel recovery (lateral scour and sediment transport), respectively. Pollution abatement efforts by New Bremen also appear highly consequential regarding this trend. As early as 1974 New Bremen's WWTP was identified as being inadequate and in a state of disrepair. The old facility was abandoned and replaced with aerated lagoon system in 1986. Since that time New Bremen has periodically enhanced or otherwise improved the system. Although incomplete, the recovery of Kopp Creek documented in 2015 is in part due to these pollution abatement activities. While impairment has persisted at selected monitoring stations, in comparison with the 1981 survey results the magnitude of the impact or degree of departure from the prescribed biocriterion identified in 2015 has decreased significantly.

A review of historical monitoring data provides an excellent opportunity to evaluate the environmental conditions of Center Branch through time. Much of the watershed was first evaluated in the mid-1980s and selected sites were revisited in the mid-1990s. An examination of historical and contemporary ambient chemistry showed improved water quality on the Center Branch mainstem and relative stable conditions in its tributaries. The most prominent of these included significant reductions in oxygen-demanding wastes, ammonia and phosphorus in the vicinity and downstream from New Knoxville. Almost without exception the fish community showed commensurate improvements through the period of record, from generally poor conditions in the 1980s to near complete recovery of the WWH use in 2015. Even sites not affected by the basin's only consequential permitted point source (New Knoxville WWTP) showed significant improvement through time. 2015 macroinvertebrate sampling on Center Branch showed a slight decline in overall condition compared to results from 1996; yet still marginally met with ecoregional expectations. Carter Creek at RM 1.86 saw an increase in EPT taxa in 2015 but overall was little changed compared to 1996 with fair narrative evaluations recorded both years.

The positive trajectory of chemical, physical and fish community indicators appeared a result of multiple factors. First among these is an overall coarsening of stream substrates within the Center Branch basin, attributable to the benefits of modern tillage and related soil conservation practices, coupled with preliminary channel recovery resulting from normal fluvial processes (for example, lateral bank scour and sediment transport). At national and regional scales, soil conservation activities have significantly reduced gross erosion since the late 1970s (NRCS 2007). Studies within the Maumee River basin and other smaller waterbodies affirm the national assessment and have gone further to demonstrate an association between agricultural BMPs, reduced soil loss, reduced in-stream sedimentation and a concurrent positive response of the ambient biology (Barton and Farmer 1997, Meyers and Metzker 2000, Yoder et al. 2004, Richards et al. 2009, Tessler and Gottgens 2012 and Miltner 2016). These findings parallel emerging phenomena Ohio EPA has observed, state-wide, regarding the reestablishment of not only formerly imperiled, substrate sensitive fish species (for example, bigeye chub and sand darter), but also broad community shifts toward lithophilic and specialist insectivorous species (substrate-dependent taxa), with a corresponding decline in ecological generalists (for example, common carp) throughout most of Ohio's major river systems.

Affecting not only the stream's competency to support aquatic life, but also its capacity to process or assimilate background pollutant loads, macrohabitat quality and recovery therein were important, if not controlling, factors. Compared against the earliest survey results from the 1980s, substrates are coarser, channel diversity is greater and corresponding ambient biology is significantly improved. Water quality improvements appeared to be an important secondary factor, more consequential at reach or station scales, particularly for the portions of Center Branch receiving wastes (treated or otherwise) from New Knoxville. Pollution abatement efforts here undoubtedly contributed to the use recovery for segments of Center Branch previously affected.

Little historical community data exists from the East Branch basin. Prior to the 2015 St. Marys River survey, these included a single sampling event in 1994 on lower Clear Creek (RM 1.3). At that time community performance was no better than fair (IBI=30). Compared against the 2015 results, six of the 12 IBI metrics improved significantly. Species richness has more than doubled from 11 to 23, including the addition of three environmentally sensitive species. Similarly, the proportion of individuals and number of fish taxa belonging to sensitive feeding and breeding guilds showed significant increases, while proportion of species with generalized life histories declined. Over the intervening 21 years the IBI increased from 30 to 44 and is now fully consistent with the prescribed WWH biocriterion. Although limited to a single station on an East Branch tributary, these results parallel the broader trends consistently observed in other ECBP tributaries where fuller historical data sets are available. Despite limited data, the positive trajectory documented on Clear Creek is likely representative of the East Branch basin as a whole.

