

Biological and Water Quality Study of Lower Auglaize River Tributaries

Defiance, Mercer, Paulding, Putnam, and Van Wert Counties



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Biological and Water Quality Study of the Lower Auglaize River Tributaries 2014 and 2015

Defiance, Mercer, Paulding, Putnam, and Van Wert counties, Ohio

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Executive Summary

Rivers and streams in Ohio support a variety of uses such as recreation, water supply, and aquatic life. Ohio EPA evaluates each stream to determine the appropriate beneficial use designations and to also determine if the uses are meeting the goals of the federal Clean Water Act. In 2014 and 2015, 28 streams in the lower Auglaize River tributaries study area, located in Defiance, Mercer, Paulding, Putnam, and Van Wert counties, were evaluated for aquatic life and recreation use potential (Table 1). Additional biological, habitat, and chemical water quality monitoring is scheduled for 2017 in order to confirm the appropriateness of the designated aquatic life use assigned to several streams; recommended use changes will be pursued in a future rule-making.

Of the 66 biological stations assessed, 54 sites (82%) were fully meeting the designated or recommended aquatic life use (ALU), four (6%) were partially attaining, and eight (12%) were not attaining (Figure 1 and Table 2). Excessive sediment and silt caused by agricultural runoff led to impairment at all twelve sites not meeting the designated ALU (Table 2). Measures to help further buffer these streams from storm runoff by allowing vegetated buffers to grow and instituting best management practices (BMPs) for field tile filtration should be made.

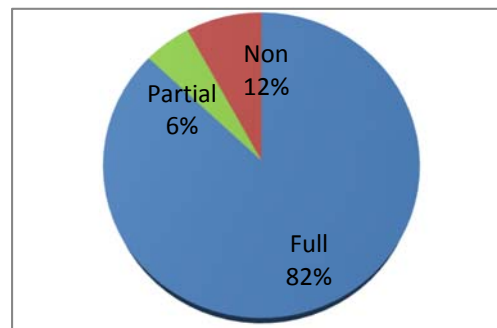


Figure 1. Percent ALU attainment of biological sampling stations in the lower Auglaize River tributary study area, 2014 and 2015.

Evaluation of *E. coli* bacteria results revealed that 40 of the 41 locations sampled from May 28, 2014 to September 15, 2014 failed to meet the applicable geometric mean recreational use criterion, indicating non-attainment of the use at these locations. Potential sources of *E. coli* contamination at locations not attaining the recreation use criteria are failing home sewage treatment systems (HSTS), livestock pasture land runoff, agricultural runoff, combined sewer overflows (CSOs), and wildlife accumulations. Most of the sites sampled had extensive amounts of agricultural land drained by subsurface tiles and drastically reduced riparian buffers along the stream.

Water quality samples were collected from 72 sites in the lower Auglaize River tributaries study area (Table 1). All sites were sampled a minimum of five times, typically at two week intervals, from March 2014 to November 2014. Single sample dissolved oxygen levels were found below the minimum Water Quality Standards (WQS) criterion at 13 sites for a total of 26 times during the sampling season. Single sample temperature levels were found above the daily average WQS criterion 22 times at 15 sites and above the daily maximum criterion two times at the Little Auglaize River downstream from Ottoville at County Road P. The lack of overhead riparian canopy due to drainage maintenance projects and flow regime alterations from tile drainage impacts stream temperatures and dissolved oxygen concentrations. Twelve of the 26 dissolved oxygen violations (46%) occurred on Sixmile Creek and Little Flatrock Creek. Single sample WQS criterion exceedances for iron and pH occurred at 14 sites across the watershed. Six of the iron exceedances on Blue Creek were likely due to groundwater influence in the creek. Five iron exceedances were found at three sites on Prairie Creek downstream from Stoneco Inc. Scott Plant.

Nutrient data for nitrate-nitrite and phosphorus exceeded the target geometric mean concentrations at 48 of the 72 sites sampled. A total of 21 sites (29%) exceeded the target for phosphorus and 46 sites (64%) exceeded the target for nitrate-nitrite. Much of the watershed appears to transport excess

nutrients, especially nitrate-nitrite, downstream rapidly. Pervasive channel alterations have much of the system functioning as a pipe, unable to access the assimilative services of a natural stream channel and floodplain. The Little Auglaize River has formed some natural channel features between its leveed banks over time that have yielded biological community improvements. However, downstream water quality improvements will not occur without increasing flood plain connectivity to help slow down flows, deposit sediment, and assimilate pollutants from storm water.

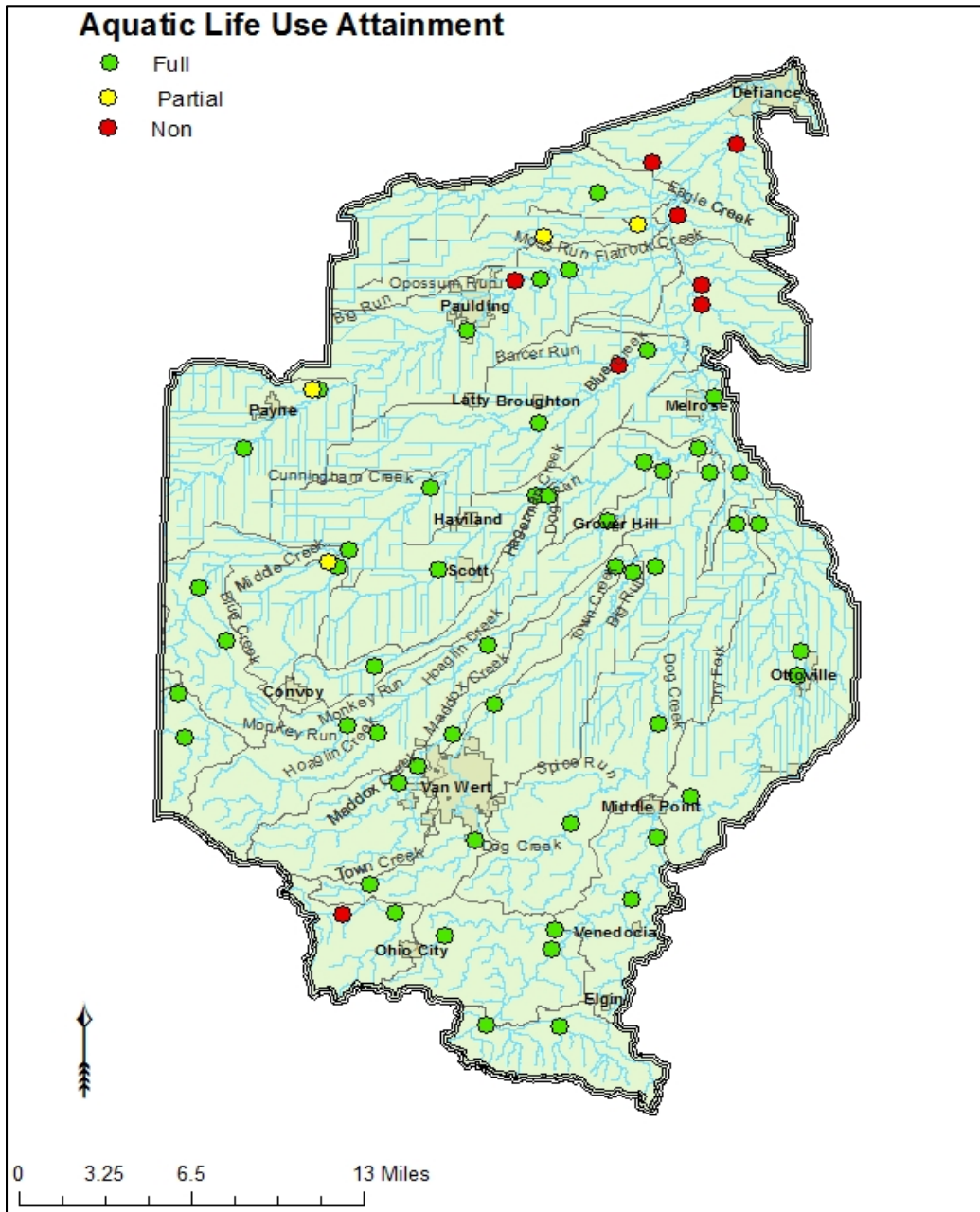


Figure 2. Aquatic life use attainment map for biological stations sampled in the lower Auglaize River tributaries study area, 2014 and 2015.

Table 1. Sampling stations for the lower Auglaize River tributaries study area, 2014 and 2015.

STATION	NAME	RIVER CODE	HUC 12	LATITUDE	LONGITUDE	RIVER MILE	DRAINAGE AREA	SAMPLE TYPE
500130	AUGLAIZE R. AT OAKWOOD @ ST. RT. 613	04-100-000	041000070907	41.092200	-84.381900	19.30	1509.0	C, D, M, Sn
P06S10	AUGLAIZE R. AT CHARLOE @ CO. RD. 138	04-100-000	041000071005	41.128600	-84.431900	14.94	2041.0	C, M
P06P16	AUGLAIZE R. NEAR JUNCTION @ REST AREA AT JCT SR 111/SR 66	04-100-000	041000071209	41.195800	-84.447800	9.73	2276.0	C, M
500290	AUGLAIZE R. UPST. DEFIANCE @ HARDING RD.	04-100-000	041000071209	41.253800	-84.389600	4.14	2330.0	C, D, B, M, Sn
302568	BOBENMYER DITCH AT STOUFFER RD (TRIB TO AUGLAIZE AT RM 13.17)	04-100-016	041000071005	41.145349	-84.419016	0.70	6.1	C, Mq, F, B
302569	SNYDER DITCH AT STOUFFER RD (TRIB TO AUGLAIZE AT RM 13.98)	04-100-017	041000071005	41.156567	-84.418686	0.30	5.2	C, Mq, F, B
303308	THREEMILE CREEK @ CANAL RD	04-101-000	041000071209	41.250643	-84.412662	0.87	4.9	C, Mq, F
303309	JACKSON DITCH @ POWER DAM RD	04-102-000	041000071209	41.237765	-84.395621	0.05	4.8	C, Mq, F
302539	FIVEMILE CREEK @ DEFINACE/PAULDING COUNTY LINE	04-104-000	041000071209	41.22603	-84.456979	1.70	2.9	C, Mq, F
P06K28	EAGLE CREEK WNW OF JUNCTION @ RIVER RD. (UPPER CROSSING)	04-105-000	041000071209	41.196872	-84.438001	1.57	3.7	C, Mq, F
302539	FIVEMILE CREEK AT DEFIANCE-PAULDING COUNTY LINE RD	04-104-000	041000071209	41.226030	-84.456979	1.70	2.9	B
P06K28	EAGLE CREEK WNW OF JUNCTION @ RIVER RD. (UPPER CROSSING)	04-105-000	041000071209	41.196872	-84.438001	1.57	3.7	B
302540	SIXMILE CREEK AT BURNS RD	04-106-000	041000071208	41.211075	-84.534308	6.70	3.0	C
302541	SIXMILE CR AT DOTTERER RD	04-106-000	041000071208	41.207989	-84.495558	3.90	12.0	C, Mq, F, D, N, B
302542	L. FLATROCK CREEK AT BROUGHTON RD	04-108-000	041000071207	41.182573	-84.534148	5.90	7.6	C, Mq, F
302543	L. FLATROCK CREEK AT OLD STATE ROUTE 111	04-108-000	041000071207	41.190327	-84.466439	1.50	17.8	C, Mq, F, D, N, B

302600	FLATROCK CREEK @ KINGS CHURCH RD	04-109-000	000004100007	40.889638	-84.783840	51.70	6.3	C, Mq, F
302544	FLATROCK CREEK @ WERNER RD	04-109-000	041000071201	40.914667	-84.788954	48.30	13.4	C, Mq, F, B
P06S37	FLATROCK CREEK UPST. PAYNE WWTP @ PUGH RD.	04-109-000	041000071205	41.056700	-84.746100	28.84	119.0	C, MQ, F2, D, N, T, B, M
P06S35	FLATROCK CREEK DST PAYNE WWTP @ ST. RT. 613	04-109-000	041000071205	41.091700	-84.693300	23.72	145.0	C, MQ, F2, D, N, B, M, Sn
500250	FLATROCK CREEK UPST. PAULDING @ CO. RD. 107	04-109-000	041000071206	41.125600	-84.592500	14.11	173.0	C, DW, B, M
P06S33	FLATROCK CREEK AT PAULDING, DST. DAM, RESERVIOR DR BEHIND WTP	04-109-000	041000071206	41.127500	-84.587500	13.80	173.0	C, MQ, F2, D, N, T
P06S32	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	04-109-000	041000071206	41.156400	-84.554200	9.70	183.0	C, MQ, F2, M
P06S31	FLATROCK CREEK DST. PAULDING WWTP @ BROUGHTON RD.	04-109-000	041000071206	41.157800	-84.535300	8.13	184.0	C, MQ, F2, D, N, B, Sd
P06S30	FLATROCK CREEK NE OF PAULDING @ LOUCK RD.	04-109-000	041000071206	41.163300	-84.515300	6.02	189.0	C, MQ, F2, D, N, T, B, M, Sn
P06P02	WILDCAT CREEK NE OF PAYNE @ ST. RT. 500	04-115-000	041000071205	41.091400	-84.697800	0.27	7.9	C, Mq, F
302545	BLUE CREEK AT DIXON CAVETT RD	04-120-000	041000071002	40.945805	-84.755293	31.95	7.4	C, Mq, F
P06K31	BLUE CREEK @ SUGAR GROVE CHURCH RD.	04-120-000	041000071002	40.975300	-84.776700	29.43	15.9	C, Mq, F, D, N, B
302546	BLUE CREEK AT YOAKUM RD	04-120-000	041000071003	40.999289	-84.669123	22.00	41.0	C, MQ, F2, D, N
302547	BLUE CREEK AT ALLISON RD	04-120-000	041000071003	41.036103	-84.611738	17.15	51.5	C, MQ, F2, D, N, T, B, M
P06W14	BLUE CREEK E OF LATTY @ PAULDING CO. RD. 123	04-120-000	041000071004	41.074700	-84.534700	10.00	77.0	C, MQ, F2, T C, MQ, F2, D, N, T, B, M, Sn
P06S02	BLUE CREEK @ CO. RD. 151	04-120-000	041000071004	41.118300	-84.457200	3.43	104.0	C, MQ, F2, D, N, T, B, M, Sn
302548	BARCER RUN	04-121-000	041000071004	41.109420	-84.477311	0.75	6.9	C, Mq, F
302549	UPPER PRAIRIE CREEK AT VAN WERT PAULDING COUNTY RD 12	04-125-000	041000071001	40.989555	-84.676672	0.90	8.8	C, Mq, F, B
302556	MIDDLE CREEK AT PARKER RD	04-125-001	041000071001	40.992636	-84.683354	0.50	5.0	C, Mq, F, B
P02S25	L. AUGLAIZE R. AT JONESTOWN @ JONESTOWN RD.	04-130-000	041000070602	40.771700	-84.516100	47.20	31.5	C, MQ, F2, D, N, B, M, Sn
P02K02	L. AUGLAIZE R. N OF VENEDOCIA @ WREN-LANDECK RD.	04-130-000	041000070603	40.801700	-84.459700	42.66	54.0	C, MQ, F2, T
P02S35	L. AUGLAIZE R. S OF MIDDLE POINT @ ST. RT. 697	04-130-000	041000070603	40.837500	-84.441900	38.26	61.0	C, MQ, F2, B, Sd, M

P02S05	L. AUGLAIZE R. DST. MIDDLEPOINT @ CONVERSE ROSELMS RD. (TWP. RD. 197)	04-130-000	041000070604	40.861400	-84.418900	34.75	68.0	C, MQ, F2, D, N, T, B, M
302550	L. AUGLAIZE DRINKING WATER	04-130-000	041000070604	40.877447	-84.371295	28.90	74.8	DW
P02S04	L. AUGLAIZE R. AT OTTOVILLE @ U.S. RT. 224	04-130-000	041000070604	40.932675	-84.344180	23.60	93.0	C, MQ, F2, M
P02S03	L. AUGLAIZE R. DST. OTTOVILLE @ CO. RD. P	04-130-000	041000070604	40.946900	-84.341700	22.51	96.0	C, MQ, F2, D, N, T, B, Sd, M
204284	L. AUGLAIZE R. W OF MANDALE @ ST. RT. 114	04-130-000	041000070604	41.019700	-84.373900	12.65	120.0	C, MQ, F2, D, N, T, B, M
P02S01	L. AUGLAIZE R. @ CO. RD. 60	04-130-000	041000070806	41.048600	-84.388900	8.72	184.0	C, MQ, F2, D, N
510200	L. AUGLAIZE R. E OF MELROSE @ ST. RT. 613	04-130-000	041000070806	41.092200	-84.407800	2.02	401.0	C, MQ, F2, D, N, T, B, M, Sn
P02S11	PRAIRIE CREEK W OF SCOTT @ PAULDING/VAN WERT CO. LINE	04-131-000	041000070703	40.989700	-84.604200	18.04	15.0	C, Mq, F, M
P02S09	PRAIRIE CREEK NE OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	04-131-000	041000070703	41.033600	-84.534700	12.50	25.9	C, MQ, F2, B, Sd, M
302551	PRAIRIE CREEK S OF MELROSE @ MERCILE RD	04-131-000	041000070703	41.053528	-84.457530	5.90	49.7	C, MQ, F2, D, N
P02S08	PRAIRIE CREEK S OF MELROSE @ ROSELMS RD.	04-131-000	041000070703	41.061900	-84.419200	1.50	105.0	C, MQ, F2, D, N, T, B, M, Sn
P02W22	WEST BRANCH AT GROVER HILL @ ST. RT. 114	04-132-000	041000070702	41.019300	-84.482800	4.40	47.0	C, MQ, F2, M, T
302554	WEST BRANCH AT MATSON RD	04-132-000	041000070702	41.048395	-84.443880	0.60	49.7	C, MQ, F2, D, N, T, B, M
302552	HOAGLIN CREEK AT TERRY RD	04-134-000	041000070702	40.894929	-84.644999	19.90	17.0	C, Mq, F
302553	HOAGLIN CREEK AT WETSEL RD	04-134-000	041000070702	40.946002	-84.567246	13.10	34.1	C, MQ, F2, B
302555	MONKEY RUN AT DULL ROBINSON RD	04-135-000	041000070702	40.898717	-84.666887	3.30	6.8	C, Mq, F
P02S14	HAGERMAN CREEK NE OF CONVOY @ RICHEY RD.	04-137-000	041000070701	40.932722	-84.648649	12.22	5.4	C, Mq, F, B, M
P02K04	HAGERMAN CREEK E OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	04-137-000	041000070701	41.033600	-84.526400	0.86	16.2	C, Mq, F, D, N, B
P02S18	MIDDLE CREEK NE OF ROSELMS @ CO. RD. 60	04-139-000	041000070805	41.048600	-84.409700	1.32	102.0	C, MQ, F2, D, N, T, B, M, Sn
302601	BIG RUN @ T-155	04-139-001	000004100007	40.994083	-84.447589	1.05	5.5	Mq, F
302557	MADDOX CREEK AT UNION RD	04-140-000	041000070803	40.866412	-84.629338	16.20	9.9	C, Mq, F
P02G02	MADDOX CREEK NEAR VAN WERT @ W. RIDGE RD. (LINCOLN HIGHWAY)	04-140-000	041000070803	40.875500	-84.615100	14.75	22.0	C, MQ, F2, B

302558	MADDOX CREEK AT DUTCH JOHN RD	04-140-000	041000070803	40.894884	-84.591405	12.20	23.6	C, MQ, F2, M
302559	MADDOX CREEK AT SR 637 TOWN CREEK AT DULL	04-140-000	041000070803	40.993484	-84.476483	0.90	32.7	C, MQ, F2, D, N, B, M
302560	ROBINSON RD	04-143-000	041000070802	40.789922	-84.666596	27.45	3.8	C, Mq, F
302561	TOWN CREEK AT RICHEY RD	04-143-000	041000070802	40.807064	-84.647817	25.35	16.3	C, Mq, F, B
P02S21	TOWN CREEK S OF VAN WERT @ PETER COLLINS RD	04-143-000	041000070804	40.833600	-84.572800	19.67	22.0	C, MQ, F2, D, N, M
302562	TOWN CREEK AT DRINKING WATER DAM POOL	04-143-000	041000070804	40.847452	-84.571799	18.30	24.8	DW
P02W10	TOWN CREEK N OF VAN WERT @ STRIPE RD	04-143-000	041000070804	40.912500	-84.561800	11.32	33.8	C, MQ, F2, B, Sd, M, Sn
302563	TOWN CREEK AT VAN WERT PAULDING COUNTY RD 12	04-143-000	041000070804	40.990105	-84.464007	0.90	52.5	C, MQ, F2, D, N, T
302564	ROLLER CREEK@ LIBERTY UNION RD.	04-144-000	041000070802	40.791339	-84.629040	1.35	6.7	C, Mq, F, B
302565	DOG CREEK AT GAMBLE RD	04-145-000	041000070801	40.844680	-84.504278	22.10	13.5	C, Mq, F
P02K07	DOG CREEK @ CHURCH RD	04-145-000	041000070801	40.903600	-84.443300	14.06	28.8	C, MQ, F2, B
P02K06	DOG CREEK E OF ROSELMS @ ST. RT. 114	04-145-000	041000070801	41.019400	-84.389400	0.97	57.0	C, MQ, F2, D, N, T, B, M, Sn
P02S23	LONG PRAIRIE CREEK DST. OHIO CITY WWTP @ ST. RT. 709	04-153-000	041000070602	40.778600	-84.592800	6.79	3.5	C, Mq, F, B, Sd, M
P02S22	LONG PRAIRIE CREEK W OF VENEDOCIA @ JONESTOWN RD.	04-153-000	041000070602	40.783600	-84.513900	0.68	11.4	C, Mq, F, D, N
302566	KYLE PRAIRIE CREEK AT MERCER VAN WERT COUNTY RD 18	04-154-000	041000070601	40.728168	-84.508609	3.30	6.9	C, Mq, F
302567	KYLE PRAIRIE CREEK UST FIRSINGER DITCH AT VAN WERT MERCER COUNTY RD 18	04-154-000	041000070601	40.727881	-84.561689	0.20	15.9	C, Mq, F, D, N, B
P02P04	EVANS DITCH N OF VENEDOCIA @ STATE RD	04-159-000	041000070603	40.815657	-84.450160	0.29	3.0	C, B, Sd, M

<u>Sample Type Key</u>		<u># Sites</u>		<u>Sample Type Key</u>		<u># Sites</u>
Water Chemistry	C	72		Drinking Water	DW	3
Macroinvertebrate quantitative	MQ	34		Fish Tissue	T	17
Macroinvertebrate qualitative	Mq	32		<i>E. coli</i>	B	39
Fish 2 pass	F2	34		Metals	M	32
Fish single pass	F	32		Sentinel	Sn	12
Datasonde®	D	30		Sediment	Sd	7
Nutrient Site (chlorophyll- <i>a</i>)	N	30		Sampled in 2015		

Table 2. Aquatic life use attainment status for sampling locations in the lower Auglaize River tributaries study area, 2014 and 2015. The Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Invertebrate Community Index (ICI) and macroinvertebrate narrative scores are based on the performance of the biological community. The Qualitative Habitat Evaluation Index (QHEI) is based on the ability of the stream habitat to support a biological community. The lower Auglaize River tributaries study area is located in the Huron-Erie Lake Plain (HELP) ecoregion. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. Orange shaded sites were sampled in 2015.

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
0.70 ^H	BOBENMYER DITCH @ STOUFFER RD.	302568	Recommended WWH	28	NA	-	<u>P</u> *	47.0	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
0.30 ^H	SNYDER DITCH @ STOUFFER RD.	302569	Recommended WWH	<u>20</u> *	NA	-	LF*	42.5	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
0.87	THREEMILE CREEK @ CANAL RD.	303308	WWH	30	NA	-	LF*	67.5	Partial	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
0.05	JACKSON DITCH @ POWER DAM RD. (WATSON RD.)	303309	WWH	26 ^{ns}	NA	-	<u>P</u> *	51.0	Non	Sedimentation/siltation, Other flow regime alterations,	Dam or impoundment, Agriculture, Crop production with subsurface drainage
1.7	FIVEMILE CREEK @ DEFINACE/PAULDING COUNTY LINE	302539	WWH	<u>20</u> *	NA	-	<u>P</u> *	33.3	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
1.57	EAGLE CREEK WNW OF JUNCTION @ RIVER RD. (UPPER CROSSING)	P06K28	WWH	<u>20</u> *	NA	-	LF*	49.5	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
3.90 ^H	SIXMILE CREEK @ DOTTERER RD.	302541	Recommended MWH	<u>24</u>	NA	-	F	54.3	Full		
5.90 ^H	L. FLATROCK CREEK @ BROUGHTON RD.	302542	Recommended MWH	<u>20</u>	NA	-	LF*	21.0	Partial	Sedimentation/siltation, Other flow regime alterations, Direct habitat alterations	Agriculture, Crop production with subsurface drainage
1.53 ^H	L. FLATROCK CREEK @ OLD ST. RT. 111	302543	WWH	<u>24^{ns}</u>	NA	-	MG ^{ns}	68.5	Full		
51.68 ^H	FLATROCK CREEK @ KINGS CHURCH RD.	302600	Recommended MWH	34	NA	-	F	25.3	Full		
48.30 ^H	FLATROCK CREEK @ WERNER RD.	302544	WWH	30	NA	-	MG ^{ns}	51.0	Full		
28.84 ^W	FLATROCK CREEK UPST. PAYNE @ PUGH RD.	P06S37	WWH	32	7.03 ^{ns}	30 ^{ns}	-	58.0	Full		
23.72 ^W	FLATROCK CREEK NE OF PAYNE @ ST. RT. 613	P06S35	WWH	33	8.02	36	-	76.0	Full		
13.80 ^W	FLATROCK CREEK AT PAULDING, DST. DAM	P06S33	WWH	39	8.56	36	-	59.5	Full		
9.70 ^W	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	P06S32	WWH	<u>27*</u>	7.92	14*	F*	69.0	Non	Sedimentation/Siltation	Agriculture
8.13 ^W	FLATROCK CREEK DST. PAULDING WWTP @ BROUGHTON RD.	P06S31	WWH	40	7.93	34	-	69.5	Full		
6.02 ^W	FLATROCK CREEK NE OF PAULDING @ LOUCK RD.	P06S30	WWH	33	7.66	44	-	81.5	Full		
0.27 ^H	WILDCAT CREEK NE OF PAYNE @ ST. RT. 500	P06P02	WWH	36	NA	-	F*	37.3	Partial	Sedimentation/siltation, Other flow regime alterations, Direct habitat alterations	Agriculture, Crop production with subsurface drainage
31.95 ^H	BLUE CREEK @ DIXON CAVETT RD.	302545	MWH-C	34	NA	-	F	24.8	Full		

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
29.43 ^H	BLUE CREEK @ SUGAR GROVE CHURCH RD.	P06K31	MWH-C	40	NA	-	MG	47.5	Full		
22.00 ^W	BLUE CREEK @ YOAKUM RD.	302546	MWH-C	35	8.72	18*	F	56.5	Full		
17.15 ^W	BLUE CREEK @ ALLISON RD.	302547	MWH-C	28	8.87	36	-	57.00	Full		
10.01 ^W	BLUE CREEK E OF LATTY @ PAULDING CO. RD. 123	P06W4	MWH-C	33	8.75	46	-	69.3	Full		
3.43 ^W	BLUE CREEK @ CO. RD. 151	P06S02	MWH-C	<u>27</u>	7.65	46	-	62.5	Full		
0.75 ^H	BARCER RUN @ ST. RT. 637	302548	Recommended WWH	28	NA	-	<u>P*</u>	41.5	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
0.9 ^H	UPPER PRAIRIE CREEK @ VAN WERT PAULDING CO. RD. 12	302549	Recommended MWH	38	NA	-	F	34.5	Full		
0.50 ^H	MIDDLE CREEK @ PARKER RD.	302556	Recommended MWH	34	NA	-	LF*	20.0	Partial	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
47.00 ^W	L. AUGLAIZE R. AT JONESTOWN @ JONESTOWN RD.	P02S25	MWH-C	31	7.67	34	-	56.0	Full		
42.66 ^W	L. AUGLAIZE R. N OF VENEDOCIA @ WREN-LANDECK RD.	P02K02	MWH-C	39	8.13	28	-	64.5	Full		
38.26 ^W	L. AUGLAIZE R. S OF MIDDLE POINT @ ST. RT. 697	P02S35	MWH-C	37	8.28	34	-	63.3	Full		
34.74 ^W	L. AUGLAIZE R. DST. MIDDLEPOINT @ CONVERSE ROSELMS RD	P02S05	MWH-C	31	7.41	36	-	59.3	Full		
23.60 ^W	L. AUGLAIZE R. AT OTTOVILLE @ U.S. RT. 224	P02S04	MWH-C	36	7.90	48	-	61.5	Full		

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
22.51 ^W	L. AUGLAIZE R. DST. OTTOVILLE @ CO. RD. P	P02S03	MWH-C	32	7.90	38	-	52.0	Full		
12.65 ^W	L. AUGLAIZE R. W OF MANDALE @ ST. RT. 114	204284	MWH-C	37	9.25	44	-	57.8	Full		
8.72 ^W	L. AUGLAIZE R. @ CO. RD. 60	P02S01	MWH-C	34	9.16	48	-	54.8	Full		
2.02 ^W	L. AUGLAIZE R. E OF MELROSE @ ST. RT. 613	510200	MWH-C	34	8.93	-	F	52.8	Full		
18.04 ^H	PRAIRIE CREEK W OF SCOTT @ PAULDING/VAN WERT CO. LINE	P02S11	MWH-C	28	NA	36	-	42.5	Full		
12.50 ^W	PRAIRIE CREEK NE OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	P02S09	MWH-C	36	8.33	30	-	48.5	Full		
5.90 ^W	PRAIRIE CREEK S OF MELROSE @ MERCILE RD.	302551	MWH-C	34	7.66	40	-	58.5	Full		
1.50 ^W	PRAIRIE CREEK S OF MELROSE @ ROSELMS RD.	P02S08	MWH-C	38	8.32	44	-	68.0	Full		
4.40 ^W	WEST BRANCH AT GROVER HILL @ ST. RT. 114	P02W2 2	MWH-C	38	7.99	38	-	67.8	Full		
0.60 ^W	WEST BRANCH @ MATSON RD.	302554	MWH-C	37	8.92	48	-	66.0	Full		
19.90 ^H	HOAGLIN CREEK @ TERRY RD.	302552	MWH-C	32	NA	-	MG	60.5	Full		
13.06 ^W	HOAGLIN CREEK @ WETSEL RD.	302553	MWH-C	32	6.59	44	-	49.8	Full		
3.30 ^H	MONKEY RUN @ DULL ROBINSON RD.	302555	MWH-C	32	NA	-	F	20.5	Full		
12.22 ^H	HAGERMAN CREEK NE OF CONVOY @ RICHEY RD.	P02S14	MWH-C	36	NA	-	F	34.5	Full		
0.86 ^H	HAGERMAN CREEK E OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	P02K04	MWH-C	32	NA	32	-	61.5	Full		

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
1.32 ^W	MIDDLE CREEK NE OF ROSELMS @ CO. RD. 60	P02S18	MWH-C	34	8.77	46	-	67.5	Full		
0.97 ^H	BIG RUN SE OF GROVER HILL @ TWP. RD. 155	302601	Recommended WWH	26 ^{NS}	NA	-	MG ^{NS}	31.5	Full		
16.20 ^H	MADDOX CREEK @ LIBERTY UNION RD.	302557	MWH-C	40	NA	-	MG	57.3	Full		
14.75 ^W	MADDOX CREEK NEAR VAN WERT @ W. RIDGE RD. (LINCOLN HIGHWAY)	P02G02	MWH-C	34	6.94	32	-	44.8	Full		
12.21 ^W	MADDOX CREEK @ DUTCH JOHN RD.	302558	MWH-C	38	7.83	32	-	53.50	Full		
0.90 ^W	MADDOX CREEK @ ST. RT. 637	302559	MWH-C	31	6.76	38	-	57.5	Full		
27.45 ^H	TOWN CREEK @ DULL ROBINSON RD.	302560	MWH-C	30	NA	-	P*	31.0	Non	Sedimentation/siltation, Other flow regime alterations	Agriculture, Crop production with subsurface drainage
25.35 ^H	TOWN CREEK @ RICHEY RD.	302561	MWH-C	40	NA	-	F	60.8	Full		
19.67 ^W	TOWN CREEK S OF VAN WERT @ PETER COLLINS RD.	P02S21	MWH-C	34	6.86	24	-	50.0	Full		
11.32 ^W	TOWN CREEK N OF VAN WERT @ STRIPE RD.	P02W10	MWH-C	34	7.85	24	-	51.5	Full		
0.72 ^W	TOWN CREEK NEAR MOUTH AT VAN VERT PAULDING CO. LINE RD.	P02K05	MWH-C	38	8.53	28	-	56.0	Full		
1.35 ^H	ROLLER CREEK @ LIBERTY UNION RD.	302564	MWH-C	32	NA	-	F	36.5	Full		
22.10 ^H	DOG CREEK @ GAMBLE RD.	302565	MWH-C	30	NA	-	F	45.3	Full		
14.06 ^W	DOG CREEK @ CHURCH RD	P02K07	MWH-C	39	8.19	46	-	62.5	Full		

RM	Stream Name	Station ID	Aquatic Life Use	IBI	MIwb	ICI	Macro Narrative ^a	QHEI	Attainment Status	Cause(s)	Source(s)
0.97 ^W	DOG CREEK E OF ROSELMS @ST. RT. 114	P02K06	MWH-C	42	8.67	48	-	69.5	Full		
6.79 ^H	LONG PRAIRIE CREEK DST. OHIO CITY WWTP @ ST. RT. 709	P02S23	MWH-C	36	NA	-	F	47.8	Full		
0.68 ^H	LONG PRAIRIE CREEK W OF VENEDOCIA @ JONESTOWN RD.	P02S22	MWH-C	32	NA	-	MG	52.0	Full		
3.23 ^H	KYLE PRAIRIE CREEK @ VAN WERT MERCER CO. RD. 18	302566	MWH-C	38	NA	-	MG	35.3	Full		
0.20 ^H	KYLE PRAIRIE CR UPST FRISINGER DITCH @ VAN WERT MERCER CR 18	302567	MWH-C	42	NA	-	F	45.0	Full		

Biological Criteria

<i>Huron-Erie Lake Plain</i>		
Index – Site Type	WWH	MWH
IBI – Headwaters	28	20
IBI – Wading	32	22
IBI – Boat	34	20
MIwb – Wading	7.3	5.6
MIwb – Boat	8.6	5.7
ICI	34	22

^a - 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 due to sampling constraints.) VP=Very Poor, P=Poor, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional.

NA - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi².

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.

- - No sample taken.

^H – Headwater site, less than 20 sq. mi. in drainage.

^W – Wading site, greater than 20 sq. mi. in drainage.

Sampled in 2015

Water Quality Use Designations and Recommendations

The streams in the lower Auglaize River tributary study area currently listed in the [Ohio Water Quality Standards](#) (WQS) are assigned Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), and Limited Resource Water (LRW) aquatic life use designations.

Twenty-eight streams in the lower Auglaize River tributaries study area were evaluated for beneficial use potential in 2014 and 2015 (Table 1). Additional biological, habitat, and chemical water quality monitoring is scheduled for 2017 in order to confirm the appropriateness of the designated aquatic life use assigned to several streams; recommended use changes will be pursued in a future rule-making. Significant findings and recommendations based on the 2014 and 2015 data are outlined below.

- Nine streams in the study area have been verified as WWH. These include the Auglaize River (Defiance Power Dam to mouth), Sixmile Creek, Threemile Creek, Jackson Ditch, Fivemile Creek, Eagle Creek, Little Flatrock Creek (State route 637 (RM 2.2) to the mouth), Flatrock Creek (Kings Church Road (RM 51.68) to the mouth), and Wildcat Creek.
- Eleven of the streams in the study area are designated MWH and have been verified. These include the Auglaize River (Blanchard River to Defiance Power Dam), Prairie Creek, West Branch, Hoaglin Creek, Monkey Run, Hagerman Creek, Middle Creek (tributary to Little Auglaize River), Maddox Creek, Town Creek, Roller Creek, Dog Creek, Long Prairie Creek, and Kyle Prairie Creek.
- Four streams have unverified WWH aquatic life uses in the WQS. Biological sampling conducted on Bobenmyer Ditch, Snyder Ditch, Barcer Run, and Big Run verified that this aquatic life use is appropriate because WWH biological communities were fully or partially present and the stream was not listed under county ditch maintenance.
- Five streams and stream segments in the study area that have unverified WWH uses in the WQS demonstrated that the MWH-C aquatic life use would be more appropriate. Biological sampling conducted on Sixmile Creek, Little Flatrock Creek (headwaters to State Route 637 (RM 2.2)), Flatrock Creek (headwaters to Kings Church Road), Upper Prairie Creek, and Middle Creek (Tributary to Blue Creek) revealed that the MWH-C aquatic life use would be appropriate based upon the fact that these streams did not have WWH biology and are perpetually under county ditch maintenance. These streams and stream segments had poor habitat with a collective average QHEI score of 31.
- Threemile Creek, Jackson Ditch, Fivemile Creek, Eagle Creek, Sixmile Creek, Little Flatrock Creek, Flatrock Creek, Wildcat Creek, Snyder Ditch, Bobenmyer Ditch, Blue Creek, Barcer Run, Upper Prairie, Middle Creek (Tributary to Blue Creek), and Prairie Creek should all maintain their AWS, IWS and PCR uses.
- The Little Auglaize River, Prairie Creek, West Branch, Hoaglin Creek, Monkey Run, Hagerman Creek, Middle Creek, Big Run, Maddox Creek, Town Creek, Roller Creek, Dog Creek, Evans Ditch, Long Prairie Creek, and Kyle Prairie Ditch should all maintain their AWS, IWS, and SCR uses.
- The Auglaize River, Flatrock Creek, Little Auglaize River, Town Creek and Evans Ditch should all maintain their PWS uses.

General Recommendations

Once a watershed's condition has been studied and any impairment identified, it is useful to examine ways to correct the problems. In this section, some general recommendations for the lower Auglaize River tributaries are discussed. More specific, quantified recommendations may result from the Total Maximum Daily Load project (TMDL). Recommendations are not limited to this section. Recommendations for changes at specific locations that would benefit stream resource quality (for example, riparian and streamside buffer practices and land use changes) are interspersed throughout this document. The greatest concerns to water quality identified by this study were nutrient enrichment and bacteria, storm water runoff and sedimentation, and direct habitat alterations.

Managing Storm Water, Sedimentation, and Direct Habitat Alterations

The lower Auglaize River tributaries and the overall water quality downstream are directly affected by storm water drainage and the ways the watershed is buffered from precipitation events. Reduction of sediment, nutrients, fertilizers/chemicals, erosion, and hydrologic modifications can be accomplished through proper storm water management.

Re-establishing natural riparian buffers (wetland and wooded riparian corridors) in the watershed to help slow storm water and filter pollutants before they reach surface waters are positive mechanisms to reduce storm water pollution. In addition to restoring riparian buffers, an effort should be made to take advantage of the stream's natural assimilative capacities. Natural development of stream channels provides an array of beneficial services, including settling fine sediments into adjacent floodplains, processing of nutrients into productive biomass instead of nuisance algae, improved water quality, creation of natural instream habitats to increase carrying capacity of biomass, and, ultimately and most importantly, evolution into a stable channel and the slowing of erosion.

The Little Auglaize River has been evolving into a more stable channel without any apparent large-scale channel modifications taking place recently. The over-wide channel may have aided in its successional evolution over time (Figure 41). Fish community scores were found to be meeting the WWH ALU criteria. Historically, the river was designated MWH due to extensive physical modifications and ongoing channel and bank maintenance. If channel maintenance stays at a minimum or ceases and water quality continues on its current trajectory, the Little Auglaize River should be re-designated WWH. A cooperative agreement should be reached with ditch maintenance crews to keep maintenance activities to a minimum and collectively strive toward better water quality throughout the watershed.

