Biological and Water Quality Study of the Ashtabula River and Select Tributaries, 2011

Ashtabula County

Ashtabula River at Benetka Road (RM 19.03)

OHIO EPA Technical Report EAS/2014-01-01

Division of Surface Water
December 19, 2014

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EXECUTIVE SUMMARY

All rivers and streams in Ohio are used for various purposes such as recreation or to support aquatic life. Ohio EPA evaluates each stream to determine the appropriate use designation and also to determine if the use is meeting the goals of the federal Clean Water Act. Thirteen streams in the study area were evaluated for aquatic life and recreational use potential in 2011 (Figure 1 and Tables 1 & 2). Five streams are listed in the Ohio Water Quality Standards with the Warmwater Habitat (WWH) aquatic life use designation, one stream is listed as Limited Resource Water (Strong Brook), five previously undesignated streams are being recommended for WWH, one stream currently designated WWH is being recommended for Coldwater Habitat (CWH) (Hubbard Run) and one previously undesignated stream is being recommended for the CWH aquatic life use designation (Trib. to Hubbard Run at RM 0.20) (Table 4). Biological sampling was conducted in the lacustuary portion of the mainstem as part of the Great Lakes Restoration Initiative (GLRI).

Twenty-three of the 26 sites (88%) within the Ashtabula River study area (excluding the lacustuary) were in full attainment of the WWH or CWH aquatic life use designations. One site (E. Br. E. Br. Ashtabula River, RM 0.39) was in partial attainment of WWH (4%), one site (Fields Brook, RM 1.84) was in non-attainment of WWH (4%) and one site (Strong Brook, RM 0.6) was in non-attainment of Limited Resource Water (LRW; 4%). In total, 88% of the sites evaluated outside of the lacustuary reach met the Clean Water Act biological integrity goal, 4% partially met and 8% were not meeting.

The Ashtabula watershed has a tendency toward low to intermittent summer flows due to the Mahoning soils, which have slow permeability, and the underlying shale bedrock which together return little ground water to surface flows. Therefore, the watershed is believed to have a limited ability to assimilate pollutants (Ohio EPA 1997: 85). Regardless, the watershed remains a high quality aquatic resource which is able to support: exceptional macroinvertebrate communities in the Ashtabula River, West Branch Ashtabula River, East Branch Ashtabula River, Ashtabula Creek, Hubbard Run and Tributary to Hubbard Run (at RM 0.20); the state Endangered fish northern brook lamprey (Ashtabula River); the Ohio EPA declining and intolerant fish species bigeye chub (Ashtabula River, E. Br. Ashtabula River, Trib. to Ashtabula River at RM 16.98) and mimic shiner (Ashtabula River, E. Br. Ashtabula River); the state Species of Concern mayfly *Maccaffertium ithaca* (W. Br. Ashtabula River, E. Br. Ashtabula River); and the new state record mayfly *Plauditus gloveri* (Ashtabula River).

Nine stations were sampled for fish, macroinvertebrates and habitat in the Ashtabula River lacustuary. Good fish community scores (L-IBI $\overline{x}$=43, MIwb $\overline{x}$=9.1) were typical, although variable results were documented downstream from Fields Brook (RM 1.3). Recently installed habitat enhancements have yielded improved cover types and aquatic vegetation abundance. With more time and the implementation of proposed new habitat enhancements additional improvement in the fish community should be realized. The macroinvertebrate communities continue to perform below expectations (average L-ICI=27). However, the relative abundance of toxic tolerant Chironomidae (midges) was substantially lower in 2011 (14.8 and 21.8%) compared to 2003 (91.7 and 34.4%) in the vicinity of the Fields Brook confluence. This may be an indication that sediment toxicity in this area may be substantially reduced. However, sediment toxicity cannot be totally discounted until recent sediment sampling results are made available by the US EPA. The most recent report (US EPA 2010) documented an average sediment total polychlorinated biphenyls (PCBs) concentration of 10,700 ppb downstream from Fields Brook (RMs 1.3-1.5). These samples were taken in 2007 after the completion of dredging and were primarily composed the dredge residuals.

The biological integrity of Fields Brook (RM 0.89) has improved since the stream was last sampled in 2000. The improvements documented in this study were directly related to the removal of PCBs in sediments, and stream channel restoration activities that were completed prior to 2003. The downstream station at Columbus Avenue was meeting or marginally meeting WWH biological criteria expectations during this study. The upstream station at State Road (RM 1.84) underwent further clean-up and mitigation which was completed by 2008. However, the site was not meeting biocriteria expectations for fish or macroinvertebrate communities due to degraded stream habitat quality.