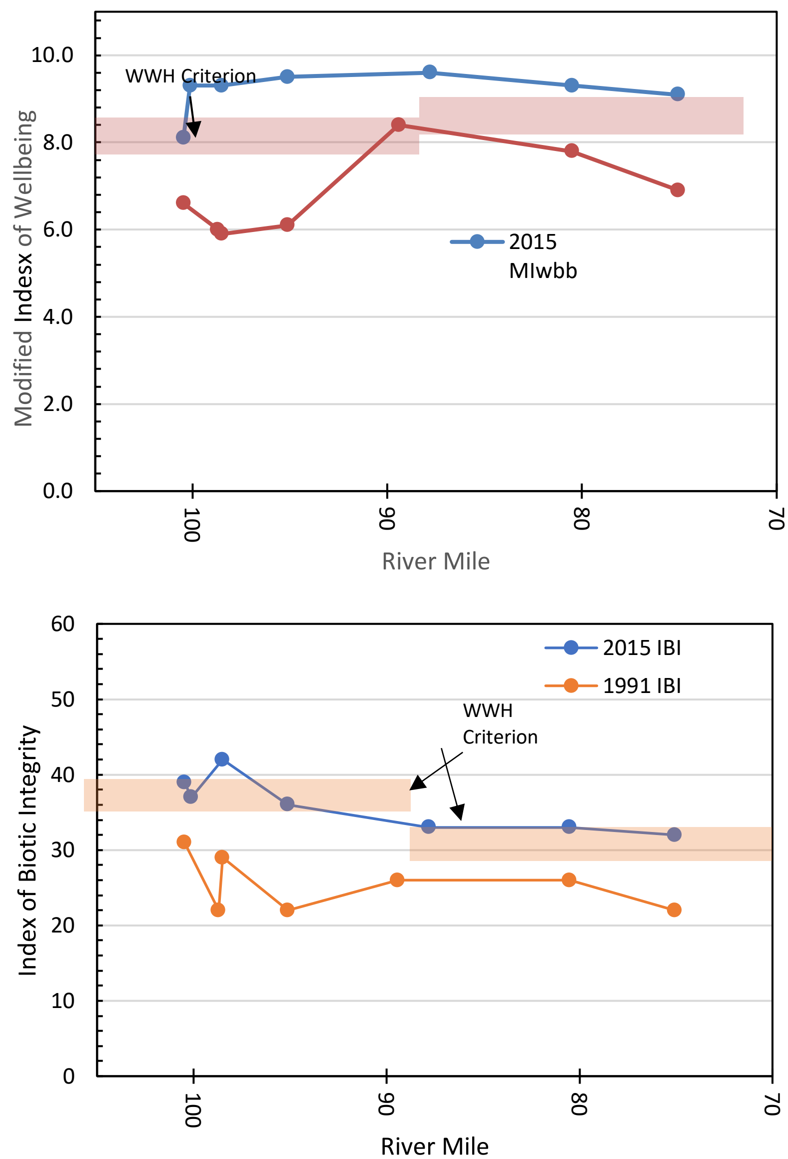

Figure 31 — Longitudinal trend of Index of Biotic Integrity and Modified Index of Well-being scores for The St. Marys River, 1991 and 2016. Shaded areas represent range of nonsignificant departure from WWH expectations.

Recreation Use

Water quality criteria for determining attainment of recreation uses are established in the Ohio Water Quality Standards based upon the presence or absence of bacteria indicators (*Escherichia coli*) in the water column.

Escherichia coli (*E. coli*) bacteria are microscopic organisms that are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour, 1977), but there is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are becoming more practicable. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose and throat infections, as well as stomach upsets, skin rashes and diarrhea. Young children, the elderly and those with depressed immune systems are most susceptible to infection.

The summer of 2015 experienced numerous intense rainfall events within the study area. On several occasions, Ohio EPA staff observed many of the streams in the St. Marys watershed overflow their banks. (Figure 32). It is well established that bacteria levels increase in the water column during and after precipitation events. Sources of bacteria during these times include, but are not limited to, farm livestock, wild and domestic animals, home septic systems and community wastewater treatment plants.

Figure 32 — June 14-23 flooding in Auglaize County, Salem Township, approximately eight inches fell.

Water quality criteria for recreation use were updated in 2017 as part of a routine Ohio Administrative Code (OAC) rule update. For this report, the streams are assessed using the criteria that were in place in 2015 at the time of the sampling. The rule citations in the text below refer to the version of the rules in effect in 2015.

Most of the streams of the St. Marys River study area are designated with the primary contact recreation (PCR) use in OAC 3745-1-11. Water bodies with a designated recreational use of PCR "...are waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking and SCUBA diving" [OAC 3745-1-07 (B)(4)(b)]. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR Class A typically have identified public access points and support, or potentially support, primary contact recreation. Streams designated PCR Class B support, or potentially support, occasional primary contact recreation activities. Streams designated PCR Class C support, or potentially support, infrequent primary contact recreation activities such as, but not limited to, wading. Water bodies with a designated recreational use of secondary contact recreation (SCR) "…are waters that result in minimal exposure potential to water borne pathogens because the waters are: rarely used for water based recreation such as, but not limited to, wading; situated in remote, sparsely populated areas; have restricted access points; and have insufficient depth to provide full body immersion, thereby greatly limiting the potential for water based recreation activities" [OAC 3745-1-07 (B)(4)(c)]. The *E. coli* criteria to be met during the recreation season include geometric means and single sample maximums for the different recreation use classes (Table 21). The geometric mean is based on two or more samples and is used as the basis for determining attainment status when more than one sample is collected.

All nine of the St. Marys River sites failed to meet the Primary Contact-A seasonal recreational criteria (126 CFU/100mls). There were 17 sites representing 14 smaller streams in the Primary Contact B recreational use designation. Eighty-eight percent (15/17) of Primary Contact-B sites did not meet the recreational use criterion. All four sites in the Secondary Contact Recreational use category (Kopp Creek and Wierth Ditch) met the recreational criterion. The results for all the sampling are presented in Appendix K and are summarized in Table 21.