Organic Enrichment and Bacteria

Organic enrichment was a problem detected in this watershed study (Please read the Recreation Use section on page 56 for more details). All of the streams in the study were found to have high levels of organic enrichment in all or parts of their reaches. Forty out of forty-one sampling locations were in non-attainment of the designated Contact Recreation uses established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the quantities of fecal indicators (*Escherichia coli* bacteria) present in the water column. Potential sources of *E. coli* contamination at locations not attaining the recreation use criteria are failing HSTS, livestock pasture land runoff, agricultural runoff, CSOs, and wildlife accumulations. Most of the sites sampled had extensive amounts of agricultural land drained by subsurface tiles and drastically reduced riparian buffers along the stream. Land applications of livestock manure should always be done with caution and follow proper BMPs when used as fertilizer. Buffering streams from storm runoff by allowing vegetated buffers to grow and instituting BMPs for field tile filtration will not only reduce sedimentation from storm events, but will also help filter organics before they wash into streams, reduce downstream erosion/loss of farm land, and lessen the amount of nutrients and fertilizers washing into the western basin of Lake Erie that feed toxic algae blooms.

Table 3. Waterbody use designation recommendations for the lower Auglaize River tributaries study area, 2014 and 2015. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). A plus sign (+) indicates a confirmation of an existing use and a triangle (▲) denotes a new recommended use based on the findings of this report.

Use designations for water bodies in the Auglaize River drainage basin.

Water Body Segment	Use Designations												Comments	
	Aquatic Life Habitat						Water Supply			Recreation				
	S R W	W W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W	P C R		S C R
Auglaize river - headwaters to Blanchard river (RM 26.2)		+							+	+			+	
- at Agerter rd. (RM 64.58)		+						+	+	+			+	PWS intake - Lima
- Blanchard river to Defiance power dam (RM 5.8)				▲					*/	*/			*/	HELP ecoregion - impounded
- Defiance power dam to the mouth		*/							*/	*/			*/	
Threemile creek		*/							*/	*/			*/	
Jackson ditch		*/							*/	*/			*/	
Beetree creek		*							*	*			*	
Fivemile creek		*/							*/	*/			*/	
Eagle creek		*/							*/	*/			*/	
Sixmile creek				▲					*/	*/			*/	HELP ecoregion – channel modification
Bull creek		*							*	*			*	
Little Flatrock creek - headwaters to state route 637 (RM 2.2)				▲					*/	*/			*/	

Use designations for water bodies in the Auglaize River drainage basin.

Water Body Segment	Use Designations												Comments
	Aquatic Life Habitat						Water Supply			Recreation			
	S R W	W W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W	P C R	
- State route 637 (RM 2.2) to the mouth		*/+						*/+	*/+		*/+		
Flatrock creek - at RM 14.13		+					o	+	+		+		PWS intake - Paulding
- Kings church road (RM 51.68) to the mouth		+						+	+		+		
- headwaters to Kings church road (RM 51.68)				△				+	+		+		HELP ecoregion - channel modification
Wildcat creek		*/+						*/+	*/+		*/+		
Snyder ditch (Auglaize river RM 12.98)		△						△	△		△		
Bobenmyer ditch (Auglaize river RM 13.17)		△						△	△		△		
Blue creek				+				+	+		+		HELP ecoregion - channel modification
Barcer run		*/+						*/+	*/+		*/+		
Dalaet-Broughton ditch (Blue creek RM 8.1)				+				+	+			+	HELP ecoregion - channel modification
Zielke ditch (aka Webster ditch)				+				+	+			+	HELP ecoregion - channel modification
Cunningham creek		*						*	*		*		
Buchanan ditch		*						*	*		*		
Upper Prairie creek				△				*/+	*/+		*/+		HELP ecoregion – channel modification
Middle creek				△				△	△		△		HELP ecoregion – channel modification
Parker ditch		*						*	*		*		
Sponseller ditch		*						*	*		*		
Little Auglaize river - at RM 23.40				+			o	+	+			+	HELP ecoregion - channel modification; PWS intake - Delphos

Use designations for water bodies in the Auglaize River drainage basin.

Water Body Segment	Use Designations												Comments	
	Aquatic Life Habitat						Water Supply			Recreation				
	S R W	W W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W	P C R		S C R
- all other segments				+					+	+			+	HELP ecoregion - channel modification
Prairie creek				+					+	+			+	HELP ecoregion - channel modification
West branch				+					+	+			+	HELP ecoregion - channel modification
Hog run				+					+	+			+	HELP ecoregion - channel modification
Hoaglin creek				+					+	+			+	HELP ecoregion - channel modification
Monkey run				+					+	+			+	HELP ecoregion - channel modification
Dog run				+					+	+			+	HELP ecoregion - channel modification
Hagerman creek				+					+	+			+	HELP ecoregion - channel modification
Dry creek				+					+	+			+	HELP ecoregion - channel modification
Middle creek				+					+	+			+	HELP ecoregion - channel modification
Big run		△							△	△			△	
Maddox creek				+					+	+			+	HELP ecoregion - channel modification
Balyeat ditch				+					+	+			+	HELP ecoregion - channel modification
Sheets ditch (Maddox creek RM 21.7)				+					+	+			+	HELP ecoregion - channel modification
Town creek - at RM 18.35				+					+	+	+		+	HELP ecoregion - channel modification; PWS intake - Van Wert
- all other segments				+					+	+			+	HELP ecoregion - channel modification
Roller creek				+					+	+			+	HELP ecoregion - channel modification
Dog creek				+					+	+			+	HELP ecoregion - channel modification

Use designations for water bodies in the Auglaize River drainage basin.

Water Body Segment	Use Designations												Comments	
	Aquatic Life Habitat						Water Supply			Recreation				
	S R W	W W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W	P C R		S C R
Emmit Bell ditch				+					+	+			+	HELP ecoregion - channel modification
Spice run				+					+	+			+	HELP ecoregion - channel modification
Evans ditch							+		+	+			+	Small drainageway maintenance
Long Prairie creek				+					+	+			+	HELP ecoregion - channel modification
Kyle Prairie ditch				+					+	+			+	HELP ecoregion - channel modification
Greens ditch				+					+	+			+	HELP ecoregion - channel modification
Prairie 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.

Introduction

During 2014 and 2015, Ohio EPA conducted a water resource assessment of 28 streams in the lower Auglaize River tributary study area using standard Ohio EPA protocols as described in Appendix A. Included in this study were assessments of the biological, surface water and recreational (bacterial) condition. A total of 66 biological, 72 water chemistry, and 39 bacterial stations were sampled in the lower Auglaize River tributary study area.

Specific objectives of the evaluation were to:

- establish the present biological conditions at the selected sites in the lower Auglaize River tributary study area by evaluating fish and macroinvertebrate communities,
- assess physical habitat influences on stream biotic integrity,
- determine recreational water quality,
- determine the attainment status of ALUs and recommend changes, if appropriate,
- evaluate NPDES and PSWS inputs and facilities,
- verify and update fish tissue consumption advisories, and
- characterize aquatic resource degradation and the extent it is attributable to particular stressors.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (*e.g.*, 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 (305[b] and 303[d]) Report.

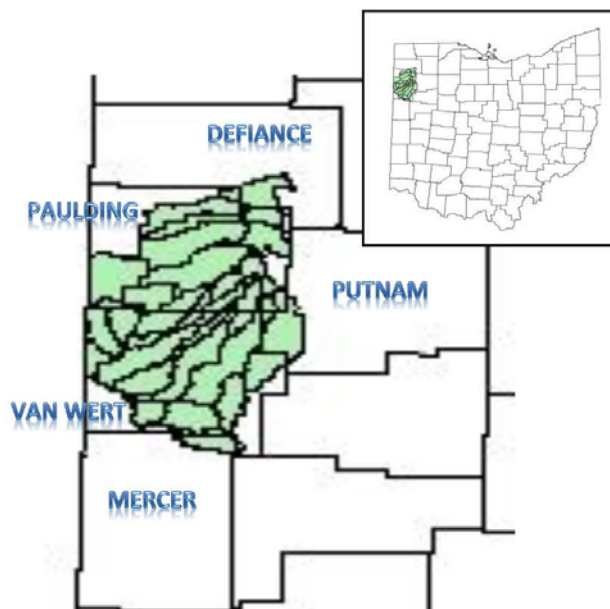


Figure 3. County and state of Ohio map with lower Auglaize River tributaries study area hydrological units outlined.

Study Area Description

The lower Auglaize River tributaries study area covers varied percentages of Defiance (4.97%), Mercer (2.99%), Paulding (74.39%), Putnam (6.91%), and Van Wert (78.26%) counties in northwest Ohio. The lower Auglaize River tributaries drain a combined 719 square miles and include the direct Auglaize River tributaries Sixmile, Little Flatrock, Flatrock, Blue, Threemile, Fivemile, and Eagle creeks, Jackson Ditch and the Little Auglaize River. At 45.5 miles long, the Little Auglaize River is the largest of the tributaries, draining 405 mi².

The lower Auglaize River tributaries study area is entirely within the Huron-Erie Lake Plain (HELP) ecoregion. The HELP ecoregion is characterized by an almost level lake plain with some glacial moraines and beach ridges. Streams in the HELP ecoregion and former Great Black Swamp are low gradient and high in organic material. Some of the richest soils in the state are found here, including Roselms, Paulding, Latty, Hoytville, Fulton, Pewamo, Gynwood, and other similar groups², and Omernik and Gallant 1988). Corn and soybean farming are the dominant land use and require an extensive drainage ditch system to make row crop farming possible throughout this once densely forested swampland.

Land use and land cover have an important influence on water quality conditions found in the watershed. Overall, agricultural land uses dominate with about 84% of the study area in row crops (Figure 4). The next leading land use in the study area is livestock agriculture with a total of 24,317 beef and dairy cows, 54,763 hogs, and 1,841 sheep (Quick Stats: <http://quickstats.nass.usda.gov/>).

According to the 2010 census, the Ohio portion of the lower Auglaize River tributaries watershed area is home to approximately 52,600 people, of which, approximately 16,000 live outside of the towns and villages (Table 5). Population densities range from 47 people/mi² in Paulding County to 70 people/mi² in Van Wert County. About 8,000 people in the city of Defiance are located within the watershed. Population densities in this area are as high as 2,000 people /mi².¹ Total population across the three primary counties (Van Wert, Paulding, and Defiance) is estimated to drop 7.4% (nearly 7,000 people) between 2010 and 2030. Each individual county expects to see a comparable population decline (Table 4).²

Table 4. Community populations in the lower Auglaize River tributaries study area.

Community	Population	Community	Population
Defiance	12,500	Grover Hill	402
Van Wert	10,846	Scott	286
Delphos	7,101	Melrose	275
Paulding	3,605	Haviland	215
Payne	1,194	Latty	193
Convoy	1,085	Cecil	188
Ottoville	976	Venedocia	124
Ohio City	705	Broughton	120
Middle Point	576	Elgin	57
Fort Jennings	485	Total	36,633

1 U.S. Census Bureau. 2013

2 http://development.ohio.gov/reports/reports_countytrends_map.htm

Table 5. Watershed population in the lower Auglaize River tributaries study area.

County	Mi² in Watershed	Est. Population in Watershed
Defiance	21	13,700
Mercer	14	700
Paulding	312	14,600
Putnam	33	1,600
Van Wert	321	21,200
Indiana	17	800
Total	718	52,600

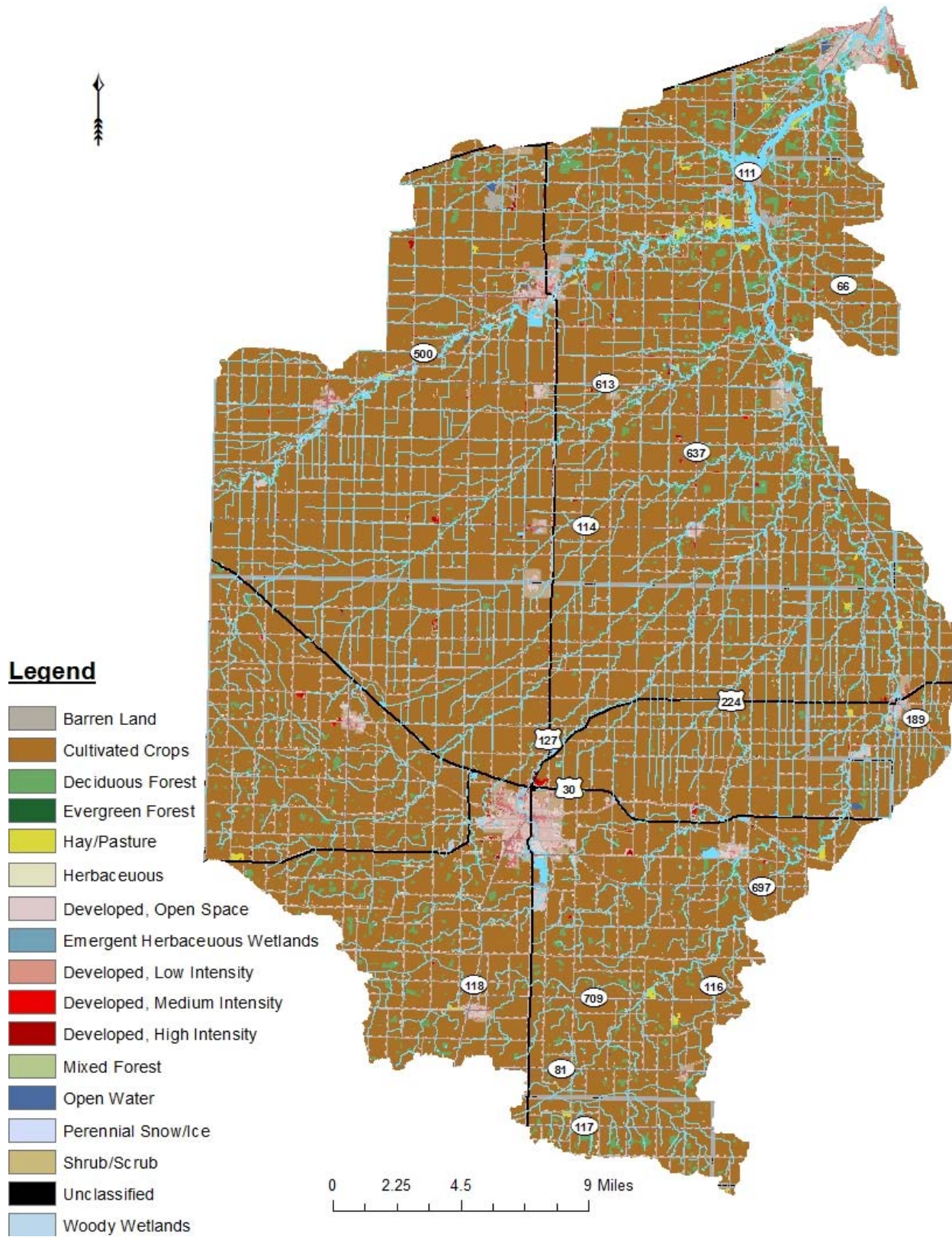


Figure 4. Land use coverage map for the lower Auglaize River tributaries study area (NLCD, 2011).

Results

Water Chemistry- Overview

Surface water chemistry samples were collected from the lower Auglaize River tributaries study area from March 2014 through November 2014 at 72 locations (Appendix K). Stations were established in free-flowing sections of the streams and were collected via bucket from bridge crossings or directly from the stream. Surface water samples were dispensed into appropriate containers, preserved and delivered to Ohio EPA's Division of Environmental Services laboratory. Collection and preservation was completed using appropriate methods, as outlined in the Ohio EPA Surface Water Field Sampling Manual, January 31, 2013 (Ohio EPA, 2013).

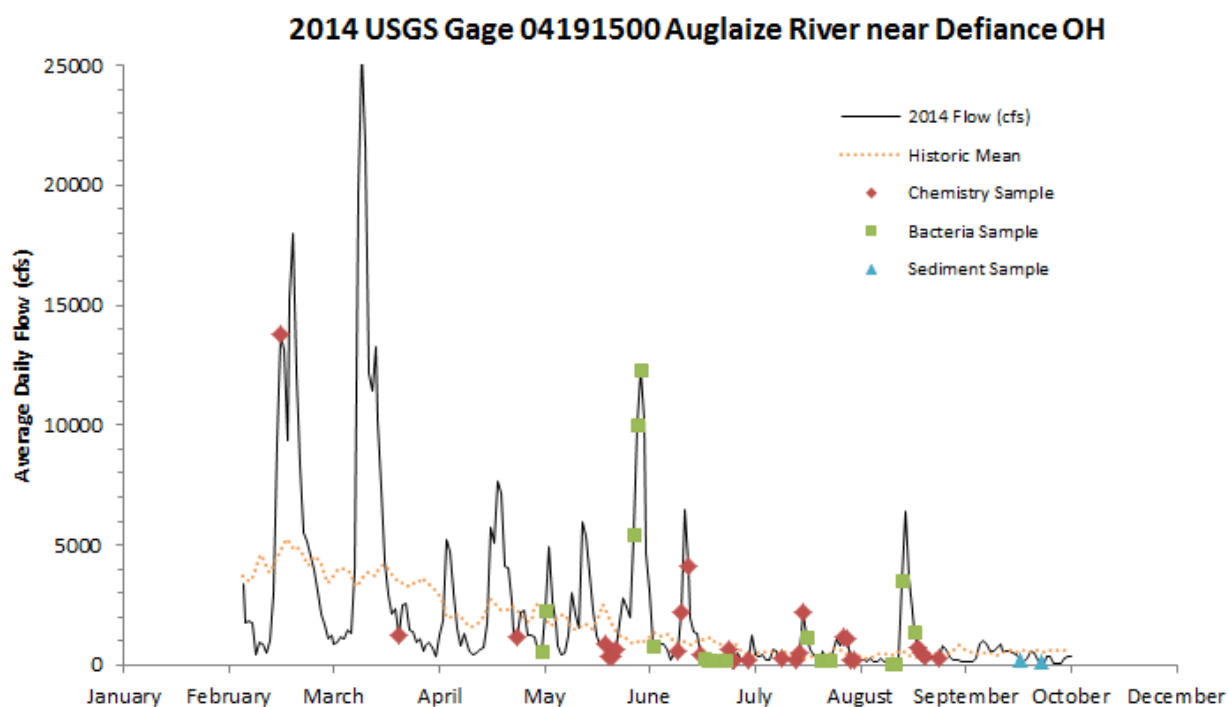


Figure 5. Auglaize River near Defiance, 2014 flow data with sampling events plotted against historic average flows.

USGS gage data from the Auglaize River near the city of Defiance (Harding Road) was used to show flow trends in the watershed during the survey (Figure 5). Dates when chemistry samples and bacteria samples were collected in the study area are noted on the graph. Flow conditions during the summer field season were slightly higher than the historic mean. Water samples captured a variety of flow conditions in the study area during the field season. Bacteria was collected during the recreation use season (defined in rule as May 1 through October 31).

Surface water samples were analyzed for metals, nutrients, semi-volatile organic compounds, herbicides, bacteria, and suspended and dissolved solids. Temperature, pH, conductivity, dissolved oxygen (D.O.), and saturation were measured in the field (Appendices G, H, J, and K). Geometric mean nutrient values are reported in Table 7. Parameters which were in exceedance of the Ohio Water Quality Standards (WQS) criteria are reported in Table 8. Bacteriological samples were collected from 41 locations. The bacteriological results are reported in the Recreation Use section.

Single sample dissolved oxygen levels were found below the minimum Water Quality Standards (WQS) criterion at 13 sites for a total of 26 times during the sampling season. Twelve of the 26 exceedances (46%) occurred on Sixmile Creek and Little Flatrock Creek. Dissolved oxygen fluctuates in a stream due to photosynthesis, biological activity, water flow/turbulence, 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 dissolved oxygen in the stream and larger daily variability.

Single sample temperature levels were found above the daily average criterion 22 times at 15 sites and above the daily maximum criterion two times at one site, the Little Auglaize River downstream from Ottoville at County Road P. The lack of overhead riparian canopy due to drainage maintenance projects and flow regime alterations from tile drainage impacts stream temperatures during summer months.

Additional single sample WQS criterion exceedances for iron, and pH occurred at 14 sites across the watershed. These items are discussed in additional detail below.

Nutrient data are evaluated against ecoregional targets (Ohio EPA, 1999) as a geometric mean during the nutrient index period (June 1 – Oct 15) (Table 6). A total of 21 sites (29%) exceeded the target for phosphorus and 46 sites (64%) exceeded the target for nitrate-nitrite (Table 7). Much of the watershed appears to transport excess nutrients, especially nitrate-nitrite, downstream rapidly. Pervasive channel alterations have much of the system functioning as a pipe, thus denying access to the assimilative services of the floodplains.

Table 6. Total phosphorus and nitrate-nitrite targets (from Ohio EPA, 1999).

Stream Size	TP (mg/l)		N+N (mg/l)	
	WWH	MWH	WWH	MWH
Headwater	0.08	0.34	1.0	1.0
Wadeable	0.10	0.28	1.0	1.6
Small River	0.17	0.25	1.5	2.2

Ammonia levels throughout the entire watershed did not exceed the relevant temperature and pH-based WQS criterion at the locations sampled and gradually declined at downstream sites.

Table 7. Seasonal geometric mean values (mg/l) for nutrients calculated from grab samples collected in the lower Auglaize River tributaries study area, organized by stream size and then subwatershed. Results highlighted are above statewide recommended targets (Ohio EPA, 1999). (^H – Headwater site < 20sq.mi., ^W – Wading site >20sq.mi.).

RM	Stream Name	Station ID	Aquatic Life Use	Phosphorus	Nitrate-nitrite
0.70 ^H	BOBENMYER DITCH @ STOUFFER RD.	302568	Recommended WWH	0.25	0.46
0.30 ^H	SNYDER DITCH @ STOUFFER RD.	302569	Recommended WWH	0.14	0.39
0.87	THREEMILE CREEK @ CANAL RD.	303308	WWH	0.09	1.84
0.05	JACKSON DITCH @ POWER DAM RD. (WATSON RD.)	303309	WWH	0.14	0.39
1.7	FIVEMILE CREEK @ DEFINACE/PAULDING COUNTY LINE	302539	WWH	0.41	0.67
1.57	EAGLE CREEK WNW OF JUNCTION @ RIVER RD. (UPPER CROSSING)	P06K28	WWH	0.09	1.84
3.90 ^H	SIXMILE CREEK @ DOTTERER RD.	302541	Recommended MWH	0.12	0.16
5.90 ^H	L. FLATROCK CREEK @ BROUGHTON RD.	302542	Recommended MWH	0.12	0.45
1.53 ^H	L. FLATROCK CREEK @ OLD ST. RT. 111	302543	WWH	0.07	0.41
48.30 ^H	FLATROCK CREEK @ WERNER RD.	302544	WWH	0.2	1.48
28.84 ^W	FLATROCK CREEK UPST. PAYNE @ PUGH RD.	P06S37	WWH	0.10	1.89
23.72 ^W	FLATROCK CREEK NE OF PAYNE @ ST. RT. 613	P06S35	WWH	0.13	1.06
13.80 ^W	FLATROCK CREEK AT PAULDING, DST. DAM	P06S33	WWH	0.11	0.89
9.70 ^W	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	P06S32	WWH	0.23	1.87
8.13 ^W	FLATROCK CREEK DST. PAULDING WWTP @ BROUGHTON RD.	P06S31	WWH	0.20	1.39
6.02 ^W	FLATROCK CREEK NE OF PAULDING @ LOUCK RD.	P06S30	WWH	0.18	1.93
0.27 ^H	WILDCAT CREEK NE OF PAYNE @ ST. RT. 500	P06P02	WWH	0.17	0.43
31.95 ^H	BLUE CREEK @ DIXON CAVETT RD.	302545	MWH-C	0.22	0.85
29.43 ^H	BLUE CREEK @ SUGAR GROVE CHURCH RD.	P06K31	MWH-C	0.18	2.36
22.00 ^W	BLUE CREEK @ YOAKUM RD.	302546	MWH-C	0.07	1.32
17.15 ^W	BLUE CREEK @ ALLISON RD.	302547	MWH-C	0.11	1.79
10.01 ^W	BLUE CREEK E OF LATTY @ PAULDING CO. RD. 123	P06W4	MWH-C	0.21	1.81
3.43 ^W	BLUE CREEK @ CO. RD. 151	P06S02	MWH-C	0.06	0.58
0.75 ^H	BARCER RUN @ ST. RT. 637	302548	Recommended WWH	0.09	0.32
0.9 ^H	UPPER PRAIRIE CREEK @ VAN WERT PAULDING CO. RD. 12	302549	Recommended MWH	0.15	1.67
0.50 ^H	MIDDLE CREEK @ PARKER RD.	302556	Recommended MWH	0.09	1.40
47.00 ^W	L. AUGLAIZE R. AT JONESTOWN @ JONESTOWN RD.	P02S25	MWH-C	0.13	2.36
42.66 ^W	L. AUGLAIZE R. N OF VENEDOCIA @ WREN-LANDECK RD.	P02K02	MWH-C	0.16	2.58
38.26 ^W	L. AUGLAIZE R. S OF MIDDLE POINT @ ST. RT. 697	P02S35	MWH-C	0.12	1.64
34.74 ^W	L. AUGLAIZE R. DST. MIDDLEPOINT @ CONVERSE ROSELMS RD	P02S05	MWH-C	0.10	0.90

RM	Stream Name	Station ID	Aquatic Life Use	Phosphorus	Nitrate-nitrite
23.60 ^W	L. AUGLAIZE R. AT OTTOVILLE @ U.S. RT. 224	P02S04	MWH-C	0.08	1.21
22.51 ^W	L. AUGLAIZE R. DST. OTTOVILLE @ CO. RD. P	P02S03	MWH-C	0.17	2.14
12.65 ^W	L. AUGLAIZE R. W OF MANDALE @ ST. RT. 114	204284	MWH-C	0.08	1.15
8.72 ^W	L. AUGLAIZE R. @ CO. RD. 60	P02S01	MWH-C	0.07	0.69
2.02 ^W	L. AUGLAIZE R. E OF MELROSE @ ST. RT. 613	510200	MWH-C	0.08	1.72
18.04 ^H	PRAIRIE CREEK W OF SCOTT @ PAULDING/VAN WERT CO. LINE	P02S11	MWH-C	0.06	1.03
12.50 ^W	PRAIRIE CREEK NE OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	P02S09	MWH-C	0.13	1.06
5.90 ^W	PRAIRIE CREEK S OF MELROSE @ MERCILE RD.	302551	MWH-C	0.13	1.05
1.50 ^W	PRAIRIE CREEK S OF MELROSE @ ROSELMS RD.	P02S08	MWH-C	0.22	1.42
4.40 ^W	WEST BRANCH AT GROVER HILL @ ST. RT. 114	P02W22	MWH-C	0.10	1.31
0.60 ^W	WEST BRANCH @ MATSON RD.	302554	MWH-C	0.09	1.50
19.90 ^H	HOAGLIN CREEK @ TERRY RD.	302552	MWH-C	0.14	2.05
13.06 ^W	HOAGLIN CREEK @ WETSEL RD.	302553	MWH-C	0.08	1.55
3.30 ^H	MONKEY RUN @ DULL ROBINSON RD.	302555	MWH-C	0.11	1.11
12.22 ^H	HAGERMAN CREEK NE OF CONVOY @ RICHEY RD.	P02S14	MWH-C	0.54	3.04
0.86 ^H	HAGERMAN CREEK E OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	P02K04	MWH-C	0.21	1.80
1.32 ^W	MIDDLE CREEK NE OF ROSELMS @ CO. RD. 60	P02S18	MWH-C	0.17	3.05
16.20 ^H	MADDOX CREEK @ LIBERTY UNION RD.	302557	MWH-C	0.14	1.35
14.75 ^W	MADDOX CREEK NEAR VAN WERT @ W. RIDGE RD. (LINCOLN HIGHWAY)	P02G02	MWH-C	0.15	1.60
12.21 ^W	MADDOX CREEK @ DUTCH JOHN RD.	302558	MWH-C	0.13	0.83
0.90 ^W	MADDOX CREEK @ ST. RT. 637	302559	MWH-C	0.08	1.24
27.45 ^H	TOWN CREEK @ DULL ROBINSON RD.	302560	MWH-C	0.15	2.45
25.35 ^H	TOWN CREEK @ RICHEY RD.	302561	MWH-C	0.16	2.99
19.67 ^W	TOWN CREEK S OF VAN WERT @ PETER COLLINS RD.	P02S21	MWH-C	0.13	1.84
11.32 ^W	TOWN CREEK N OF VAN WERT @ STRIPE RD.	P02W10	MWH-C	0.28	3.46
0.72 ^W	TOWN CREEK NEAR MOUTH AT VAN VERT PAULDING CO. LINE RD.	P02K05	MWH-C	0.17	4.22
1.35 ^H	ROLLER CREEK @ LIBERTY UNION RD.	302564	MWH-C	0.15	3.04
22.10 ^H	DOG CREEK @ GAMBLE RD.	302565	MWH-C	0.06	1.03
14.06 ^W	DOG CREEK @ CHURCH RD	P02K07	MWH-C	0.09	1.76
0.97 ^W	DOG CREEK E OF ROSELMS @ ST. RT. 114	P02K06	MWH-C	0.10	1.46
6.79 ^H	LONG PRAIRIE CREEK DST. OHIO CITY WWTP @ ST. RT. 709	P02S23	MWH-C	0.21	2.91
0.68 ^H	LONG PRAIRIE CREEK W OF VENEDOCIA @ JONESTOWN RD.	P02S22	MWH-C	0.12	1.20
3.23 ^H	KYLE PRAIRIE CREEK @ VAN WERT MERCER CO. RD. 18	302566	MWH-C	0.08	0.84
0.20 ^H	KYLE PRAIRIE CR UPST FRISINGER DITCH @ VAN WERT MERCER CR 18	302567	MWH-C	0.16	1.83

Little Auglaize River

The Little Auglaize River is wide, shallow, and lacks tree cover throughout much of the length of the stream. Drainage maintenance practices, including one-sided construction and the installation of weirs, have been used to try to mitigate water quality impacts, with varying degrees of success. Twelve of the 24 total temperature exceedances from across the lower Auglaize River tributaries watershed were recorded on the Little Auglaize River proper. The altered riparian condition is readily apparent at the County Road P site (downstream from Ottoville), where two daily maximum WQS criterion exceedances for temperature were recorded. Field measured pH values of 9.37 (06/19) and 9.40 (07/28) were recorded with the YSI meter, along with temperatures of 29.70 °C (06/19) and 31.70 °C (07/14), all of which were exceedances of the pH and daily maximum temperature WQS criteria. The July 28 sample seems to be dominated by groundwater flow as well as WWTP effluent, as dissolved minerals are elevated along with total phosphorus on this date. Three daily average temperature criterion exceedances occurred at the State Route 114 site.

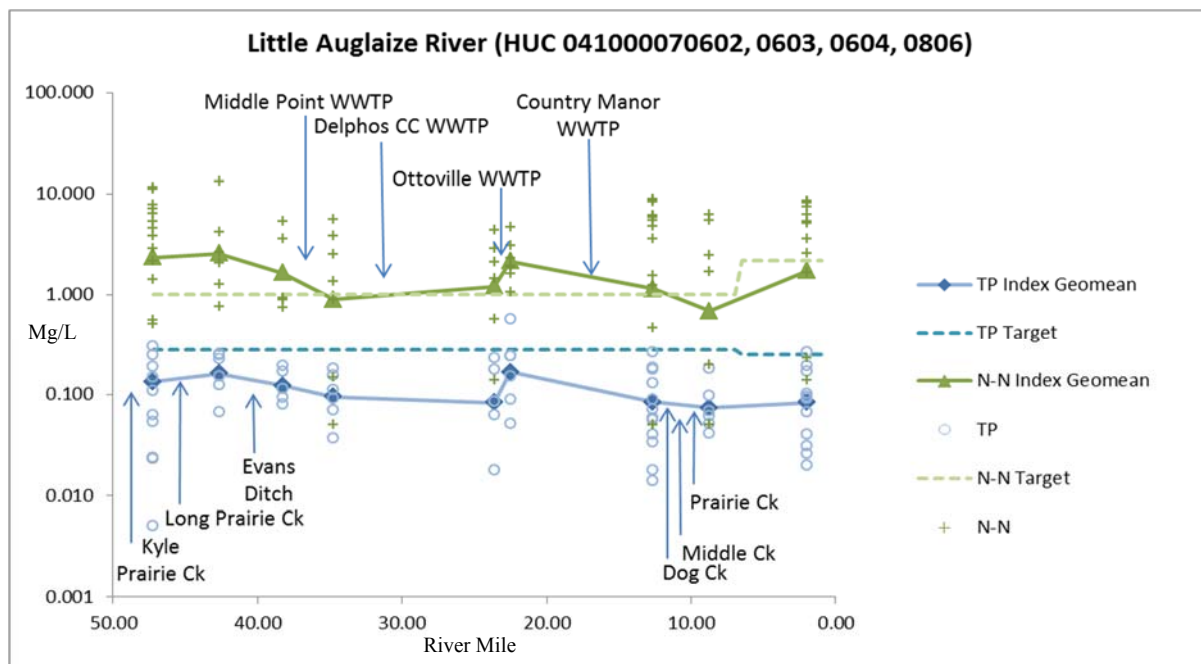


Figure 6. Longitudinal values for total phosphorus, nitrate-nitrite, and ammonia in the Little Auglaize River, 2014.

While total phosphorus stayed below the target at the County Road P site, there were increases in both total phosphorus and nitrate-nitrite downstream of Ottoville (Figure 6). The stream meets the total phosphorus target down its entire length, but fails to meet the nitrate-nitrite target at six of the nine sites. The nitrate-nitrite index period geometric mean was 2.14 mg/l, an excursion from the target of 1.0 mg/l. Targets for TP and nitrate-nitrite are adjusted for the downstream site based on drainage area.

Ohio EPA fish crews noted a large bloom of algae downstream from the most downstream chemistry site. The excess nutrients in the system seem to be feeding biomass growth once the creek loses its downstream energy and receives greater solar inputs at its mouth. Additional discussion and photos are included in the fish community section.

Sixmile Creek

The upstream site on Sixmile Creek at Burns Road was only sampled once each in June, July, and September, as it was without adequate flow the other months. The drainage to this site was reduced with the development of the Sixmile Creek cutoff channel on the west side of Cecil, which drains approximately 11 square miles of what was once Sixmile Creek directly to the Maumee River mainstem. This portion of the watershed will be evaluated as a part of the Maumee River tributaries project in 2015.

The Sixmile Creek site at Dotterer Road has no overhead canopy to provide shade, and despite maintaining adequate water for sampling all summer, lacked active flow. A mat of algae was often visible on the downstream side of the road. Summer index period geometric mean phosphorus was 0.12 mg/l at this site, an excursion from the 0.08 mg/l target, while nitrate-nitrite values were below the reporting limit on multiple visits. Sampling was conducted from a deep pool that may not have been well-fed by fresh upstream water, and, thus, oxygen became easily depleted at this site. There is a positive correlation between the time of day each sample was collected and the dissolved oxygen value, with the concentration of oxygen increasing as the day progressed. Dissolved oxygen exceedances were recorded on five of the six visits to this site. On the seventh visit, the dissolved oxygen probe on the field meter malfunctioned, resulting in no data being available.

Little Flatrock and Flatrock Creeks

Nutrient levels in Flatrock Creek were variable from site to site, likely the result of varying degrees of uptake by biomass and inputs from the landscape. As all sites on Flatrock Creek except the Louck Road site were in exceedance of the target values for nitrate-nitrite and total phosphorus, Flatrock Creek is likely a significant source of nutrients to the downstream watershed (Figure 7).

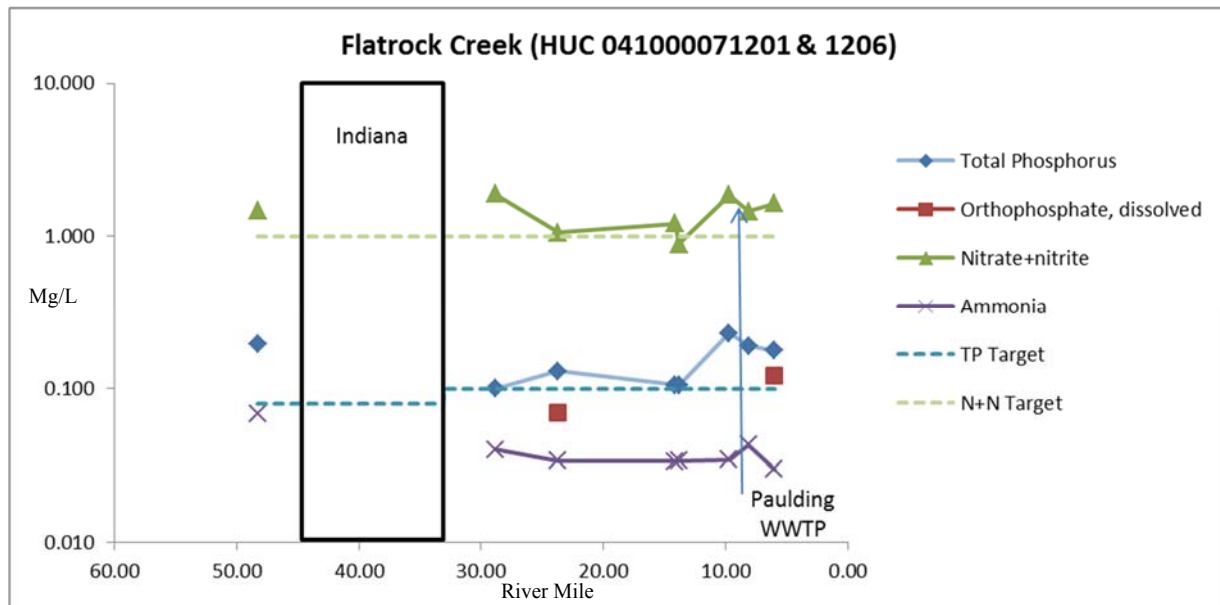


Figure 7. Longitudinal values for total phosphorus, nitrate-nitrite, and ammonia in Flatrock Creek, 2014.

Little Flatrock Creek had seven dissolved oxygen exceedances between its two sites. Flatrock Creek had one temperature and two dissolved oxygen exceedances across its eight sites. The more intact riparian area adjacent to Flatrock Creek provides adequate shading to the stream, mitigating temperature swings

and, thus, likely helping it meet dissolved oxygen standards. The intact stream corridor may be providing adequate shade to limit the growth of excessive biomass in this nutrient-rich system.

Blue Creek

Nitrate-nitrite levels in Blue Creek exceeded the target at all but the most upstream and downstream sites (Figure 8). The highest geometric mean was at Sugar Grove Church Road, downstream from Blue Stream Farms. Phosphorus levels did not exceed the target at any time. The largest increase from the immediate upstream site was recorded at Paulding County Road 123, downstream from Wayne Trace WWTP. As the stream increases in size and widens from State Route 637 to County Road 151, both total phosphorus and nitrate-nitrite decreased. The stream system may be utilizing the nutrient load for the growth of biomass as the flow slows in this downstream section of the creek.

There were six iron violations between the Allison Road and County Road 151 sites. These levels were likely due to the influence of groundwater on the system.

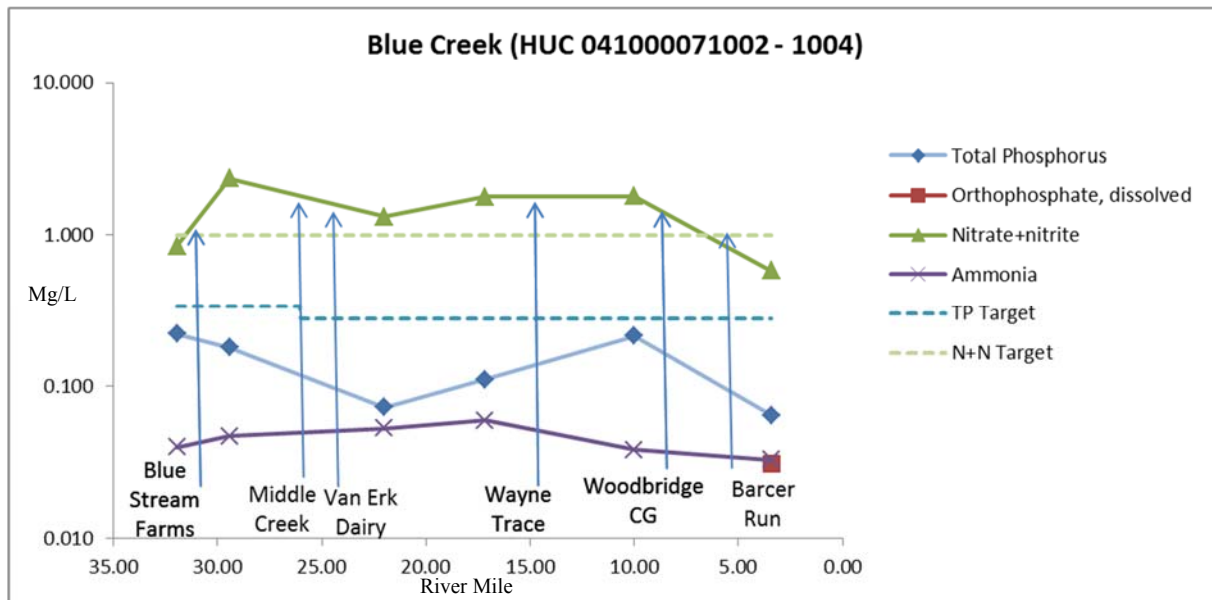


Figure 8. Longitudinal values for total phosphorus, nitrate-nitrite, and ammonia in Blue Creek, 2014.