The sampling of sediment by the Ohio EPA in the Ashtabula River basin was conducted in 2012 and was limited to the Strong Brook watershed. Strong Brook is a designated Limited Resource Water stream with a drainage area of 2.81 mi^2 and its confluence is at RM 1.62 of the Ashtabula River. The primary data quality objective of the sediment sampling in Strong Brook was to determine if releases of PCB oils from the Clean Harbors PPM, LLC facility located at 1302 West 38th Street in Ashtabula, were continuing to have an effect on sediment quality and potential impacts on aquatic life in Strong Brook as well as the potential for contributing to sediment contamination in the Ashtabula River lacustuary. Total sediment PCB concentrations exceeded the Threshold Effect Concentration (TEC) and the Probable Effect Concentration (PEC) at all of the stream sites sampled in Strong Brook upstream from Lake Avenue (RM 0.46). One of the two samples collected downstream from Lake Avenue also exceeded the TEC for total PCBs. The source of the PCB contamination in the stream can conclusively be assigned to the Clean Harbors PPM facility. The PCB arochlors present in the sediment samples collected in 2012 (PCB-1242 and PCB-1260) precisely match those detected in storm water discharged from the site and catch basins sampled in 2007. No PCBs were detected in either of the sediment samples collected from tributaries entering the Strong Brook drainage system, but a very high concentration of PCBs was found in the catch basin at the end of West 38th Street, just downstream from the discharge point of the Clean Harbors PPM, LLC facility storm water collection system to the City of Ashtabula storm sewer. Seven polyaromatic hydrocarbon (PAH) compounds were also found in concentrations exceeding the PEC or TEC (with total PAH concentrations also exceeding the PEC) in Strong Brook. Sediment metals in Strong Brook were found to exceed the Ohio Sediment Reference Values (cadmium, calcium, copper, lead, magnesium, strontium, zinc) and the TEC (arsenic, copper, lead, nickel, zinc). The results of the 2012 sampling indicated that a continuing potential source of toxicity to aquatic life exists in Strong Brook based primarily upon releases of PCB's to the stream. Concentrations of PAHs and heavy metals also contribute to the potential for toxic effects.

Twenty-seven locations in the watershed were tested for *Escherichia coli (E. coli)* bacteria to determine recreation use attainment status. Evaluation of *E. coli* results revealed that 22 of the 27 locations sampled failed to attain the applicable geometric mean Water Quality Standards (WQS) criterion, indicating an impairment of the recreation use at these locations. Sources of elevated bacteria concentrations were ubiquitous and most likely due to a variety of inputs depending on the site location. In rural areas agricultural activities (including livestock production and land application of manure) and failing home sewage treatment systems (HSTS) are more common and likely sources. In the lower portion of the watershed (including the

Ashtabula urban area), likely sources include urban runoff, the Ryber Development, LLC Wastewater Treatment Plant (WWTP), sanitary sewer overflows (SSOs) and failing HSTS.

Fifteen fish tissue samples were collected from the lower reach of the Ashtabula River stretching from US Route 20 (Prospect Road) to the mouth (Lake Erie). There was sufficient data to support a one meal per week advisory for largemouth bass (arsenic, mercury) and smallmouth bass (arsenic, mercury, PCBs). This is a significant improvement compared to an historic do not eat advisory on all fish. Fish tissue data were adequate to determine partial attainment status of the human health WQS criteria due to high PCBs. PCB concentrations in fish tissue showed a drastic decrease between 2002 (prior to remedial dredging) and 2011 (after remedial dredging) for all species sampled.

Table 1. Sampling locations for the Ashtabula River study area, 2011. **M** - macroinvertebrate quantitative sample, M - macroinvertebrate qualitative sample only, **F** - fish sample (2 passes), F - fish sample (1 pass), C - conventional water chemistry parameters (5-10 runs), B - bacteria (5-12 runs), D - Datasonde© monitor, O - organic water chemistry (2-4 runs). Latitude, longitude coordinates are provided in decimal degrees.

Stream RM*	Sample Type	Lat, Long (DD)	Location	USGS Quad
Ashtabula River				
27.0	M,F,C,B	41.8186, -80.6239	Hilldom Road	Pierpont
23.8	M,F,C,B	41.852202, -80.617266	Kelloggsville Road	Pierpont
19.03	M,F,C,B,D	41.8489, -80.6889	Benetka Road	Gageville
13.9	M,F,C,B	41.8516, -80.7272	Green Hill Road	Gageville
10.0	M,F,C,B	41.8742, -80.7158	Hadlock Road	Gageville
6.24	M,F,C,B	41.8556, -80.7622	State Road	Ashtabula South
3.42	M,F,C,B,D	41.87311, -80.78185	Tannery Hill Road	Ashtabula South
2.32	M,F	41.882572, -80.794527	24th Street	Ashtabula North
1.8	M	41.89, -80.7978	upstream Fields Brook	Ashtabula North
1.6	M,F	41.8902333, -80.8002667	upstream & across Fields Brook	Ashtabula North
1.3	F	41.8978, -80.7944	downstream Fields Brook	Ashtabula North
1.2	F	41.897, -80.79435	at fish shelf	Ashtabula North
1.1	M,F	41.8972, -80.7933	at 5½ slip	Ashtabula North
0.9	M,F	41.90011, -80.7945	downstream 5½ slip	Ashtabula North
0.6	M,F	41.9022, -80.7981	coast guard station	Ashtabula North
0.3	M	41.9064, -80.7981	near mouth	Ashtabula North
West Branch Ashtabula River				
11.28	M,F,C,B	41.69695, -80.58568	Hall Road	Leon
9.04	M,F,C,B	41.71414, -80.61453	North Richmond Road	Leon
6.3	M,F,C,B	41.73924, -80.61969	Schrambling Road	Leon
2.7	M,F,C,B,D	41.7817, -80.6178	Graham Road	Pierpont
Tributary to West Branch Ashtabula River (at RM 3.50)				
0.92	M,F,C,B	41.76483, -80.60802	Caine Road	Pierpont
East Branch Ashtabula River				
7.97	M,F,C,B	41.7397, -80.55936	Turner Road	Leon
5.47	M,F,C,B	41.76487, -80.57803	Caine Road	Pierpont
2.4	M,F,C,B,D	41.79845, -80.59433	Adams Road	Pierpont
East Branch of East Branch Ashtabula River				
0.39	M,F,C,B	41.76902, -80.57191	SR 7	Pierpont