Five WWTPs in the watershed were sampled for *E. coli*. The *E. coli* results are not used in the watershed recreational analysis but verify the facilities' disinfection performance. Information gathered during the

WWTP sampling can be used to prioritize Ohio EPA inspection frequencies. The results are included in Table 21 as well.

Table 21 — Statewide numerical criteria for the protection of recreation uses. These criteria apply inside and outside the mixing zone at all times during the recreation season.

	E. coli (colony counts per 100 ml)	
Recreation use	Seasonal geometric mean	Single sample maximum[1]
Bathing water	126	235[a]
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523
Class C primary contact recreation	206	940
Secondary contact recreation	1,030	1,030

[1] Except as noted in footnote a, these criteria shall not be exceeded in more than 10 percent of the samples taken during any 30-day period.
[a] This criterion shall be used for the issuance of beach and bathing water advisories.
In 2017, the water quality standards for recreational use was changed. The evaluation of recreational attainment for this survey is based on the rule that was in effect at the time of the sampling.

Table 22 — A summary of *E. coli* data for locations sampled in the St. Marys watershed, (May 27 –Sept. 10, 2015). Recreation use attainment is based on comparing the geometric mean to the Contact Recreation criterion (OAC 3745-1-07, Table 7-13). All values are expressed in colony forming units (cfu) per 100 ml of water. Red colored italicized bold values exceed the applicable geometric mean criterion. Gray shaded cells indicate the location did not meet the recreational use criteria.

Location	River Mile	Recreation Use Criteria Seasonal Geometric Mean	# of Samples	Geometric Mean[†]	Maximum Value	Recreational Attainment Status	Probable Source(s) of Bacteria
HUC 04100004-01-06 St. Marys River (Primary Contact Recreational –A) (WWH)							
At St. Marys, dst. Kopp Creek @ Greenville St.	100.12	126	6	***506***	2,870	No	Multiple
St. Marys WWTP outfall 001 to St. Marys River	98.60	N/A	6	33	238	N/A	WWTP
Dst. St. Marys WWTP	98.50	126	6	***391***	4,200	No	Multiple
North of St. Marys @ Glynwood Rd.	95.12	126	6	***311***	4,400	No	Multiple
HUC 04100004-02-05 St. Marys River (Primary Contact Recreational –A) (WWH)							
South of Kossuth at Barbara-Werner Rd.	87.80	126	6	***172***	261	No	Multiple
East of Mendon at Gallman Rd.	75.07	126	6	***314***	649	No	Multiple
HUC 04100004-03-03 St. Marys River (Primary Contact Recreational –A) (WWH)							
East of Rockford at Frysinger Rd.	61.50	126	6	***306***	2,420	No	Multiple
Rockford WWTP outfall 001 to St. Marys River	57.84	N/A	6	7.0	248	N/A	WWTP
At St. Rte. 118	57.82	126	5	***344***	1,410	No	Multiple
Dst. Rockford at Townline Rd.	52.13	126	6	***317***	2,710	No	Multiple
HUC 04100004-03-05 St. Marys River (Primary Contact Recreational –A) (WWH)							
At Willshire at St. Rte. 81	43.48	126	6	***342***	1,075	No	Multiple
Willshire WWTP Outfall 001 to St. Marys River	43.12	N/A	6	2740	39,700	N/A	WWTP

Location	River Mile	Recreation Use Criteria Seasonal Geometric Mean	# of Samples	Geometric Mean[†]	Maximum Value	Recreational Attainment Status	Probable Source(s) of Bacteria
HUC 04100004-01-02 Center Branch (Primary Contact Recreational –B) (WWH)							
Just upst. New Knoxville WWTP	5.20	161	6	***419***	866	No	Multiple
New Knoxville WWTP outfall 001 to Center Branch	5.18	N/A	5	35	3,330	N/A	WWTP
At Glynwood-New Knoxville Rd.	3.22	161	6	***701***	1,550	No	Multiple
At Plattner Rd.	0.35	161	6	***353***	2,030	No	Multiple
HUC 04100004-01-03 Clear Creek (Primary Contact Recreational –B) (WWH)							
East of St. Marys at Bay Rd.	1.32	161	6	***1984***	11,000	No	Multiple
HUC 04100004-01-03 East Branch (Primary Contact Recreational –B) (WWH)							
East Branch at St. Rte. 29	0.25	161	6	***714***	2,420	No	Multiple
HUC 04100004-01-04 Kopp Creek (Secondary Contact Recreational) (WWH)							
North of New Bremen at Montezuma Rd.	8.88	1030	6	492	1,300	Yes	N/A
North of New Bremen at lane off St. Rte. 66	7.62	1030	6	658	2,420	Yes	N/A
South of St. Marys @ St. Rte. 66	4.10	1030	6	721	3,110	Yes	N/A
HUC 04100004-01-04 Wierth Ditch (Secondary Contact Recreational) (MWH)							
New Bremen WWTP outfall 001 to Wierth Ditch	2.40	N/A	6	168	3,100	N/A	WWTP
North of New Bremen @ St. Rte. 66	0.45	1030	6	118	2,750	Yes	N/A
HUC 04100004-01-05 Sixmile Creek (Primary Contact Recreational –B) (WWH)							
At St. Marys-Kossuth Rd.	1.06	161	6	***575***	1,990	No	Multiple
HUC 04100004-02-01 Hussy Creek (Primary Contact Recreational –B) (WWH)							
At Hesse Rd.	0.10	161	5	***496***	1,050	No	Multiple
HUC 04100004-02-02 Eightmile Creek (Primary Contact Recreational –B) (WWH)							
Southeast of Mendon at Mercer Rd.	1.22	161	6	154	238	Yes	N/A
HUC 04100004-02-03 Blierdofer Ditch (Primary Contact Recreational –B) (MWH)							
North of Celina at Oregon Rd.	1.70	161	6	***1542***	4,620	No	Multiple
HUC 04100004-02-04 Twelvemile Creek (Primary Contact Recreational –B) (WWH)							
Near Mendon at Neptune-Mendon Rd.	0.70	161	6	***211***	461	No	Multiple
HUC 04100004-02-05 Prairie Creek (Primary Contact Recreational –B) (Undesignated – recommended MWH)							
At St. Rte. 197 south of Kossuth	0.40	161	6	151	579	Yes	N/A
HUC 04100004-03-01 Little Black Creek (Primary Contact Recreational –B) (WWH)							
At Jordan Rd.	1.00	161	6	***1044***	2,930	No	Multiple
HUC 04100004-03-02 Black Creek (Primary Contact Recreational –B) (MWH)							
At Winkler Rd.	2.50	161	6	***635***	3,450	No	Multiple