Prairie Creek

Prairie Creek, as well as its tributaries, Hagerman Creek and West Branch Prairie Creek, exceeded the nitrate-nitrite target at all sites except Prairie Creek at the Paulding/Van Wert County line, the most upstream site. Nitrate-nitrite levels slightly increased downstream in Prairie Creek (Figure 9). Total phosphorus only exceeded the target in Hagerman Creek at its most upstream site, Richey Road, northeast of Convoy. Natural assimilation of nutrients is disrupted because land use (*i.e.*, agriculture) and habitat alterations (*i.e.*, channelization and removal of riparian corridor) affect both the types of nutrients delivered (coarse versus fine) and the balance of aquatic communities that process the energy into favorable biomass (*i.e.*, fish and macroinvertebrates versus algae). As a result, nutrients are simply exported downstream.

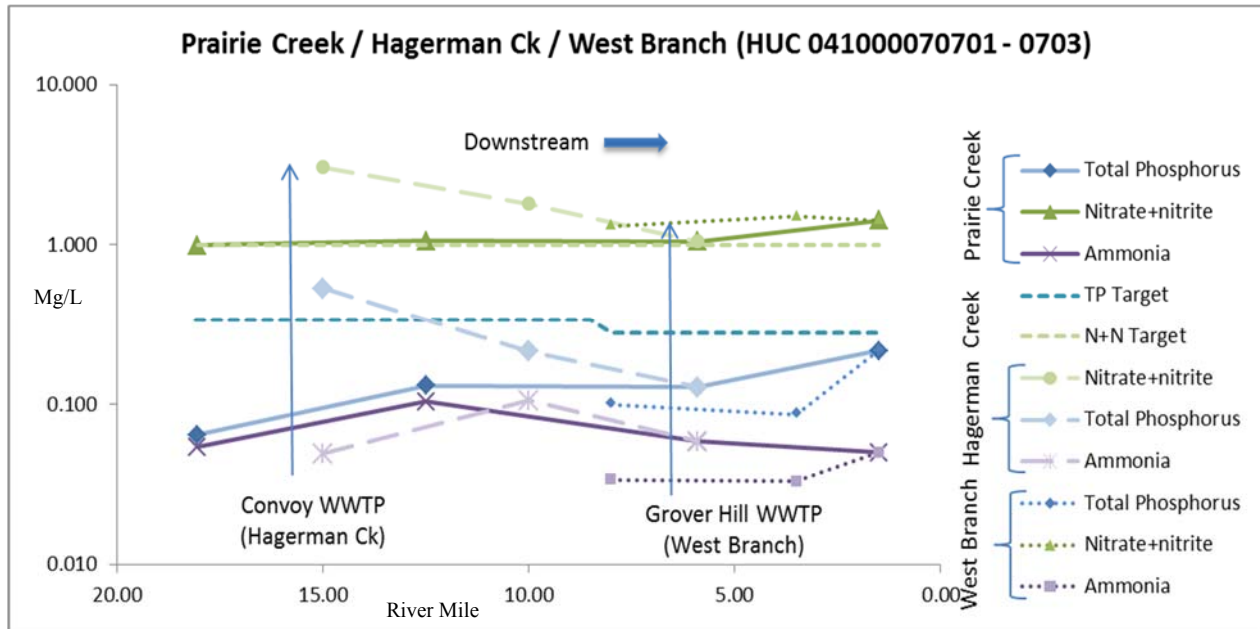


Figure 9. Longitudinal values for total phosphorus, nitrate+nitrite, and ammonia in Prairie Creek, Hagerman Creek, and West Branch Prairie Creek, 2014.

Prairie Creek exceeded the iron standard in five single samples at three sites over the course of the project. Two of these were at the Van Wert County Line site, downstream from the Stoneco Inc. Scott Plant. There were three exceedances of the temperature standard at three sites on Prairie Creek as well. Hagerman Creek, West Branch Prairie Creek, and the smaller tributaries to Prairie Creek, including Hoaglin Creek and Monkey Run, had no WQS exceedances.

Maddox Creek/Town Creek/Middle Creek

Nitrate-nitrite exceeded the target at three of the four sites on Maddox Creek (Figure 10). Higher levels of total phosphorus occurred in the headwaters and decreased at the downstream sampling sites due to uptake of total phosphorus by the biomass. The increase in nitrate-nitrite over the last ten downstream miles indicated that the amount entering the stream exceeds the amount the biomass can assimilate, resulting in total phosphorus being the limiting factor for algal growth in the stream. The downstream exceedance of the nutrient target for nitrate-nitrite was minor relative to many of the streams in the study area.

Nitrate-nitrite exceeded the target across the entire length of Town Creek (Figure 10). Levels gradually increased at the downstream sites. Total phosphorus increased through RM 11.32, downstream from Van Wert at Stripe Road, where the geometric mean exceeded the target. Over the last ten miles of Town Creek, the biomass appeared to utilize total phosphorus, and nitrate-nitrite inputs were in excess of what the biomass needs, much like Maddox Creek. Town Creek appears to export significant amounts of nitrate-nitrite to Middle Creek, with the most downstream geometric mean values more than four times the target. Town Creek had one temperature exceedance downstream from Van Wert which is most likely due to habitat alterations.

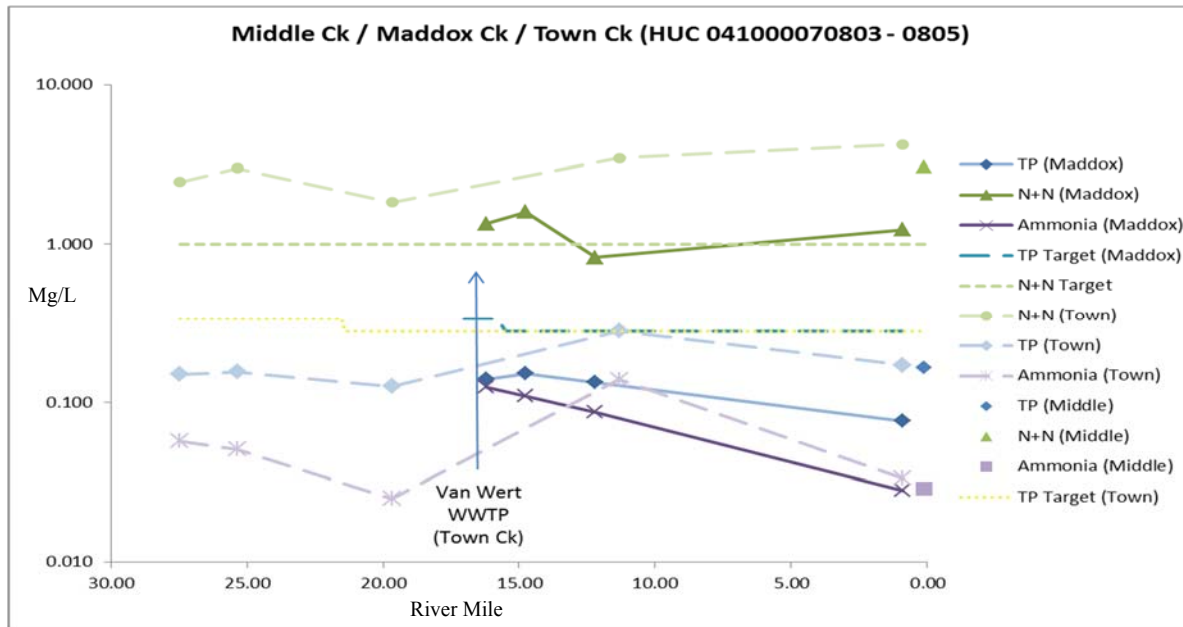


Figure 10. Longitudinal values for total phosphorus, nitrate-nitrite, and ammonia in Middle Creek, Maddox Creek, and Town Creek, 2014.

Middle Creek’s single site exceeded the nitrate-nitrite target, likely in large part due to the nutrient transport occurring from Town Creek. Figure 10 shows the longitudinal nutrient values for the two tributary streams, Town Creek and Maddox Creek, as well as providing the single point nutrient values for Middle Creek.

Dog Creek

Nitrate-nitrite levels were elevated at two of the three Dog Creek sites (Figure 11). The most downstream site had three temperature exceedances. Dog Creek appears to serve as a source of nitrate-nitrite to downstream systems.

The downstream site had three temperature and two iron violations. The lack of adequate riparian corridor and other direct habitat alterations are most likely responsible for the temperature exceedances.

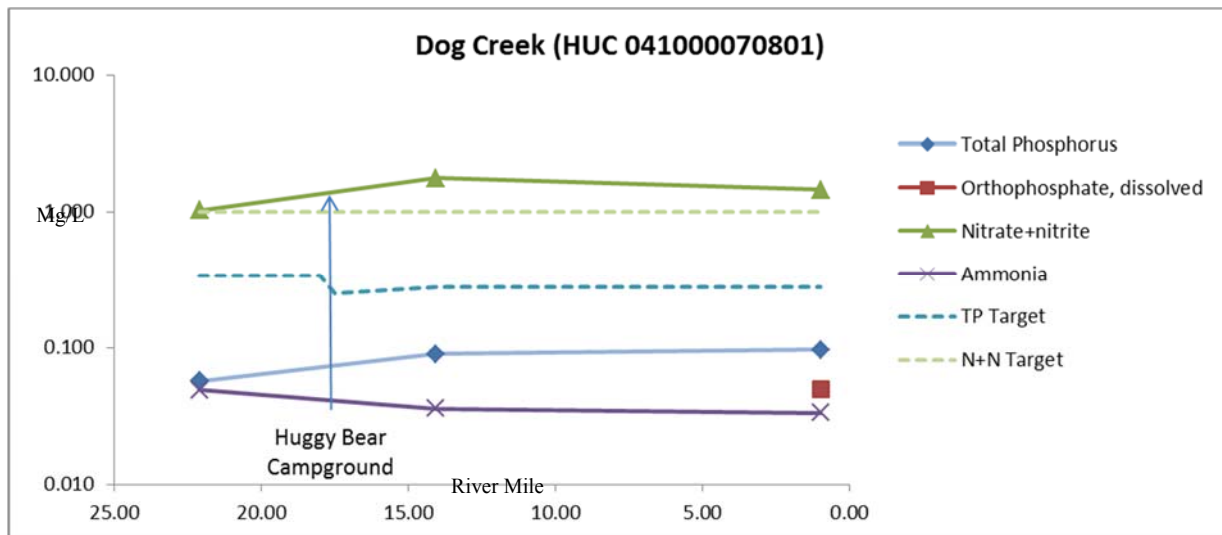


Figure 11. Longitudinal values for total phosphorus, nitrate-nitrite, and ammonia in Dog Creek, 2014.

Long Prairie Creek

Nitrate-nitrite was elevated above the target value at both sites on Long Prairie Creek. Total phosphorus was below the target at both sites. Both nutrient parameters were decreasing, likely as the stream biomass made use of inputs from the Ohio City WWTP and the surrounding landscape.

Some of the highest chloride levels in the study area were recorded at the two Long Prairie Creek sites, with two of them downstream from the Ohio City WWTP and the other further downstream (Figure 12). The geometric mean chloride value decreased downstream while minerals typically associated with groundwater influence increased. Chloride generally indicates the presence of a municipal or industrial waste stream (often used in cleaning products, water softener salt, etc.).

Minor Tributaries

Bobenmyer Ditch and Snyder Ditch are direct tributaries to the Auglaize River. Both sites exceeded the dissolved oxygen standard a combined five times. These stations were evaluated in an effort to quantify the potential impact that agricultural uses in eastern Paulding County may be having on these streams. Like much of the watershed, there are many large livestock operations which are below the permitted CAFO threshold. An absence of data on manure application patterns makes it difficult to determine if these facilities are contributing significant nutrients to specific locations in the watershed. Both of these streams had summer index period geometric mean total phosphorus levels that were above the target, 0.25 mg/l and 0.14 mg/l, respectively, while their nitrate-nitrite values were well under the target.

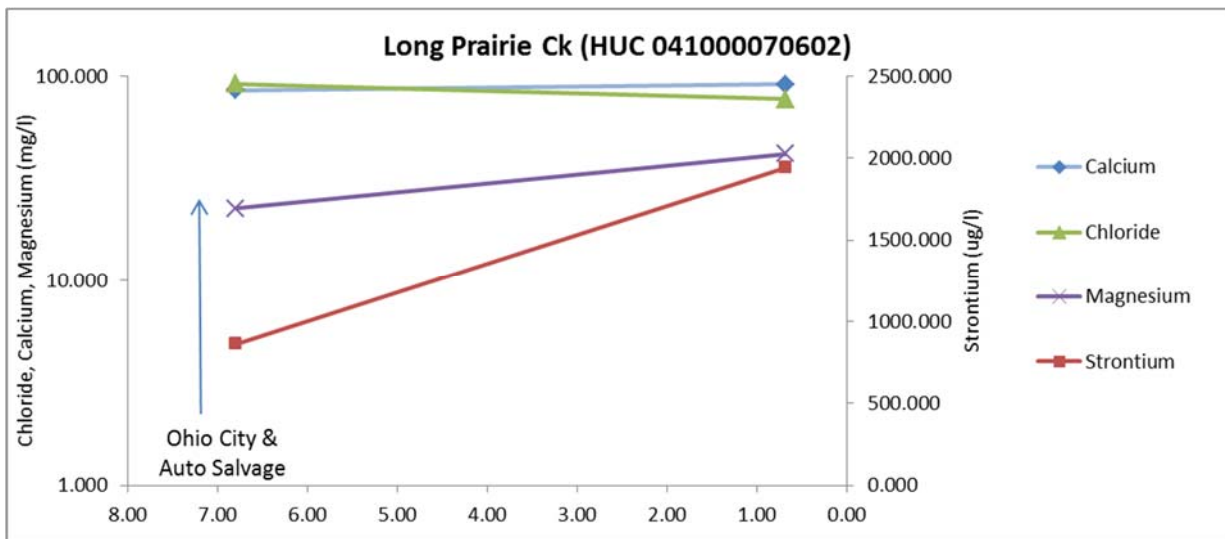


Figure 12. Longitudinal values for calcium, chloride, magnesium, and strontium in Long Prairie Creek, 2014.

Table 8. Exceedances of Ohio Water Quality Standards criteria (OAC Chapter 3745-1) for chemical/physical parameters measured in the lower Auglaize River Tributaries study area, 2014.

Stream/ RM	Location	Parameter (value – mg/l unless noted)
<i>Little Auglaize River</i>		<i>MWH-C Existing</i>
47.00	Jonestown @ Jonestown Rd (P02S25)	Temperature: 19.6 ^t ; Iron: 6,850 ^g
42.66	N. of Venedocia @ Wren-Landecker (P02K02)	<i>No exceedances.</i>
38.26	S. of Middle Point @ St. Rt. 697 (P02S35)	<i>No exceedances.</i>
34.54	Dst. Middle Point @ Converse Roselms Rd	<i>No exceedances.</i>
28.90	Upst. Delphos Water Intake @ John Brickner	Temperature: 28.0 ^t
23.60	Ottoville @ US Rt. 224 (P02S04)	Temperature: 28.6 ^t
22.51	Dst. Ottoville @ Co Rd P (P02S03)	Temperature: 29.7 ^y , 31.7 ^y ; pH: 9.37, 9.40
12.65	W. of Mandale @ St. Rt. 114 (204284)	Temperature: 13.3 ^t , 20.0 ^t , 29.3 ^t ; Iron: 7,830 ^g ; 6,320 ^g
8.72	Co. Rd. 60 (P02S01)	Temperature: 28.8 ^t
2.02	E. of Melrose @ St. Rt. 613 (510200)	Temperature: 13.8 ^t , 19.9 ^t , 27.9 ^t ; Iron: 11,300 ^g
<i>Bobenmyer Ditch</i>		<i>Recommended WWH</i>
0.70	Stouffer Rd. (302568)	Dissolved Oxygen: 4.88 ^a , 4.20 ^a
<i>Snyder Ditch</i>		<i>Recommended WWH</i>
0.30	Stouffer Rd. (302569)	Dissolved Oxygen: 4.81 ^a , 4.82 ^a , 4.02 ^a
<i>Sixmile Creek</i>		<i>WWH Existing</i>
6.70	Burns Rd. (302540)	<i>No exceedances.</i>
3.90	Dotterer Rd. (302541)	Dissolved Oxygen: 4.27 ^a , 3.23 ^m , 3.77 ^m , 3.60 ^m , 3.59 ^m ; Iron: 7,710 ^g
<i>Little Flatrock Creek</i>		<i>WWH Existing</i>
5.90	Broughton Rd. (302542)	Dissolved Oxygen: 4.48 ^a , 4.55 ^a
1.53	Old St. Rt. 111 (302543)	Dissolved Oxygen: 4.93 ^a , 2.99 ^m , 3.94 ^m , 3.49 ^m , 0.77 ^m
<i>Flatrock Creek</i>		<i>WWH Existing</i>
48.30	Werner Rd. (302544)	<i>No exceedances.</i>
28.84	Upst. Payne @ Pugh Rd. (P06S37)	Dissolved Oxygen: 4.94 ^a
23.72	NE of Payne @ St. Rt. 613 (P06S35)	Temperature: 19.0 ^t
14.11	Upst. Paulding @ Co. Rd. 107 (500250)	<i>No exceedances.</i>
14.10	Paulding Reservoir, L-1 (alt location) (201362)	<i>No exceedances.</i>
13.80	Paulding, Dst. Dam (P06S33)	<i>No exceedances.</i>
9.70	Upst. Paulding WWTP Lagoons (P06S32)	<i>No exceedances.</i>
8.13	Dst Paulding WWTP @ Broughton Rd.	Dissolved Oxygen: 4.47 ^a
6.02	NE of Paulding @ Louck Rd. (P06S30)	<i>No exceedances.</i>
<i>Wildcat Creek</i>		<i>WWH Existing</i>
0.27	NE of Payne @ St. Rt. 500 (P06P02)	Dissolved Oxygen: 4.28 ^a , 3.41 ^m
<i>Blue Creek</i>		<i>MWH-C Existing</i>
31.95	Dixon Cavett Rd. (302545)	Dissolved Oxygen: 3.80 ^a

Stream/ RM	Location	Parameter (value – mg/l unless noted)
29.43	Sugar Grove Church Rd. (P06K31)	No exceedances.
22.00	Yoakum Rd. (302546)	No exceedances.
17.15	Allison Rd. (302547)	Iron: 7,790 ^g , 9,330 ^g , 11,500 ^g
10.01	E. of Latty @ Paulding Co. Rd. 123 (P06W14)	No exceedances.
3.43	Co. Rd. 151 (P06S02)	Iron: 10,100 ^g , 8,550 ^g , 14,700 ^g
<i>Barcer Run</i>		<i>Recommended WWH</i>
0.75	St. Rt. 637 (302548)	Dissolved Oxygen: 4.18 ^a
<i>Upper Prairie Creek</i>		<i>MWH Existing</i>
0.90	Van Wert - Paulding Co. Rd. 12 (302549)	Dissolved Oxygen: 3.20 ^m
<i>Middle Creek</i>		<i>Recommended MWH</i>
0.50	Parker Rd. (302556)	No exceedances.
<i>Prairie Creek</i>		<i>MWH-C Existing</i>
18.04	W. of Scott @ Paulding - Van Wert Co. Line	Temperature: 28.00 ^t ; Iron: 5,650 ^g ; 7,070 ^g
12.50	NE of Haviland @ Allison Rd. (Twp. Rd. 48)	Iron: 7,820 ^g , 5,040 ^g
5.90	S. of Melrose @ Mercile Rd. (302551)	Temperature: 28.80 ^t
1.50	S. of Melrose @ Roselms Rd. (P02S08)	Temperature: 19.70 ^t ; Iron: 9,560 ^g
<i>West Branch Prairie Creek</i>		<i>MWH-C Existing</i>
4.40	Grover Hill @ St. Rt. 114 (P02W22)	No exceedances.
0.60	Matson Rd. (302554)	No exceedances.
<i>Hoaglin Creek</i>		<i>MWH-C Existing</i>
19.90	Terry Rd. (302552)	No exceedances.
13.06	Wetsel Rd. (302553)	No exceedances.
<i>Monkey Run</i>		<i>MWH-C Existing</i>
3.30	Dull Robinson Rd. (302555)	No exceedances.
<i>Hagerman Creek</i>		<i>MWH-C Existing</i>
12.22	NE of Convoy @ Richey Rd. (P02S14)	No exceedances.
0.86	E. of Haviland @ Allison Rd. (Twp. Rd. 48)	No exceedances.
<i>Middle Creek</i>		<i>MWH-C Existing</i>
1.32	NE of Roselms @ Co. Rd. 60 (P02S18)	Temperature: 19.20 ^t , 28.3 ^t ; Iron: 8,560 ^g ; pH: 9.15
<i>Big Run</i>		<i>Recommended WWH</i>
0.97	SE of Grover Hill @ Twp. Rd. 155 (302601)	No exceedances.
<i>Maddox Creek</i>		<i>MWH-C Existing (RM 18.3 MWH-I)</i>
16.20	Liberty Union Rd. (302557)	No exceedances.
14.75	Near Van Wert @ W. Ridge Rd. (Lincoln Hwy.)	Dissolved Oxygen: 3.22 ^a
12.21	Dutch John Rd. (302558)	Dissolved Oxygen: 1.78 ^m
0.90	St. Rt. 637 (302559)	No exceedances.
<i>Town Creek</i>		<i>MWH-C Existing</i>
27.45	Dull Robinson Rd. (302560)	No exceedances.

Stream/ RM	Location	Parameter (value – mg/l unless noted)
25.35	Richey Rd. (302561)	No exceedances.
19.67	S. of Van Wert @ Peter Collins Rd. (P02S21)	No exceedances.
18.30	Van Wert Water Intake Dam Pool (302562)	No exceedances.
11.32	N. of Van Wert @ Stripe Rd (P02W10)	Temperature: 19.90 ^t
0.72	Van Wert – Paulding Co. Rd. 12 (P02K05)	No exceedances.
<i>Roller Creek</i>		<i>MWH-C Existing</i>
1.35	Liberty Union Rd. (302564)	No exceedances.
<i>Dog Creek</i>		<i>MWH-C Existing</i>
22.10	Gamble Rd. (302565)	No exceedances.
14.06	Church Rd. (P02K07)	Temperature: 28.4 ^t
0.97	E. of Roselms @ St. Rt. 114 (P02K06)	Temperature: 12.30 ^t , 19.30 ^t , 29.2 ^t ; Iron: 5,990 ^g , 8,540 ^g
<i>Long Prairie Creek</i>		<i>MWH-C Existing</i>
6.79	Dst. Ohio City WWTP @ St. Rt. 709 (P02S23)	
0.68	W. of Venedocia @ Jonestown Rd. (P02S22)	
<i>Kyle Prairie Creek</i>		<i>MWH-C Existing</i>
3.23	Van Wert - Mercer Co. Rd. 18 (302566)	No exceedances.
0.20	Upst. Frisinger Ditch @ Van Wert-Mercer Co.	No exceedances.
<i>Evans Ditch</i>		<i>LRW</i>
0.29	N. of Venedocia @ State Rd. (P02P04)	No exceedances.
<i>Auglaize River</i>		<i>MWH-C Existing (RM 19.30, 14.94, 9.73); WWH Existing (Large River Unit - RM 4.94)</i>
19.30	Oakwood @ St. Rt. 613 (500130)	Iron: 6,090 ^g , 13,900 ^g
14.94	Charloe @ Co. Rd. 138 (P06S10)	Temperature: 29.2 ^t
9.73	Junction @ Rest Area at Jct. St. Rt. 111/St. Rt.	No exceedances.
4.14	Upst. Defiance @ Harding Rd. (500290)	Iron: 9,550 ^g , 5,800 ^g

^a Exceedance of the Outside Mixing Zone Average Dissolved Oxygen criteria (WWH 5.0; MWH 4.0 mg/l).

^m Exceedance of the Outside Mixing Zone Minimum Dissolved Oxygen criteria (WWH 4.0; MWH 3.0; MWH HELP ecoregion 2.5 mg/l).

^t Exceedance of daily average temperature criterion.

^y Exceedance of daily maximum temperature criterion.

^g Exceedance of the statewide criterion for the protection of agricultural uses.

Reporting Values - Dissolved Oxygen: mg/l; Iron: µg/l; Temperature: °C.

Water Chemistry- Historic Data

Adequate data is available for the Little Auglaize River in 1983 to produce longitudinal graphs of nutrient geometric means (Figure 13). Total phosphorus in the stream has declined relative to the 1983 values at all sites. Ammonia is relatively unchanged at most sites, but has declined substantially downstream from Middle Point. Nitrate-nitrite is higher at all sites, especially downstream sites. The 1983 data appears to demonstrate the use of nitrate-nitrite by stream biomass and large amounts of phosphorus loading to the stream from the villages of Middle Point and Ottoville. The impacts of Middle Point have been significantly dampened through improvements to wastewater systems in the Village, whose treatment plant was constructed in 1991. Ottoville has lessened its total phosphorus impact on the stream, but it still appears to be a source of nitrate-nitrite and total phosphorus.

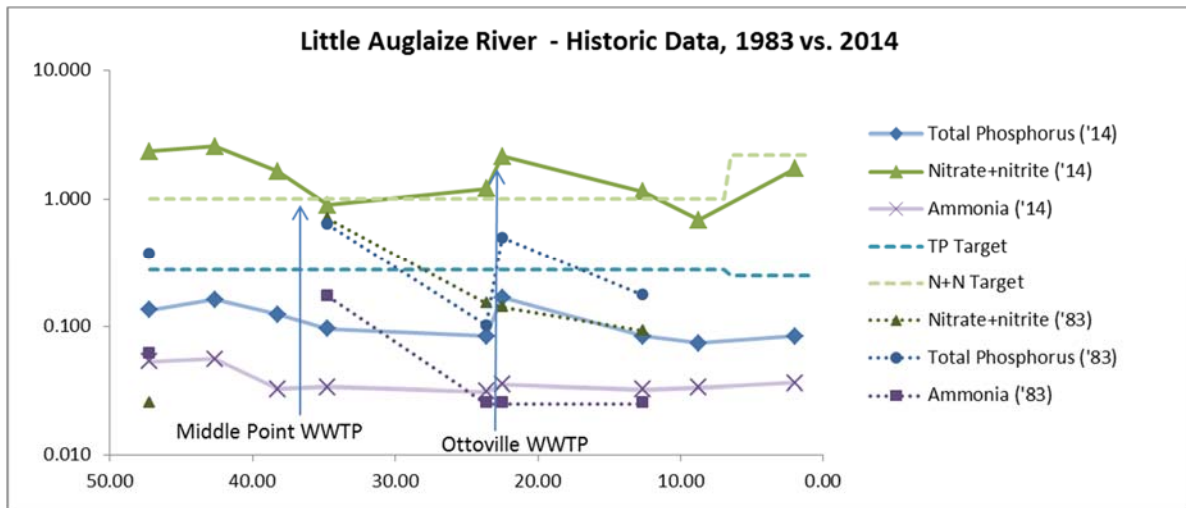


Figure 13. Longitudinal trend of total phosphorus, nitrate-nitrite, and ammonia at Little Auglaize River sites, 1983 and 2014.

Water Quality Sonde Summary

Multi-parameter water quality sondes were deployed to monitor temperature, dissolved oxygen (D.O.), pH, and specific conductance (conductivity). Temperature, dissolved oxygen and pH are influenced by diel patterns. These diel patterns have the greatest impact for streams during certain critical conditions that include 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 stream flow. The water quality sondes collect readings hourly to monitor parameters throughout the diel cycle. Grab readings differ because they only represent one point on the diel curve. 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. However, when the diel fluctuations are of concern, continuous monitoring at regular intervals throughout the diel cycle is needed to characterize the parameter of concern.

Diel patterns in temperature reflect air temperature, solar radiation, base flow (ground water), discharge, and shading. In general, diel fluctuations in temperature increase as base flow, discharge, and shading decrease. The inverse is also true.

Dissolved oxygen responds in a similar diel pattern to temperature, as they are affected by similar factors. In addition, dissolved oxygen trends are directly dependent on temperature. At high temperatures, the solubility of oxygen in water decreases, resulting in an inverse relationship. Without the influence of other environmental conditions, this would cause the two parameters to follow opposite trends. However, the dissolved oxygen produced by photosynthesis is, in most instances, enough to overwhelm the inverse relationship, causing the trends to follow similar trajectories. Increasing diel fluctuation relates to an increase in productivity because dissolved oxygen concentrations reach super-saturation during the day and subsequently deplete by respiration at night. The result is a diel trend that typically reaches a maximum in the early evening and a minimum preceding sunrise. In some cases, dissolved oxygen does not exhibit strong diel trends in low flow, warm conditions. Either primary productivity is limited or decomposition of organic matter in the stream is controlling the dissolved oxygen concentrations. Sonde monitoring contributes to the body of evidence to identify dissolved oxygen trends that are more influenced by primary productivity or decomposition.

Diel patterns in pH are also reflective of primary productivity. Carbon dioxide, which dissolves in water to form carbonic acid, is consumed during photosynthesis, raising the pH of the stream. The result is a maximum pH value observed at a similar time to the maximum dissolved oxygen.

Twenty-nine sites in the lower Auglaize River tributaries study area were sampled with water quality sondes to represent the general watershed area as well as target areas of concern (i.e. point sources or historically impaired areas). Due to extensive rain during the first deployment in the northern portion of the study area, 13 sites were revisited in the Flatrock, Blue and Prairie watersheds. The land use in the overall watershed is largely row crop agriculture; however local point sources have impacts, especially on smaller tributaries where many are located.

Critical conditions for temperature and dissolved oxygen 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 in low flow conditions from June to September. Sondes were deployed July 22-24, 2014 and August 15-19, 2014 (Figure 14) in the tributaries of the Lower Auglaize River. In 2014, weather conditions were generally cooler and wetter than normal and the conditions sampled were not ideal. However, the conditions were still

sufficient to describe general stream conditions. Summary plots of all data collected are included in Appendix I of this document. The plots are of hourly readings taken for temperature, dissolved oxygen, pH, and specific conductance.

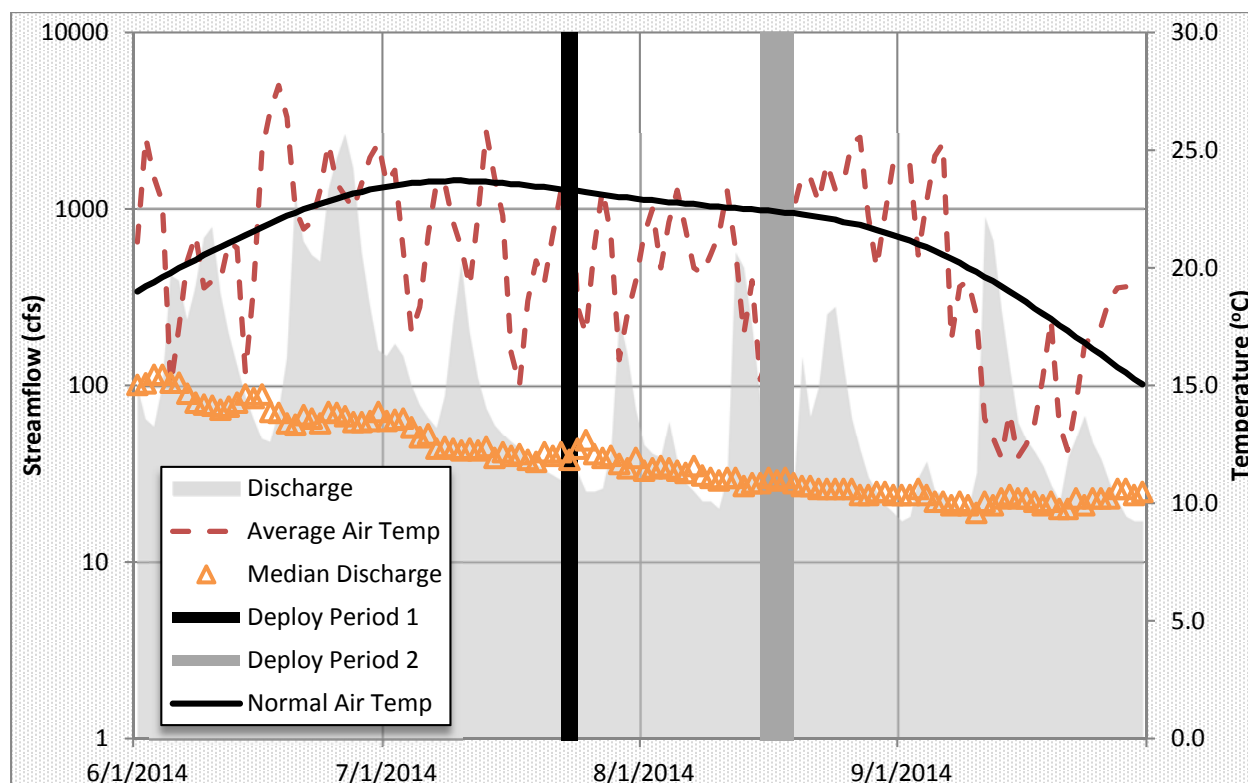


Figure 14. Graph of average daily streamflow relative to the daily median streamflow (USGS 04186500 Auglaize River near Fort Jennings OH), including the average and normal daily air temperature (NOAA -GHCND: USC00338609) for the sampling season. No gage was present in the study area; however, this nearby gage represents general hydrological conditions for the region.

Ohio promulgates water quality standards (WQS) through Ohio Administrative Code Chapter 3745-1. The data collected during the sonde deployments are sufficient to evaluate exceedances of WQS criteria for the protection of aquatic life for maximum daily temperature, minimum at any time dissolved oxygen, 24-hour average dissolved oxygen, 24-hour average pH, and 24-hour average specific conductivity. Absolute minima or maxima exceedances are compared directly to hourly readings reported from the water quality sondes. An exceedance of the water quality criteria does not represent stream impairment; rather if biological impairment is present the exceedances help develop a body of evidence that identifies the conditions that are stressing aquatic life. A summary of the exceedances is presented in Table 9. Based on Ohio EPA staff's knowledge of specific sites, comments that describe exceedances are included in the table.

Table 9. Exceedances of Ohio Water Quality Standards criteria (OAC Chapter 3745-1) for chemical and physical parameters derived from diel monitoring in the lower Auglaize River tributaries study area, 2014. Sondes were deployed at 29 sites and a subset of the sites was sampled twice. The first deployment was 7/22-24/2014 and 20-48 hours of data were collected at 29 sites. The second was 8/15-19/2014, resulting in an additional 96 hours of data collection at 13 sites. Sites that were sampled on both deployments are indicated in bold within 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 criteria. The magnitude of an exceedance is presented as the most extreme value measured that exceeds the criteria. The duration is the count of consecutive hours that exceeded the criteria and is presented in parenthesis after the measure of magnitude. Applicable WQS criteria include: minimum dissolved oxygen (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 °C,)	Comments
<i>Sixmile Creek</i> <i>HELP - Warmwater Habitat (Recommended)</i>			
3.90	@ Dotterer Rd	D.O. min.: 1.8(12), 1.8(9)	Wetland conditions
		D.O. avg.: 4.0(17)	Wetland conditions
<i>Little Flatrock Creek</i> <i>HELP - Warmwater Habitat (Existing)</i>			
1.5	@ old St Rt. 111	D.O. min.: 0.4(46)	Wetland conditions
		D.O. avg.: 0.9(23)	Wetland conditions
<i>Flatrock Creek</i> <i>HELP - Warmwater Habitat (Existing)</i>			
28.84	UPST Payne @ Pugh Rd	None	
23.72	NE of Payne @ St Rt. 613	None	
13.8	At Paulding DST dam	None	
8.13	DST Paulding WWTP @ Broughton Rd	D.O. min.: 3.8(4), 2.7(10), 3.9(4)	Organic enrichment
		D.O. avg.: 4.1(15), 4.9(9)	Organic enrichment
6.02	NE of Paulding @ St Rt. 613	None	
<i>Blue Creek</i> <i>HELP - Modified Warmwater Habitat (Existing)</i>			
29.43	@ Sugar Grove Church Rd	None	
22	@ Yoakum Rd	Temp. max.: 32.4(7), 29.9(3), 29.9(5)	No riparian shading
17.15	@ Allison Rd	Temp. max.: 33.2(8), 31.2(5), 31.7(5)	No riparian shading
3.43	@ Co Rd 151	None	
<i>Little Auglaize River</i> <i>HELP - Modified Warmwater Habitat (Existing)</i>			
47.2	At Jonestown @ Jonestown Rd	None	
34.75	DST Middle Point @ Roselms Rd (Twp. Rd 197)	Temp. max.: 31.2(9)	No riparian shading
22.51	DST Ottoville @ Co Rd P	Temp. max.: 34.5(9)	No riparian shading & shallow to bedrock substrate
		D.O. min.: 2.0(3)	Typical of primary

RM	Location	Parameter (D.O. in mg/l, Temp in °C,)	Comments
			production
12.65	W of Mandale @ St Rt. 114	Temp. max.: 31.4(9)	No riparian shading
8.72	@ Co Rd 60	Temp. max.: 31.2(8)	No riparian shading
2.02	E of Melrose @ St Rt. 613	None	
<i>Prairie Creek</i>		<i>Modified Warmwater Habitat (Existing)</i>	
5.9	S of Melrose @ Mercile Rd	Temp. max.: 32.2(7)	No riparian shading
		pH: 9.1(3)	Typical of primary production
1.5	S of Melrose @ Roselms Rd	Temp. max.: 30.7 (4)	No riparian shading
		pH: 9.4(16), 9.3(8)	
<i>West Branch Prairie Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.6	@ Matson Rd	None	
<i>Hagerman Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.86	E of Haviland @ Allison Rd (Twp. Rd 48)	None	
<i>Middle Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
1.32	NE of Roselms @ Co Rd 60	Temp. max.: 30.8(7)	No riparian shading
<i>Maddox Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.9	@ St Rt. 637	None	
<i>Town Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
19.67	S of Van Wert @ Peter Collins Rd	None	
11.32	N of Van Wert @ Stripe Rd	None	
0.9	@ Van Wert - Paulding Co Rd 12	Temp. max.: 30.9(6)	
<i>Dog Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.97	E of Roselms @ St Rt. 114	None	
<i>Long Prairie Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.68	W of Venedocia @ Jonestown Rd	Temp. max.: 33.3(9)	No riparian shading
		D.O. min.: 2.2(1)	Typical of primary production
<i>Kyle Prairie Creek</i>		<i>HELP - Modified Warmwater Habitat (Existing)</i>	
0.2	UST Firsinger Ditch @ Van	None	

RM	Location	Parameter (D.O. in mg/l, Temp in °C,)	Comments
	Wert - Mercer Co Rd 18		

Notes: HELP - Huron-Erie Lake Plain ecoregion

^a The General Lake Erie basin daily maximum temperature criteria apply; See OAC 3745-1-07, Table 7-14(G).

^b Applicable minimum 24-hour average D.O. criteria - WWH: 5.0 mg/l, MWH: 4.0 mg/l.

^c Applicable minimum D.O. criteria - WWH: 4.0 mg/l, MWH (HELP): 2.5 mg/l.

^d The criterion for pH is 6.5-9.0 S.U.

^e The criterion for specific conductivity is 2400 μ S/cm.