Stream* RM	**Sample Type**	**Lat, Long (DD)**	**Location**	**USGS Quad**
Tributary to East Branch Ashtabula River (at RM 1.35)				
1.1	M,F,C,B	41.81175, -80.58082	Scribner Road	Pierpont
Tributary to Tributary to East Branch Ashtabula River (at RM 1.35, 0.80)				
0.3	M,F,C,B	41.8188, -80.58342	Hilldom Road	Pierpont
Ashtabula Creek				
5.24	M,F,C,B	41.8778, -80.5442	Middle Road	Conneaut
0.28	M,F,C,B,D	41.844, -80.6112	Reger Road	Pierpont
Tributary to Ashtabula River (at RM 16.98)				
0.43	M,F,C,B	41.8364, -80.70668	Gageville Road	Gageville
Hubbard Run				
0.21	M,F,C,B	41.85296, -80.77596	upstream tributary at RM 0.20	Ashtabula South
Tributary to Hubbard Run (at RM 0.20)				
0.1	M,F,C,B	41.85312, -80.77566	upstream mouth	Ashtabula South
Strong Brook				
0.46	M,F,C,B,D,O	41.8861, -80.8042	Lake Avenue	Ashtabula North
Fields Brook				
1.84	M,F,C,B,O	41.8931, -80.7726	State Road	Ashtabula North
0.89	M,F,C,B,O	41.889, -80.7868	Columbus Avenue	Ashtabula North
0.33	C,B,D,O	41.893506, -80.792796	15th Street	Ashtabula North

* RM = River Mile of the chemistry sample. The RM for the biological samples and Datasonde© monitors may have been conducted a few tenths of a mile upstream or downstream.