Location	River Mile	Recreation Use Criteria Seasonal Geometric Mean	# of Samples	Geometric Mean†	Maximum Value	Recreational Attainment Status	Probable Source(s) of Bacteria
Southeast of Willshire at U.S. 33	0.90	161	6	***515***	4,370	No	Multiple
HUC 04100004-03-04 Duck Creek (Primary Contact Recreational –B) (WWH)							
Downstream County Line Rd.	1.05	161	6	***421***	6,150	No	Multiple
HUC 04100004-04-01 Twentyseven Mile Creek (Primary Contact Recreational –B) (WWH)							
At OH/IN state line	1.2	161	6	***663***	2,790	No	Multiple
HUC 04100004-01-01 Muddy Creek (Primary Contact Recreational –B) (WWH)							
Washington Rd.	0.45	161	6	***636***	2,590	No	Multiple

† Attainment status is determined based on the seasonal geometric mean.

N/A WWTPs are not evaluated in terms of attainment for nonattainment.

Fish Tissue Contamination

Ohio has been sampling streams annually for sport fish contamination since 1993. Fish are analyzed for contaminants that bioaccumulate in fish and that could pose a threat to human health if consumed in excessive amounts. Contaminants analyzed in Ohio sport fish include mercury, PCBs, DDT, mirex, hexachlorobenzene, lead, selenium and several other metals and pesticides. Other contaminants are sometimes analyzed if indicated by site-specific current or historic sources. For more information about the chemicals analyzed, how fish are collected, or the history of the fish contaminant program, see ***State Of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program, Ohio EPA, January 2010*** (***epa.ohio.gov/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf***).

Fish contaminant data are primarily used for three purposes: 1) to determine fish advisories; 2) to determine attainment with the water quality standards; and 3) to examine trends in fish contaminants over time.

Fish Advisories

Fish contaminant data are used to determine a meal frequency that is safe for people to consume (for example, two meals a week, one meal a month, do not eat), and a fish advisory is issued for applicable species and locations. Because mercury mostly comes from nonpoint sources, primarily aerial deposition, Ohio has had a statewide one meal a week advisory for most fish since 2001. Most fish are assumed to be safe to eat once a week unless specified otherwise in the fish advisory, which can be viewed at ***epa.ohio.gov/dsw/fishadvisory/index***.

Prior to the 2015 sampling of the St. Marys River, there were consumption advisories in place for three species—freshwater drum, northern pike, and saugeye—at the one meal per month advisory level due to mercury. The minimum data requirement for issuing a new fish advisory is three samples of a single species from within the past 10 years. As a result of the 2015 sampling, in 2016 an advisory was posted for largemouth bass, also at the one meal per month level for mercury, in addition to the already existing advisories for drum, pike and saugeye.

For all other species, the statewide advisories apply, which are summarized in the table below:

Overall Fish Consumption Advice	
Two meals per week	Yellow perch, sunfish (for example, bluegill, green, longear, redear)*
One meal per week	All fish not specified in this table
One meal per month	Flathead catfish 23" and over, northern pike 23" and over, steelhead trout from Lake Erie and its tributaries

For a listing of fish tissue data collected from St. Marys River in support of the advisory program, and how the data compare to advisory thresholds, see Table 23 and Table 24 at the end of this section.