Temperature exceedances of the WQS criteria only occurred in streams that were heavily habitat modified with limited shading. Exceedances all occurred on sunny, hot summer days, supporting the theory that a lack of shading was the primary cause of high peak stream temperatures. The condition of high temperatures was the most significant at a site on the Little Auglaize River downstream from Ottoville where the stream flowed over a bedrock ridge. None of the temperature exceedances were in areas where external thermal loading through point sources was a contributing factor.

The tributaries of the lower Auglaize River are exposed to natural stressors that make them prone to dissolved oxygen stress. The primary natural stressor is low stream gradient, which is a result of glacial events. Low gradient streams have limited reaeration and export organic material slowly. Therefore, they are naturally prone to organic enrichment and additional anthropogenic sources of organic material are poorly assimilated. Anthropogenic sources of organic material include point sources such as municipal wastewater treatment plants and nonpoint sources such as wash-off of crop residue. Additional internal organic loading can occur through primary production fueled by nutrient loading. In cases of high primary production, especially when reaeration is limited, exceedances of the WQS criteria for dissolved oxygen are common in the early morning hours.

Sixmile Creek and Little Flatrock Creek have limited base flow in the summer months due to their small drainage areas, which is further exacerbated by the intensive drainage for agricultural production. In the areas where the streams were sampled, they were either unmodified or not recently modified and maintain the WWH aquatic life use designation. The lack of base flow and the naturally low gradient of the streams result in wetland-like conditions that persist through the dry summer months. Dissolved oxygen exceedances observed in the two streams are typical of streams that have persistent wetland-like habitat conditions.

Flatrock Creek represented the least modified stream condition and the typically wide riparian area resulted in shading of the stream channel. The diel fluctuations in dissolved oxygen from primary production described previously were subdued in the stream system. Exceedances of the WQS criteria were instead linked to external loading of organic sources. The monitoring site where exceedances of the dissolved oxygen minimum and average criteria occurred was immediately downstream from the Paulding WWTP. The dissolved oxygen stress is likely the result of naturally susceptible conditions, and point/non-point source loading. The conditions in Flatrock Creek included flows still elevated from prior rains and temperatures that were below normal; dissolved oxygen stress likely would have been worse if conditions were hotter and drier.

The rest of the sampled tributaries have been heavily modified for agricultural drainage. Channel modifications include straightening, deepening, widening, removing woody riparian cover, and mowing of leveed stream banks. Organic material is not fully assimilated within the channel; rather it is rapidly exported downstream. The rich agricultural drainage waters are exposed to nearly unlimited sunshine due to the lack of a woody riparian area, resulting in enhanced primary production. As a result, the dissolved oxygen in these streams exhibit wide diel ranges. Dissolved oxygen exceedances in these streams were limited to instances where diel fluctuations resulted in low dissolved oxygen in the early morning hours.

All of the tributaries of the lower Auglaize River expressed pH values that are typical of productive streams in northwest Ohio. The pH exhibits diel fluctuations due to carbon dioxide consumption for photosynthesis. This results in elevated pH values. In Prairie Creek, the diel fluctuations caused pH values to exceed 9.0, the upper limit of the WQS criteria range. Point sources do not appear to be a factor influencing pH in the streams within the study area.

Specific conductance is not exposed to the same diel processes as the other parameters monitored with the water quality sondes. The specific conductance generally increases from higher to lower stream flow. The tributaries of the lower Auglaize River all exhibited this typical trend. The presence of point sources influences specific conductance at low stream flows because streams typically have lower conductance than point sources. Town Creek downstream from the Van Wert WWTP and Long Prairie Creek downstream from the Ohio City WWTP exhibited elevated conductivity relative to the rest of the study area. There were no exceedances of the WQS criterion; however, the observation denotes the prevalence of waste water at these sites.

Trophic Evaluation

Two trophic states exist for streams, the autotrophic state and the heterotrophic state (Dodds 2007). Generally, the autotrophic state represents primary production and the heterotrophic state represents respiration. The trophic status is generally split into three categories - oligotrophic, mesotrophic, and eutrophic (Dodds *et al.* 1998). Oligotrophic systems are described as having low nutrients, low algal biomass and high clarity. Conversely, eutrophic systems are rich in nutrients, have high algal biomass, and have high swings of dissolved oxygen (D.O.). Mesotrophic systems have intermediate characteristics between oligotrophic and eutrophic systems. The transition from oligotrophic to eutrophic generally reflects a system that has shifted from heterotrophic dominance to autotrophic dominance and the process is commonly referred to as eutrophication. For the purposes of this evaluation, eutrophication will be defined as the process by which a stream becomes enriched with nutrients, resulting in high chlorophyll-*a* concentrations and wide diel swings of D.O. (USGS 2014). Therefore, the focus for identifying eutrophication requires effective monitoring of the autotrophic state, which is dictated by primary production. The objective of a trophic status evaluation is to identify streams that are exhibiting eutrophication.

Ohio and other states have been developing nutrient reduction strategies in recent years to address cultural eutrophication (USEPA 2015, Ohio EPA 2014, Miltner 2010, Heiskary and Markus 2003). Wide diel ranges of D.O. are associated with eutrophication, which is caused by excessive photosynthesis (O₂ production) during daylight hours and ongoing respiration, including decomposition (O₂ consumption), at night. The most recent investigations by Ohio EPA have identified a diel range of 6.5 mg/l D.O. as a threshold indicative of eutrophication in Ohio streams (Ohio EPA 2014).

Benthic (or attached) algae are monitored as the primary algal community in wadeable streams and small rivers, while sestonic (or suspended) algae is monitored as the primary algal community in large rivers. However, stream factors such as width-depth ratio and longitudinal gradient may have a stronger influence on whether sestonic or benthic algae dominate the algal community than the stream size. Therefore, sestonic algae typically dominate streams defined as large rivers, and benthic algae typically dominate small streams. With that in mind, chlorophyll-*a* is used as an indicator of the level of benthic production primarily in smaller stream systems, and as an indicator of the concentration of sestonic organisms primarily in large rivers. The most recent work by Ohio EPA in assessing benthic chlorophyll-*a* concentrations identified break points for low, moderate, and high categories (Ohio EPA 2014). The low-moderate category breakpoint is identified as 182 mg/m² and the moderate-high category is identified as 320 mg/m². A review of studies on sestonic chlorophyll-*a* by Dodds (2006), which included some Midwestern streams, and work in Ohio (Miltner 2010) suggest that concentrations of 40-100 µg/l of sestonic chlorophyll-*a* identify eutrophic conditions while concentrations >100 µg/l indicate hyper-eutrophic conditions.

More than 15 years ago, in pursuit of developing a nutrient strategy, Ohio EPA published a report (Ohio EPA 1999) that analyzed associations between nutrient concentrations and performance of aquatic organisms. The report proposed statewide water quality nutrient targets (Table 10 and Table 11). The nutrient data that is collected throughout the biological assessment season is summarized using a geometric mean for comparison to the target concentrations.

Table 10: Phosphorus concentration targets proposed for the protection of aquatic life (Ohio EPA 1999). All units are in mg/l.

Stream Size	WWH	EWH	MWH
Headwaters (<20 mi ²)	0.08	0.05	0.34
Wadeable (20 - 200 mi ²)	0.1	0.05	0.28
Small River (200 - 1000 mi ²)	0.17	0.10	0.25
Large River (>1000 mi ²)	0.3	0.15	0.32

Table 11: Nitrate + nitrite concentration targets proposed for the protection of aquatic life (Ohio EPA 1999). All units are in mg/l.

Stream Size	WWH	EWH	MWH
Headwaters (<20 mi ²)	1.0	0.5	1.0
Wadeable (20 - 200 mi ²)	1.0	0.5	1.6
Small River (200 - 1000 mi ²)	1.5	1.0	2.2
Large River (>1000 mi ²)	2.0	1.5	2.4

The proposed targets were never adopted into rule; however, they can serve as benchmarks to identify elevated nutrient levels in streams. The presence of elevated nutrients increases the risk of eutrophication in streams but cannot alone serve to identify eutrophication. More recent work relative to developing nutrient criteria is considering risk levels relative to ratios between the macro-nutrients of nitrogen and phosphorus (D. Dudley, personal correspondence, Aug. 13, 2014).

Seasonality is an important consideration when examining eutrophication. Two factors influencing eutrophication are linked to seasonality - light availability and temperature. When streams are turbid

due to storm events, light penetration is not adequate to allow enough production of algae to cause eutrophic conditions. Dodds (2006) documents streams experiencing eutrophication in late spring/early summer before leaf canopy shades a stream. Then those same streams have drops in algal production, ameliorating the deleterious effect of excess nutrients once the canopy shades the stream channel. Streams that are of sufficient width or lack a wooded riparian due to anthropogenic management practices (i.e., channelization) do not have adequate canopy coverage to subdue photosynthetic primary production. Photosynthesis is a chemical reaction that is impacted by temperature; however, the kinetics are complicated because they involve biological organisms that have optimal temperature ranges as well. Dauta and others (1990) examined four freshwater algae species and found maximal growth at 25 – 30 °C and a reduction in growth to the point of being insignificant around 10 °C. These factors complicate the definition of a critical time period for monitoring algae as indicators of eutrophication. However, D.O. is most impacted during summer low flows due to warmer temperatures and limited reaeration. While this may not always correspond to maximum algal biomass, Ohio EPA typically samples chlorophyll-*a* and diel D.O. at the same time. The advantage of coupling the two sampling efforts is that the algae sampled represent the productivity captured in the diel D.O. trend. In addition, while D.O. and chlorophyll-*a* sampling targets low flow critical conditions, ideal conditions are not always achieved. If conditions during a survey are less than ideal, an additional sampling event is often planned to capture low flow conditions.

For the purpose of trophic status evaluation, Ohio EPA designates ‘nutrient sites’ where benthic/sestonic chlorophyll-*a* concentrations and diel D.O. ranges are monitored. These sites coincide with grab sampling for chemistry that is then used to characterize the seasonal nutrient availability. Twenty-nine sites within the lower Auglaize River tributaries study area were designated as nutrient sites. Occasionally sites do not have substrates that support the sampling methods used for benthic algae assessment; therefore, only sestonic algae are collected. The only site affected by inadequate substrates was Flatrock Creek at RM 28.84. To assess the trophic state in the study area, two surveys were completed using water quality sondes to monitor D.O. on an hourly basis. During each of these surveys, both benthic and sestonic chlorophyll-*a* were sampled. The surveys occurred July 22-24, 2014 and August 15-19, 2014 (Figure 14) in the tributaries of the lower Auglaize River.

Sampling events are expected to represent the potential of primary production. Therefore, the largest D.O. range found in these sampling events is used in the summary figures. The hourly samples from a 24-hour diel cycle are summarized in box plots that identify the minimum, maximum, average, median, 75th percentile and 25th percentile of values measured. If benthic or sestonic algae were sampled in multiple surveys, the value corresponding to the highest D.O. range is shown. The complete chlorophyll-*a* and sonde dataset are reported in Appendices K and I, respectively. Instream nutrient concentrations are also considered as a contributing factor for assessing the trophic state. To assess nutrient concentrations, the geometric mean of the samples collected from May 1 – October 31, corresponding to the biological assessment season, is calculated. Total phosphorus and nitrate + nitrite are considered for comparison to the targets in Table 10 and Table 11. The critical data for assessing the trophic state are presented in Figure 15 - Figure 18. Figure 15 through Figure 18 are presented as longitudinally spaced plots, showing data appropriately spaced by river mile representing the spatial extent of sampling. Flatrock Creek, Blue Creek and the mainstem of the Little Auglaize River are all presented in this manner. The fourth and final plot in the sequence (Figure 18) shows tributaries that were not extensively sampled and are not presented with longitudinal spacing.

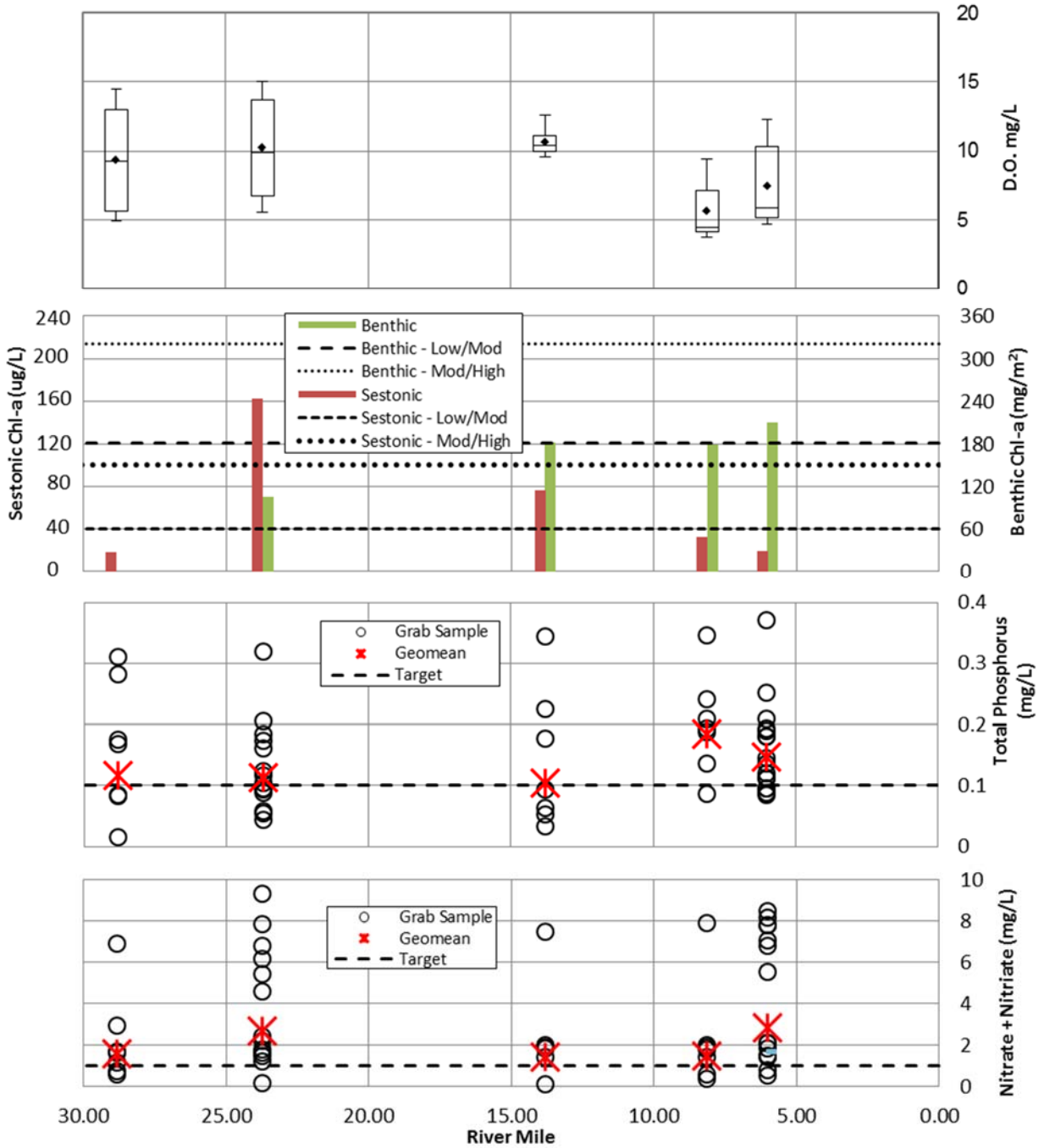


Figure 15: Longitudinal representation of D.O., benthic/sestonic chlorophyll-*a*, total phosphorus and nitrate + nitrite for a trophic assessment of Flatrock Creek. Relevant targets for chlorophyll-*a* and nutrient concentrations are presented on the respective plots. Sites at RMs 23.2 and 6.02 are sentinel sites where additional chemistry sampling occurred relative to the other sites.

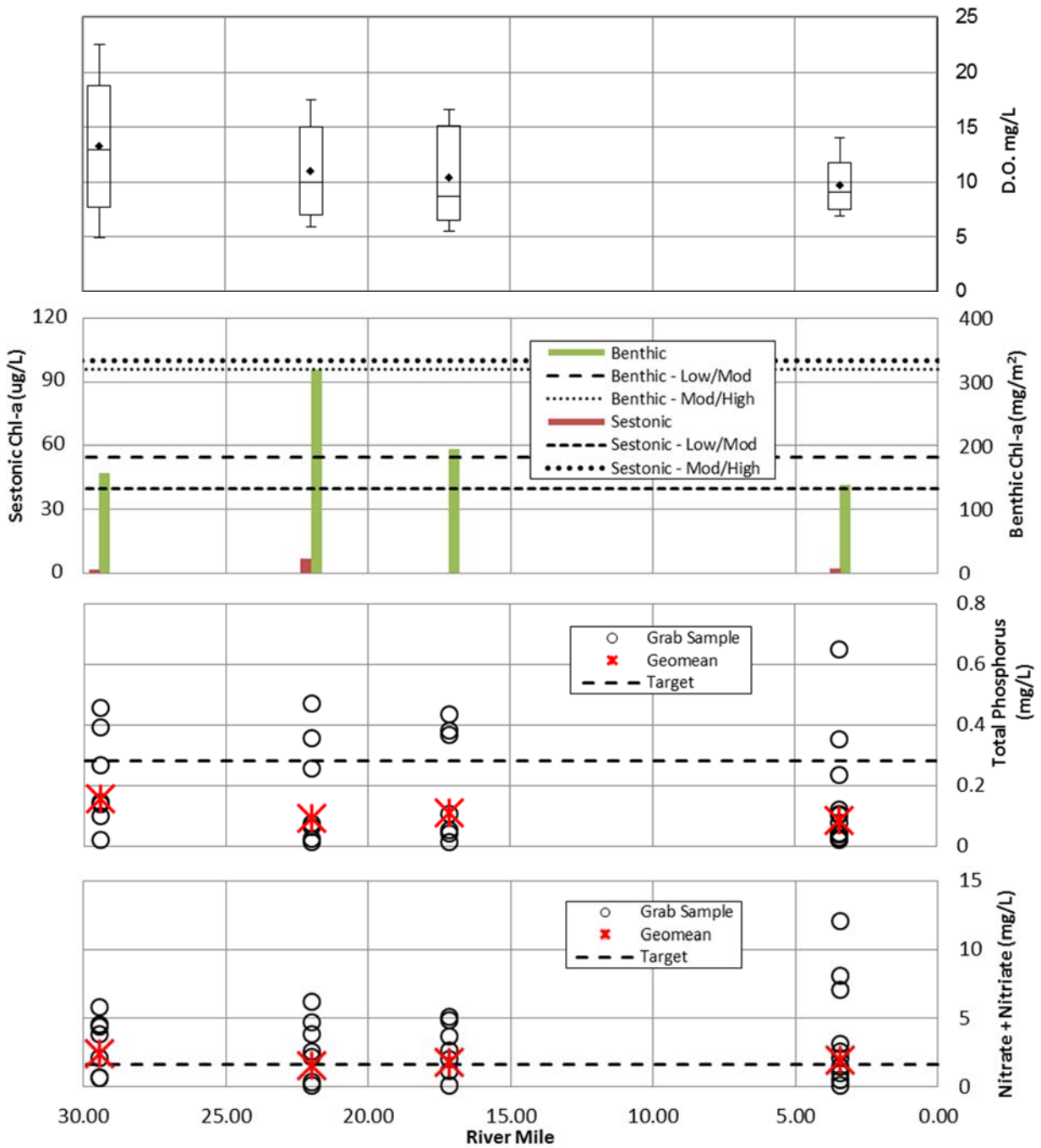


Figure 16: Longitudinal representation of D.O., benthic/sestonic chlorophyll-*a*, total phosphorus and nitrate + nitrite for a trophic assessment of Blue Creek. Relevant targets for chlorophyll-*a* and nutrient concentrations are presented on the respective plots. The site at RM 3.43 is a sentinel site where additional chemistry sampling occurred relative to the other sites.

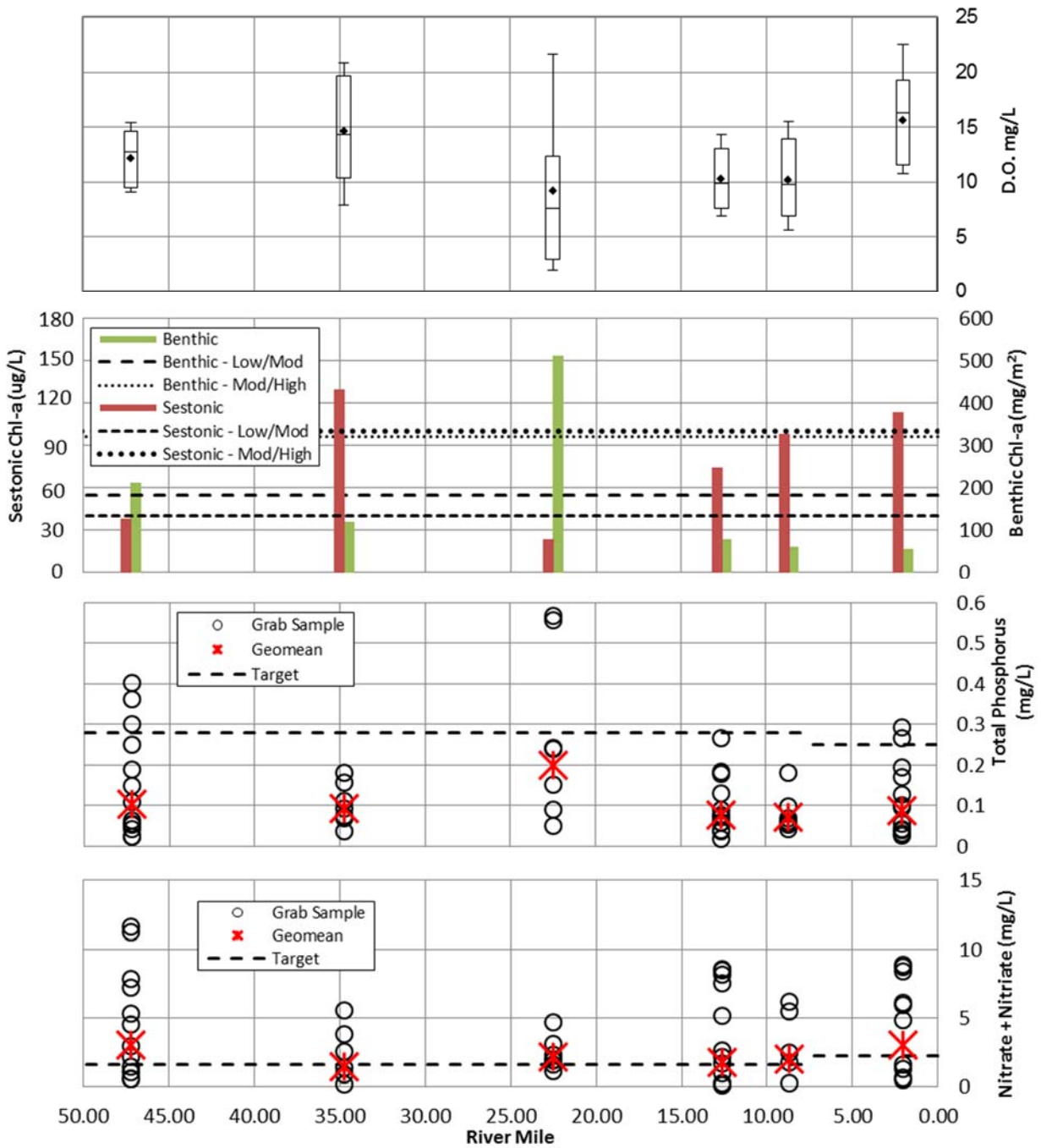


Figure 17: Longitudinal representation of DO, benthic/sestonic chlorophyll-*a*, total phosphorus and nitrate + nitrite for a trophic assessment of the Little Auglaize River. Relevant targets for chlorophyll-*a* and nutrient concentrations are presented on the respective plots. Sites at RM 47.2, 12.65 and 2.02 are sentinel sites where additional chemistry sampling occurred relative to the other sites.

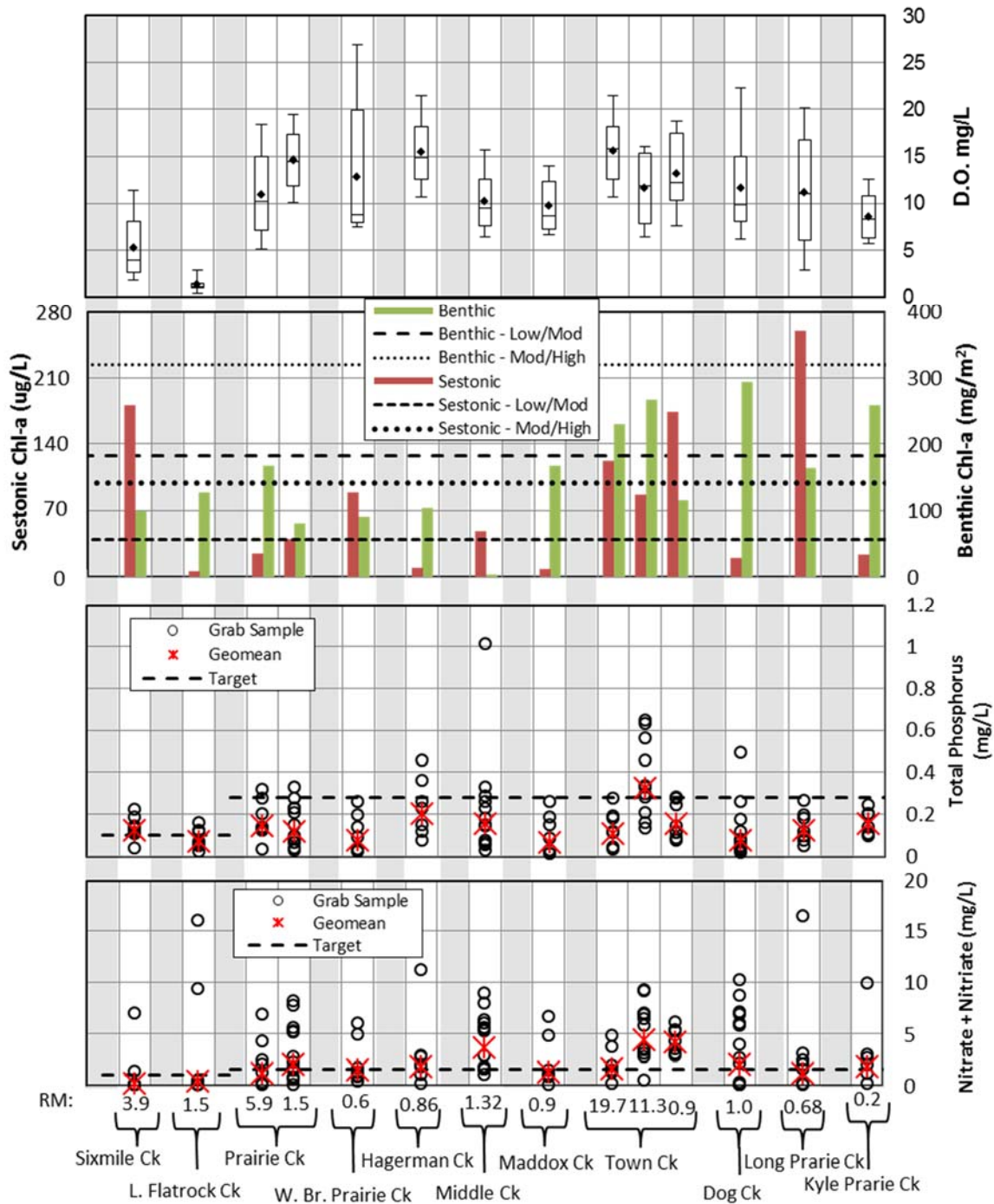


Figure 18: Data used for a trophic assessment of select tributaries to the lower Auglaize River. The assessment includes DO, benthic/sestonic chlorophyll-a, total phosphorus and nitrate + nitrite. Relevant targets for chlorophyll-a and nutrient concentrations are presented on the respective plots. Prairie Creek RM 1.5, Middle Creek RM 1.32, Town Creek RM 11.3 and Dog Creek RM 1.0 are all sentinel sites where additional chemistry sampling occurred relative to the other sites.

D.O. ranges and chlorophyll-*a* concentration are the primary indicators of eutrophication. If both indicators fall into an elevated range, there is strong evidence that the stream is exhibiting an advanced eutrophic state. If one or the other indicator is in an elevated range, there is evidence of a system imbalance but it is less conclusive regarding a eutrophic state. Some of the reasons for inconclusive results could be less than ideal sampling conditions or one sample misrepresents the total character of the stream. After these two indicators identify the location of the stream on the trophic spectrum, nutrient concentrations in the stream are evaluated. The response to nutrient inputs varies from stream to stream so using nutrient concentrations as an assessment endpoint is not always effective. However, if elevated nutrients are present, the risk of eutrophication increases. The sites are assessed following this logic and sites demonstrating eutrophication are identified.

Sixmile Creek and Little Flatrock Creek are direct tributaries to the lower Auglaize River and both are designated as WWH aquatic life use. However, both streams were historically modified and are maintained in a modified condition in all but the lowest reaches of the streams. Sixmile Creek showed high D.O. ranges representative of high productivity. The presence of sestonic chlorophyll-*a* was anomalous for a small stream though it accurately reflected the pooled and stagnant stream condition. In contrast, Little Flatrock Creek exhibited small D.O. ranges with minimal benthic or sestonic chlorophyll-*a* present. However, organic loading resulted in sustained low D.O. The site sampled was within the less maintained portion of the channel. It is likely that upstream reaches with ample sunlight likely contributed some of the organic material that depressed D.O. at the monitoring location.

Flatrock Creek is the best representative of a natural stream system in the study area. The stream exhibits a wide, wooded riparian area that provides shading to the stream channel. The channel had good access to a floodplain area and natural channel obstructions (primarily log jams) that helped mitigate high flows. The result was sustained flows over a long recession period, resulting in shorter duration low flows. The worst conditions monitored in the recent surveys showed some potential for benthic chlorophyll-*a* concentrations to approach moderately high levels. However, the impact to D.O. was mitigated by the previously mentioned sustained flows and wooded riparian area. Several sites had elevated sestonic chlorophyll-*a* values likely reflecting the deep, pooled areas at or immediately upstream from the sampling locations. If the sampling conditions would have reflected a period with little precipitation, it is possible that the stream would have represented more extreme conditions. The productivity that was observed as elevated chlorophyll-*a* values may have also emerged as high D.O. ranges. However, amongst other streams in the study area, the natural channel conditions of Flatrock Creek ameliorated the elevated nutrients contributed by point and non-point sources.

Blue Creek is unlike other streams in the study area as it had clear water at low flows. This was demonstrated by the absence of sestonic chlorophyll-*a* in samples collected. All of the monitoring stations in Blue Creek had wide D.O. ranges which generally decreased from upstream to downstream. Typical of small drainage area streams, the clear water allowed benthic algae to consistently dominate the system. Ohio EPA staff noted a prevalence of floating algal mats of filamentous algae at sampling locations. These mats are not represented in the sampling effort; however, they contribute to overall productivity and affect D.O. Even with the dominance of algal mats noted, two of the four sites sampled had benthic algae elevated to the moderate range. Throughout the sampling season, total phosphorus in the water column fell within the normal range of modified streams in Ohio. However, spates of high total phosphorus concentrations were captured in the sampling efforts and the mean seasonal concentration, represented as a geometric mean, was high enough not to limit algal production. The geometric mean of seasonal nitrate concentrations was elevated relative to expectations for modified

streams. Overall, Blue Creek demonstrated an advanced eutrophic state revealed by high diel ranges of D.O. and ample algal biomass.

The rest of the survey area consisted of the Little Auglaize River and its tributaries. The entire watershed has been extensively modified to facilitate drainage for agricultural production. The result of the stream modifications was removal of woody riparian vegetation, deepening/widening the stream channel and disconnection of the floodplain area. All of these physical stressors serve to increase the likelihood of the streams expressing eutrophic conditions. All of the monitoring sites had elevated diel D.O. ranges representing high levels of primary productivity. Most of the sites had moderately elevated levels of benthic chlorophyll-*a* representing the dominant algal community. However, the deep, pooled nature of the modified streams led to several areas where sestonic algae dominated the stream. While every assessed site had indicators of primary production suggesting eutrophic conditions, there were several sites that exhibited severe eutrophication. These sites included the Little Auglaize River at RM 22.51 (downstream from Ottoville), Prairie Creek at RM 5.9 (downstream from Scott and Haviland), West Branch Prairie Creek at RM 0.6 (downstream from Grover Hill), Dog Creek at RM 0.97 and Long Prairie Creek at RM 0.68 (downstream from Ohio City). Excluding Dog Creek, each stream had a point source or population center located upstream from the monitoring location. Phosphorus from point sources is typically soluble reactive phosphorus which is readily converted into biomass once in a stream. This differs from non-point source loading which typically has a high percentage of particulate phosphorus that is only 30% available for biomass production (Baker 2011). The evidence suggests that the already stressed watershed is especially susceptible to point source inputs of phosphorus. The sites downstream from point sources also had the highest seasonal concentrations of nutrients. This includes the only sites where seasonal nutrient concentrations were above normal for modified streams.

Recreation Use

Water quality criteria for determining attainment of the recreation use are established in the Ohio Water Quality Standards (Table 7-13 in OAC Chapter 3745-1-07) based upon the quantities of fecal indicators (*Escherichia coli* bacteria) present in the water column. New revisions to the recreation use rules in Ohio became effective on January 4, 2016. However, as sampling to assess the recreation use for the lower Auglaize River tributaries study area was designed and carried out when the previous rules were in effect, the assessment of data and determination of recreation use attainment status provided in this section were based on the prior rules.

Escherichia coli (*E. coli*) bacteria are microscopic organisms that are normally 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). 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 feasible. 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 every type of pathogen. 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 or multiple sources. Swimming or other recreation-based contact with water having a high *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.

Portions of the lower Auglaize River tributaries study area is designated as Primary Contact Recreation (PCR) use in OAC Rules 3745-1-07 and 3745-1-11. Water bodies with a designated recreation use of PCR "...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 support, or potentially support, frequent primary contact recreation activities. Streams designated PCR class B support, or potentially support, occasional primary contact recreation activities. The streams in the study area are designated as Class A and Class B Primary Contact Recreation waters.

The *E. coli* criterion that applies to PCR class A streams is a geometric mean of ≤ 126 colony forming units (cfu)/100 ml. The *E. coli* criterion that applies to PCR class B streams is a geometric mean of ≤ 161 cfu/100 ml. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the recreation use (Table 12).

The complete bacteria result dataset is reported in Appendix J.

Forty-one locations in the watershed were tested for *E. coli* levels five times between May 28, 2014 and September 15, 2014. Evaluation of *E. coli* results revealed that 40 of the 41 locations sampled failed to

meet the applicable geometric mean criterion, indicating non-attainment of the recreation use at these locations. The sole station in attainment was the Auglaize River upstream from Defiance at Harding Road (500290), with a geometric mean of 42. The four highest geometric means were at Town Creek North of Van Wert at Stripe Road (P02W10), Eagle Creek WNW of Junction at River Road (P06K28), Fivemile Creek at Defiance/Paulding County Line (302539), and Maddox Creek near Van Wert at West Ridge Road (P02G02), with geometric means of 2973, 2859, 2248, and 2196, respectively. Sites on Eagle, Fivemile, and Maddox creeks are downstream from areas dominated by rural residential and agricultural uses. The Town Creek site is downstream from the city of Van Wert and multiple NPDES permitted outfalls, including the City's WWTP and CSOs (Ohio EPA Permit: 2PD00006), and Cooper Farms Cooked Meats (Ohio EPA Permit: 21H00110).

Potential sources of *E. coli* contamination at locations not attaining the recreation use criteria are failing home sewage treatment systems (HSTS), livestock pasture land runoff, agricultural runoff, combined sewer overflows (CSOs), and wildlife accumulations. Many of the sites sampled had extensive amounts of agricultural land and drastically reduced riparian buffer along the stream.

Areas listed in non-attainment of the recreation use standard for failing HSTS may need individual system improvements to reduce the discharge of bacteria. Runoff from livestock manure application and livestock grazing areas could be improved by the installation of additional buffers and/or livestock exclusion fencing between the activity and the stream.

Table 12. Primary Contact Recreation (PCR) beneficial use attainment table for 41 locations in the lower Auglaize River tributaries study area, May 1 through October 31, 2014.

Note: All *E. coli* values are expressed as colony forming units (cfu) per 100 ml of water. Shaded values exceed applicable criteria.

Location	River Mile	PCR Class*	Number of Samples	Geometric Mean [†]	Attainment Status	Potential Source(s) of Bacteria
HUC 12 (Kyle Prairie Creek 4100007 06 01)						
Kyle Prairie Creek UST Firsinger Ditch @ Van Wert (302567)	0.20	B	5	1250	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Long Prairie Creek-Little Auglaize River 4100007 06 02)						
Little Auglaize River at Jonestown @ Jonestown Rd. (P02S25)	47.20	B	5	475	NON	Failing HSTS, Livestock Runoff, Wildlife.
Long Prairie Creek Dst. Ohio City WWTP @ St. Rt. 709 (P02S23)	6.79	B	5	640	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
HUC 12 (Wolf Ditch-Little Auglaize River 4100007 06 03)						
Evans Ditch N of Venedocia @ State Rd. (P02P04)	0.29	B	5	1126	NON	Failing HSTS, Livestock Runoff, Wildlife.
Little Auglaize R. S of Middle Point @ St. Rt. 697 (P02S35)	38.26	B	5	405	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Dry Fork-Little Auglaize River 4100007 06 04)						
Little Auglaize River Dst. Middlepoint @ Converse Roselms Rd. (P02S05)	34.75	B	5	502	NON	Failing HSTS, Livestock Runoff, Wildlife.
Little Auglaize River Dst. Ottoville @ Co. Rd. P (P02S03)	22.51	B	5	386	NON	Failing HSTS, Livestock Runoff, Wildlife.
Little Auglaize River W of Mandale @ St. Rt. 114 (204284)	12.65	B	5	412	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Hagerman Creek 4100007 07 01)						
Hagerman Creek E of Haviland @ Allison Rd. (Twp. Rd. 48) (P02K04)	0.86	B	5	379	NON	Failing HSTS, Livestock Runoff, Wildlife.
Hagerman Creek Ne of Convoy @ Richey Rd. (P02S14)	12.22	B	5	1784	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (West Branch Prairie Creek 4100007 07 02)						
Hoaglin Creek @ Wetsel Rd. (302553)	13.10	B	5	1213	NON	Failing HSTS, Livestock Runoff, Wildlife.
West Branch @ Matson Rd. (302554)	0.60	B	5	365	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Prairie Creek 4100007 07 03)						
Prairie Creek Ne of Haviland @ Allison Rd. (TWP. RD. 48) (P02S09)	12.50	B	5	201	NON	Failing HSTS, Livestock Runoff, Wildlife.