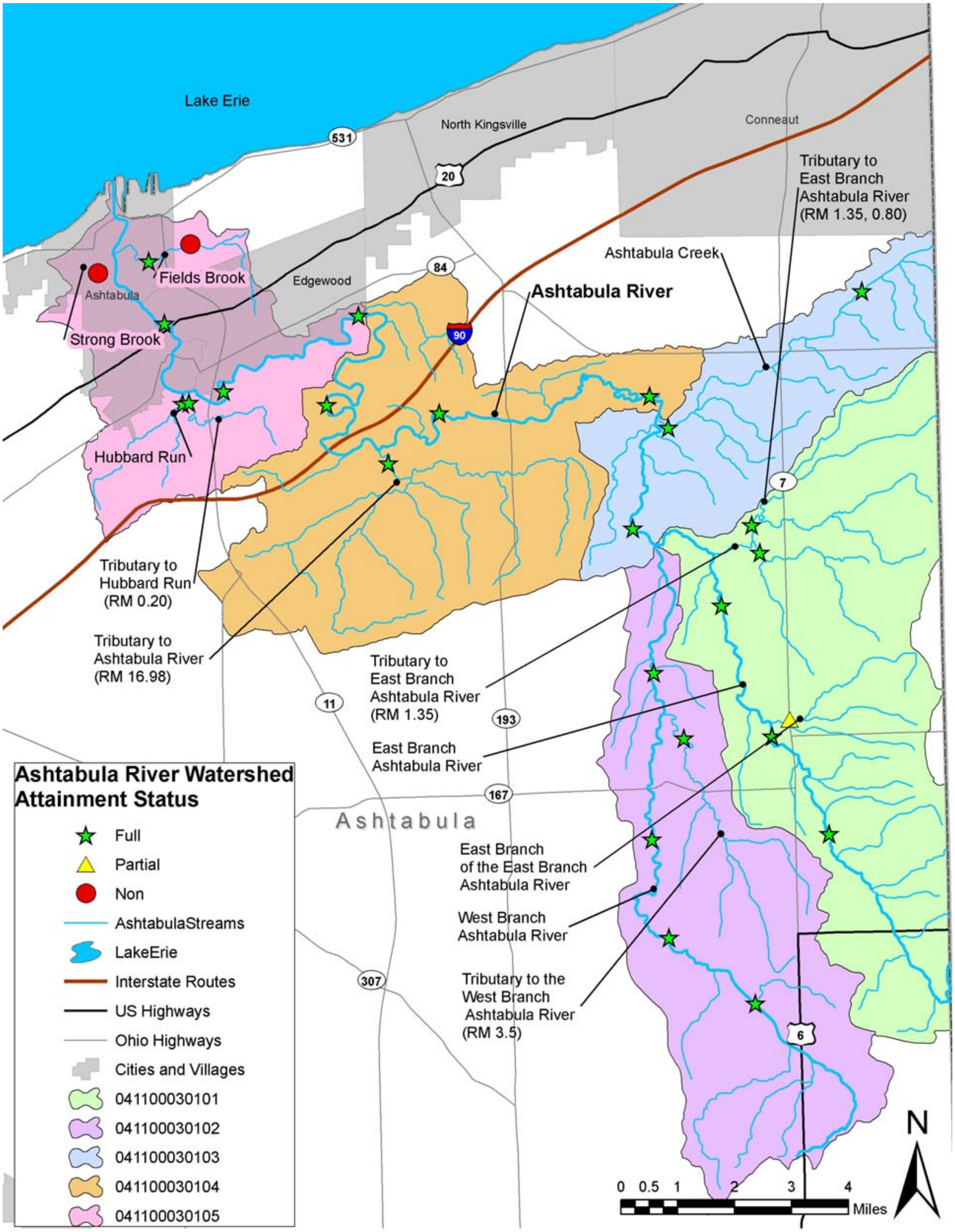


Figure 1. Map of the aquatic life use attainment status in the free-flowing reaches of the Ashtabula River basin, 2011.

Table 2. Aquatic life use attainment status for stations sampled in the Ashtabula River basin based on data collected June-October 2011. The Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biological communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biological communities. The Ashtabula River basin is located in the Erie-Ontario Lake Plain ecoregion.

River Mile[a] - Location	Station	Drain. (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attainment Status[d]	Causes	Sources
Ashtabula River (07-001-000) *WWH Existing*									
27.2[W]/27.0 – Hilldom Road	A01S02	65.2	45	9.6	42	75.0	FULL		
23.7[W]/23.8 – Kelloggsville Road	502810	88.4	50	9.8	42	73.5	FULL		
19.0[W]/19.03 – Benetka Road	A01W20	94	57	9.4	50	75.0	FULL		
14.0[W]/13.9 – Green Hill Road	A01K09	113	49	9.3	50	67.0	FULL		
10.1[W]/9.9 – Hadlock Road	A01K07	118	47	8.1	E	64.0	FULL		
5.8[W]/6.24 – State Road	502760	121	53	9.2	E	71.0	FULL		
3.6[W] – Tannery Hill Road	301398	127	47	9.3	50	76.0	FULL		
Ashtabula River - Lacustuary									
2.3[B]/2.4 – 24th Street	502790	132	44	9.0	44/-	53.1	FULL		
1.8 – upstream Fields Brook	A01K03	132	-	-	20/-	-	(NON)	Direct habitat alteration, alteration in streamside or littoral vegetative cover	Channelization, habitat modification other than hydromidification

River Mile[a] - Location	Station	Drain. (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attainment Status[d]	Causes	Sources
1.6[B] – ust. & across Fields Brook	301777	132	46	9.0	12/24	38.5	PARTIAL	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer
1.3[B] – downstream Fields Brook	A01K02	137	43	8.5	-	33.0	(PARTIAL)	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer
1.2[B] – dst. Fields Br. at fish shelf	301776	137	46	9.9	-	65.0	(FULL)		
1.1[B] – at 5½ slip	300381	137	37	8.7	32/44	54.5	PARTIAL	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer

River Mile[a] - Location	Station	Drain. (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attainment Status[d]	Causes	Sources
0.9[B] – downstream 5½ slip	301397	137	40	9.3	28/22	67.0	PARTIAL	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer
0.6[B] – coast guard station	A01S23	137	42	9.3	24/26	45.0	PARTIAL	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer
0.3 – near mouth	A01K01	137	-	-	24/-	-	(NON)	Direct habitat alteration, alteration in streamside or littoral vegetative cover, priority organics, sediment screening value / exceedance	Channelization, habitat modification other than hydromodification, inappropriate waste disposal, sediment resuspension (contaminated sediment), urban runoff/storm sewer

River Mile[a] - Location	Station	Drain. (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attainment Status[d]	Causes	Sources
West Branch Ashtabula River (07-004-000) *WWH Existing*									
11.2[H]/11.28 – Hall Road	301394	7.6	36[NS]	-	MG[NS]	49.5	FULL		
8.8[H]/9.04 – North Richmond Rd.	301393	12.9	42	-	VG	62.0	FULL		
6.3[H] – Schrambling Road	301392	15.1	42	-	E	70.5	FULL		
2.7[W] – Graham Road	A01K12	31	42	8.4	42	67.8	FULL		
Tributary to West Branch Ashtabula River at RM 3.50 (07-026 / 07-004-001) *Undesignated / WWH Recommended*									
1.0[H]/0.92 – Caine Road	301391	6.8	38[NS]	-	G	67.5	FULL		
East Branch Ashtabula River (07-005-000) *WWH Existing*									
8.0[H]/7.97 – Turner Road	301390	9.3	48	-	G	75.0	FULL		
5.5[H]/5.47 – Caine Road	301389	13.0	48	-	E	72.0	FULL		
2.4[W]/2.7 – Adams Road	301388	21.0	46	8.8	46	75.5	FULL		
East Branch of East Branch Ashtabula River (07-027 / 07-005-001) *Undesignated / WWH Recommended*									
0.4[H]/0.39 – SR 7	301387	2.5	38[NS]	-	F*	76.5	PARTIAL	Natural conditions (interstitial flow)	
Tributary to East Branch Ashtabula River at RM 1.35 (07-028 / 07-005-002) *Undesignated / WWH Recommended*									
1.1[H] – Scribner Road	301385	4.9	40	-	G	72.0	FULL		
Tributary to tributary to East Branch Ashtabula River at RM 1.35, 0.80 (07-029 / 07-005-003) *Undesignated / WWH Recommended*									
0.3[H] – Hilldom Road	301386	8.9	44	-	MG[NS]	89.3	FULL		
Ashtabula Creek (07-003-000) *WWH Existing*									
5.3[H]/5.24 – Middle Road	A01S16	10.0	38[NS]	-	E	76.5	FULL		
0.3[H]/0.28 – Reger Road	301395	17.3	44	-	48	86.0	FULL		
Tributary to Ashtabula River at RM 16.98 (07-025 / 07-001-002) *Undesignated / WWH Recommended*									
0.4[H]/0.43 – Gageville Road	301396	17.3	48	-	G	60.0	FULL		