Fish Tissue/Human Health Use Attainment

In addition to determining safe meal frequencies, fish contaminant data are also used to determine attainment with the human health water quality criteria pursuant to OAC Rules 3745-1-33 and 3745-1-34. The human health water quality criteria are presented in water column concentrations of μg/l, and are then translated into fish tissue concentrations in mg/kg. [See ***Ohio's 2016 Integrated Report, Section E*** (***epa.ohio.gov/Portals/35/tmdl/2016intreport/SectionE.pdf***) for further details of this conversion.]

In order to be considered in attainment of the water quality standards, the sport fish caught within a HUC12 watershed must have a weighted average concentration of the geometric means for all species below 0.350 mg/kg for mercury, and below 0.023 mg/kg for PCBs within the Lake Erie basin.

Fish tissue samples were collected as outlined in the *Ohio EPA Fish Tissue Collection Manual* (Ohio EPA 2012a). Lists of typical sport fish species sampled for fish tissue are presented in Table 23 and Table 24. Within the St. Marys River study area, fish tissue data were adequate to determine attainment status for all four of the watershed assessment units (WAUs) that were sampled. Of the WAUs with sufficient information for assessment, one unit was deemed to be in attainment (status of 1), and three units were deemed to be impaired due to PCBs in fish tissue (status of 5). Table 25 shows these details.

Table 23 — Select fish tissue mercury data from 2015 St. Marys River sampling (mg/kg). The shading indicates the advisory category that each sample falls into. Blue = unrestricted, Green = two meals per week, yellow = one meal per week, orange = one meal per month.

Site	River Mile	Species	Value
St. Marys R. at Willshire @ St. Rte. 81	43.48	Channel Catfish	0.092
St. Marys R. at Willshire @ St. Rte. 81	43.48	Bluegill Sunfish	0.1
St. Marys R. at Willshire @ St. Rte. 81	43.48	Channel Catfish	0.15
St. Marys R. at Willshire @ St. Rte. 81	43.48	Common Carp	0.16
St. Marys R. at Willshire @ St. Rte. 81	43.48	Black Crappie	0.213
St. Marys R. at Willshire @ St. Rte. 81	43.48	Flathead Catfish	0.229
St. Marys R. at Willshire @ St. Rte. 81	43.48	Largemouth Bass	0.247
St. Marys R. at Willshire @ St. Rte. 81	43.48	Sauger X Walleye	0.281
St. Marys R. at Willshire @ St. Rte. 81	43.48	Sauger X Walleye	0.314
St. Marys R. at Willshire @ St. Rte. 81	43.48	Freshwater Drum	0.43
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Channel Catfish	0.081
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Channel Catfish	0.122
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Flathead Catfish	0.229
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Freshwater Drum	0.353
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Sauger X Walleye	0.501
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Channel Catfish	0.064
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Bluegill Sunfish	0.089
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.092
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Largemouth Bass	0.093
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.101
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Flathead Catfish	0.123
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Largemouth Bass	0.128
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Freshwater Drum	0.131
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Common Carp	0.142
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.15
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Black Crappie	0.158
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Sauger X Walleye	0.165
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Sauger X Walleye	0.229
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Freshwater Drum	0.234
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Channel Catfish	0.05
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Common Carp	0.122
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Sauger X Walleye	0.352
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Freshwater Drum	0.372
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Common Carp	0.082
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Channel Catfish	0.118
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Freshwater Drum	0.12
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Walleye	0.146

Site	River Mile	Species	Value
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Flathead Catfish	0.279
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Sauger X Walleye	0.378
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Rock Bass	0.124
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Sauger X Walleye	0.126
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Freshwater Drum	0.291
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Black Crappie	0.027
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Yellow Bullhead	0.059
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Bluegill Sunfish	0.063
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Channel Catfish	0.073
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Flathead Catfish	0.075
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Common Carp	0.08
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Northern Pike	0.094
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Black Crappie	0.111
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Freshwater Drum	0.125
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Largemouth Bass	0.126
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Rock Bass	0.188
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Freshwater Drum	0.254
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Northern Pike	0.267

Table 24 — Select fish tissue PCB data from 2015 St. Marys River sampling (mg/kg). The shading indicates the advisory category that each sample falls into. Blue = unrestricted, yellow = one meal per week, orange = one meal per month.

Site	River Mile	Species	Value	Detected?
St. Marys R. at Willshire @ St. Rte. 81	43.48	Black Crappie	0.0198	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Freshwater Drum	0.0199	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Sauger X Walleye	0.0199	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Channel Catfish	0.0199	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Bluegill Sunfish	0.0199	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Common Carp	0.02	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Sauger X Walleye	0.02	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Channel Catfish	0.02	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Largemouth Bass	0.02	No
St. Marys R. at Willshire @ St. Rte. 81	43.48	Flathead Catfish	0.02	No
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Freshwater Drum	0.0198	No
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Sauger X Walleye	0.0199	No
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Channel Catfish	0.0199	No
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Channel Catfish	0.0199	No
St. Marys R. dst. Rockford @ Townline Rd.	52.13	Flathead Catfish	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Channel Catfish	0.0198	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.0198	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Sauger X Walleye	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Sauger X Walleye	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Flathead Catfish	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Freshwater Drum	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Freshwater Drum	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Bluegill Sunfish	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Largemouth Bass	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Largemouth Bass	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.0199	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Black Crappie	0.02	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	White Crappie	0.02	No
St. Marys R. N of Mercer @ U.S. Rte. 127	65.7	Common Carp	0.0245	Yes