Location	River Mile	PCR Class*	Number of Samples	Geometric Mean [†]	Attainment Status	Potential Source(s) of Bacteria
Prairie Creek S of Melrose @ Roselms Rd. (P02S08)	1.50	B	5	377	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Dog Creek 4100007 08 01)						
Dog Creek @ Church Rd. (P02K07)	14.06	B	5	1260	NON	Failing HSTS, Livestock Runoff, Wildlife.
Dog Creek E of Roselms @ St. Rt. 114 (P02K06)	0.97	B	5	365	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Upper Town Creek 4100007 08 02)						
Roller Creek @ Liberty Union Rd. (302564)	1.35	B	5	1176	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
HUC 12 (Maddox Creek 4100007 08 03)						
Maddox Creek @ St. Rt. 637 (302559)	0.90	B	5	660	NON	Failing HSTS, Livestock Runoff, Wildlife.
Maddox Creek Near Van Wert @ W. Ridge Rd. (Lincoln Highway) (P02G02)	14.75	B	5	2196	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Lower Town Creek 4100007 08 04)						
Town Creek @ Richey Rd (302561)	25.35	B	5	841	NON	Failing HSTS, Livestock Runoff, Wildlife.
Town Creek N of Van Wert @ Stripe Rd. (P02W10)	11.32	B	5	2973	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
HUC 12 (Middle Creek 4100007 08 05)						
Middle Creek Ne of Roselms @ Co. Rd. 60 (P02S18)	1.32	B	5	322	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Burt Lake-Little Auglaize River 4100007 08 06)						
Little Auglaize R. E of Melrose @ St. Rt. 613 (510200)	2.02	B	5	280	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Upper Prairie Creek 4100007 10 01)						
Middle Creek @ Parker Rd (302556)	0.50	B	5	381	NON	Failing HSTS, Livestock Runoff, Wildlife.
Upper Prairie Creek @ Van Wert Paulding Co. Rd. 12 (302549)	0.90	B	5	395	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Upper Blue Creek 4100007 10 02)						
Blue Creek @ Sugar Grove Church Rd. (Elm Sugar Rd) (P06K31)	29.43	B	5	478	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Middle Blue Creek 4100007 10 03)						
Blue Creek @ Allison Rd. (302547)	17.15	B	5	214	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Lower Blue Creek 4100007 10 04)						

Location	River Mile	PCR Class*	Number of Samples	Geometric Mean [†]	Attainment Status	Potential Source(s) of Bacteria
Blue Creek @ Co. Rd. 151 (P06s02)	3.43	B	5	193	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Town of Charloe-Auglaize River 4100007 10 05)						
Bobenmyer Ditch @ Stouffer Rd. (302568)	0.70	B	5	180	NON	Failing HSTS, Livestock Runoff, Wildlife.
Snyder Ditch @ Stouffer Rd. (302569)	0.30	B	5	711	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Headwaters Flatrock Creek 4100007 12 01)						
Flatrock Creek @ Werner Rd. (302544)	48.30	B	5	505	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Wildcat Creek-Flatrock Creek 4100007 12 05)						
Flatrock Creek Dst Payne WWTP @ St. Rt. 613 (P06S35)	23.72	B	5	617	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
Flatrock Creek Upst. Payne WWTP @ Pugh Rd. (P06S37)	28.84	B	5	528	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Big Run-Flatrock Creek 41000071206)						
Flatrock Creek Dst. Paulding WWTP @ Broughton Rd. (P06S31)	8.13	B	5	499	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
Flatrock Creek Ne of Paulding @ Louck Rd. (P06S30)	6.02	B	5	564	NON	Failing HSTS, Livestock Runoff, Wildlife, CSOs.
Flatrock Creek Upst. Paulding @ Co. Rd. 107 (500250)	14.11	B	5	322	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Little Flatrock Creek 4100007 12 07)						
Little Flatrock Creek @ Old St. Rt. 111 (302543)	1.50	B	5	579	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Sixmile Creek 4100007 12 08)						
Sixmile Creek @ Dotterer Rd. (302541)	3.90	B	5	235	NON	Failing HSTS, Livestock Runoff, Wildlife.
HUC 12 (Eagle Creek-Auglaize River 4100007 12 09)						
Auglaize River Upst. Defiance @ Harding Rd. (500290)	4.14	A	5	42	FULL	
Eagle Creek WNW of Junction @ River Rd. (Upper Crossing) (P06K28)	1.57	B	5	2859	NON	Failing HSTS, Livestock Runoff, Wildlife.
Fivemile Creek @ Defiance Paulding Co Line (302539)	1.70	B	5	2248	NON	Failing HSTS, Livestock Runoff, Wildlife.

* Recreation class includes primary contact recreation classes A or B.

[†] Attainment status is determined based on the seasonal geometric mean. The status cannot be determined at locations where fewer than two samples were collected during the recreation season.

Sediment Quality

Sampling locations were selected in the study plan to determine background sediment quality, assess the impact from point sources and urban non-point runoff, and evaluate downstream transport and recovery. Samples were collected following the Sediment Sampling Guide and Methodologies, 3rd Edition (Ohio EPA 2012). The goal was to collect a representative sample that was composed of >30% silt and clay particles. These fine grained particles are much more physically, chemically and biologically reactive because they hold more interstitial water and have unbalanced electrical charges that can attract contaminants.

Most of the streams of the lower Auglaize River tributaries study area contained little in the way of fine grained sediment in large enough volumes to have much of an ecological impact. Fine particles are predominantly washed downstream at higher flows. Exceptions to this include impounded segments, isolated eddies, and in the headwaters where feeder streams are channelized. Fine grained sediments in large enough quantities for collection could not be found at Flatrock Creek at Broughton Road, Little Auglaize River at St. Rt. 697, Little Auglaize River at CR. P, and Town Creek at Stripe Road.

A total of three sediment samples were collected. One sample was collected each in Evans Ditch north of Venedocia at State Road (RM 0.29), Long Prairie Creek downstream from the Ohio City WWTP at St. Rt. 709 (RM 6.79), and in Prairie Creek northeast of Haviland at Allison Road (RM 12.50). Sediment samples were analyzed for metals including mercury and s-VOCs (PAHs).

Sediment sample results were evaluated using Tier I procedures for aquatic life described in the Guidance on Evaluating Sediment Contaminant Results (Ohio EPA 2010a). Numeric Sediment Quality Guidelines (SQGs) that are used include Ohio Sediment Reference Values (SRVs) for metals contained in the Ecological Risk Assessment Guidance (Ohio EPA 2008) and toxicity values in the Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et.al 2000). When contaminants are at concentrations above the SQGs, either appropriate treatment options should be explored to remediate the problem, or consideration should be given to investigate if bioavailability affects toxicity. This would likely require further studies to be done.

Heavy metals and PAHs are common contaminants in urban areas because of vehicular emissions, asphalt pavement and their use in industrial processes. For example, mercury is used in the production of chlorine gas and caustic soda and in the manufacture of batteries and compact fluorescent light bulbs. It is also common in the atmosphere from coal burned to produce electricity. Besides urban storm water runoff and atmospheric deposition, other likely sources include municipal and industrial wastewater, and combined sewer overflows in municipal sewage collection systems.

A summary of parameters measured above SQGs is presented in Table 13. Metals that were above their threshold effect concentration (TEC), but that did not exceed their sediment reference value (SRV) are not displayed. Harmful effects are unlikely below the TEC and more likely above the PEC.

Table 13. Chemical parameters measured above SQGs in surficial sediment samples collected by Ohio EPA in the lower Auglaize River tributaries study area, 2014.

Parameter	Result (mg/kg)	SRV (mg/kg)	TEC (mg/kg)	PEC (mg/kg)
HUC 12 (04100007-06-03) Wolf Ditch – Little Auglaize River				
EVANS DITCH N OF VENEDOCIA @ STATE RD (RM 0.29)				
Arsenic (mg/kg)	17.80	11.0	9.79	33.00
Cadmium (mg/kg)	9.66	0.96	0.99	4.98
HUC 12 (04100007-06-02) Long Prairie Creek – Little Auglaize River				
LONG PRAIRIE CREEK DST OHIO CITY WWTP 2 ST RT 709 (RM 6.79)				
Arsenic (mg/kg)	12.7	11.0	9.79	33.00
Cadmium (mg/kg)	2.11	0.96	0.99	4.98
Copper (mg/kg)	46.80	42.0	31.6	149.00
Mercury (mg/kg)	0.16	0.12	0.18	1.06
HUC 12 (04100007-07-03) Prairie Creek				
PRAIRIE CREEK NE OF HAVILAND @ ALLISON RD (TR 48) (RM 12.50)				
Arsenic (mg/kg)	69.20	11.0	9.79	33.00
Nickel (mg/kg)	45.80	36.0	22.7	48.60

A Tier II evaluation was completed for simultaneously extracted metals (silver, zinc, cadmium, copper, nickel, and lead) at all three sampling locations due to observed exceedances of the SRVs for multiple parameters and the probable effect concentration (PEC) for cadmium in Evans Ditch. The Tier II evaluation resulted in the calculated potential metals toxicity in the sediment as having little to no risk to aquatic life at all three sites.

The arsenic PEC exceedance in Prairie Creek is potentially a result of historic and current agricultural pesticide use. Additional potential impact to the sediment arsenic levels at the Prairie Creek site could include the unsewered communities of Scott and Haviland, a grain and fertilizer company located in Scott, and potential land application of chicken and turkey manure. The arsenic PEC exceedance did not negatively impact the fish and macroinvertebrate populations at this site due to full attainment of the MWH-C aquatic life use.

Public Drinking Water Supplies

The Public Water Supply (PWS) beneficial use in the Ohio WQS (OAC Chapter 3745-1-33) currently applies within 500 yards of drinking water intakes and for all publicly owned lakes. Ohio EPA has developed an assessment methodology for this beneficial use which focuses on source water contaminants not effectively removed through conventional treatment methods. The 2014 Integrated Water Quality Monitoring and Assessment Report (2014 Ohio IR) describes this methodology and is available on Ohio EPA's website:

<http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx>.

Impaired source waters may contribute to increased human health risk or treatment costs. For the case when stream water is pumped to a reservoir, the stream and reservoir will be evaluated separately. These assessments are designed to determine if the quality of source water meets the standards and criteria of the Clean Water Act. Monitoring of the safety and quality of treated finished drinking water is regulated under the Safe Drinking Water Act and evaluated separately from this assessment. For those cases when the treatment plant processes do not specifically remove a source water contaminant, the finished water quality data may be considered representative of the raw source water directly feeding into the treatment plant.

There are three public water systems (Delphos, Paulding and Van Wert) directly served by surface water sources within the study area. Delphos has an intake on the Little Auglaize River (RM 28.7), Paulding has an intake on Flatrock Creek (RM 14.1) and Van Wert has two intakes located on Town Creek (RM 18.35). Table 14 provides a summary of results for the PWS use while Appendices G, J, and K contain all of the water quality analytical results.

City of Delphos

The city of Delphos operates a community public water system that serves a population of approximately 6,944 people through 2,750 service connections. The water treatment system obtains its water from the Little Auglaize River via a reservoir located in the northwest part of the City. The system's treatment capacity is approximately 3.75 million gallons per day, but current average production is 0.836 million gallons per day. The city of Delphos' treatment processes include lime softening, coagulation/flocculation, sedimentation, filtration, stabilization, fluoridation, and disinfection. The backup supply of water for the city is a ground water system consisting of eight wells.

Ohio EPA collected water quality samples from the Little Auglaize River (just upstream from the intake) and Delphos Reservoir (L-1 site) during 2014 and 2015. To assess the PWS beneficial use, samples were analyzed for nitrate, atrazine and cyanotoxins (microcystins, saxitoxin and cylindrospermopsin). The PWS assessment unit is HUC 0410007 06 04 Dry Fork-L. Auglaize R.

Twenty nitrate sample results ranged from below detection to 15.9 mg/l. The median was 3.49 mg/L. Nitrate results would lead to a full support watch list determination, due to two results exceeding 80% of the WQS criterion for nitrate, but only one result exceeded the criterion. Nitrate was not assessed for the 2014 Ohio IR for this HUC watershed due to selective pumping to the reservoir and lack of source water quality data.

For atrazine, sample results (n=21) ranged from below detection to 13.0 ug/l. Two results (13.0 ug/l and 9.4 ug/l) were more than 4 times higher than the atrazine WQS criterion, placing this watershed on the full support watch list (since there were no annual average exceedances). Atrazine was not assessed for the 2014 Ohio IR for this HUC watershed for the same reasons listed above.

All cyanotoxin sample results were just at or below detection levels. No excursions were observed above state drinking water thresholds. These results would meet full attainment conditions. The algae cyanotoxin indicator was not assessed for the 2014 Ohio Integrated Water Quality Report for this HUC watershed due to lack of source water data.

Village of Paulding PWS

The village of Paulding operates a community public water system that serves a population of approximately 3,605 people with 1,635 service connections. The Village draws water from a surface water intake on Flatrock Creek. The system's treatment capacity is approximately 1.5 million gallons per day, but current average production is 0.425 million gallons per day. The village of Paulding's water treatment system consists of carbon adsorption, coagulation, sedimentation, sand filtration, lime softening, fluoridation and disinfection.

Ohio EPA collected samples from one location on Flatrock Creek (just upstream from the intake) and two locations on Paulding Reservoir during 2014 and 2015. To assess the PWS beneficial use, samples were analyzed for nitrate, atrazine and cyanotoxins (microcystins, saxitoxin and cylindrospermopsin). The PWS assessment unit is HUC 0410007 12 06 Big Run-Flatrock Creek.

Sample results for nitrate from the reservoir sites (including L-1) were low. The average for these samples was 0.65 mg/l (n=11). For Flatrock Creek samples (n=12), results were much higher with an average value of 3.72 mg/l and a maximum of 8.34 mg/l. Nitrate results would trigger a future full attainment watch list determination for this assessment unit. Nitrate was not assessed for the 2014 Ohio IR for this HUC watershed due to selective pumping to the reservoir and lack of source water quality data.

For atrazine, several elevated results were observed, including 18 ug/l and 12 ug/l during May 2015 sample events from Flatrock Creek. Reservoir sampling results in 2014 were much lower during summer sampling events. However, due to the Flatrock Creek sample results, a full support watch list determination for future IR submittal will follow. Both the running quarterly average and maximum instantaneous values were exceeded, but the annual average was not exceeded. Atrazine was not assessed for the 2014 Ohio IR for this HUC watershed due to the same reasons stated above for nitrate.

All cyanotoxin sample results were just at or below detection levels. No excursions were observed above state drinking water thresholds. These results would meet full attainment conditions. The algae cyanotoxin indicator was not assessed for the 2014 Ohio IR for this HUC watershed due to a lack of source water quality data.

City of Van Wert

The city of Van Wert operates a community public water system that serves a population of approximately 11,000 people through 4,946 service connections. The water treatment system obtains its water from Town Creek. The system's treatment capacity is 4.5 million gallons per day, but current average production is 1.67 million gallons per day. Water is pumped from two intakes on Town Creek into two upground reservoirs for storage prior to treatment. Water normally flows by gravity to the water treatment plant from the reservoirs. However, if the reservoir water level is too low for gravity flow to the plant, water is pumped directly to the treatment plant. The city of Van Wert's water treatment system consists of potassium permanganate addition, lime softening, coagulation, sedimentation, filtration, carbon dioxide stabilization, fluoridation, and disinfection.

Ohio EPA collected samples from the intake location on Town Creek in 2015 and from Reservoir #2 in 2014 and 2015. To assess the PWS beneficial use, samples were analyzed for nitrate, atrazine and cyanotoxins (microcystins, saxitoxin and cylindrospermopsin). The PWS assessment unit is HUC 0410007 08 04 Lower Town Creek.

In 2015, ten samples were collected from the Town Creek intake and tested for nitrate. The 2015 average was 3.84 mg/l. Two sample results (10.6 mg/l and 8.15 mg/l) exceeded 80% of the WQS criterion for nitrate triggering a future full attainment watch list condition. Nitrate testing from sample location L-1 on Reservoir 2 averaged 0.82 mg/l (n=10) with a maximum observed result of 2.56 mg/l during sampling conducted by Ohio EPA in 2014-2015. Nitrate was not assessed for the 2014 Ohio IR for this HUC watershed due to selective pumping to reservoir and lack of source water quality data.

For atrazine, Ohio EPA collected 15 samples at the intake location over the two-year period from 2014-2015. Both watch list conditions were met for atrazine in 2015, but annual averages were not exceeded (full support, watch list determination). A running quarterly average of 4.7 ug/l (WQS criterion 3.0 ug/l) was observed based on seven samples collected during the second quarter of 2015. In addition, two samples (15.0 ug/l and 9.7 ug/l) exceeded four times the WQS criterion for atrazine. This indicator was not assessed for the 2014 Ohio IR due to the same reasons stated above for nitrate.

Finally, Ohio EPA collected cyanotoxin samples from Reservoir 2 during 2014 and 2015. All results, including microcystins were below detection. Cyanotoxins were not assessed for the 2014 Ohio IR due to a lack of source water quality data.

Table 14. Summary of available water quality data for nitrate and atrazine at sampling sites near/at PWS intakes in the lower Auglaize River tributaries study area, 2014-2015.

Location	PDWS Parameters of Interest					
	Nitrate-Nitrite WQC = 10 mg/L ¹		Atrazine WQC = 3.0 ug/L ²			
	Average (sample count)	Maximum (#samples>WQC)	Average (sample count)	Annual Average (2014) ³	Annual Average (2015) ³	Maximum Instantaneous Value
HUC 0410007 06 04 Dry Fork-L. Auglaize River / Delphos PWS						
L. Auglaize River ust. Intake (302550)	5.04 mg/L (10)	15.90 mg/L (1)	3.21 ug/L (11)	2.25 ug/l	1.50 ug/l	13.0 ug/l
Delphos Reservoir L1 (302533)	1.93 mg/l (10)	2.72 mg/l (0)	0.80 ug/L (10)	0.48 ug/l	0.32 ug/l	1.20 ug/l
HUC 04100007 12 06 Big Run-Flatrock Creek / Paulding PWS						
Flatrock Creek ust. Intake (500250)	3.72 mg/l (12)	8.34 mg/l (0)	3.97 ug/l (11)	0.84 ug/l	1.80 ug/l	18.0 ug/l
Paulding Res. L1 (204362)	0.65 mg/l (11)	1.20 mg/l (0)	1.29 ug/l (8)	0.32 ug/l	0.32 ug/l	2.20 ug/l
HUC 04100007 08 04 Lower Town Creek / Van Wert PWS						
Town Creek ust. Intake (302562)	3.84 mg/l (10)	10.6 mg/l (1)	2.36 ug/l (15)	0.40 ug/L	1.20 ug/l	15.0 ug/l
Van Wert Res. #2 L1 (302535)	0.82 mg/l (10)	2.56 mg/l (0)	0.95 ug/l (10)	0.55 ug/l	0.36 ug/l	1.60 ug/l

- 1 Nitrate Water Quality Criterion (WQC) evaluated as maximum value not to be exceeded, impaired waters defined as having two or more excursions about the criteria. Watch List conditions include maximum instantaneous value > 8.0 mg/l.
- 2 Atrazine WQC evaluated as annual average based on quarterly averages. Watch List conditions include maximum instantaneous value > 12.0 ug/l.
- 3 Quarterly averages assume zero for quarters without data.

Lake Sampling

Inland Lakes Monitoring

Ohio EPA has implemented a sampling strategy that focuses on evaluating chemical conditions near the surface and physical conditions in the water column of inland lakes. Physical profile measurements are summarized either for the entire water column or the epilimnion depending on thermal stratification. The sampling target consists of an even distribution of a total of ten sampling events divided over a two-year period and collected during the index period of May 1 – October 31. Key parameters used to determine the attainment status of lakes include chlorophyll-*a*, ammonia, dissolved oxygen, pH, total dissolved solids and various metals. Other parameters used to evaluate the degree of support or non-support includes Secchi depth, total phosphorus and total nitrogen. Details of the sampling protocol are outlined in Appendix I of the Ohio EPA Surface Water Field Sampling Manual and can be found [here](#) on Ohio EPA's web page.

Water Quality Standards for the Protection of Aquatic Life in Lakes

Presently, lakes in Ohio are designated as Exceptional Warmwater Habitat (EWH) with respect to the aquatic life use designation (with the exception of upground reservoirs which are designated Warmwater Habitat [WWH]). Revisions to Ohio's WQS that would change the aquatic life use from EWH to Lake Habitat (LH) were proposed for adoption in December, 2011, but were subsequently withdrawn. A future rulemaking is anticipated but the timeframe is unknown. A primary reason for this revision is that in Ohio, a set of biological criteria applies to rivers and streams, whereas no biocriteria apply to lakes. The numeric chemical criteria to protect the LH use will remain the same as the criteria to protect the EWH or WWH uses that currently apply to lakes and upground reservoirs, with a suite of nutrient criteria added. These criteria are tiered based on the type of lake and the ecoregion in which it is located. A set of numeric criteria that applies to all surface waters for the protection of aquatic life, regardless of specific use designation, also apply to inland lakes and are referred to as "base aquatic life use criteria" in the proposed WQS rules. The base aquatic life use criteria will be the same aquatic life numeric criteria that currently apply to lakes. Examples include various metals such as copper, lead, and cadmium as well as organic chemicals such as benzene and phenol. Specific details concerning the progress of revisions to Ohio's Water Quality Standards involving the proposed Lake Habitat aquatic life use and associated criteria can be found [here](#) as information becomes available. Details of the proposed use designation, draft criteria and assessment methodology are previewed in the Ohio EPA 2012 Integrated Water Quality Monitoring and Assessment Report and can be found [here](#) on Ohio EPA's web page.

Delphos Gillmor Reservoir

Delphos Gillmor Reservoir is a manmade upground reservoir built to store drinking water. It's made of an earthen levee that is about 12 feet wide at the top with 2:1 side slopes. The inside of the levee is covered with limestone rip-rap to protect the shoreline from wind and wave erosion. The lake became operational in 2007 and was filled by pumping water from the Little Auglaize River. It covers a surface area of 50 acres with 1.1 miles of shoreline and holds about 450 million gallons. Upground reservoirs are typically designed to provide 6 months of capacity. As needed and when source quality is good, more water is pumped into the lake from the river.

The reservoir is located in Van Wert County on Shenk Road, about 2.5 miles northwest of Delphos. The lake is open to the public for boating and fishing, but swimming is not allowed. Watercrafts are limited

to electric motors only. A concrete ramp is located on the west side of the reservoir. Fish management activities include routine stocking, population monitoring, and angler harvest studies.

Key Attributes

Lake Type: Upground Reservoir

Ecoregion: Huron-Erie Lake Plain

Surface Area: 50 acres

Maximum Depth: 33 ft.

Lake Habitat Use

Environmental samples were collected during the 2014-15 recreation seasons. Data used to determine status of the use is summarized in Table 15. Base aquatic life parameters that were evaluated included dissolved solids, arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc. Individual sample concentrations were first compared to outside mixing zone average (OMZA) numeric criteria. If the OMZA was exceeded in more than 10% of the total samples tested for any parameter, the use was considered non-support.

Tiered aquatic life parameters were evaluated using a couple of different methods. Chlorophyll-*a*, total phosphorus, total nitrogen and Secchi depth were evaluated by first calculating a median value from the two year dataset. This value was then compared to the criteria in Table I-1 of the 2012 Integrated Report. Dissolved oxygen (D.O.), pH and ammonia were evaluated in a manner similar to the base aquatic life parameters. Dissolved oxygen (average) and pH (median) numbers are calculated from profile readings taken in either the epilimnion or the entire water column if the lake was not stratified. Status of the Lake Habitat use was considered non-support if chlorophyll-*a*, dissolved oxygen, pH or ammonia exceeded criteria based on their assessment method. A watch list designation was assigned if total phosphorus, total nitrogen or Secchi depth values exceeded their criteria. Delphos Reservoir was considered in support of the Lake Habitat use, but on the watch list due to the total nitrogen and Secchi depth medians exceeding respective target values.

Useful information was also obtained from samples collected near the bottom. The hypolimnion can become depleted of oxygen if consumption by decomposing organic matter exceeds reaeration by atmospheric diffusion and photosynthesis. Fish access to habitat, cool water and benthic prey can be limited if conditions become hypoxic (D.O. < 2 mg/L). Hypoxia was documented during every sampling event. On most occasions, hypoxia was documented at depths of 8-9 meters. Chemistry data from samples collected 0.5 m from the bottom did not indicate that phosphorus bound to sediment particles was being released to the water column due to redox reactions that break the bond between phosphate molecules and calcium and iron. The lack of phosphorus release was likely because the reservoir was recently constructed and little sediment has accumulated. Mean total phosphorus concentration at the surface for the 10 sampling events was 6.57 ppb and bottom mean concentration was 8.1 ppb. This release of nutrients is what typically stimulates fall algae blooms when thermal stratification is broken and the lake "turns over".

A surface sediment sample was collected in October 2014 and analyzed for metals, nutrients, s-VOCs (PAHs), PCBs and pesticides (organo-chlorine insecticides). Most compounds tested were either not detected or were well below guidelines used by Ohio EPA to evaluate data.

Recreation Use

The recreation use was evaluated by measuring levels of *Escherichia coli* bacteria at the lake (L-1) station and comparing the geometric mean to the bathing water criterion of 126 CFU/100 mL. It was sampled 10 times over the two-year assessment period and the recreation use was considered in support since the geometric mean was 1.14 CFU/100 mL.

Public Drinking Water Use

Public drinking water use attainment status was determined and reported in the 2016 Integrated Water Quality Monitoring and Assessment Report. As of this report's completion, Ohio EPA was in the process of finalizing the Integrated Report, which fulfills the State's reporting obligations under Section 305(b) (33 U.S.C. 1315) and Section 303(d) (33 U.S.C. 1313) of the Federal Clean Water Act. The Integrated Report is available [here](#).

Fish Consumption Use

An attempt was made to evaluate the fish consumption use. However, the sample size of fish collected was too small to make a determination. No consumption advisories have been issued beyond the state wide advisory for mercury.

Table 15. Summary of data used to determine status of the Lake Habitat use in Delphos Reservoir, 2014 and 2015.

Parameter	Chl.-a (µg/L)	Secchi (m)	T-N (µg/L)	T-P (µg/L)	D.O. (mg/L)	pH (SU)	NH ₃ -N (mg/l)
Draft Targets	≤6.0	≥2.6	≤1225	≤18	≥6.0	6.5>pH<9.0	(WQS)
5/22/2014	1.7	4.62	2510	7.7	8.77	8.18	0.064(3.6)
6/18/2014	4.3	1.40	2930	5.9	8.70	8.14	0.025(4.5)
7/15/2014	6.1	1.80	3140	5.6	9.12	8.46	0.025(2.0)
8/20/2014	8.5	1.30	2470	4.6	9.43	8.47	0.025(2.0)
9/18/2014	4.7	1.80	1920	4.4	7.41	8.07	0.081(4.5)
5/13/2015	3.4	1.40	2780	6.6	10.16	8.28	0.025(2.9)
6/30/2015	13.5	1.95	2310	10.5	9.56	8.35	0.025(2.9)
7/15/2015	10.1	1.60	1880	7.3	9.38	8.49	0.025(2.0)
8/18/2015	5.6	2.08	1830	6.1	7.24	8.29	0.029(3.0)
8/31/2015	6.6	2.30	1710	7.0	9.57	8.46	0.019(2.0)
Median	5.85	1.80	2390	6.35	-	-	-
% Exceeded	-	--	-	-	0%	0%	0%
Narrative	support	watch list	watch list	support	support	support	support

Phytoplankton Assessment

The phytoplankton community in Delphos Reservoir during 2014 and 2015 was characterized based on raw water samples collected using a tube sampler. Samples were collected during the May, July and September sampling events, fixed with Lugol's solution, and submitted to a contract lab. Phytoplankton present in a representative aliquot was identified to at least genus level (usually species) and cell densities (cells/L) and bio-volumes (µm³/L) were estimated.

Phytoplankton communities typically exhibit a seasonal succession when factors like water temperature, nutrients, transparency and photoperiod favor certain types. Grazing by larval fish and zooplankton also has an effect. Temperate lakes in Ohio are usually dominated by diatoms in the spring until micronutrients like silica are depleted, and blue green algae in the fall when an ability to control buoyancy and fix nitrogen from the atmosphere gives certain types a competitive edge.

Figure 19 and Figure 20 summarize total bio-volume by algal class in Delphos Reservoir. In general, the population seemed diverse and balanced, with six different classes of algae represented. Temporal variability exhibited a normal succession for the most part. This can be greatly affected by springtime extremes in temperature and rainfall on either end of the spectrum.

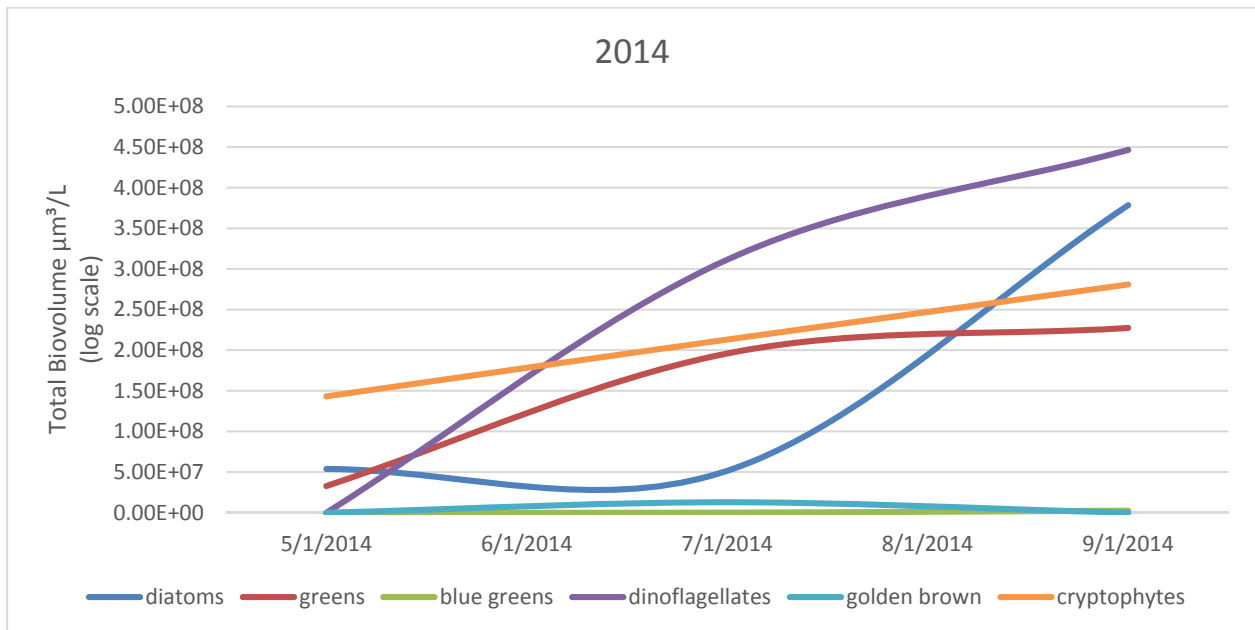


Figure 19. Total bio-volume by algal class in Delphos Reservoir, 2014.

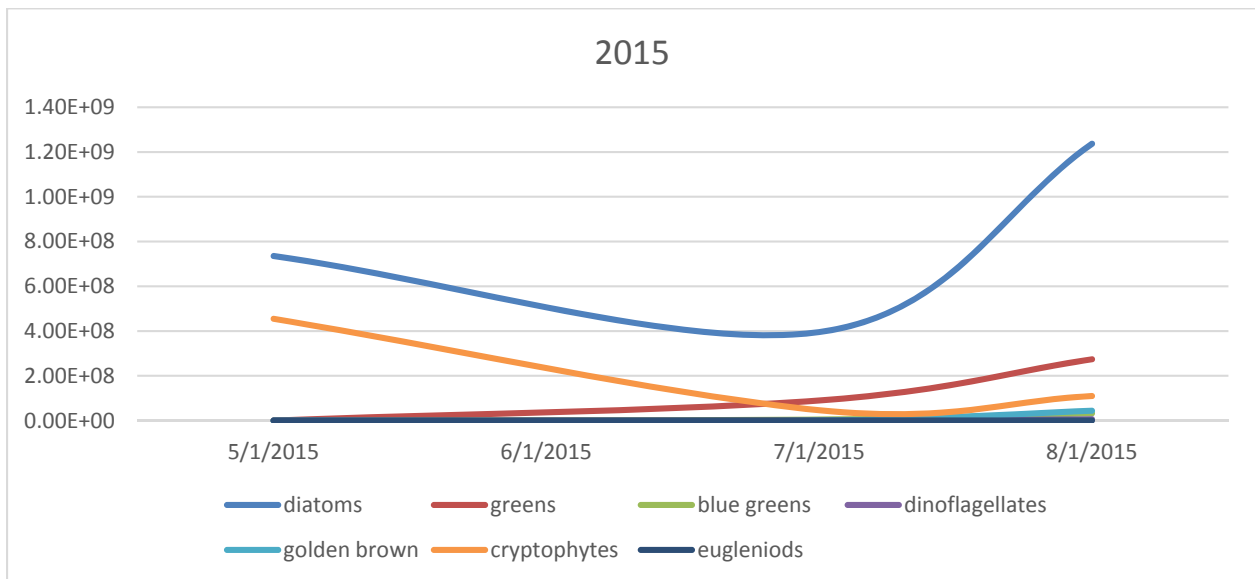


Figure 20. Total bio-volume by algal class in Delphos Reservoir, 2015.

Samples to test for a suite of cyanotoxins (microcystins, cylindrospermopsin and saxitoxin) were also submitted during all sampling events. To protect public health, Ohio has drinking and recreation action levels for the microcystin toxin. A “Do Not Drink” advisory is issued at concentrations in finished water ≥ 1 ppb. A “Recreational Public Health” advisory is posted at beaches with surface water levels ≥ 6 ppb and a “No Contact” advisory is posted at levels ≥ 20 ppb if human or animal illness is also documented. Even though some genera with the ability to produce toxins were documented in the enumeration samples, results for all of the toxin samples were below respective reporting limits. This indicated that either no toxins were being produced or that population densities were low and little toxin was present.

Van Wert Reservoir #2

Van Wert Reservoir #2 is a manmade upground reservoir built to store drinking water. It's made of an earthen levee that is about 12 feet wide at the top with 2:1 side slopes. The inside of the levee is covered with limestone rip-rap to protect the shoreline from wind and wave erosion. An expansion of the lake was completed in late 2010, increasing the size from a surface area of 60 to 100 acres. Reservoirs #1 and #2 combined store about 1 billion gallons of water and both are filled by pumping water from Town Creek. Upground reservoirs are typically designed to provide 6 months of capacity. As needed and when source quality is good, more water is pumped into the lake from the river.

The reservoir is located in Van Wert County north of Peter Collins Road south of the town of Van Wert. The lake is open to the public for boating and fishing, but swimming is not allowed. Watercrafts are limited to electric motors only. A concrete ramp is located on the southeast side of the reservoir. Fish management activities include routine stocking, population monitoring, and angler harvest studies.

Key Attributes

Lake Type: Upground Reservoir
Surface Area: 100 acres

Ecoregion: Huron-Erie Lake Plain
Maximum Depth: 27 ft.

Lake Habitat Use

Environmental samples were collected during the 2014-15 recreation seasons. Data used to determine status of the use is summarized in Table 16. Base aquatic life parameters that were evaluated included dissolved solids, arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc. Individual sample concentrations were first compared to OMZA numeric criteria. If the OMZA was exceeded in more than 10% of the total samples tested for any parameter, the use was considered non-support.

Tiered aquatic life parameters were evaluated using a couple of different methods. Chlorophyll *a*, total phosphorus, total nitrogen and Secchi depth were evaluated by first calculating a median value from the two-year dataset. This value was then compared to the criteria in Table I-1 of the 2012 Integrated Report. Dissolved oxygen, pH and ammonia were evaluated in a manner similar to the base aquatic life parameters. Dissolved oxygen (average) and pH (median) numbers were calculated from profile readings taken in either the epilimnion or the entire water column if the lake was not stratified. Status of the Lake Habitat use was considered non-support if chlorophyll-*a*, dissolved oxygen, pH or ammonia exceeded criteria based on their assessment method. A watch list designation was assigned if total phosphorus, total nitrogen or Secchi depth values exceeded their criteria. The Lake Habitat use of Van Wert Reservoir #2 was considered non-support due to a median chlorophyll-*a* level exceeding the target value and on the watch list due to total nitrogen and Secchi depth exceeding their respective target values.

Useful information was also obtained from samples collected near the bottom. The hypolimnion can become depleted of oxygen if consumption by decomposing organic matter exceeds reaeration by atmospheric diffusion and photosynthesis. Fish access to habitat, cool water and benthic prey can be limited if conditions become hypoxic (D.O. <2 mg/L). Hypoxia was documented during several sampling events. On most occasions hypoxia was documented at depths of 4 meters or greater. Chemistry data from samples collected 0.5 m from the bottom did not indicate that phosphorus bound to sediment particles was being released to the water column due to redox reactions that break the bond between phosphate molecules and calcium and iron. The lack of phosphorus release was likely because the reservoir was recently constructed and little sediment has accumulated. Mean total phosphorus concentration at the surface for the 10 sampling events was 23.63 ppb and bottom mean concentration

was 14.33 ppb. This release of nutrients is what typically stimulates fall algae blooms when thermal stratification is broken and the lake “turns over”.

A surface sediment sample was collected in October 2014 and analyzed for metals, nutrients, s-VOCs (PAHs), PCBs and pesticides (organo-chlorine insecticides). Most compounds tested were either not detected or were well below guidelines used by Ohio EPA to evaluate data.

Recreation Use

The recreation use was evaluated by measuring levels of *Escherichia coli* bacteria at the lake (L-1) station and comparing the geometric mean to the bathing water criterion of 126 CFU/100 mL. It was sampled 10 times over the two-year assessment period and the recreation use was considered in support since the geometric mean was 2.43 CFU/100 mL.

Public Drinking Water Use

Public drinking water use attainment status was determined and reported in the 2016 Integrated Water Quality Monitoring and Assessment Report. As of this report’s completion, Ohio EPA was in the process of finalizing the Integrated Report, which fulfills the State’s reporting obligations under Section 305(b) (33 U.S.C. 1315) and Section 303(d) (33 U.S.C. 1313) of the Federal Clean Water Act. The Integrated Report is available [here](#).

Fish Consumption Use

An attempt was made to evaluate the fish consumption use. However, the sample size of fish collected was too small to make a determination. No consumption advisories have been issued beyond the state wide advisory for mercury.

Table 16. Summary of data used to determine status of the Lake Habitat use in Van Wert Reservoir #2, 2014 and 2015.

Parameter	Chl. <i>a</i> (µg/L)	Secchi (m)	T-N (µg/L)	T-P (µg/L)	D.O. (mg/L)	pH (SU)	NH ₃ -N (mg/l)
Draft Criteria	≤6.0	≥2.6	≤1225	≤18	≥6.0	6.5>pH<9.0	(WQS)
5/22/2014	24.8	1.52	2680	32.2	8.5	8.04	0.025(4.5)
6/18/2014	9.3	1.70	3130	14.7	7.1	8.19	0.052(3.0)
7/15/2014	13.1	1.60	2000	56.1	8.5	8.51	0.054(2.0)
8/20/2014	15.0	1.60	1150	23.1	8.6	8.51	0.053(2.0)
9/18/2014	32.8	0.55	740	13.8	7.2	7.94	0.071(5.6)
5/13/2015	3.7	1.72	1440	17.4	8.3	8.06	0.052(5.7)
6/30/2015	53.5	1.03	680	20.0	9.3	8.33	0.064(2.9)
7/15/2015	31.7	0.80	550	19.0	6.6	8.14	0.093(2.9)
8/18/2015	40.6	0.76	850	16.9	5.3	8.18	0.021(1.6)
8/31/2015	26.1	1.97	580	25.3	7.2	8.44	0.014(1.6)
Median	25.45	1.56	1000	19.5	-	-	-
% Exceeded	-	-	-	-	10%	0%	0%
Narrative	Non support	watch list	support	watch list	support	support	support

Phytoplankton Assessment

The phytoplankton community in Van Wert Reservoir #2 during 2014 and 2015 was characterized based on raw water samples collected using a tube sampler. Samples were collected during the May, July and September sampling events, fixed with Lugol's solution, and submitted to a contract lab. The phytoplankton present in a representative aliquot was identified to at least genus level (usually species) and cell densities (cells/L) and bio-volumes ($\mu\text{m}^3/\text{L}$) were estimated.

Phytoplankton communities exhibit a seasonal succession when factors like water temperature, nutrients, transparency and photoperiod favor certain types. Grazing by larval fish and zooplankton also has an effect. Temperate lakes in Ohio are usually dominated by diatoms in the spring until micronutrients like silica are depleted, and blue green algae in the fall when an ability to control buoyancy and fix nitrogen from the atmosphere gives certain types a competitive edge.

Figure 21 and Figure 22 summarize total bio-volume by algal class in Van Wert Reservoir #2. In general, the population seemed diverse and balanced, with five different classes of algae represented. Temporal variability exhibited a normal succession for the most part. This can be greatly affected by springtime extremes in temperature and rainfall on either end of the spectrum.