River Mile[a] - Location	Station	Drain. (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attainment Status[d]	Causes	Sources
Hubbard Run (07-002-000) *WWH Existing / CWH Recommended*									
0.25[H]/0.21 – ust. Trib. (RM 0.20)	301399	2.7	38	-	E	82.5	FULL		
Tributary to Hubbard Run at RM 0.20 (07-016 / 07-002-001) *Undesignated / CWH Recommended*									
0.1[H] – upstream mouth	301400	2.1	40	-	E	69.3	FULL		
Strong Brook (07-013 / 07-001-001) *LRW Existing*									
0.6[H] – Lake Avenue	502800	2.7	12*	-	P	58.3	NON	PCBs and PAHs in sediments	Urban runoff, Inappropriate waste disposal
Fields Brook (07-010-000) *WWH Existing*									
1.8[H]/1.84 – State Road	A01W09	1.5	32*	-	F*	47.0	NON	Direct habitat alterations	Channelization
0.5[H]/0.9 – Columbus Avenue	A01W14	3.4	48	-	MG[NS]	70.0	FULL		

Biological Criteria/Targets **Erie - Ontario Lake Plains**				
Index – Site Type	**EWH**	**WWH**	**MWH**	**LRW**
IBI - Headwaters	50	40	24	18
IBI - Wading	50	38	24	18
IBI - Boat	48	40	24	16
IBI – Lacustuary Target[e]	-	42	-	-
MIwb - Wading	9.4	7.9	6.2	4.5
MIwb - Boat	9.6	8.7	5.8	5.0
MIwb – Lacustuary Target[e]	-	8.6	-	-
ICI	46	34	22	8
ICI – Lacustuary Target[e]	-	34	-	-

a If two river miles are listed, the first is for the fish station and the second is for the macroinvertebrate station. H - headwater site. W - wading site, B - boat site.

b MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

c A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional. The lacustuary stations were evaluated with the Lacustuary ICI (LICI) and were sampled in the mid-channel (first LICI score) and near the margin (second LICI score).

d Attainment status is given for the existing or if a change is proposed then the proposed use designations. Attainment status was not assigned to isolated stream segments that were sampled with only qualitative macroinvertebrate methods.

e No biological criteria for lacustuaries are promulgated in the Ohio WQS: IBI, MIwb, and ICI targets are used to help determine a narrative assessment of the designated WWH aquatic life use status.

NS Nonsignificant departure from applicable aquatic life use biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

* Indicates significant departure from applicable aquatic life use biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

INTRODUCTION

Figure 2. Location of the Ashtabula River watershed in Ohio.

The Ashtabula River watershed, delineated by United States Geological Survey as 8-digit hydrological unit code (HUC) 04110003, is located in the northeast corner of Ashtabula County in northeast Ohio (Figure 2). In 2011 the Ohio EPA conducted a water resource assessment of the Ashtabula River mainstem and tributaries using standard Ohio EPA protocols as described in Appendix A. Included in this study are assessments of the biological, habitat, surface water, sediment, and recreational (bacterial) condition. The Ashtabula River mainstem and twelve tributaries were evaluated with a total of 26 biological, 26 habitat, 27 water chemistry and 26 recreation stations sampled within the study area. Eight stations were sampled in 2012 from Strong Brook and its tributaries to evaluate sediment contamination (Table S1). Nine stations were also sampled in the lacustuary in 2011 as part of a Great Lakes Restoration Initiative (GLRI) grant (#GL00E00569) received by Ohio EPA and these will be further assessed and reported on in detail by that process.

Specific objectives of the evaluation were to:

- establish the present biological conditions in the study area by evaluating fish and macroinvertebrate communities,
- assess physical habitat influences on stream biotic integrity,
- identify the relative levels of organic, inorganic, and nutrient parameters in the sediments and surface water,
- determine recreational water quality,
- compare present results with historical conditions,
- assign uses to undesignated streams, and
- determine the attainment status of the existing beneficial use designations, and recommend changes if appropriate.