Site	River Mile	Species	Value	Detected?
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Common Carp	0.0199	No
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Sauger X Walleye	0.0199	No
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Channel Catfish	0.02	No
St. Marys R. N of St. Marys @ St. Rte. 116	80.51	Freshwater Drum	0.0767	Yes
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Common Carp	0.0198	No
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Channel Catfish	0.0198	No
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Walleye	0.0199	No
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Flathead Catfish	0.0199	No
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Sauger X Walleye	0.02	No
St. Marys R. S of Kossuth @ Barber-Werner Rd.	87.8	Freshwater Drum	0.0269	Yes
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Sauger X Walleye	0.0199	No
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Rock Bass	0.02	No
St. Marys R. N of St. Marys @ Glynwood Rd.	95.12	Freshwater Drum	0.0443	Yes
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Largemouth Bass	0.0198	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Northern Pike	0.0198	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Freshwater Drum	0.0199	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Black Crappie	0.0199	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Yellow Bullhead	0.0199	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Common Carp	0.0199	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Northern Pike	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Flathead Catfish	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Rock Bass	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Black Crappie	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Bluegill Sunfish	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Channel Catfish	0.02	No
St. Marys R. at St. Marys, dst. Kopp Creek @ Greenville St.	100.12	Freshwater Drum	0.023	Yes

Table 25 — Recommended updates to human health attainment status for the St. Marys River study area in Ohio's 2018 Integrated Report.

WAU	Previous status (2016)	New status (2018)	Cause of impairment	Assessment Unit Name
41000040106	1	5	PCBs	Fourmile Creek-St. Marys River
41000040205	5	5	PCBs	Prairie Creek-St. Marys River
41000040303	1	5	PCBs	Yankee Run-St. Marys River
41000040305	1	1		Town of Willshire-St. Marys River

Green (1)=Use Attaining; Yellow (5)=Impaired, TMDL needed

Fish Contaminant Trends

Fish contaminant levels can be used as an indicator of pollution in the water column at levels lower than laboratory reporting limits for water concentrations but high enough to pose a threat to human health from eating fish. Most bioaccumulative contaminant concentrations are decreasing in the environment because of bans on certain types of chemicals like PCBs, and because of stricter permitting limits on dischargers for other chemicals. However, data show that PCBs continue to pose a risk to humans who consume fish, and mercury concentrations have been increasing in some locations because of increases in certain types of industries for which mercury is a byproduct that is released to air and/or surface water.

For this reason, it is useful to compare the results from the survey presented in this TSD with the results of the previous survey(s) done in the study area. Recent data can be compared against historical data to determine whether contaminant concentrations in fish tissue appear to be increasing, decreasing or staying the same in a water body or watershed.

St. Marys River has been sampled six times between 1995 and 2015. Mercury concentrations (Figure 33) were low to moderate, with species falling into the one meal per month advisory range or better. Of the species sampled during these surveys, there were three species—channel catfish, freshwater drum and saugeye—that had data available from each sampling event. There is no consistent trend apparent in the data for these species, and the variation between years occurs over a relatively shallow range, which is often the case for mercury.