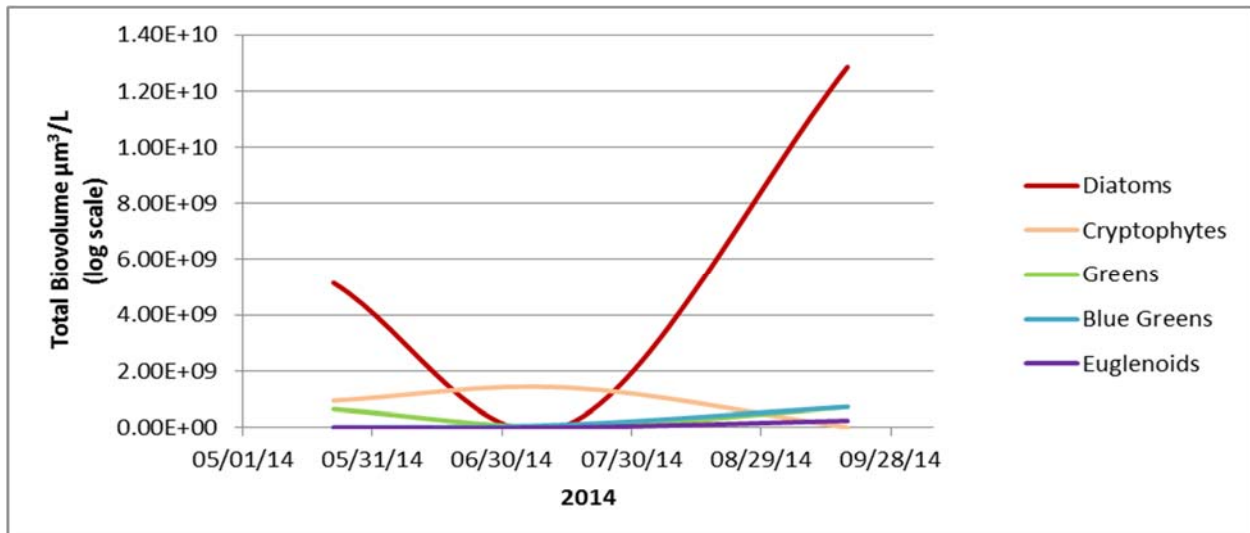


Figure 21. Total bio-volume by algal class in Van Wert Reservoir #2, 2014.

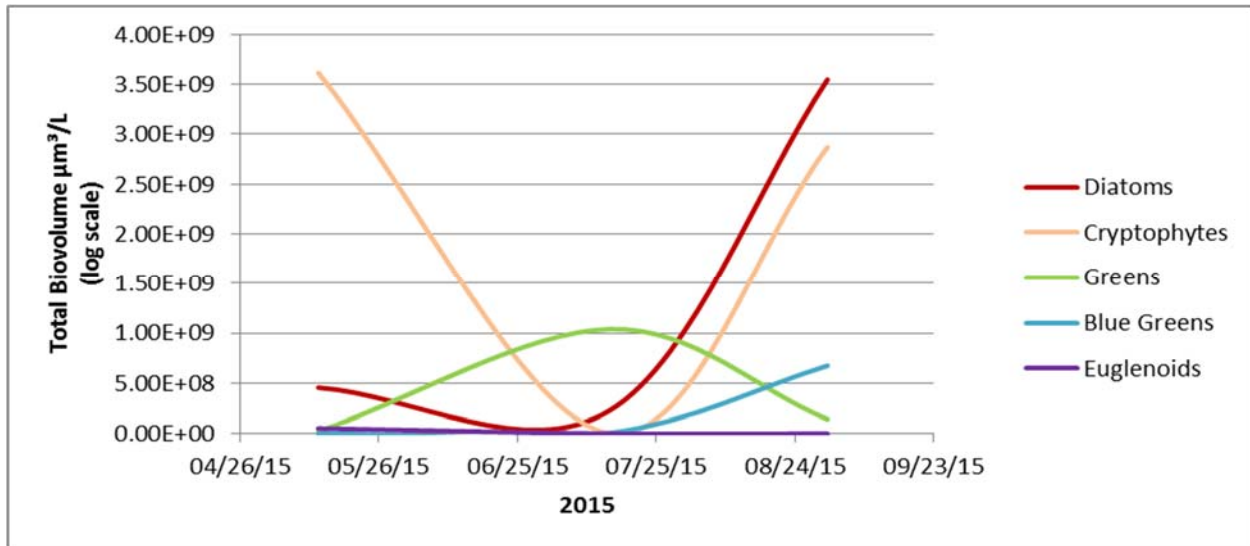


Figure 22. Total bio-volume by algal class in Van Wert Reservoir #2, 2015.

Samples to test for a suite of cyanotoxins (microcystins, cylindrospermopsin and saxitoxin) were also submitted during all sampling events. To protect public health, Ohio has drinking and recreation action levels for the microcystin toxin. A “Do Not Drink” advisory is issued at concentrations in finished water ≥ 1 ppb. A “Recreational Public Health” advisory is posted at beaches with surface water levels ≥ 6 ppb and a “No Contact” advisory is posted at levels ≥ 20 ppb if human or animal illness is also documented. Even though some genera with the ability to produce toxins were documented in the enumeration samples, results for all of the toxin samples were below respective reporting limits. This indicated that either no toxins were being produced or that population densities were low and little toxin was present.

NPDES Permitted Facilities

A total of 31 National Pollutant Discharge Elimination System (NPDES) permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the lower Auglaize River tributaries study area within Defiance, Paulding, Putnam, 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 within the study area's watershed are listed in Table 17. The city of Van Wert is considered a major discharger based on the volume (>1 million gallons per day (MGD)) and type of waste they discharge. All other individual NPDES permitted facilities in the watershed are considered minor dischargers. Permitted minor dischargers include three Concentrated Animal Feeding Operations (CAFOs), one activated sludge sewage treatment plant, five sewage lagoons, seven package plants, and four 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: <http://epa.ohio.gov/dsw/permits/NonStormgplist.aspx>. 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: <http://epa.ohio.gov/dsw/permits/gplist.aspx>.

Table 17. Facilities regulated by an individual NPDES permit within the lower Auglaize River tributaries study area.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Stone Co Inc.- Auglaize Plant	2IJ00026	UT Auglaize River	11.12	1.44 MGD Sedimentation pond discharge
Paulding WWTP	2PD00027	Flatrock Creek	9.12	0.75 MGD Aerated Lagoon
BP Amoco Oil Bulk Plant Paulding	2IN00184	UT Oppossum Run	--	Sorption treatment of surface water to discharge; <i>Does not discharge</i>
Paulding WTP	2IW00230	Flatrock Creek	14.12	Filter backwash, lime sludge lagoon; <i>Does not discharge</i>
Payne WWTP	2PA00019	Flatrock Creek	24.6	0.270 MGD Lagoon System
Latty WWTP	2PA00073	Zielke Ditch	1.4	0.024 MGD Sequencing Batch Reactor
Wayne Trace Jr/Sr HS	2PT00039	UT Blue Creek	--	0.0126 MGD Package Plant – extended aeration & sand filters

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Woodbridge Campground	2PR00248	UT Blue Creek	--	0.0125 MGD Lagoon System – controlled discharge; Has not discharged to date
Grover Hill WWTP	2PA00085	West Branch Prairie Creek	3.51	0.060 MGD Activated Sludge
Stoneco Inc. Scott Plant	2IJ00061	Wahl Ditch	--	3.6 MGD Sedimentation Pond
Sugar Lane Dairy LLC / Arts Dairy	2IK00014	UT Upper Prairie Creek	--	Storm water, manure discharge to fields
Blue Stream Farms LLC	2IK00037	Blue Creek	--	Storm water, manure discharge to fields
Convoy WWTP	2PB00005	North Creek / Hagerman Creek	17.2	0.20 MGD Aeration
Timberwoods Camping Resort	2PS00015	Tindall Ditch	--	0.0225 MGD Package Plant
Boyd Theaters	2PR00213	Maddox Creek	~14.7	0.002 MGD Package Plant to leaching tile field
Hickory Sticks Golf Club	2PR00270	Town Creek	20.34	0.003 MGD Package Plant
Van Wert WTP	2PD00006	Town Creek	18.35	Lime Sludge Lagoon
Federal Mogul Corp	2IR00025	Town Creek	15.22	Non-contact cooling water
Van Wert WWTP	2PD00006	Town Creek	13.87	4.0 MGD Aeration
Cooper Farms Cooked Meats	2IH00110	Town Creek	12.12	Lagoon – controlled discharge, spray irrigation
Huggy Bear Campground	2PS00014	Dog Creek	17.95	Lagoon – controlled discharge
Middle Point WWTP	2PA00022	Little Auglaize River	36.3	0.080 MGD Bio-Lac
Delphos Country Club	2PR00157	Little Auglaize River	26.4	0.003 MGD Package Plant – sand filtration
Ottoville WWTP	2PA00002	UT Little Auglaize River	0.30	0.339 MGD Extended Aeration

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Country Manor Estates	2PY00043	Utrup Ditch	--	2,450 GPD Package Plant
Ohio Electro Polishing Co Inc.	2IC00024	Evans Ditch	--	0.030 MGD pH adjustment and settling
Ohio City Auto Salvage	2II00105	Long Prairie Creek	7.98	Oil / water separator for storm water
Ohio City WWTP	2PB00030	Long Prairie Creek	7.95	0.150 MGD Oxidation Ditch
Gina Dairy	2IK00017	Roller Creek / Town Creek		Storm water, manure discharge to fields
ODOT Park 1-27	2PP00035	Monkey Run	1.3	0.004 MGD Package Plant
Defiance County Landfill	2IN00111	Three Mile Creek	0.7	Sedimentation pond discharge

City of Van Wert Wastewater Treatment Plant (WWTP) (Ohio EPA Permit #2PD00006)

The city of Van Wert WWTP serves approximately 10,600 residents. The WWTP discharges to Town Creek at RM 13.87. Town Creek combines with Maddox Creek to form Middle Creek in northeast Van Wert county. The WWTP was updated in 2001, and has an average daily design flow of 4.0 MGD. Wet stream processes include influent pumping, screening and grit removal, pre-aeration, primary settling, activated sludge aeration, phosphorus removal by chemical precipitation, secondary clarification and ultraviolet disinfection. Solid stream processes are aerobic digestion, dewatering by belt filter press, lime stabilization,

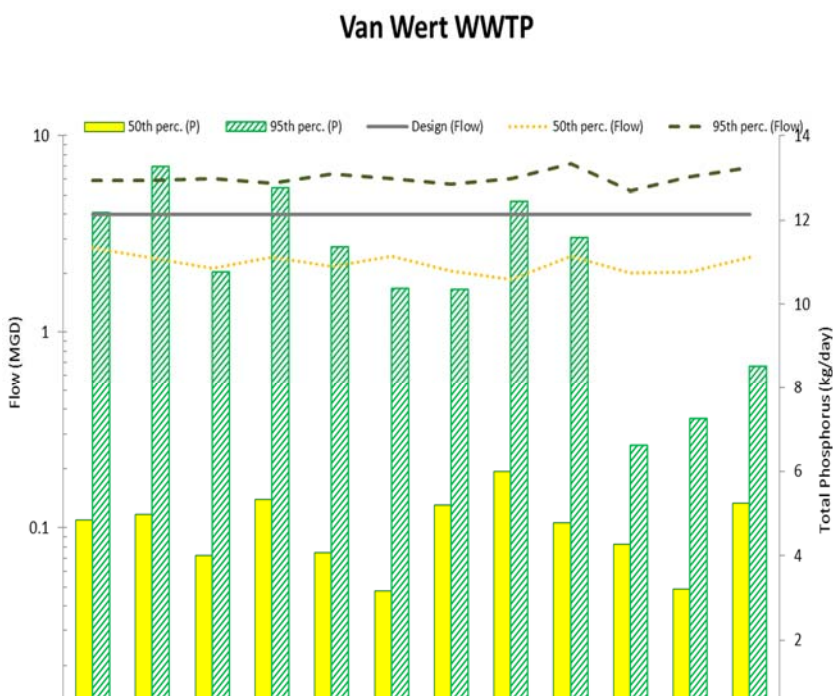


Figure 23. Total phosphorus annual loads, Van Wert WWTP, 2003-2014.

biosolids disposal by land application at agronomic rates, landfill disposal, and transfer to another facility.

The city of Van Wert implements an Ohio EPA-approved industrial pretreatment program. Two categorical industrial users discharge an average flow of 0.0873 MGD to the treatment plant based on information in the 2012 NPDES renewal application. The Van Wert collection system is approximately 30 percent separate sanitary sewers and 70 percent combined sewers. There are five combined sewer overflows (CSOs) on the combined portion of the system. Ohio EPA approved the city’s Long Term Control Plan in 2011. During the 2014 sampling season, the number of overflow events and total flow for all five outfalls was six occurrences for a total of 4.175 million gallons (MG) in March, seven occurrences for a total of 7.221 MG in April, five occurrences for a total of 3.094 MG in May, eight occurrences for a total of 1.757 MG in June, four occurrences for a total of 1.242 MG in July, and four occurrences for a total of 3.958 MG in September.

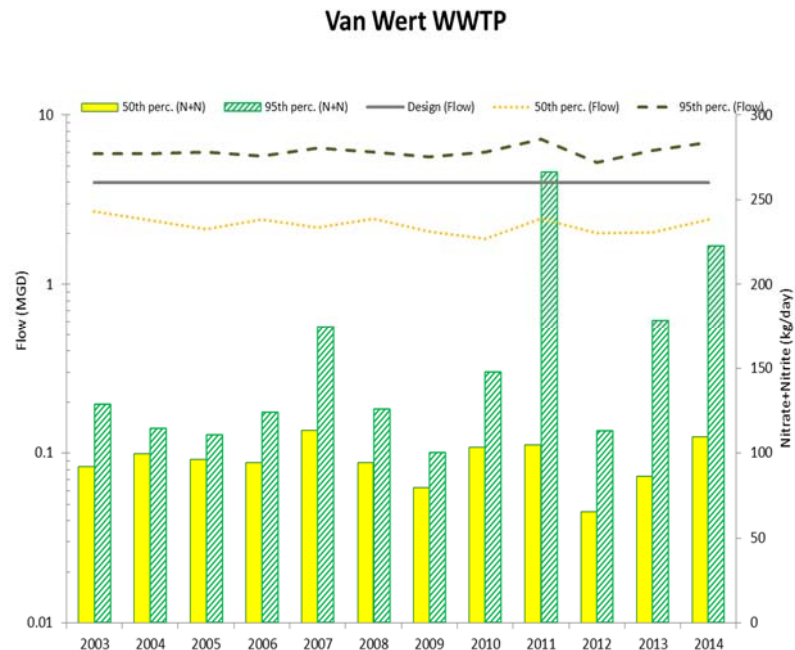


Figure 24. Nitrate + nitrite annual loads, Van Wert WWTP, 2003 – 2014.

Ohio EPA most recently conducted a compliance sampling inspection and bioassay of the Van Wert WWTP on May 2-3, 2011. The effluent from outfall 001 was not acutely toxic to the fathead minnow *Pimephales promelas* or the crustacean *Ceriodaphnia dubia*.

Pollutant loadings from the WWTP between 2003 and 2014 were evaluated and annual statistics for nitrate-nitrate, total phosphorus, and ammonia loadings are displayed in Figure 23, Figure 24 and Figure 25. The plant discharged at a fairly consistent flow during the evaluation period, trending

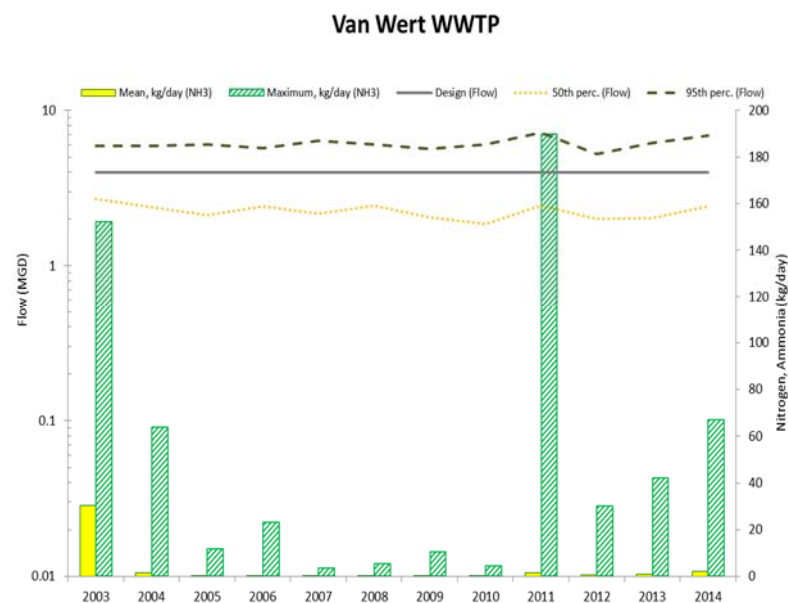


Figure 25. Ammonia-nitrogen annual loads, Van Wert WWTP, 2003-2014.

slightly lower over time. The 50% value for annual nitrate+nitrite loadings have decreased slightly, with 2011 and 2014 representing the highest loads. Phosphorus loads have decreased over the past decade, most notably in 2012, which was the driest year of the period in question. The annual statistics for ammonia loadings from the Van Wert WWTP demonstrate an increasing trend since 2011, and hence

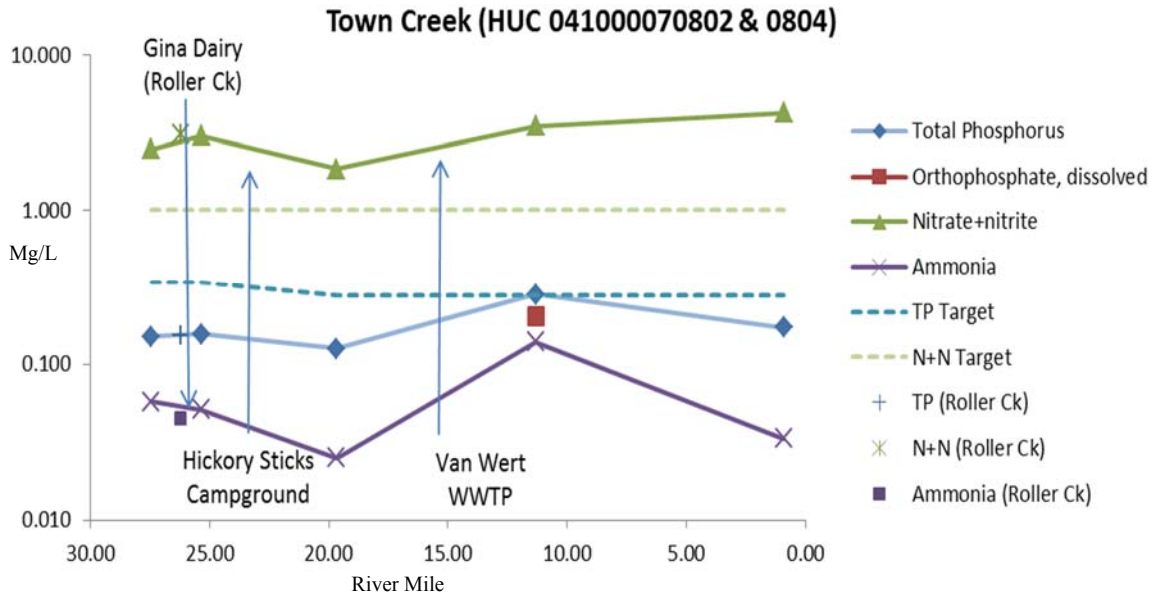


Figure 26. Longitudinal profile of nutrient geometric means for Town Creek, 2014.

contribute to the elevated levels of ammonia at the Town Creek sampling location downstream from the plant. Ammonia and total phosphorus values in Town Creek are most elevated downstream from the Van Wert WWTP (Figure 26).

Village of Ottoville WWTP (Ohio EPA Permit #2PA00002)

The village of Ottoville WWTP provides sanitary wastewater treatment to approximately 975 people. The municipal wastewater treatment consists of extended aeration with an average daily design flow of 0.339 MGD from the plant. The sanitary waste discharges into an unnamed tributary (RM 0.30) that flows into the Little Auglaize River at RM 23.0.

The Village of Ottoville did not have any permit limit violations during the sampling period in 2014.

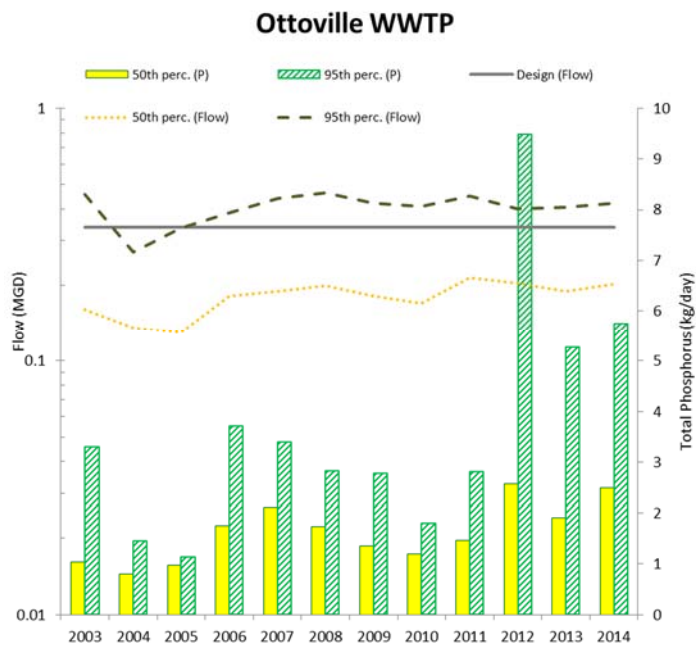


Figure 27. Total phosphorus annual loads, Ottoville WWTP, 2003-2014.

Pollutant loadings from the village of Ottoville WWTP between 2003 and 2014 were evaluated and annual statistics for total phosphorus, nitrate+nitrite, and ammonia loadings are displayed in Figure 27, Figure 28 and Figure 29. The phosphorus load overall trend has steadily increased in the last 12 years with significant increases from 2012 to 2014. The annual nitrate+nitrite loadings reported for the past 3 years (2011 only had one sample collected) have remained steady. The WWTP discharges an overall small contribution to the flow of the Little Auglaize River. However, monthly nitrate+nitrite reporting by the plant from 2012 to 2014 averaged 14.74 mg/l which is high and does contribute to nutrient enrichment of the stream. Median and 95th percentile ammonia loading from the plant has decreased significantly from 2005 but has had a gradual increasing trend over the last 8 years.

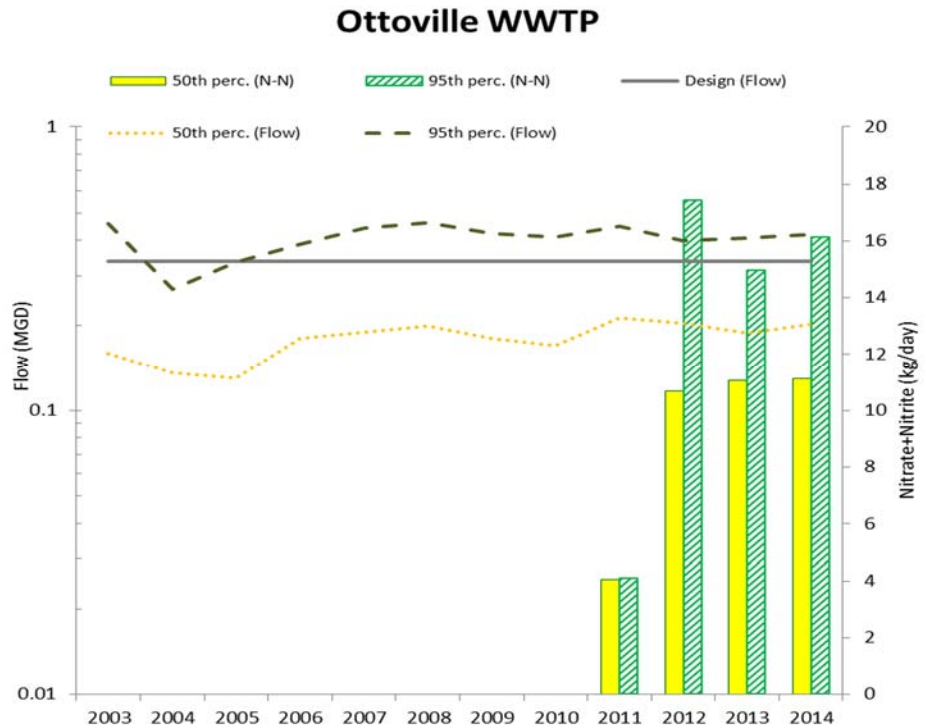


Figure 28. Nitrate + Nitrite annual loads, Ottoville WWTP, 2011 – 2014.

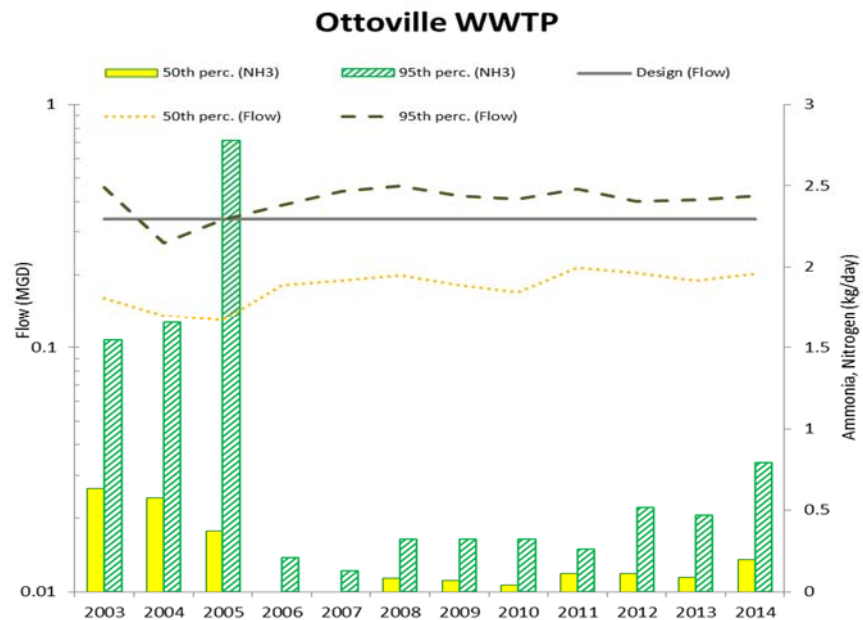


Figure 29. Ammonia-nitrogen annual loads, Ottoville WWTP, 2003-2014.

Stream Physical Habitat

Stream habitat was evaluated at 66 fish sampling locations throughout the lower Auglaize River tributaries study area in 2014 and 2015. The study sites consisted mainly of fair to poor quality stream habitats (Table 18). Fair to poor stream habitat was recorded at 38 sites (58%) with five sites scoring very poor – Little Flatrock Creek (RM 5.9), Flatrock Creek (RM 51.68), Blue Creek (RM 31.95), Middle Creek (RM 0.50), and Monkey Run (RM 3.30) (Figure 28). Only 32% (n=21) of the sample sites were found to have good quality stream habitats and only two sites on Flatrock Creek were found to have excellent habitat (RMs 23.72 & 6.02) (Figure 29). The average QHEI score for the lower Auglaize River tributary sites was 51.98, which reflected the overall fair habitat quality in the study area (Appendix F). Except for the Ohio portions and headwaters of Flatrock Creek, most of the lower Auglaize River tributaries have been physically modified and are perpetually under county ditch maintenance programs.



Figure 28. Very poor stream habitat quality in Blue Creek RM 31.95. The stream channel resembles and functions like a gutter more than a stream. No riffles, runs, and pools are present to filter and help assimilate excess nutrients and other pollutants before they wash down into the Auglaize River and ultimately the western basin of Lake Erie. Steeply leved banks prevent the stream from breaking out into a floodplain and depositing pollutants. A lack of sinuosity and flood plain connectivity exacerbate downstream flooding, erosion, and is a sluiceway for pollutants.



Figure 29. Exceptional physical habitat in Flatrock Creek (RM 23.72) northeast of Payne at State Route 613. The riffles, runs, pools, and glides in this reach formed by Flatrock Creek over centuries are naturally assimilating upstream runoff and pollutants. Features such as gently tapered banks (well connected to the floodplain), vegetated/treed riparian buffers with shading, rooted aquatic plants, and coarse substrates with little siltation provide excellent physical habitat.

A positive correlation (coefficient = 0.61) between physical habitat and fish community health, based on the comparison of QHEI and IBI scores, is graphically visible in Little Auglaize River data (Figure 30). Good to fair physical habitat quality was found throughout the Little Auglaize River (Table 18). The key habitat features absent from the Little Auglaize River, which precluded good to excellent habitat, were intact vegetated riparian buffers along the banks and floodplain connectivity (Figure 31). The Little Auglaize River has steeply leveed banks throughout its historically modified reaches and pollutants cannot settle out onto a connected flood plain and be assimilated, but are exported downstream. As such, localized effects from runoff are not readily apparent. Many of the lower Auglaize River tributaries, including the Little Auglaize River, function as sluiceways for storm water and pollutants as they have been engineered to efficiently carry storm water off agricultural fields via subsurface tiles and surface runoff. However, as the Little Auglaize River slows down amid the backwaters of the impounded Auglaize River mainstem, an artificially elevated level of nutrients and other pollutants begin to settle out, producing highly eutrophic conditions (Figure 32).

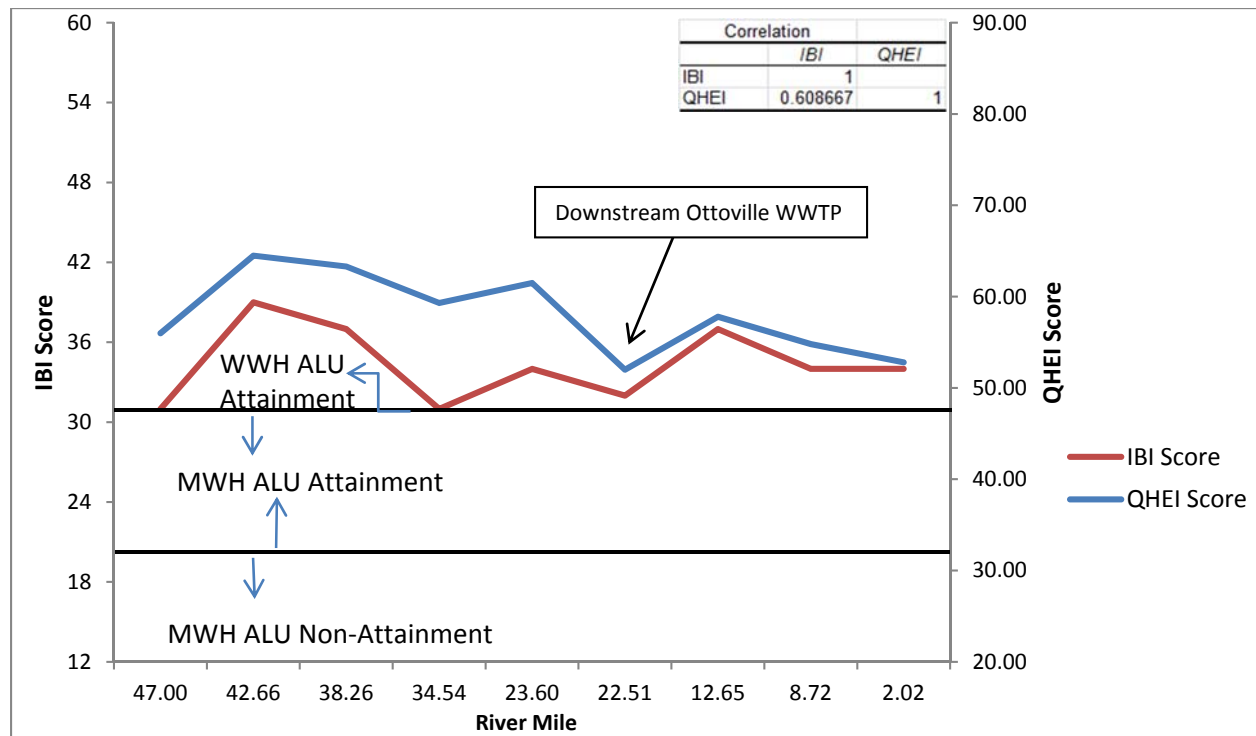


Figure 30. IBI and QHEI scores plotted linearly from upstream to downstream for the Little Auglaize River, 2014. The coefficient of 0.61 indicates a positive correlation with QHEI and IBI values. IBI thresholds for WWH and MWH show that the entire length of the Little Auglaize River meets the HELP ecoregion criterion for WWH.



Figure 31. Little Auglaize River downstream from the Ottoville WWTP has begun to self-form good habitat features such as bars and riffles with rooted macrophytes. However, monthly nitrate+nitrite reporting by the plant from 2012 to 2014 averages 14.74 mg/L, which is high and contributes to nutrient enrichment of the stream visible in the extensive algae mats smothering the stream substrates. The QHEI score and fish community quality was lower here compared to up and downstream sites due to localized excess nutrients and temperature exceedances, contributing to the poor quality substrates and overall water quality.

Table 18. Summarized results of QHEI scores for the lower Auglaize River tributaries study area, 2014 and 2015.

RM	Stream Name	Sample Type	QHEI
0.70	BOBENMYER DITCH @ STOUFFER RD.	Headwater	47.00
0.30	SNYDER DITCH @ STOUFFER RD.	Headwater	42.50
0.87	THREEMILE CREEK @ CANAL RD.	Headwater	67.5
0.05	JACKSON DITCH @ POWER DAM RD.	Headwater	51.0
1.70	FIVEMILE CREEK @ DEFINANCE/PAULDING COUNTY LINE	Headwater	33.3
1.57	EAGLE CREEK WNW OF JUNCTION @ RIVER RD. (UPPER CROSSING)	Headwater	49.5
3.90	SIXMILE CREEK @ DOTTERER RD.	Headwater	54.30
5.90	LITTLE FLATROCK CREEK @ BROUGHTON RD.	Headwater	21.00
1.53	LITTLE FLATROCK CREEK @ OLD ST. RT. 111	Headwater	68.50
51.68	FLATROCK CREEK @ KINGS CHURCH RD.	Headwater	25.30
48.30	FLATROCK CREEK @ WERNER RD.	Headwater	51.00
28.84	FLATROCK CREEK UPST. PAYNE @ PUGH RD.	Wading	58.00
23.72	FLATROCK CREEK NE OF PAYNE @ ST. RT. 613	Wading	76.00
13.80	FLATROCK CREEK AT PAULDING, DST. DAM	Wading	59.50
9.70	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	Wading	69.00
8.13	FLATROCK CREEK DST. PAULDING WWTP @ BROUGHTON RD.	Wading	69.50
6.02	FLATROCK CREEK NE OF PAULDING @ LOUCK RD.	Wading	81.50
0.27	WILDCAT CREEK NE OF PAYNE @ ST. RT. 500	Headwater	37.30
31.95	BLUE CREEK @ DIXON CAVETT RD.	Headwater	24.80
29.43	BLUE CREEK @ SUGAR GROVE CHURCH RD.	Headwater	47.50
22.00	BLUE CREEK @ YOAKUM RD.	Wading	56.50
17.15	BLUE CREEK @ ALLISON RD.	Wading	57.00
10.01	BLUE CREEK E OF LATTY @ PAULDING CO. RD. 123	Wading	69.30
3.43	BLUE CREEK @ CO. RD. 151	Wading	62.50
0.75	BARCER RUN @ ST. RT. 637	Headwater	41.50
0.90	UPPER PRAIRIE CREEK @ VAN WERT PAULDING CO. RD. 12	Headwater	34.50
0.50	MIDDLE CREEK @ PARKER RD.	Headwater	20.00
47.00	LITTLE AUGLAIZE R. AT JONESTOWN @ JONESTOWN RD.	Wading	56.00
42.66	LITTLE AUGLAIZE R. N OF VENEDOCIA @ WREN-LANDECK RD.	Wading	64.50
38.26	LITTLE AUGLAIZE R. S OF MIDDLE POINT @ ST. RT. 697	Wading	63.30
34.54	LITTLE AUGLAIZE R. DST. MIDDLEPOINT @ CONVERSE ROSELMS RD	Wading	59.30
23.60	LITTLE AUGLAIZE R. AT OTTOVILLE @ U.S. RT. 224	Wading	61.50
22.51	LITTLE AUGLAIZE R. DST. OTTOVILLE @ CO. RD. P	Wading	52.00
12.65	LITTLE AUGLAIZE R. W OF MANDALE @ ST. RT. 114	Wading	57.80
8.72	LITTLE AUGLAIZE R. @ CO. RD. 60	Wading	54.80
2.02	LITTLE AUGLAIZE R. E OF MELROSE @ ST. RT. 613	Boat	52.80
18.04	PRAIRIE CREEK W OF SCOTT @ PAULDING/VAN WERT CO. LINE	Headwater	42.50
12.50	PRAIRIE CREEK NE OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	Wading	48.50
5.90	PRAIRIE CREEK S OF MELROSE @ MERCILE RD.	Wading	58.50
1.50	PRAIRIE CREEK S OF MELROSE @ ROSELMS RD.	Wading	68.00
4.40	WEST BRANCH AT GROVER HILL @ ST. RT. 114	Wading	67.80
19.90	HOAGLIN CREEK @ TERRY RD.	Headwater	60.50

RM	Stream Name	Sample Type	QHEI
13.06	HOAGLIN CREEK @ WETSEL RD.	Wading	49.80
0.60	WEST BRANCH @ MATSON RD.	Wading	66.00
3.30	MONKEY RUN @ DULL ROBINSON RD.	Headwater	20.50
12.22	HAGERMAN CREEK NE OF CONVOY @ RICHEY RD.	Headwater	34.50
0.86	HAGERMAN CREEK E OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	Headwater	61.50
1.32	MIDDLE CREEK NE OF ROSELMS @ CO. RD. 60	Wading	67.50
0.97	BIG RUN SE OF GROVER HILL @ TWP. RD. 155	Headwater	31.50
16.20	MADDOX CREEK @ LIBERTY UNION RD.	Headwater	57.30
14.75	MADDOX CREEK NEAR VAN WERT @ W. RIDGE RD. (LINCOLN HIGHWAY)	Wading	44.80
12.21	MADDOX CREEK @ DUTCH JOHN RD.	Wading	53.50
0.90	MADDOX CREEK @ ST. RT. 637	Wading	57.50
27.45	TOWN CREEK @ DULL ROBINSON RD.	Headwater	31.00
25.35	TOWN CREEK @ RICHEY RD.	Headwater	60.80
19.67	TOWN CREEK S OF VAN WERT @ PETER COLLINS RD.	Wading	50.00
11.32	TOWN CREEK N OF VAN WERT @ STRIPE RD.	Wading	51.50
0.72	TOWN CREEK NEAR MOUTH AT VAN WERT PAULDING CO. LINE RD.	Wading	56.00
1.35	ROLLER CREEK @ LIBERTY UNION RD.	Headwater	36.50
22.10	DOG CREEK @ GAMBLE RD.	Headwater	45.30
14.06	DOG CREEK @ CHURCH RD	Wading	62.50
0.97	DOG CREEK E OF ROSELMS @ ST. RT. 114	Wading	69.50
6.79	LONG PRAIRIE CREEK DST. OHIO CITY WWTP @ ST. RT. 709	Headwater	47.80
0.68	LONG PRAIRIE CREEK W OF VENEDOCIA @ JONESTOWN RD.	Headwater	52.00
3.23	KYLE PRAIRIE CREEK @ VAN WERT MERCER CO. RD. 18	Headwater	35.30
0.20	KYLE PRAIRIE CR UPST FRISINGER DITCH @ VAN WERT MERCER CR 18	Headwater	45.00






General narrative ranges assigned to QHEI scores.			
Narrative		QHEI Range	
		Headwaters (<20 sq. mi)	Larger Streams
Excellent		≥70	≥75
Good		55 to 69	60 to 74
Fair		43 to 54	45 to 59
Poor		30 to 42	30 to 44
Very Poor		<30	<30



Figure 32. Little Auglaize River downstream from State Route 613 has steeply eroded banks due to flashy storm water events and is highly enriched by excess nutrients. Storm water and nutrient management improvements in the watershed need to occur before areas like this can improve.

Spills and Fish Kills

A total of seven spills which resulted in three fish kills were reported in the lower Auglaize River tributaries study area between 2010 and 2015 (Table 19).

Table 19. Documented spills and fish kills in the lower Auglaize River tributaries study area, 2010-2015.