The study area is located in the Erie-Ontario Lake Plains (EOLP) ecoregion and most streams are currently assigned the Warmwater Habitat (WWH) aquatic life use designation, or are currently undesignated, in the Ohio Water Quality Standards (WQS). The Ashtabula River mainstem along with its West Branch and East Branch are designated WWH, and the lower 5.8 miles of the mainstem is also designated Seasonal Salmonid Habitat (SSH). Most of the tributaries were sampled by Ohio EPA for the first time during 2011 and were either undesignated or had unverified beneficial uses. In addition, most streams are currently assigned the following uses: Primary Contact Recreation (PCR), Agricultural Water Supply (AWS) and Industrial Water Supply (IWS).

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

STUDY AREA

Among Ohio's significant Lake Erie tributary rivers, the Ashtabula with a 137 mi^2 drainage area is the smallest. Located east of Cleveland, with 10 mi^2 of watershed across the Pennsylvania border, the Ashtabula River enters Lake Erie near the State's far northeastern corner (Figure 2). This location places the basin directly within the Lake's Snow Belt where 70 inches fall annually. Including snow, the area's annual 40 inches of precipitation ranks among the wetter places in the State. See the ODNR Division of Soil and Water Resources, Water Inventory web site for more information, http://www.dnr.state.oh.us/tabid/4237/Default.aspx.

Excepting Pennsylvania's portion, the Ashtabula watershed is wholly contained within Ashtabula County. Conceptually the Ashtabula River is formed by the confluence of the West and East Branches (65 mi^2, 16.5 mi. long and 31 mi^2, 10.7 mi. long, respectively). From this juncture the Ashtabula River flows 39.7 miles and falls an average 11.6 feet until it meets Lake Erie. Ashtabula Creek (17.8 mi^2, 10 mi. long) and an unnamed stream which joins the Ashtabula River at RM 16.98 (17.4 mi^2, 6 mi. long) are principal tributaries. Smaller named tributaries include Hubbard Run (3 mi^2, 3.1 mi. long), Strong Brook (3 mi^2, 1.5 mi. long) and Fields Brook (4 mi^2, 2.5 mi. long). Fields Brook is also reported with a 6 mi^2 drainage area if a diverted upper portion of the subbasin is included.

Fields Brook joins the Ashtabula River at RM 1.6. Numerous industrial operations contributed to a legacy of environmental contamination within the small subbasin. Following a 1986 Record of Decision publication, the US EPA began the formal process of remediating the Fields Brook area as a Superfund site. Potentially responsible parties were identified and ensuing cost recovery procedures were implemented. After a decade of further study, planning, and legal discussions, physical operations to treat and dispose hazardous waste-laden sediments and soil began in 2000. The most expansive cleanup operations were completed by 2003. Work has continued at the Fields Brook Superfund site and new activities are anticipated through 2013 (http://www.epa.gov/region5/cleanup/fieldsbrook/index.htm).

In 1983 lower Ashtabula River fish were deemed unsafe to eat. Contaminated sediments mostly emanating from Fields Brook were specified as a source of impairment. Hoping to address this and the loss of other beneficial uses, the lowest two miles of the Ashtabula River were defined as an Area of Concern (AOC), an Ashtabula River Remedial Action Plan (RAP) Advisory Council was formed, and in 1991 a Stage 1 report was produced. Following limited dredging in 1993 to aid recreational boaters, deeper dredging to facilitate commercial shipping was stymied by disposal constraints for the underlying toxic stream bed materials.

Recognizing the need for dredging and preferring the RAP type process over actions associated with Superfund site designation, local leaders formed the Ashtabula River Partnership in 1994 and the Ashtabula River Cooperation Group in 1997. Private and public stakeholders worked together in these affiliations to produce the *Ashtabula River Comprehensive Management Plan and Environmental Impact Statement* in 2002. Concurrent passage of the Great Lakes Legacy Act enabled federal matching funds to become available for the dredging project in 2005. The Ashtabula City Port Authority secured matching funds and provided leadership for the $60 million sediment remediation effort completed in 2008. The US Army Corps of Engineers completed an additional $15 million downstream dredging project to fully open passage to the Lake at the same time (http://www.epa.gov/greatlakes/aoc/ashtabula/index.html).

To further the recovery of beneficial uses in the Ashtabula River AOC, habitat enhancement features were installed along the banks of the 5½ slip at RM 1.1. The Ashtabula City Port Authority with help from Cooperation Group members, accessed easements from the Norfolk

Southern Railway, and with $1.4 million via the Great Lakes Legacy Act, began the restoration in 2009 (http://www.epa.gov/glla/ashtabula/index.html). An additional $1.5 million Great Lakes Restoration Initiative (GLRI) grant completed the project in 2012. (http://greatlakesrestoration.us/index.html)