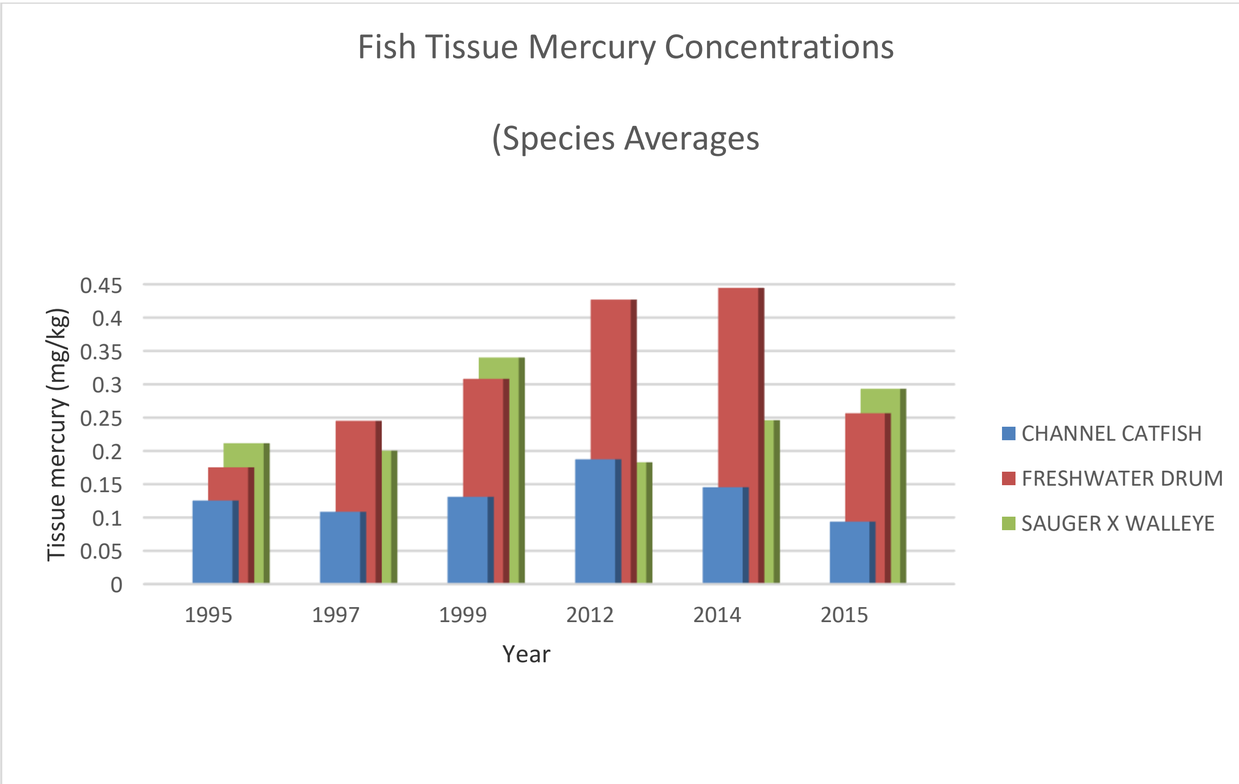

Figure 33 — Mercury concentrations in St. Marys River for three species.

PCB values for fish in the St. Marys River are shown in Figure 34. For the vast majority of samples, PCB concentrations were below the laboratory's limit of detection, resulting in a data set that is mostly censored. For any given year, there were generally only a few samples that had PCBs detected above the laboratory reporting limit. All of the samples collected during this time period were below 0.07 mg/kg, representing very low levels of PCBs in fish tissue, with most samples falling into the unrestricted consumption advisory range below 0.05 mg/kg.

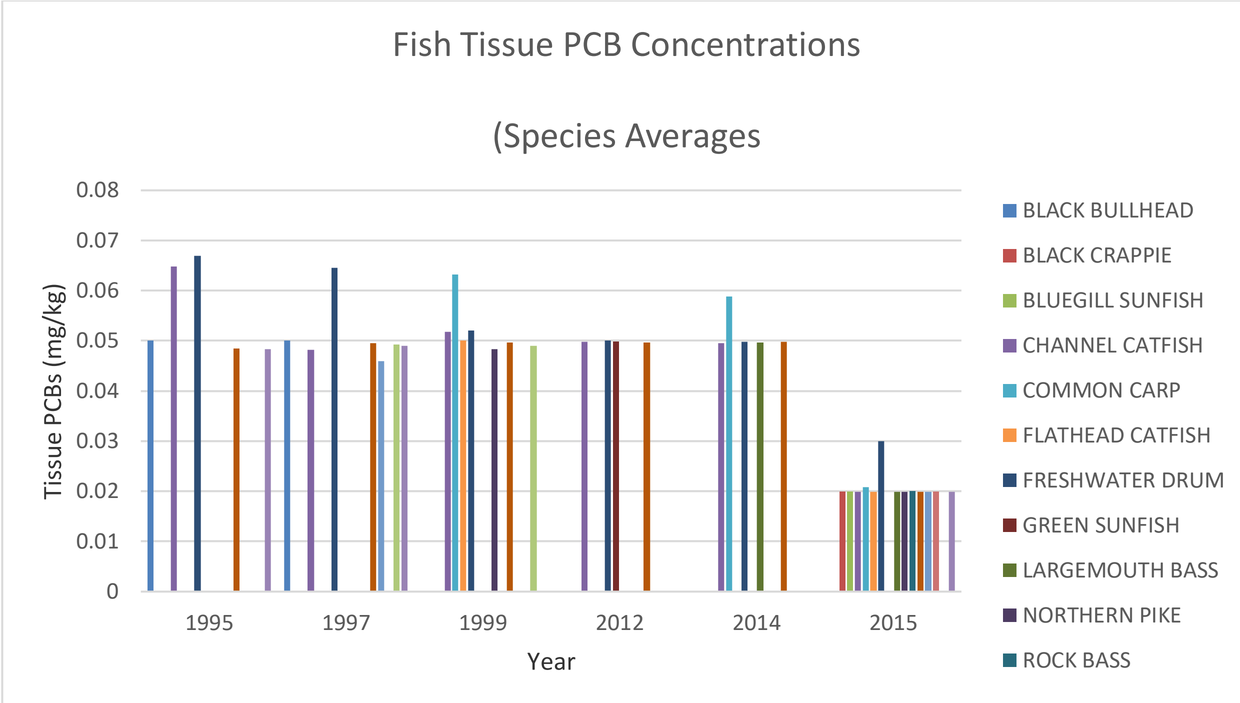

Figure 34 — Total PCB concentrations in fish tissue in the St. Marys River. From 1995 to 2014, values at or below 0.05 mg/kg signify non-detects for all samples of a given species in a given year, while values above 0.05 mg/kg in those years represent detections or a mix of detections and non-detects. In 2015 the laboratory reporting limit was changed, and values at or below 0.02 mg/kg signify that all samples of a given species were non-detect for PCBs for that year.