River	Date	RM	Length Affected (miles)	# Fish Killed	Operation	Pollutant	Source
Big Run	8/2/10	2.80	0.11	None found	farm and feedlots	manure	Schilderink Dairy Farm
Unnamed tributary to Town Creek	9/2/10	0.24	0.6	111	fair grounds	unknown	unknown
Upper Prairie Creek	10/1/10	1.50	0.02	None found	farm and feedlots	manure	Andy Sekel
Maddox Creek	5/2/12	24.00	0.80	None found	farm and feedlots	diesel fuel	Adolf Germann
Unnamed tributary to Hagerman Creek (RM 5.93)	8/9/15	1.00	0.75	249	farm and feedlots	manure	Lion Farms
Unnamed tributary to Flatrock Creek (RM 18.25)	8/26/15	2.0	2.0	None found	farm and feedlots	manure	Flatland Dairy
Unnamed tributary to Flatrock Creek (RM 47.97)	9/23/15	1.25	1.25	25 found in OH	farm and feedlots	fertilizers	Schlemmer Farms

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](#)

(<http://www.epa.state.oh.us/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf>).

Fish contaminant data are primarily used for three purposes: 1) to determine sport fish consumption advisories; 2) to determine attainment with Ohio WQS human health criteria; and 3) to examine trends in fish contaminants over time.

For the 2014 lower Auglaize River tributaries survey, fish tissue from the following streams was sampled: Auglaize River, Little Auglaize River and Flatrock, Blue, Prairie, West Branch Prairie, Middle, Town, and Dog creeks. Most of these tributaries had small sample sizes, and/or have not been sampled in previous years. This review will focus on the lower Auglaize River (up to RM 60), the Little Auglaize River (entire reach), and Flatrock Creek (entire reach), since these water bodies had sufficient data for meaningful analysis.

Fish advisories

Prior to the survey data collected in 2014, the Auglaize River had consumption advisories on freshwater drum and smallmouth bass, both for mercury, at the “one meal per month” advisory level. As a result of the 2014 data, rock bass was also added to this list, at the “one meal per month” level for mercury.

PCB concentrations in common carp could also have warranted a consumption advisory of “one meal per month”; however, the data was unusual in that most (11 out of 13) carp samples in the last ten years were non-detect for PCBs, while one sample in 2014 was very contaminated (3 ppm PCBs, above the “Do Not Eat” threshold of 2 ppm). Because this sample appeared to be an extreme outlier, and because the risk level of the average PCB concentration in carp was close to the statewide advisory level of “one meal per week,” the advisory committee felt that no consumption advisory for carp was warranted at this time.

For the Little Auglaize River and Flatrock Creek, there were no advisories in place prior to the 2014 data, and no new advisories were warranted based on the new data collected.

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 WQS criteria pursuant to OAC Rules 3745-1-33 and 3745-1-34. The human health criteria are presented in water column concentrations of $\mu\text{g}/\text{Liter}$, and are then translated into fish tissue concentrations in mg/kg . [See [Ohio’s 2010 Integrated Report, Section E](#) (<http://www.epa.state.oh.us/portals/35/tmdl/2010IntReport/Section%20E.pdf>) for further details of this conversion].

In order to be considered in attainment of the Ohio WQS criteria for mercury and PCBs, the sport fish caught within a HUC12 must have a weighted average concentration of the geometric means for all species below 0.35 mg/kg for mercury, and below 0.023 mg/kg for PCBs.

Within the lower Auglaize River tributary study area, fish tissue data were adequate to determine attainment status for several Watershed Assessment Units (WAUs) and one Large River Assessment Unit (LRAU). The details of these assessments are depicted in Table 20 through Table 23 of this report. In general, about half of the assessment units showed no fish tissue impairment, while the other half showed impairment for PCBs, including the lower Auglaize River LRAU, which is typical of LRAUs in the state of Ohio.

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 report 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.

Fish tissue was collected from the lower Auglaize River, the Little Auglaize River, and Flatrock Creek across multiple years, going as far back as 1974 for the Auglaize River, and 1996 for the Little Auglaize River and Flatrock Creek. Summary charts showing average contaminant concentrations by WAU, trophic level, and year are provided in Figure 33 through Figure 37 of this report. Contaminant concentrations seem generally steady, with some small fluctuation across years. No discernable trends were observed in the data. Figure 33 clearly shows the common carp outlier PCB sample that was discussed in the fish advisory section above. Figure 37 shows the various mercury and PCB thresholds used by the fish tissue program, including fish consumption advisory thresholds for “one meal per month” and “do not eat” advisories, and impairment thresholds for Ohio’s Integrated Report, for both the Lake Erie and Ohio River basins.

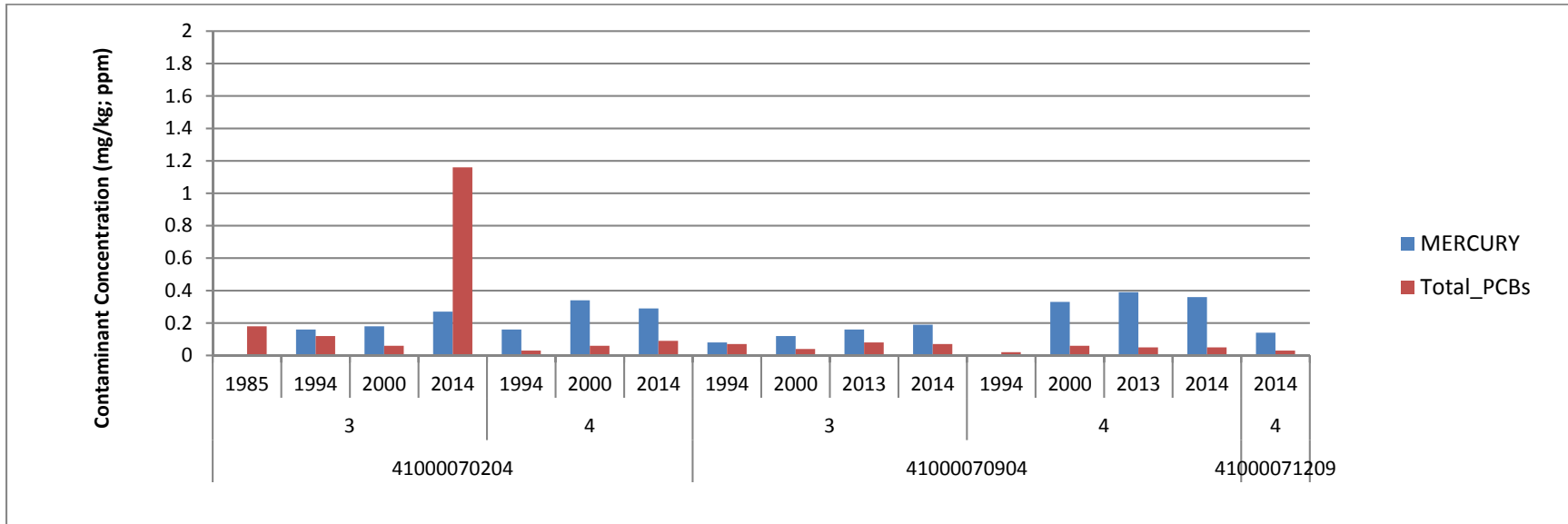


Figure 33. Contaminant concentrations by HUC12, trophic level, and year, for all Auglaize River data up to RM 60, excluding data from LRAUs. Note that the PCB spike in 2014 for the 04100007 02 04 HUC12 was due to one very hot carp sample (3 ppm PCBs), which was an apparent outlier in the data.

HUC 12	Results (Previous IR)	Results (Current IR)	Pass/Fail	Cause of Impairment	Assessment Unit Name	PCBs (ppm)	PCBs Threshold	Hg (ppm)	Hg Threshold	Trophic Level 3 Sample Size	Trophic Level 4 Sample Size
41000070204	1h	5	Fail	PCBs	Sixmile Creek-Auglaize River	0.31	0.023	Insufficient Sample Size	0.35	3	3
41000070904	1h	1	Pass	NA	Big Run Auglaize River	Non-detect	0.023	0.308	0.35	3	7

Table 20. Changes to lower Auglaize River 303(d) WAUs, excluding data from LRAUs, listings in the 2016 Integrated Report.

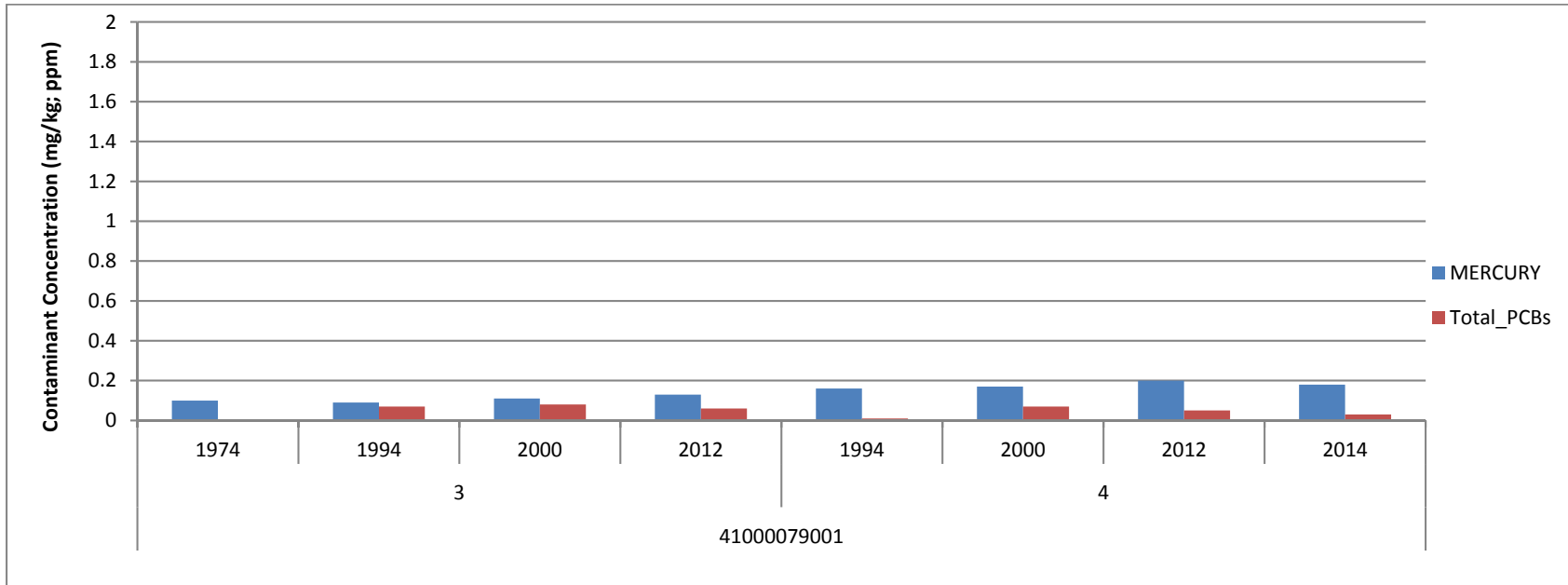


Figure 34. Contaminant concentrations by LRAU, trophic level, and year, for Auglaize River data up to RM 60. Contaminant concentrations were low and very nearly steady over time.

LRAU	Results (Previous IR)	Results (Current IR)	Pass/Fail	Cause of Impairment	Assessment Unit Name	PCBs (ppm)	PCBs Threshold	Hg (ppm)	Hg Threshold	Trophic Level 3 Sample Size	Trophic Level 4 Sample Size
41000079001	5	5	Fail	PCBs	Auglaize River Mainstem (Ottawa River to Mouth)	0.052	0.023	0.173	0.35	16	17

Table 21. Changes to the Auglaize River LRAU listing in the 2016 Integrated Report.

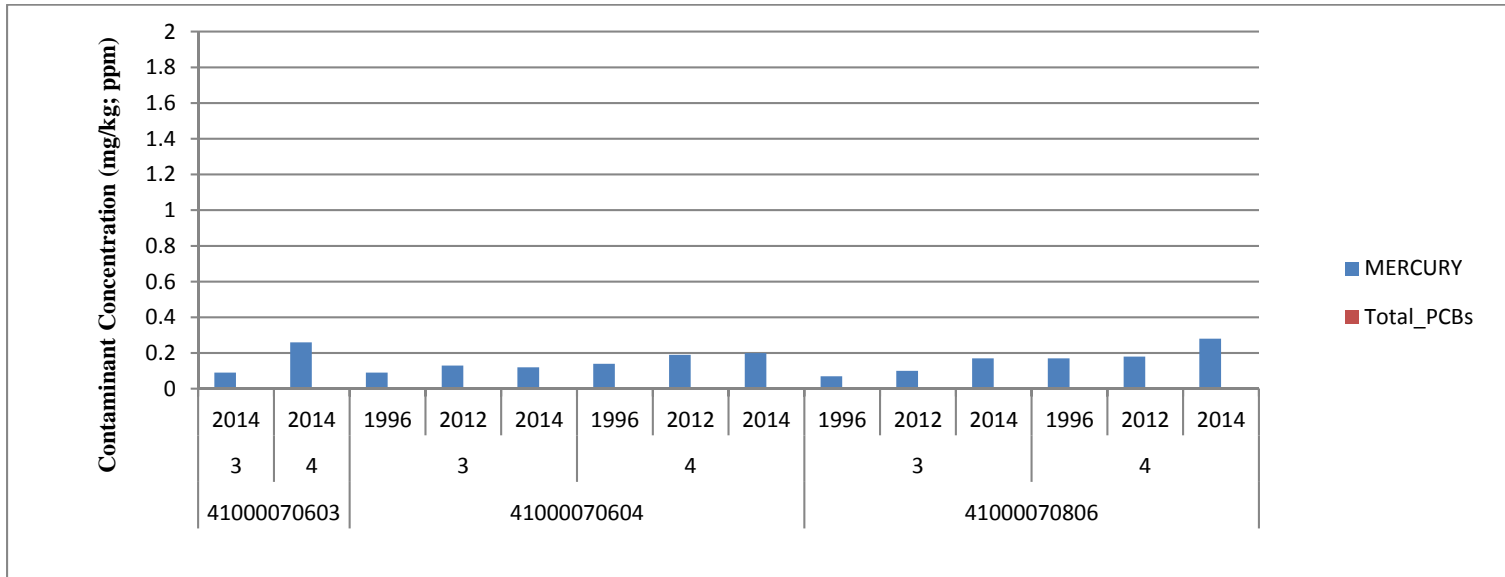


Figure 35. Contaminant concentrations by HUC12, trophic level, and year, for all Little Auglaize River data.

HUC 12	Results (Previous IR)	Results (Current IR)	Pass/Fail	Assessment Unit Name	PCBs (ppm)	PCBs Threshold	Hg (ppm)	Hg Threshold	Trophic Level 3 Sample Size	Trophic Level 4 Sample Size
41000070603	3	1	Pass	Wolf Ditch-Little Auglaize River	Non-detect	0.023	Insufficient Sample Size	0.35	3	2
41000070604	1	1	Pass	Dry Fork-Little Auglaize River	Non-detect	0.023	0.173	0.35	18	7
41000070806	3i	1	Pass	Burt Lake-Little Auglaize River	Non-detect	0.023	0.157	0.35	8	4

Table 22. Changes to Little Auglaize River HUC12 WAU listings in the 2016 Integrated Report.

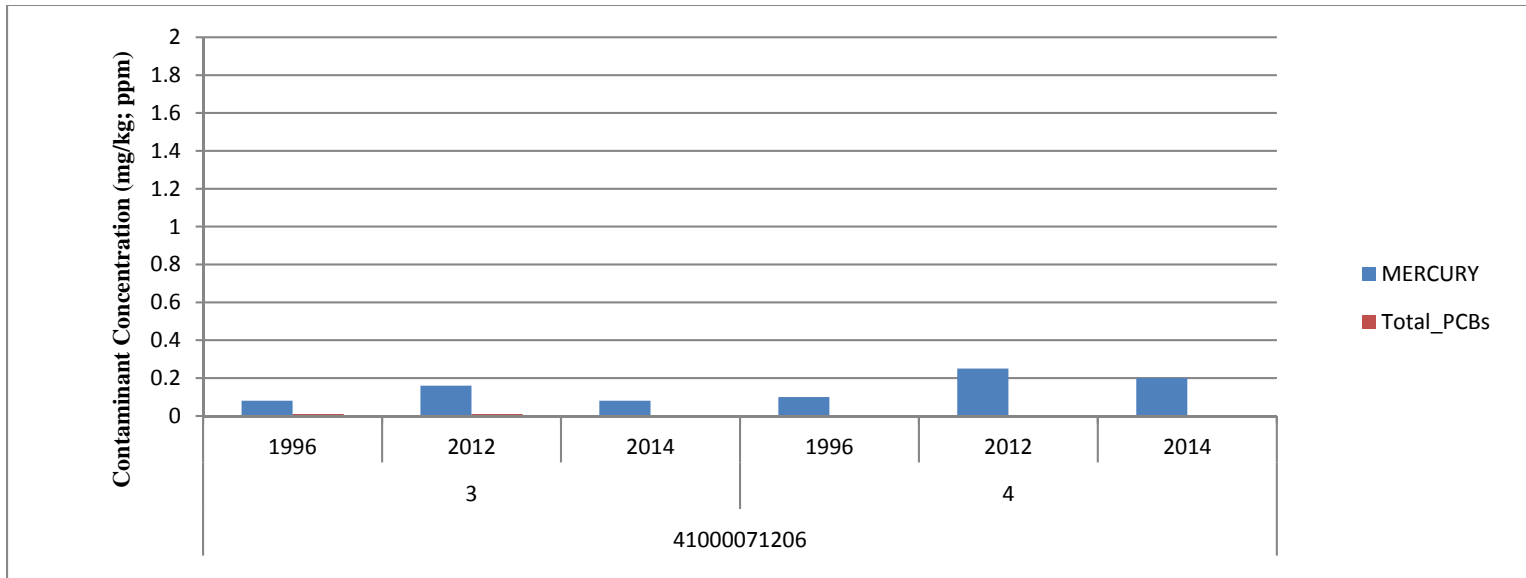


Figure 36. Contaminant concentrations by HUC12, trophic level, and year, for all Flatrock Creek data.

HUC 12	Results (Previous IR)	Results (Current IR)	Pass/Fail	Cause of Impairment	Assessment Unit Name	PCBs (ppm)	PCBs Threshold	Hg (ppm)	Hg Threshold	Trophic Level 3 Sample Size	Trophic Level 4 Sample Size
41000071206	3i	5	Fail	PCBs	Big Run-Flatrock Creek	0.026	0.023	0.227	0.35	9	2

Table 23. Changes to the Flatrock Creek HUC12 WAU listing in the 2016 Integrated Report.

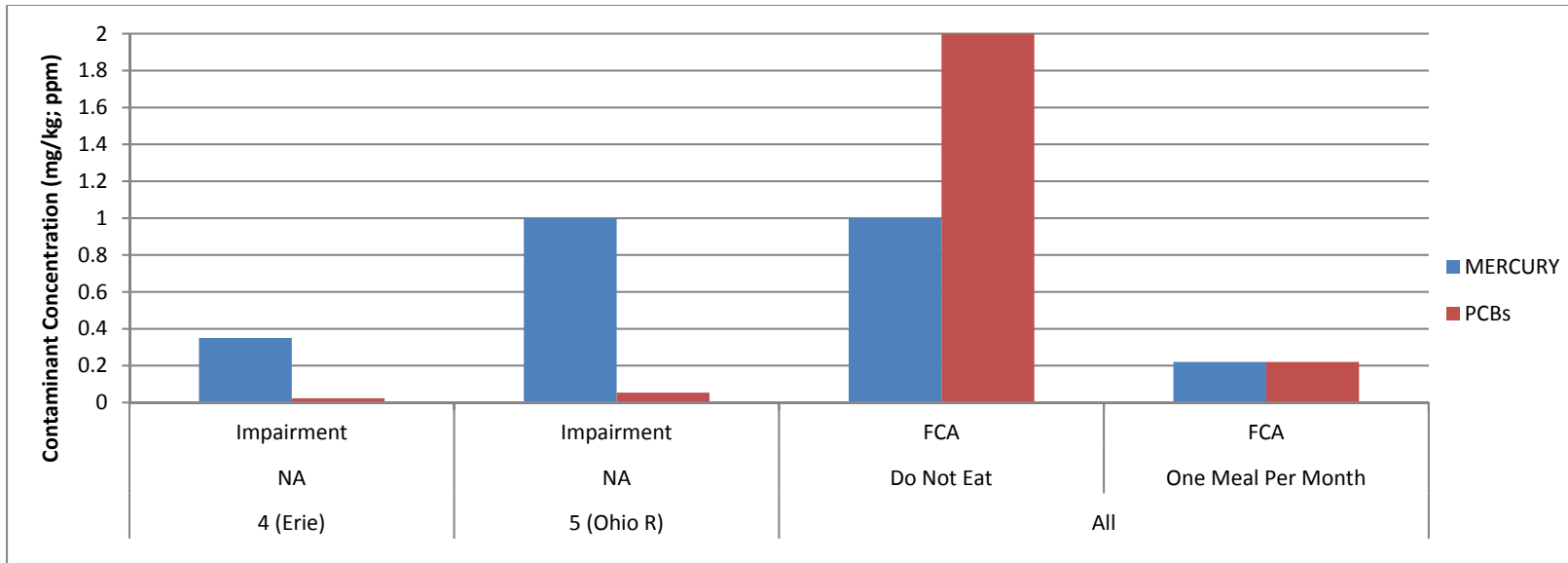
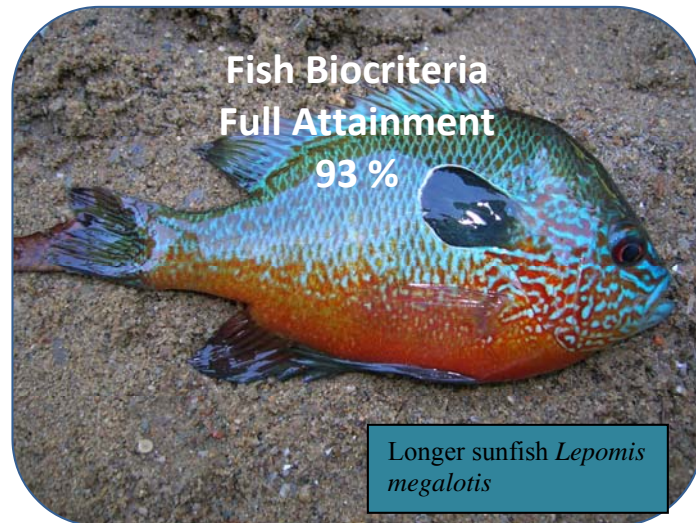


Figure 37. Fish tissue contaminant thresholds of concern in the Lake Erie and Ohio River basins for the Fish Consumption Advisory (FCA) program (at the “one meal per month” and “do not eat” levels), and the use attainment assessment of the Human Health (Fish Contaminants) beneficial use as reported in the Integrated Report. These thresholds are depicted at the same scale as the preceding charts, and are provided to give a sense of meaning to the values shown in those charts.

Fish Community

Fish sampling was conducted at 66 sites in the lower Auglaize River tributaries study area in 2014 and 2015. Relative numbers of fish species collected per location are presented in Appendix D. IBI and MIwb scores are presented in Table 2 and Table 24 and the IBI metric breakdowns can be found in Appendix E. Sampling locations were evaluated using MWH and WWH biocriteria. A summary of the fish data is presented in Table 24.

Just 4 of the 66 fish sampling stations did not meet the applicable WWH or MWH biocriteria. Fivemile Creek (RM 1.7), Eagle Creek (RM 1.57) and Snyder Ditch (RM 0.30) did not attain WWH biocriteria and Flatrock Creek (RM 9.70) partially achieved WWH criteria for numeric fish community indices due to habitat modifications and sedimentation (Table 2). Pervasive channel modifications in the study area decreased habitat quality and niche availability for sensitive fish species. The four non-attaining sites did not have any sensitive fish species and just 36% of all sites had pollution sensitive fish species inhabiting their waters (Appendix E).



Narrative fish community evaluations, based on IBI and MIwb scores, are provided in Table 24. Descriptive evaluations allow for the comparison of fish communities from site to site. None of the sites scored exceptional fish communities out of the 66 total sites³. Ninety-three percent of fish sites scored within the narrative very good to fair range. Sites that were scored within the very good, good, marginally good and fair categories would meet WWH expectations for fish in the HELP ecoregion. Only seven percent were found to have poor fish communities, which were degraded from habitat alterations, siltation due to agricultural runoff and organic enrichment (Table 24 and Table 2).

Less than one percent (0.13%) of all fish collected (68 out of 54,472) in the study area had at least one DELT (deformities, erosions, lesions, and tumors) anomaly (Appendix E). However, percentages were much higher at a per site basis with as many as four percent of the fish being affected for a single sampling event in the Little Auglaize River near State Route 613 (RM 2.02). Highly eutrophic conditions near this sample site demonstratively exemplify the vast amounts of nutrients and other pollutants that begin to settle out in this area as the river backs up from the impounded Auglaize River mainstem (Figure 32). Select sites on Flatrock Creek, Blue Creek, and the Little Auglaize River scored DELTs above the 90th percentile of reference condition (90th percentile for wading sites is 1.3%). Three species of catfish, channel catfish (*Ictalurus punctatus*), black bullhead (*Ictalurus melas*) and yellow bullhead (*Ictalurus natalis*) comprised 72 percent of the total fish having anomalies in the study area. Catfish are particularly susceptible to skin anomalies due to the absence of scales and benthic feeding behavior (Figure 38). An increase in the frequency of occurrence of anomalies is generally an indication of stress and environmental degradation which may be caused by chemical pollutants, overcrowding, improper diet, excessive siltation, and other disturbances (Ohio EPA 1988).

³ All samples are displayed in Table 24; however, discussion is based on averaging samples at multiple pass sites.

Table 24. Fish community status for stations sampled in the lower Auglaize River tributaries study area based on data collected in 2014 and 2015. The Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) are scores based on the performance of the fish community. The narrative fish evaluations (exceptional, very good, etc.) were based upon the corresponding IBI and MIwb scores relative to the drainage area, ecoregion, and the assigned aquatic life use. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile		Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	MIwb		Narratives	Drainage Area
04-100-016											
Bobenmyer Ditch											
0.70	E	10	-	72	144.00	47.0	28	-		Marginally Good	6.1
04-100-017											
Snyder Ditch											
0.30	E	13	-	77	154.00	42.5	20	-		Poor	5.2
04-101-000											
Threemile Creek											
<i>Warmwater</i>											
0.87	E	16	-	387	774.00	67.5	30	-		Marginally Good	4.9
04-102-000											
Jackson Ditch											
<i>Warmwater</i>											
0.05	E	7	-	53	106.00	51.0	26	-		Fair	4.8
04-104-000											
Fivemile Creek											
<i>Warmwater</i>											
1.70	E	4	-	25	50.00	33.3	20	-		Poor	2.9
04-105-000											
Eagle Creek											
<i>Warmwater</i>											
1.57	E	7	-	124	248.00	49.5	20	-		Poor	3.7
04-106-000											
Sixmile Creek											
<i>Warmwater</i>											
3.90	E	12	-	678	1356.00	54.3	24	-		Fair	12.0
04-108-000											
Little Flatrock Creek											
<i>Warmwater</i>											
5.90	E	7	-	575	1150.00	21.0	20	-		Poor	7.6
1.53	E	16	-	447	894.00	68.5	24	-		Fair	17.8
04-109-000											
Flatrock Creek											
<i>Warmwater</i>											

⁴ Relative numbers and weights are per 0.3 km for wading and headwater sites, and per 1.0 km for boat sites. Similar to ALUs, the above discussion of narrative evaluations on the previous page is based upon averages between sample passes where more than one sample exists per location, i.e., no locations averaged exceptional scores.

River Mile		Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	MIwb	Narratives		Drainage Area
51.68	E	7	-	27	54.00	25.3	34	-	Marginally Good	: NA	6.3
48.30	E	14	-	183	366.00	51.0	30	-	Marginally Good	: NA	13.4
28.84	D	16	47.51	235	352.50	58.0	28	6.2	Fair	: Fair	119.0
28.84	D	23	76.74	870	1305.00	58.0	36	7.9	Marginally Good	: Good	119.0
23.72	D	22	24.51	956	1434.00	76.0	30	7.8	Marginally Good	: Good	145.0
23.72	D	25	61.39	1696	2826.67	76.0	36	8.2	Marginally Good	: Good	145.0
13.80	D	23	15.92	1220	1830.00	59.5	40	8.3	Good	: Good	173.0
13.80	D	23	25.27	1438	2157.00	59.5	38	8.8	Good	: Good	173.0
9.70	D	24	11.76	1637	2455.50	69.0	28	8.3	Fair	: Good	183.0
9.70	D	23	12.86	614	921.00	69.0	26	7.6	Poor	: Marginally Good	183.0
8.13	D	24	7.16	304	456.00	69.5	40	8.0	Good	: Good	184.0
8.13	D	20	7.36	249	373.50	69.5	40	7.8	Good	: Marginally Good	184.0
6.02	D	22	6.82	358	537.00	81.50	36	8.0	Marginally Good	: Good	189.0
6.02	D	21	4.38	331	496.50	81.50	30	7.4	Fair	: Marginally Good	189.0
04-115-000											
Wildcat Creek											
Warmwater											
0.27	E	8	-	196	392.00	37.30	36	-	Marginally Good	: NA	7.9
04-120-000											
Blue Creek											
Modified Channel Modified											
31.95	E	16	-	541	1082.00	24.80	34	-	Marginally Good	: NA	7.4
29.43	E	21	-	594	1188.00	47.50	40	-	Good	: NA	15.9
22.00	D	21	9.79	668	1002.00	56.50	36	8.9	Marginally Good	: Very Good	41.0
22.00	D	20	10.71	919	1378.50	56.50	34	8.6	Marginally Good	: Good	41.0
17.15	D	22	12.39	2475	3712.50	57.00	30	8.7	Fair	: Good	51.5
17.15	D	21	10.11	2032	3048.00	57.00	26	9.0	Poor	: Very Good	51.5
10.01	D	26	9.21	1325	1987.50	69.30	34	8.7	Marginally Good	: Good	77.0
10.01	D	23	8.94	704	1056.00	69.30	32	8.8	Fair	: Good	77.0
3.43	D	21	18.25	643	964.50	62.50	24	6.9	Poor	: Fair	104.0
3.43	D	23	24.45	466	635.45	62.50	30	8.4	Fair	: Good	104.0

River Mile		Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	Mlwb	Narratives		Drainage Area
04-121-000											
Barcer Run											
0.75	E	15		533	1066.00	41.50	28	-	Marginally Good	: NA	6.9
04-125-000											
Upper Prairie Creek											
<i>Warmwater</i>											
0.90	E	19		748	1496.00	34.50	38	-	Marginally Good	: NA	8.8
04-125-001											
Middle Creek											
0.50	E	18		205	410.00	20.00	34	-	Marginally Good	: NA	5.0
04-130-000											
Little Auglaize River											
<i>Modified Channel Modified</i>											
47.00	D	19	18.28	297.00	445.50	56.0	28	7.1	Fair	: Fair	31.5
47.00	D	25	24.68	764.00	931.71	56.0	34	8.2	Marginally Good	: Good	31.5
42.66	D	20	32.12	314.00	471.00	64.5	40	8.2	Good	: Good	54.0
42.66	D	20	27.94	438.00	477.82	64.5	38	8.1	Marginally Good	: Good	54.0
38.26	D	20	14.46	251.00	376.50	63.3	34	8.1	Marginally Good	: Good	61.0
38.26	D	17	27.01	531.00	796.50	63.3	40	8.5	Good	: Good	61.0
34.74	D	21	32.92	331.00	496.50	59.3	36	7.9	Marginally Good	: Good	68.4
34.74	D	15	31.85	344.00	516.00	59.3	26	7.0	Poor	: Fair	68.4
23.60	D	26	43.53	402.00	603.00	61.5	36	8.0	Marginally Good	: Good	93.0
23.60	D	17	45.06	468.00	702.00	61.5	32	7.8	Fair	: Marginally Good	93.0
22.51	D	23	13.11	1310.00	1965.00	52.0	36	8.9	Marginally Good	: Good	96.0
22.51	D	20	22.63	228.00	342.00	52.0	28	6.9	Fair	: Fair	96.0
12.65	D	30	25.72	954.00	1431.00	57.8	36	9.2	Marginally Good	: Very Good	120.0
12.65	D	32	32.01	944.00	1132.80	57.8	38	9.3	Good	: Very Good	120.0
8.72	D	33	23.88	973.00	1459.50	54.8	36	9.2	Marginally Good	: Very Good	184.0
8.72	D	31	16.30	894.00	1341.00	54.8	32	9.1	Fair	: Very Good	184.0
2.02	A	21	81.24	117.00	234.00	52.80	36	8.3	Marginally Good	: Good	401.0
2.02	A	20	55.55	108.00	216.00	52.80	36	8.0	Marginally Good	: Good	401.0
04-131-000											
Prairie Creek											
<i>Modified Channel Modified</i>											

River Mile		Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	MIwb	Narratives		Drainage Area
18.04	E	17		481.00	962.00	42.50	28	-	Marginally Good	: NA	15.0
12.50	D	25	30.54	576.00	864.00	48.50	36	8.3	Marginally Good	: Good	25.9
5.90	D	25	11.24	413.00	619.50	58.50	36	8.0	Marginally Good	: Marginally Good	49.7
5.90	D	20	33.08	598.00	897.00	58.50	32	7.3	Fair	: Fair	49.7
1.50	D	27	17.94	513.00	769.50	68.00	38	8.3	Good	: Good	105.0
1.50	D	30	17.42	637.00	955.50	68.00	38	8.3	Good	: Good	105.0
04-132-000											
West Branch											
<i>Modified Channel Modified</i>											
4.40	D	29	11.21	418.00	627.00	67.80	38	8.1	Good	: Good	47.0
4.40	D	24	23.38	334.00	501.00	67.80	38	7.9	Good	: Good	47.0
0.60	D	29	64.29	702.00	1053.00	66.00	38	9.5	Marginally Good	: Exceptional	49.7
0.60	D	23	35.30	569.00	682.80	66.00	36	8.3	Marginally Good	: Good	49.7
04-134-000											
Hoaglin Creek											
<i>Modified Channel Modified</i>											
19.90	E	16		419.00	838.00	60.50	32	-	Fair	: NA	17.0
13.06	E	16	11.40	686.00	1029.00	49.80	34	6.9	Marginally Good	: Fair	34.1
13.06	E	15	11.75	392.00	588.00	49.80	30	6.3	Fair	: Fair	34.1
04-135-000											
Monkey Run											
<i>Modified Channel Modified</i>											
3.30	E	13		177.00	354.00	20.50	32	-	Fair	: NA	6.8
04-137-000											
Hagerman Creek											
<i>Modified Channel Modified</i>											
12.22	E	14		286.00	572.00	34.50	36	-	Marginally Good	: NA	5.4
0.86	E	15		322.00	644.00	61.50	32	-	Marginally Good	: NA	16.2
04-139-000											
Middle Creek											
<i>Modified Channel Modified</i>											
1.32	D	33	11.83	1717.00	2575.50	67.50	34	9.5	Marginally Good	: Exceptional	102.0
1.32	D	23	7.18	466.00	699.00	67.50	34	8.0	Marginally Good	: Good	102.0
04-139-001											
Big Run											
None											
0.97	E	10		417.00	834.00	31.50	26	-	Fair	: NA	5.5
04-140-000											
Maddox Creek											
<i>Modified Channel Modified</i>											
16.20	E	20		416.00	832.00	57.30	40	-	Good	: NA	9.9

River Mile		Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	Mlwb	Narratives		Drainage Area
14.75	D	17	14.06	143.00	214.50	44.80	34	6.5	Marginally Good	Fair	22.0
14.75	D	20	26.99	254.00	381.00	44.80	34	7.4	Marginally Good	Marginally Good	22.0
12.21	E	21	20.48	407.00	610.50	53.50	38	7.8	Good	Marginally Good	23.6
12.21	E	20	21.70	995.00	1492.50	53.50	38	7.8	Good	Marginally Good	23.6
0.90	D	19	12.75	521.00	781.50	57.50	30	7.2	Fair	Fair	32.7
0.90	D	19	17.61	259.00	388.50	57.50	32	6.3	Fair	Fair	32.7
04-143-000											
Town Creek											
<i>Modified Channel Modified</i>											
27.45	E	12		140.00	280.00	31.00	30	-	Marginally Good	NA	3.8
25.35	E	19		549.00	1098.00	60.80	40	-	Good	NA	16.3
19.67	D	18	25.27	185.00	277.50	50.00	34	6.7	Marginally Good	Fair	22.0
19.67	D	16	33.17	191.00	254.67	50.00	34	7.0	Marginally Good	Fair	22.0
11.32	D	17	32.55	284.00	426.00	51.50	34	7.3	Marginally Good	Fair	33.8
11.32	D	18	28.86	698.00	1047.00	51.50	34	8.4	Marginally Good	Good	33.8
0.72	D	23	12.35	746.00	1119.00	56.00	42	8.9	Good	Very Good	52.5
0.72	D	16	39.01	524.00	786.00	56.00	34	8.2	Marginally Good	Good	52.5
04-144-000											
Roller Creek											
<i>Modified Channel Modified</i>											
1.35	E	17		225.00	450.00	36.50	32	-	Marginally Good	NA	6.7
04-145-000											
Dog Creek											
<i>Modified Channel Modified</i>											
22.10	E	16		142.00	284.00	45.30	30	-	Marginally Good	NA	13.5
14.06	D	22	25.89	381.00	571.50	62.50	42	8.7	Good	Good	28.8
14.06	D	19	39.62	321.00	481.50	62.50	36	7.7	Marginally Good	Marginally Good	28.8
0.97	D	28	17.92	343.00	514.50	69.50	40	8.8	Good	Good	57.0
0.97	D	24	22.59	244.00	366.00	69.50	44	8.6	Good	Good	57.0
04-153-000											
Long Prairie Creek											
<i>Modified Channel Modified</i>											
6.79	E	13		489.00	978.00	47.80	36	-	Marginally Good	NA	3.5
0.68	E	18		923.00	1846.00	52.00	32	-	Marginally	NA	11.4

River Mile	Number of Species	Relative Weight ⁴	# of Fish	(all) Relative Number ⁴	QHEI	IBI	MIwb	Narratives		Drainage Area
								Good		
04-154-000										
Kyle Prairie Creek										
<i>Modified Channel Modified</i>										
3.23	E	22	236.00	472.00	35.30	38	-	Marginally Good		6.9
0.20	E	20	460.00	920.00	45.00	42	-	Good		15.9

Narrative ranges and WWH biocriteria (bold) for the HELP ecoregion. Exceptional (EWH biocriteria), very good (EWH nonsignificant departure), poor and very poor evaluations are common statewide.

IBI			MIwb		Narrative Evaluation
Headwater	Wading	Boat	Wading	Boat	
50-60	50-60	48-60	≥9.4	≥9.6	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	Very Good
<i>Huron Erie Lake Plain</i>					
40-45	38-45	38-43	7.9 -8.8	8.6 -9.0	Good
36-39	34-37	34 -37	7.4-7.8	8.1-8.5	Marginally Good
28 -35	28- (32) 33	26-33	5.9- 7.3	6.4-8.0	Fair
24-27	28-31	30-33	6.8-7.2	8.1-8.5	Nonsignificant Departure
18-27	18-27	16-25	4.5-5.8	5.0-6.3	Poor
12-17	12-17	12-15	0-4.4	0-4.9	Very Poor

NA - Headwater site, MIwb is not applicable, no weights taken
 E - Electro-fishing with Longline
 D - Electro-fishing with Roller Pram
 * - Relative number



Figure 38. Anomalies, like these external lesions on channel catfish, were encountered throughout the lower Auglaize River tributaries study area. Lesions such as these were also found on yellow bullhead, and black bullhead as well. Specific causative stressors associated with these lesions are unknown.

Fish Community Trends

Historical fish community data for streams in this study area available from multiple sampling locations is mostly limited to 1991 data from Flatrock Creek and 1983 data collected from the Little Auglaize River and Hagerman Creek. Wildcat, Blue, Prairie, Town, Dog, and Long Prairie creeks had just one site historically sampled which could be used for trends analysis. The three streams having more than one site for trends analysis displayed significant improvements from historical fish IBI and MIwb (where applicable) scoring. The major stream modification projects in the study area were completed by the mid 1990s. Siltation, turbidity and stream channel homogeneity are common habitat features in the study area. However, siltation and turbidity may have lessened in some of the over-wide channels which had room within the incised leveed banks to evolve into more stable channels over time. The improved fish communities in Hagerman Creek and the Little Auglaize River could be attributed to the degraded habitat conditions from channel modification evolving into more stable channels. IBI and MIwb scores that have improved significantly over time have been highlighted in yellow in Table 25. It is recommended that future channel modifications in the lower Auglaize River basin be curtailed to only those absolutely necessary and, even then, efforts should be made to keep the impacts light. This would allow these streams to further recover toward a more natural condition, to increase their beneficial assimilative capacities, and to enhance nutrient sequestration.