During the time that dredging operations were conceived and accomplished, a separate procedure to stipulate financial accountability for Ashtabula River pollution also progressed. In 2001 the Natural Resource Trustees, including representatives from the US Department of the Interior (US Fish and Wildlife Service), the US Department of Commerce (National Oceanic and Atmospheric Administration), and the Ohio EPA under authorities of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA a.k.a. Superfund program) and the Federal Water Pollution Control Act (FWPCA a.k.a. Clean Water Act) began a Natural Resource Damage Assessment (NRDA) to describe the amount of environmental degradation in the Ashtabula River area. A Consent Decree was signed in 2012. Valued at $5.5 million, acquisition and restoration of ecologically important river property and cost reimbursement were specified components of the agreement. (http://www.fws.gov/midwest/es/ec/nrda/AshtabulaRiverNRDA/)

Since 2008, $9.6 million in GLRI funding has been secured to continue dredging. NRDA settlement money was dedicated for sediment removal in pursuit of habitat improvement. Based on an US Army Corps of Engineers estimate, dredging at the current pace only maintains the status quo. A backlog of sediment ten times the amount annually removed on average remains within the Ashtabula Harbor (USACE 2012). Therefore, upland practices which prevent or minimize soil movement and erosion will reduce dredging costs and at the same time improve water resource quality.

Ohio EPA participated in the dredging projects with technical support, direct funding, and active participation at numerous meetings. An initial 1989 study, *Biological Community Status of the Lower Ashtabula River and Harbor Within the Area of Concern* (Ohio EPA 1992), characterized some of the AOC pollution issues. In 1995, the *Biological and Water Quality Study of the Grand and Ashtabula River Basins* (Ohio EPA 1997) discussed issues in the upstream reaches of the watershed. The 2003 *Biological Study of the Lower Ashtabula River and Conneaut Creek* (Ohio EPA 2006) was conducted primarily to support the NRDA process. Likewise, the 2007 *Fish Community Aquatic Life Use Attainment Study, Upper Mainstem Ashtabula River*, *2007* (Ohio EPA 2007) was a limited investigation to support the State Scenic River designation interests. Many of these documents can be found at the following web site: (http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx).

The Ashtabula River became Ohio's 14th State Scenic River in 2008. The designation recognizes high quality streams that retain most of their natural characteristics. Beyond necessary natural features, evidence of community support is required to obtain State Scenic River status. Having three Scenic Rivers within its boundaries uniquely distinguishes Ashtabula County in Ohio.

ODNR conducted a survey of the natural and cultural features within the Ashtabula River basin in 2008 (Smith 2008). The *Ashtabula State Scenic River Designation Study* is available at http://www2.ohiodnr.gov/Portals/watercraft/PDFs/sr/AshtabulaSRStudy.pdf . The study includes narratives of principal stream physical conditions, an accounting of plant and animal species, and several GIS-based maps depicting watershed natural resources. The ODNR study notes the critical functions provided by streamside forested buffer strips and cautions against unwise water use in this low flow prone watershed (Smith 2008: 41-42).

Although the Ashtabula River basin annually receives above Ohio average rainfall, it also annually exhibits low to nearly intermittent flow. In 1995, Ohio EPA (1997: 85) noted low flow conditions exacerbated stresses associated with residential on-site sewage treatment and livestock farming operations. These sources were inferred to have contributed to an organic load which challenged stream assimilative capacity. Low dissolved oxygen (D.O.) values were referenced as a cause of aquatic community impairment, but the lack of flow was deemed more stressful and the variable source of water was accepted as a natural or typical background exposure condition.

The area Mahoning soils common throughout the watershed have slow permeability and underlying shales return little ground water to surface flows (Schiefer 2002: 79). Agricultural and developed land uses further influence local hydrology (Figure 3, Table 3). Drainage improvements, encouraged since settlement (Williams 1878: 16) and continuing today, lower the local water table. Combined, these factors expedite surface runoff and impede infiltration. So, although the Ashtabula basin has a high mean annual runoff (17.3" compared to 10" to 21" statewide, Schiefer 2002: 81, 27), it routinely exhibits zero summer low flow conditions (Q7, 2=0 cfs).

Since intermittent flow tends to recur annually in the Ashtabula watershed, this may be regarded as a "natural" condition. The distinction recognizes past hydromodification to be widespread across Ohio and assumes reference conditions from which biocriteria were derived were also subject to the array of typical drainage improvement projects. It's possible that the Ashtabula basin's low flows are exacerbated beyond the normal convention. Numerous wetlands once dominated the Ashtabula basin and many drainage ditches have been established.

It's difficult to substantiate concern that the routine lack of water in the Ashtabula basin is compounded by any human influence unique to the watershed. Rather, the Ashtabula catchment may be uniquely susceptible to the typical drainage enhancements frequent throughout Ohio. The areas fairly homogeneous till soils are better at shedding water, not retaining it. That quality also limits the soil capacity for home site sewage treatment and breakdown of livestock waste. The Natural Resources Conservation Service characterizes all Ashtabula watershed soils to have *very limited* capacity for sewage or livestock waste treatment (Milliron et al. 2007: 426, 447).