Beneficial Use Designations and Recommendations

The St. Marys River and Kopp Creek are listed in the Ohio Water Quality Standards (WQS) with the warmwater habitat (WWH) aquatic life use designation; three streams (Black Creek, Blierdofer Ditch and Wierth Ditch) are listed as a modified warmwater habitat (MWH) (Table 26). Sampling of the remaining streams represented their initial assessment by Ohio EPA using standardized protocols to assess aquatic life use designations and evaluate biological community condition. The study area involved 17 HUC 12 watershed assessment units located in Shelby, Auglaize, Mercer and Van Wert counties.

Eighteen streams in the study area were evaluated for unverified or undesignated aquatic life and recreation use status in 2015 (Table 26). Significant findings include the following:

- The WWH aquatic life use is verified for 13 streams, including: Little Black Creek; Town Run; Yankee Run; Twelvemile Creek; Eightmile Creek; Hussey Creek; Sixmile Creek; Fourmile Creek; the unnamed tributary to Kopp Creek Creek (RM 5.41); Clear Creek; Center Branch; Carter Creek; and Muddy Creek. Streams in this category will go from * to + in the WQS.
- Based upon the biological and habitat assessments, the WWH use designation is recommended for two previously undesignated streams: East Branch and the unnamed tributary to Twentyseven Mile Creek (RM 3.1).
- The Modified Warmwater Habitat use (MWH-C) is recommended for Prairie Creek and Duck Creek upstream from RM 2.97 (Winkler Rd.) based on the biological and habitat assessment conducted in 2015. QHEI scores for the two streams were in the low 20s, well below benchmark values considered sufficient to fully support typical WWH assemblages. The sampling locations supported marginally good fish assemblages, but the macroinvertebrates communities were in fair to poor

condition. Both are low gradient streams which are also formally maintained as open ditches as provided for by Ohio drainage law. These conditions make natural channel recovery unlikely.

- A more sinuous stream channel was present in the lower portion of Duck Creek. The QHEI score of 49 at RM 1.05 demonstrated continued deficiencies in the habitat but was nevertheless improved compared to upstream conditions. Commensurate with the improved habitat, fish and macroinvertebrate communities demonstrated full attainment of the WWH biocriteria at RM 1.05. As such, the current designation of WWH for the lower reach of Duck Creek is recommended to remain WWH.
- All sampled streams currently designated for primary contact recreation should retain the use. Two streams, Kopp Creek and Wierth Ditch, were designated with the secondary contact recreation (SCR) use in a previous assessment based on a lack of water depth sufficient for full body immersion. Current evaluation procedures take additional factors such as actual use, potential use by children or accessibility factors into account. Due to the presence of homes bordering Kopp Creek and a public park near the confluence with the St. Marys River, the recreational use of this stream is recommended to be changed to primary contact recreation (PCR). Similarly, the PCR use is recommended to be applied to Wierth Ditch which flows past a number of residences and borders the Kuenning-Dicke Natural Area. The agricultural water supply (AWS) and industrial water supply (IWS) uses apply to all the study area streams.

Table 26 — Waterbody use designation recommendations for the St. Marys River study area. Designations based on the 1978 and 1985 Ohio Water Quality Standards appear as asterisks (*). A plus sign (+) indicates a confirmation of a current designation and a triangle (▲) denotes a new recommended use based on the findings of this study.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
St. Marys River		+							+	+		+		
Twentyseven Mile Creek (Prairie Creek)		*+							*+	*+		*+		
Unnamed tributary (Twentyseven Mile Cr. RM 3.1)		▲							▲	▲		▲		
Duck Creek – headwaters to Winkler Rd. (RM 2.97)				▲					*+	*+		*+		HELP ecoregion - channel modification
- Winkler Rd. (RM. 2.97) to mouth		*+							*+	*+		*+		
Black Creek				+					+	+		+		HELP ecoregion - channel modification
Little Black Creek		*+							*+	*+		*+		
Sanift Ditch		*							*	*		*		
Town Run		*+							*+	*+		*+		
Ayre Ditch		*							*	*		*		
Yankee Run		*+							*+	*+		*+		
Dennison Ditch		*							*	*		*		
Twelvemile Creek		*+							*+	*+		*+		
Blierdofer Ditch				+					+	+		+		ECBP ecoregion - channel modification
Green Ditch		*							*	*		*		
Eightmile Creek		*+							*+	*+		*+		
Hussey Creek		*+							*+	*+		*+		
Prairie Creek				▲					▲	▲		▲		ECBP ecoregion – channel modification
Sixmile Creek		*+							*+	*+		*+		
Fourmile Creek		*+							*+	*+		*+		
Unnamed tributary (Kopp Creek RM 5.4)		+							+	+			+	
Kopp Creek		+							+	+		▲		
Wierth Ditch				+					+	+		▲		ECBP ecoregion - channel modification
Unnamed tributary (Kopp Creek RM 5.41)		*+							*+	*+		*+		
East Branch		▲							▲	▲		▲		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Clear Creek		*+							*+	*+		*+		
Muddy Creek		*+							*+	*+		*+		
Center Branch		*+							*+	*+		*+		
Carter Creek		*+							*+	*+		*+		

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.

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