Table 25. Trends of fish community IBI and MIwb scores at sampling locations in the lower Auglaize River tributaries study area, 1983-2014. Yellow highlighted scores reflect significant improvement over time at the relevant sites.

RM	Stream Name	Current Aquatic Life Use	2014	2014	2000	2000	1996	1996	1991	1991	1984	1984	1983	1983
			IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb
28.84	FLATROCK CREEK UPST. PAYNE @ PUGH RD.	WWH	32	7.03					29	5.2				
23.72	FLATROCK CREEK NE OF PAYNE @ ST. RT. 613	WWH	33	8.02					26	5.8				
13.80	FLATROCK CREEK AT PAULDING, DST. DAM	WWH	39	8.56					31	7.4				
9.70	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	WWH	27*	7.92					29	6.5				
6.02	FLATROCK CREEK NE OF PAULDING @ LOUCK RD.	WWH	33	7.66					28	6.6				
0.27	WILDCAT CREEK NE OF	WWH	36		32									

RM	Stream Name	Current Aquatic Life Use	2014	2014	2000	2000	1996	1996	1991	1991	1984	1984	1983	1983
			IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb
	PAYNE @ ST. RT. 500													
3.43	BLUE CREEK @ CO. RD. 151	MWH-C	27	7.65			22	7.6			26	8		
47.00	L. AUGLAIZE R. AT JONESTOWN @ JONESTOWN RD.	MWH-C	31	7.67			27	7.2					30	7.5
42.66	L. AUGLAIZE R. N OF VENEDOCIA @ WREN-LANDECK RD.	MWH-C	39	8.13									25	5.0
38.26	L. AUGLAIZE R. S OF MIDDLE POINT @ ST. RT. 697	MWH-C	37	8.28									27	5.2
34.54	L. AUGLAIZE R. DST. MIDDLEPOINT @ CONVERSE ROSELMS RD	MWH-C	31	7.41									20	5.1
23.60	L. AUGLAIZE R. AT OTTOVILLE @ U.S. RT. 224	MWH-C	34	7.96			27	6.9					32	7.6
22.51	L. AUGLAIZE R. DST. OTTOVILLE @ CO. RD. P	MWH-C	32	7.90									27	8.6
18.04	PRAIRIE CREEK W OF SCOTT @ PAULDING/VAN WERT CO. LINE	MWH-C	28	na			27							
12.22	HAGERMAN CREEK NE OF CONVOY @ RICHEY RD.	MWH-C	36										21	
0.86	HAGERMAN CREEK E OF HAVILAND @ ALLISON RD. (TWP. RD. 48)	MWH-C	32				20						17	
0.72	TOWN CREEK NEAR MOUTH AT VAN VERT PAULDING CO. LINE RD.	MWH-C	39	8.61									26	6.65
0.97	DOG CREEK E OF ROSELMS @ ST. RT. 114	MWH-C	42	8.67									25	5.4
0.68	LONG PRAIRIE CREEK W OF VENEDOCIA @ JONESTOWN RD.	MWH-C	32										28	

Macroinvertebrate Community

Macroinvertebrate communities were evaluated at 66 stations in the lower Auglaize River tributaries study area in 2014 and 2015. Qualitative sampling was conducted from all sampling locations and quantitative Hester-Dendy artificial substrate samples were collected from 35 locations. A summary of the macroinvertebrate data is presented in Table 26 and the raw data can be found in Appendices B and C. A list of intolerant or uncommonly collected sensitive macroinvertebrate taxa and all freshwater mussel collection locations can be found in Table 27. Overall, 82% of the sites were meeting the applicable Invertebrate Community Index (ICI) biocriterion or narrative equivalent. The Little Auglaize mainstem, although designated as MWH-C for the entire sampled reach, meets the WWH biocriterion at seven of the nine stations. Prairie, West Branch Prairie, Middle, and Hoaglin creeks are also designated as MWH and are achieving the WWH biocriterion for their sampled lengths. The most common and widespread stressors in the watershed were sedimentation and siltation due to the channelization and runoff associated with agriculture in this part of the state.



Artificially constructed riffles or weirs were found in many of the streams within the study area. In some cases, these riffles acted as miniature dams creating impounded conditions upstream from the riffle, but the smaller rocks and boulders that were not embedded were able to support riffle-dwelling macroinvertebrate communities at most sites. Unfortunately, unless the streams had the ability to recover from previous channelization activities by meandering within their straight banks, these constructed riffles were usually the only riffle or run habitats in a stream dominated by a homogenous glide or pool (Figure 39).



Figure 39. Blue Creek, RM 14.06 at Church Rd., upstream view. Constructed rock weir acting as riffle in an otherwise homogenous habitat.

Little Auglaize River Mainstem

The Little Auglaize River begins at the confluence of Frisinger Ditch and Kyle Prairie Creek just north of the Van Wert/Mercer county line and flows north for approximately 51.5 miles to its confluence with the Auglaize River. All stations but the most downstream site are free-flowing; the lower site at RM 2.02 was affected by backwater from the Auglaize River. The entire length of the Little Auglaize River was channelized and is designated as MWH. The nine stations sampled on the river met the biocriterion for MWH and seven of the nine stations met or exceeded the WWH biocriterion. The average ICI score (eight values) was 38.75 (good), plus one station without an ICI score that was narratively evaluated as fair, which meets MWH in channel modified systems. Longitudinally, the Little Auglaize River generally improved until the final station at RM 2.02, which was backwatered from the Auglaize River (Figure 40). Because of the sluggish water condition, the site did not provide suitable habitat for high numbers of Ephemeroptera, Plecoptera, and Trichoptera taxa (mayfly, stonefly, and caddisfly orders, respectively, known as EPT taxa) and other sensitive taxa. In some areas, the river's ability to meander within its artificially over-widened channel helped it to develop riffle, runs, and pools, as well as point bars and areas of aquatic vegetation that are beneficial to diverse macroinvertebrate communities (Figure 41). The site located at RM 8.72 had the greatest total number of EPT and sensitive taxa of any the nine sampling locations (Table 26).

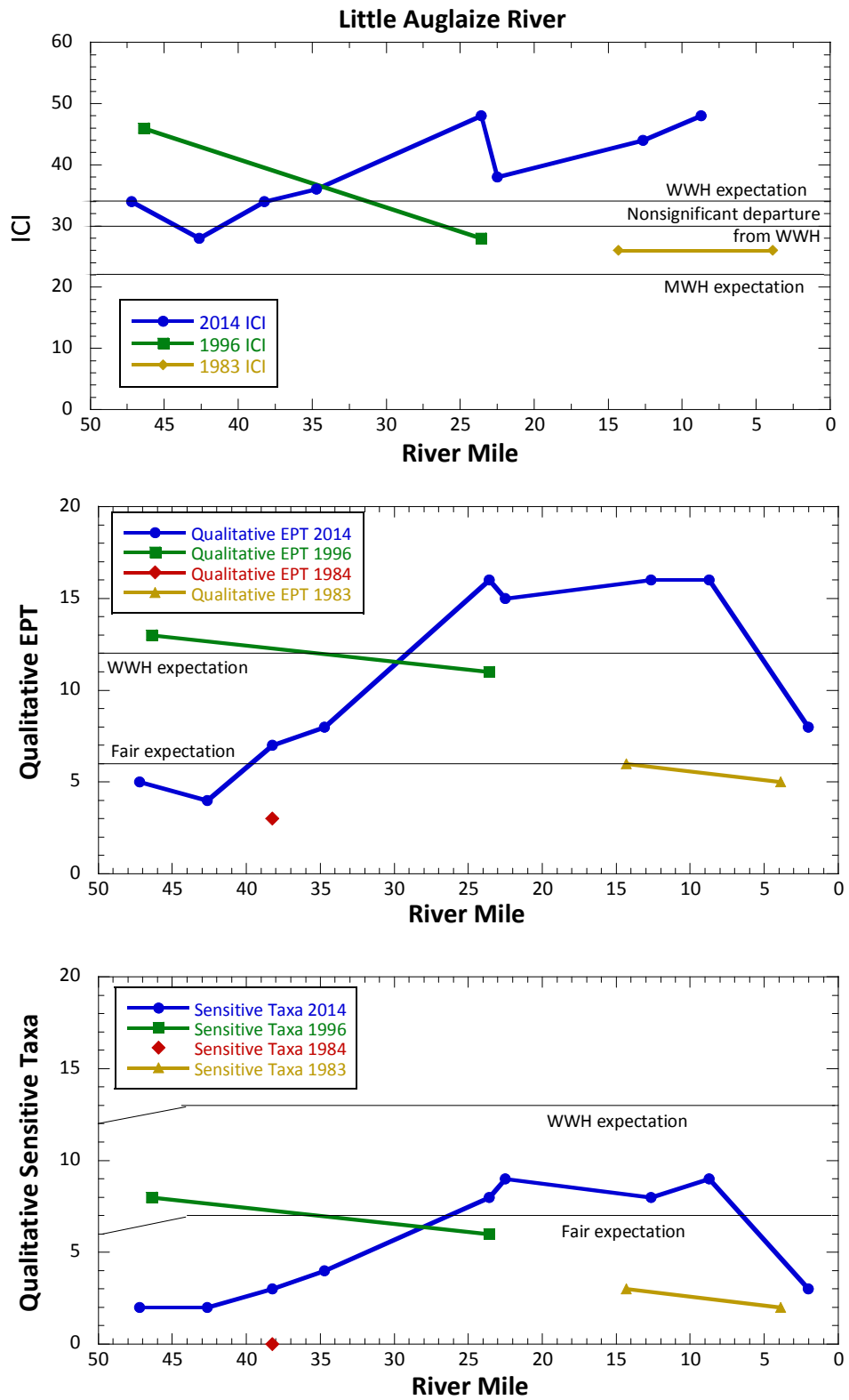


Figure 40. Longitudinal trend of the ICI, number of EPT taxa in the qualitative samples, and the number of sensitive taxa in the qualitative samples from sites in the Little Auglaize River, 1983-2014.



Figure 41. Little Auglaize River, RM 22.51 at County Road P, downstream view. The picture shows the stream's ability to meander within its artificially constructed banks, providing a better variety of habitats for aquatic macroinvertebrates.

Upper Little Auglaize River Tributaries

Tributaries within the upper Little Auglaize River watershed include Kyle Prairie Creek and Long Prairie Creek. Kyle Prairie Creek forms the Little Auglaize River at the confluence with Frisinger Ditch, and Long Prairie Creek flows into the Little Auglaize River at RM 46.1. Both streams were achieving their MWH macroinvertebrate biocriterion with fair and marginally good communities at the four sampled locations (two stations on each stream).

Lower Little Auglaize River Tributaries

Dog Creek

Dog Creek is the most upstream direct tributary to the Little Auglaize River and is designated as MWH-C. All three sampled locations attained MWH-C, with the most upstream site having a fair qualitative macroinvertebrate community and the two downstream locations having good to very good communities. The Dog Creek site at RM 0.97 had one of the highest total EPT and sensitive taxa counts and also contained three uncommonly collected sensitive macroinvertebrate taxa and one freshwater mussel. The higher performance at the most downstream two sites may be attributable to the retention of trees on at least one side of the stream and an attendant increase in habitat quality and diversity.

Middle Creek Watershed

Middle Creek (MWH-C) is formed by the confluence of Town Creek and Maddox Creek. The sole sampling location on Middle Creek at County Road 60 was unique in that the land owner has requested that routine maintenance (*i.e.*, control of woody vegetation with herbicide along banks and removal of point bars within the stream) not be performed on their portion of the creek. This has allowed the stream to meander within its banks and recover natural habitat features. In addition to these restrictions, conservation of the wooded riparian zone on both sides of the stream may have helped to

maintain a population of eight species of freshwater mussels- more than any other stream in the survey (Table 27). The aquatic macroinvertebrate community was also performing better than the majority of other streams in the survey with 15 qualitative EPT taxa, 17 qualitative sensitive taxa, and an exceptional ICI score. Despite the abundance of freshwater mussels and exceptional ICI score, evidence of flashy flows caused by surrounding drainage tiles and extensive stream channelization were made apparent by the dozens of stranded mussels found at the site during the two visits. Town Creek attained MWH-C with fair ICI scores and a fair narrative score at three of the four sampling locations. The most upstream site had a poor macroinvertebrate community and no EPT or sensitive taxa due to sedimentation and siltation and flow alterations from agricultural practices. Roller Creek, a tributary to Town Creek at RM 26.50, is an actively maintained ditch that has a fair macroinvertebrate community reflective of the MWH-C designation. The site was dominated by tolerant blackflies, flatworms, and leeches but was able to support six EPT taxa for a fair narrative evaluation. Maddox Creek (MWH-C) supported better macroinvertebrate communities than Town Creek with marginally good scores at four of five sites. The most downstream location at RM 0.90 had a good ICI score and had 19 qualitative EPT taxa, 11 sensitive taxa, two uncommonly collected macroinvertebrate species, and one mussel species that is a species of concern in Ohio.

Flatrock Creek Watershed

One of the least channelized streams in the lower Auglaize River tributaries study area, Flatrock Creek had a relatively intact riparian zone for the WWH designated reach downstream from the Ohio-Indiana border. The headwaters of Flatrock Creek that begin in Ohio have been channelized and the portion of Flatrock Creek within Indiana (RMs 47.3-34.2) is also channelized. Once back into Ohio at approximately RM 34.2 to the confluence with the Auglaize River, the stream was never channelized. Thus, this section of Flatrock Creek is able to utilize its riparian corridor, unlike the other streams in the survey area that were deeply entrenched by channelization processes. The stream met its designated or recommended use at all stations except for RM 9.70, upstream from the Paulding wastewater (WWTP) lagoons. An ICI score was not generated at this site due to lack of appropriate flow, so the site was evaluated narratively based on the qualitative sample. Although the qualitative sample was comparable to other sites on Flatrock Creek, the qualitative EPT and sensitive taxa were below WWH expectations (Figure 42). This site did not have any sensitive or EPT taxa predominant on natural substrates like the surrounding sites. The entire length of Flatrock Creek showed evidence of sedimentation and siltation from surrounding agricultural practices and flow alterations, and this was reflected in the lack of EPT and sensitive taxa diversity. Wildcat Creek (WWH), a tributary of Flatrock Creek at RM 23.74, had a fair macroinvertebrate community that was impacted by poor habitat quality and heavy siltation.

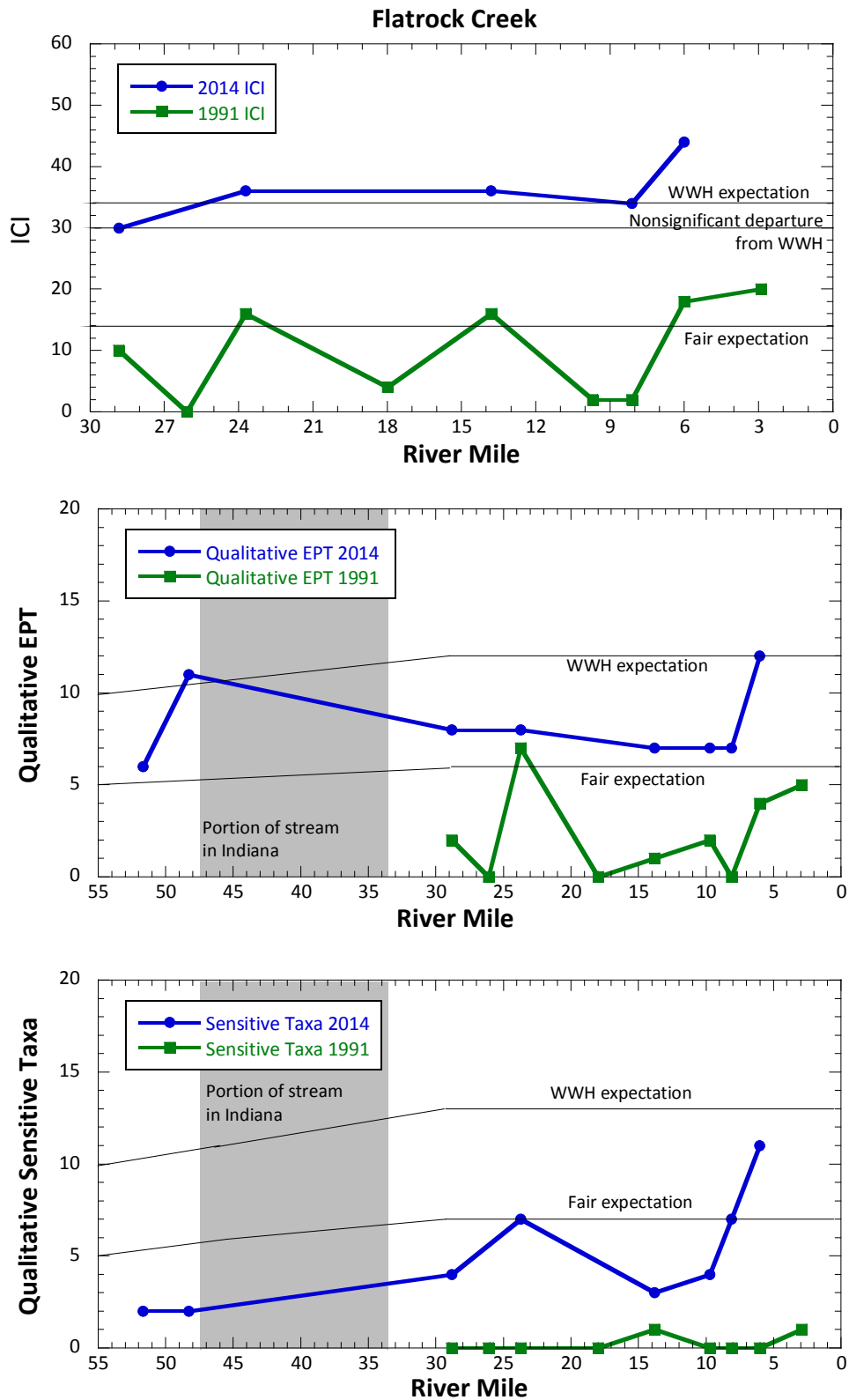


Figure 42. Longitudinal trend of the ICI, number of EPT taxa in the qualitative samples, and the number of sensitive taxa in the qualitative samples from sites in Flatrock Creek, 1991 and 2014.

Blue Creek Watershed

Blue Creek, a direct tributary to the Auglaize River, is a MWH-C stream that had six sampling stations and one sampling location each on three of its recommended MWH-C tributaries- Barcer, Upper Prairie, and Middle creeks. The four upstream Blue Creek sampling locations met the MWH-C biocriterion with scores of fair, marginally good, fair, and good, respectively in order from upstream to downstream. The most downstream sites at RMs 10.01 and 3.43 had better qualitative EPT and sensitive taxa as well as more uncommonly collected species and freshwater mussels. The station at RM 10.01 had two uncommonly collected species while the site at RM 3.43 had three uncommonly collected species and five freshwater mussel species (Table 27). An increase in macroinvertebrate diversity may be linked to the progression of a wooded riparian buffer downstream from RM 11.5. Barcer and Middle creeks did not attain the MWH-C designation due to sedimentation/siltation and flow alterations from subsurface drainage from agricultural practices. Upper Prairie Creek met the minimum requirements for MWH-C with a narrative evaluation of fair.

Prairie Creek Watershed

Prairie Creek and its tributaries, West Branch Prairie and Hoaglin creeks, all MWH-C streams, had marginally good to exceptional ICI scores at all of their sampled stations. The most downstream site on Prairie Creek at RM 1.50 had two uncommonly collected taxa and higher qualitative EPT and sensitive taxa than many of the other streams in the survey. The two sampling locations on West Branch Prairie Creek were also performing better than other sites in the survey, with an exceptional 20 qualitative EPT taxa at the downstream most sampling station. Wooded corridors from approximately RM 9.0 on Prairie Creek and all of West Branch Prairie Creek may be serving to improve habitat conditions and enhance the macroinvertebrate communities. The two sites on Hoaglin Creek were not superficially different from many of the other streams in the lower Auglaize River tributaries study area, so it is unknown as to why they performed better than the other similar streams. The upstream sampling location on Hagerman Creek at RM 12.22 and the sole sampling location on Monkey Run were similar with fair macroinvertebrate communities. These sites achieved their MWH-C designations. The downstream station on Hagerman Creek attained MWH-C with a marginally good ICI score.

Other Direct Auglaize River Tributaries

Eight direct Auglaize River tributaries- Bobenmyer, Synder, and Jackson ditches, and Sixmile, Little Flatrock, Threemile, Fivemile, and Eagle creeks, were sampled in 2014 and 2015. Sampling on Threemile, Fivemile, and Eagle creeks and Jackson Ditch was performed in 2015 in order to assess the most downstream Auglaize River HUC12 (4100007 12 09). All streams had one sampling location except for Little Flatrock Creek, which had two sampling stations. Only Sixmile Creek (recommended MWH-C) and one site on Little Flatrock at RM 1.53 (WWH) met the applicable biocriterion or narrative equivalent. Impairment for the remaining direct tributaries that did not attain their aquatic life use designations were due to sedimentation/siltation and flow alteration attributed to crop production with subsurface drainage from surrounding agricultural practices. Cattle had unrestricted access to Jackson Ditch and this was evident by the slumping, eroded banks. Little Flatrock Creek was also impaired due to direct habitat alteration and was recommended for MWH-C.

Macroinvertebrate Community Trends

The 2014 survey was the first time that the majority of the lower Auglaize River basin tributaries had been systematically sampled. The Little Auglaize River was sampled at five different stations in 1983, 1984, and 1996. Little comparisons can be made from the historical data due to lack of continuous data; however, it appears that the stream is performing better than it did during the 1980s sampling (Figure

40). Three sites on Town Creek were sampled in 1983 and one site in 1996. Qualitative EPT and sensitive taxa numbers may show that current water quality or habitat have improved from about RM 15.0 to the mouth since 1983 (Figure 43). Flatrock Creek was sampled in 1991 at nine sites downstream from the Ohio-Indiana border. Due to insufficient current and intermittent conditions, the ICI scores from 1991 could not be used in an evaluation of the macroinvertebrate community performance, but they were included within the ICI graph in Figure 42 for reference. Sampling in 2014 and 1991 revealed that Flatrock Creek is not performing to WWH expectations at the majority of its stations for qualitative EPT and sensitive taxa. The causes and sources for the prevalence of partial and non-attainment in 1991 included habitat factors and organic loadings due to raw sewage and organic enrichment from malfunctioning sewer and WWTP lagoon discharges (Ohio EPA 1992). Based on the macroinvertebrate community, it appears that the point source impacts have improved but nonpoint sources (*i.e.* siltation, embeddedness) have kept the EPT and sensitive taxa below expected numbers. It will be essential that Flatrock Creek's riparian buffer and natural stream channel are maintained and improved where possible in order to minimize anthropogenic impacts.

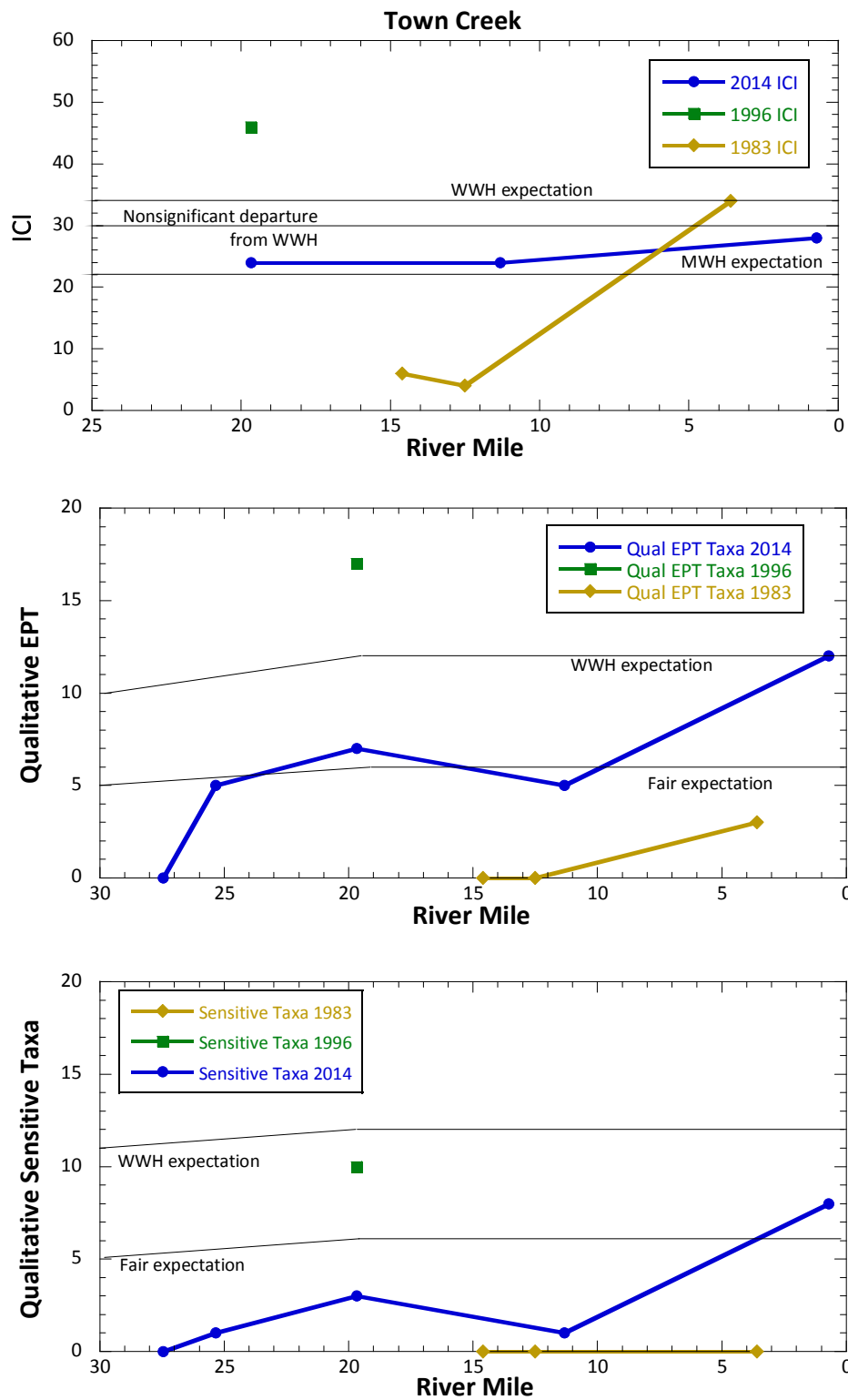


Figure 43. Longitudinal trend of the ICI, number of EPT taxa in the qualitative samples, and the number of sensitive taxa in the qualitative samples from sites in Town Creek, 1983-2014.

Table 26. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the lower Auglaize River tributaries study area, June to September, 2014 and 2015.

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI ^a	Narrative Evaluation
Bobenmyer Ditch (04-100-016)										
0.70	6.1	-	29	1	0	L	0	Snails and midges	-	Poor
Synder Ditch (04-100-017)										
0.30	5.2	-	23	3	0	L	0	Scuds and isopods	-	Low Fair
Threemile Creek (04-101-000)^b										
0.87	4.9	-	33	2	0	M	0	Isopods	-	Low Fair
Jackson Ditch (04-102-000)^b										
0.05	4.8	-	34	1	1	M	0	Water boatmen	-	Poor
Fivemile Creek (04-104-000)^b										
1.7	2.9	-	26	0	0	L	1	Isopods	-	Poor
Eagle Creek (04-105-000)^b										
1.57	3.7	-	28	2	0	M - L	0	Water boatmen	-	Low Fair
Sixmile Creek (04-106-000)										
3.9	12.0	-	45	6	2	M	0	Crayfish	-	Fair
Little Flatrock Creek (04-108-000)										
5.9	7.6	-	26	4	0	L	0	Crayfish	-	Low Fair
1.53	17.8	-	38	10	4	M	0	Hydropsychid caddisflies and snails	-	Marg. Good
Flatrock Creek (04-109-000)										
51.68	6.3	-	40	6	2	M	0	Snails and midges	-	Fair
48.30	13.4	-	48	11	2	M	0	Blackflies, midges, and water mites	-	Marg. Good
28.84	119.0	X12	35	8/9	4/5	L / 325	0	Midges and water boatmen	30 ^{ns}	
23.72	145.00	-	56	8/9	7/8	M / 1162	0	Midges, baetid mayflies, hydropsychid caddisflies	36	
13.80	173.00	-	41	7/9	3/5	H / 932	0	Hydropsychid caddisflies, <i>Chimarra</i> caddisflies, baetid mayflies	36	

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI ^a	Narrative Evaluation
9.70	183.00	X8	45	7/8	4/4	L / 389	0	Midges, damselflies	[14]	Fair
8.13	184.00	-	44	7/8	7/8	M / 1022	0	Hydropsychid caddisflies, <i>Chimarra</i> caddisflies, baetid mayflies, riffle beetles	34	
6.02	189.00	-	57	12/15	11/14	M / 430	0	<i>Chimarra</i> caddisflies, baetid mayflies	44	
Wildcat Creek (04-115-000)										
0.27	7.9	-	41	5	2	M	0	Snails and midges	-	Fair
Blue Creek (04-120-000)										
31.95	7.40	-	42	8	0	M	0	Snails	-	Fair
29.43	15.9	-	52	10	3	M	0	Blackflies, hydropsychid caddisflies, baetid mayflies	-	Marg. Good
22.00	41.00	X15	38	5/5	2/2	799	0	Flatworms, midges, baetid mayflies	[18]	Fair
17.15	51.50	-	41	11/12	7/8	M / 1429	0	Midges, flatworms, baetid mayflies, hydropsychid caddisflies	36	
10.01	77.00	-	46	16/18	12/15	M / 495	0	Heptageniid mayflies, hydropsychid caddisflies, baetid mayflies, <i>Petrophila</i> moth	46	
3.43	104.00	-	50	10/15	12/19	M / 1150	0	Hydropsychid caddisflies, baetid mayflies, riffle beetles	46	
Barcer Run (04-121-000)										
0.75	6.9	-	25	2	1	M - L	0	Midges	-	Poor
Upper Prairie Creek (04-125-000)										
0.9	8.80	-	39	7	2	M - H	0	Hydropitilid and hydropsychid caddisflies	-	Fair
Middle Creek (04-125-001)										
0.5	5.0	-	26	3	0	M	0	Blackflies, midges	-	Low Fair
Little Auglaize River (04-130-000)										
47.20	31.80	-	35	5/7	2/2	M / 731	0	Hydropsychid caddisflies, baetid mayflies, and Bryozoa	34	
42.66	54.00	-	36	4/7	2/3	L / 531	1	Bryozoa, flatworms, and hydropsychid caddisflies	28	

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI ^a	Narrative Evaluation
38.26	61.00	-	29	7/9	3/6	M / 1506	0	Hydropsychid caddisflies, Bryozoa, and <i>Chimarra</i> caddisflies	34	
34.74	68.40	-	45	8/10	4/7	M / 2625	0	Bryozoa, baetid mayflies, and hydropsychid caddisflies	36	
23.60	93.00	-	38	16/19	8/10	M / 649	0	Baetid mayflies, midges, and heptageniid mayflies	48	
22.51	96.00	-	48	15/18	9/13	M / 1023	0	Baetid mayflies and hydropsychid caddisflies	38	
12.65	120.00	X6	42	16/20	8/10	M / 830	0	Hydropsychid caddisflies, midges, and heptageniid mayflies	44	
8.72	184.00	-	40	16/23	9/17	M-L / 632	0	Baetid mayflies and midges	48	
2.02	401.00	No flow set then lost	33	8	3	M-L	0	Water boatmen and midges	-	Fair
Prairie Creek (04-131-000)										
18.04	15.00	X6	44	10/10	5/5	M / 1325	0	Hydropsychid caddisflies, midges, and flatworms	36	
12.50	25.90	-	44	8/10	3/7	M / 2371	0	Hydropsychid caddisflies, midges, and flatworms	30 ^{ns}	
5.90	49.70	-	49	12/17	7/11	M-H / 1693	1	Hydropsychid caddisflies, baetid mayflies, and riffle beetles	40	
1.50	105.00	-	54	15/22	10/17	M / 3811	0	Hydropsychid caddisflies, baetid mayflies, and riffle beetles	44	
West Branch Prairie Creek (04-132-000)										
4.40	47.00	-	51	14/18	9/15	H / 1256	0	<i>Chimarra</i> caddisflies and riffle beetles	38	
0.60	49.70	-	60	20/26	13/18	H / 1312	0	<i>Chimarra</i> caddisflies, hydropsychid caddisflies, baetid mayflies, midges, and <i>Petrophila</i> moth	48	
Hoaglin Creek (04-134-000)										
19.90	17.00	-	47	10	2	M	0	Blackflies, hydropsychid caddisflies, baetid mayflies	-	Marg. Good

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI ^a	Narrative Evaluation
13.06	34.10	-	43	15/16	8/10	M / 312	0	Hydropsychid caddisflies, baetid mayflies, and riffle beetles	44	
Monkey Run (04-135-000)										
3.3	6.80	-	51	7	2	M	-	Hydropsychid caddisflies, midges, and hydroptilid caddisflies	-	Fair
Hagerman Creek (04-137-000)										
12.22	5.4	X8	43	6	0	M-H	0	Snails, midges, and hydroptilid caddisflies	-	Fair
0.86	16.20	1	33	8/10	3/4	M / 794	0	Hydropsychid caddisflies, baetid mayflies, <i>Chimarra</i> caddisflies, and midges	32 ^{ns}	
Middle Creek (04-139-000)										
1.32	102.00	-	54	15/18	17/24	3469	0	Baetid mayflies, midges, hydropsychid caddisflies, and damselflies	46	
Big Run (04-139-001)										
0.97	5.5	-	41	9	3	M-L	0	Snails and heptageniid mayflies	-	Marg. Good
Maddox Creek (04-140-000)										
16.90	9.90	-	46	11	3	M	0	Midges and blackflies	-	Marg. Good
14.75	22.00	-	41	6/6	1/1	M-L / 1048	0	Flatworms, midges, and blackflies	32 ^{ns}	
12.21	23.60	-	40	10/11	4/5	M / 1921	0	Hydropsychid caddisflies, midges, and riffle beetles	32 ^{ns}	
0.90	32.70	-	53	19/21	11/15	M-H / 3120	0	Hydropsychid caddisflies, midges, and baetid mayflies	38	
Town Creek (04-143-000)										
27.45	3.80	-	25	0	0	H	0	Snails, water boatmen, and beetles	-	Poor
25.35	16.30	-	34	5	1	M	0	Hydropsychid caddisflies and blackflies	-	Fair
19.67	22.00	X15	38	7/7	3/3	M / 784	0	Hydroptilid caddisflies and midges	24	
11.32	33.80	-	29	5/5	1/1	M / 706	0	Midges	24	
0.72	52.50	-	38	12/13	8/10	M / 2690	0	Baetid mayflies, hydropsychid caddisflies, and midges	28	

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI ^a	Narrative Evaluation
Roller Creek (04-144-000)										
1.35	6.70	-	48	6	1	M	1	Flatworms and midges	-	Fair
Dog Creek (04-145-000)										
22.10	13.50	-	55	6	2	M	0	Flatworms and midges	-	Fair
14.06	28.80	-	50	15/20	4/8	M-H / 2922	0	<i>Chimarra</i> and hydropsychid caddisflies, baetid mayflies, and midges	46	
0.97	57.00	-	62	19/25	14/20	H / 1804	0	Hydropsychid caddisflies, baetid mayflies, and blackflies	48	
Long Prairie Creek (04-153-000)										
6.79	3.5	-	42	6	0	M	0	Isopods and midges	-	Fair
0.68	11.40	-	46	9	2	M	0	Midges and hydropsychid caddisflies	-	Marg. Good
Kyle Prairie Creek (04-154-000)										
3.23	6.90	-	41	9	2	M	0	Blackflies, water mites, and water boatmen	-	Marg. Good
0.20	15.90	-	45	7	0	M-L	0	Hydropsychid caddisflies, baetid mayflies, and midges	-	Fair

RM: River Mile.

Dr. Ar.: Drainage Area

Data Codes: X6= 4 HDs only collected, X8=Non-Detectable Current, X12=Suspected High Water Influence / Disturbance, X15=Current >0.0 fps but <0.3 fps.

Ql.: Qualitative sample collected from the natural substrates.

Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).

Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per ft².

Qualitative sample relative density: L=Low, M=Moderate, H=High.

CW: Cold Water.

^a ICI values in parentheses are invalidated due to insufficient current speed over the artificial substrates. The station evaluation is based on the qualitative sample narrative evaluation.

^b Sample was collected in 2015.

^c - Narrative evaluations for samples with a valid ICI reflect the narrative associated with that ICI score and is not an independent evaluation of the qualitative sample.

Table 27. Intolerant or uncommonly collected sensitive macroinvertebrate taxa and all freshwater mussel collection locations in the lower Auglaize River tributaries study area, 2014. State listed species: SC=Species of Concern.

Taxa	Collection Location by River Mile
Caddisflies	
<i>Hydropsyche venularis</i>	Town Cr. 0.72; Dog Cr. 0.97; Prairie Cr. 1.5; Middle Cr. 1.32; Maddox Cr. 0.9; L. Auglaize R. 8.72, 12.65, 22.51, 23.6
<i>Tranodes injustus</i>	West Branch Prairie Cr. 0.6; Blue Cr. 10.01
Midges	
<i>Cladotanytarsus vanderwulpi group sp. 4</i>	Middle Cr. 1.32; Flatrock Cr. 23.72
<i>Cladotanytarsus vanderwulpi group sp. 5</i>	Middle Cr. 1.32; L. Auglaize R. 8.72; Flatrock Cr. 13.8, 8.13, 6.02; Blue Cr. 3.43
<i>Corynonuera sp. 12</i>	Flatrock Cr. 6.02; Blue Cr. 3.43
<i>Glyptotendipes chelonia</i>	Dog Cr. 0.97; Maddox Cr. 0.9; L. Auglaize R. 42.66; Hoaglin Cr. 13.06
<i>Polypedilum ontario</i>	Dog Cr. 0.97; Prairie Cr. 1.5, 12.5; West Branch Prairie Cr. 0.6, 4.4; Blue Cr. 3.43, 10.01
Mussels	
<i>Amblema plicata</i> (Threeridge)	Middle Cr. 1.32
<i>Anodontoides ferussacianus</i> (Cylindrical Papershell)	Upper Prairie Cr. 0.90
<i>Fusconaia flava</i> (Wabash Pigtoe)	Middle Cr. 1.32; Flatrock Cr. 9.7; Blue Cr. 3.43
<i>Lasmigona complanata</i> (White Heelsplitter)	Middle Cr. 1.32
<i>Lasmigona compressa</i> (Creek Heelsplitter) (SC)	Maddox Cr. 0.90
<i>Lampsilis radiata luteola</i> (Fatmucket)	Blue Cr. 3.43
<i>Leptodea fragilis</i> (Fragile Papershell)	Dog Cr. 0.97; Middle Cr. 1.32; Flatrock Cr. 8.13
<i>Potamilus alatus</i> (Pink Heelsplitter)	Middle Cr. 1.32; Blue Cr. 3.43
<i>Pyganodon grandis</i> (Giant Floater)	Kyle Prairie Cr. 3.23; Sixmile Cr. 3.9; Town Cr. 19.67, 0.72; Hagerman Cr. 0.86; Middle Cr. 1.32; L. Auglaize R. 34.74; Blue Cr. 3.43
<i>Quadrula pustulosa</i> (Pimpleback)	Middle Cr. 1.32; Blue Cr. 3.43
<i>Quadrula</i> (Mapleleaf)	Middle Cr. 1.32
<i>Strophitus undulatus</i> (Creeper)	West Branch Prairie Cr. 4.40
<i>Utterbackia imbecillis</i> (Paper Pondshell)	Maddox Cr. 16.2; L. Auglaize R. 34.74

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