Historically, the Ashtabula River once flowed a few blocks from the center of Kelloggsville (Lake 1874). A cut off channel formed and other modifications occurred apparently as a consequence of a severe flood in 1878. The 1906 Conneaut, O.-PA. United States Geological Survey (USGS) topographic map shows the Ashtabula River with a large island south from Kellogsville (USGS 1906). By 1960, the northern loop had been abandoned, but another channel formed downstream, creating a new island area (Figure 4, USGS 1960a, USGS 1960b). Contemporary maps appear similar to the 1960 conditions. In 2011, the Ashtabula River upstream from Stanhope Kellogsville Road (the north south bisecting route in Figure 4) was unstable. Outside bends of the two closest meanders were severely eroded. Overall, this reach appeared to be in disequilibrium with periodically elevated storm flows.

Table 3. Ashtabula watershed land use.

Sub basin 04110003 01 xx	Developed	Forest	Grass/Pasture	Row Crops	Other
East Branch Ashtabula River 01 (37.3 mi^2)	5.4%	45.9%	14.2%	26%	8.4%
West Branch Ashtabula River 02 (27.7 mi^2)	4.2%	40.1%	15.4%	32.3%	7.9%
Upper Ashtabula River 03 (23.3 mi^2)	6.2%	42.5%	12.2%	34.8%	4.3%
Middle Ashtabula River 04 (30.4 mi^2)	8%	45.5%	14.5%	27.7%	4.2%
Lower Ashtabula River 05 (18.3 mi^2)	53.1%	31.3%	6.5%	6.4%	2.7%

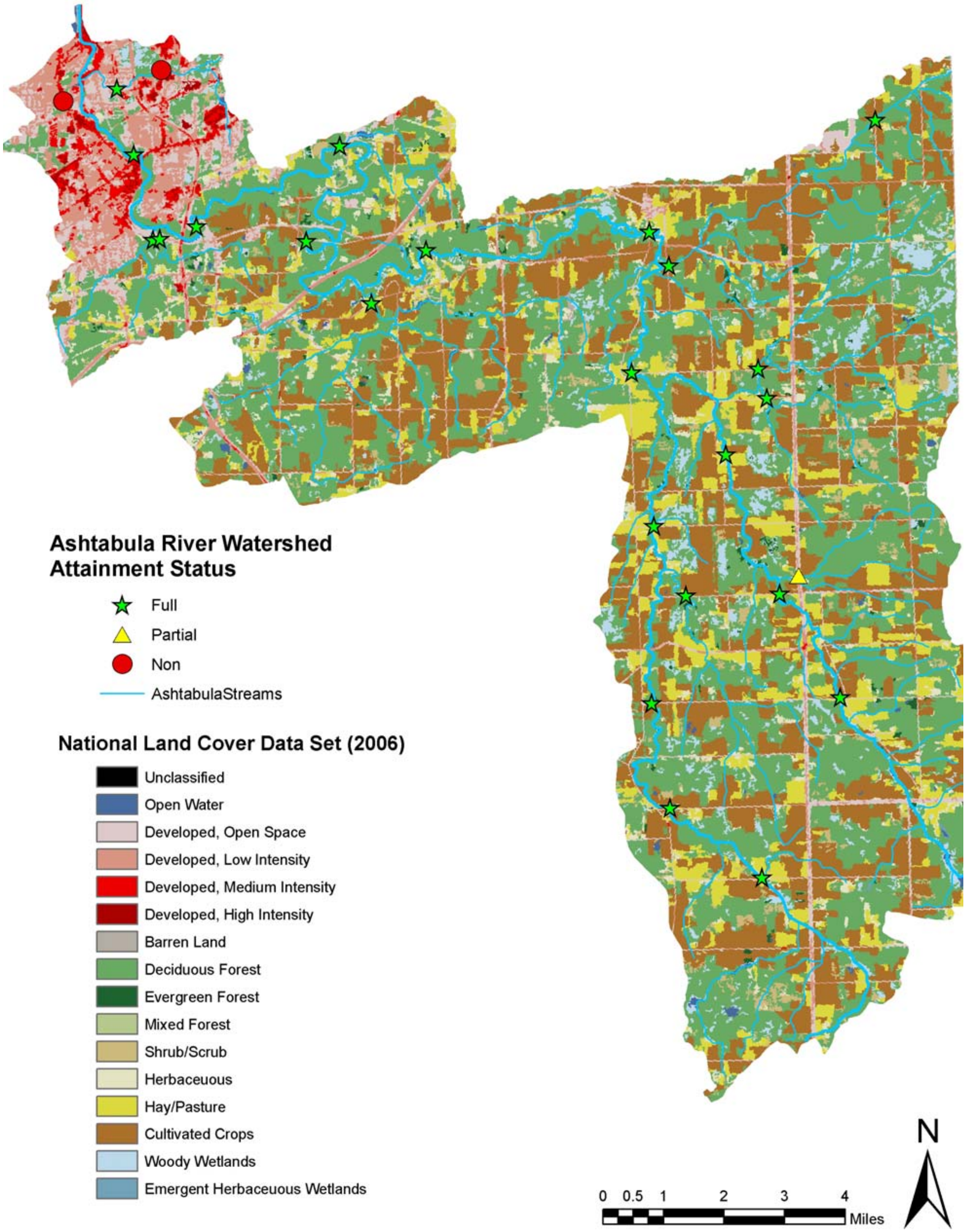


Figure 3. Map of land use in the Ashtabula River watershed (Fry et al. 2011) and the aquatic life use attainment status in the free-flowing reaches.

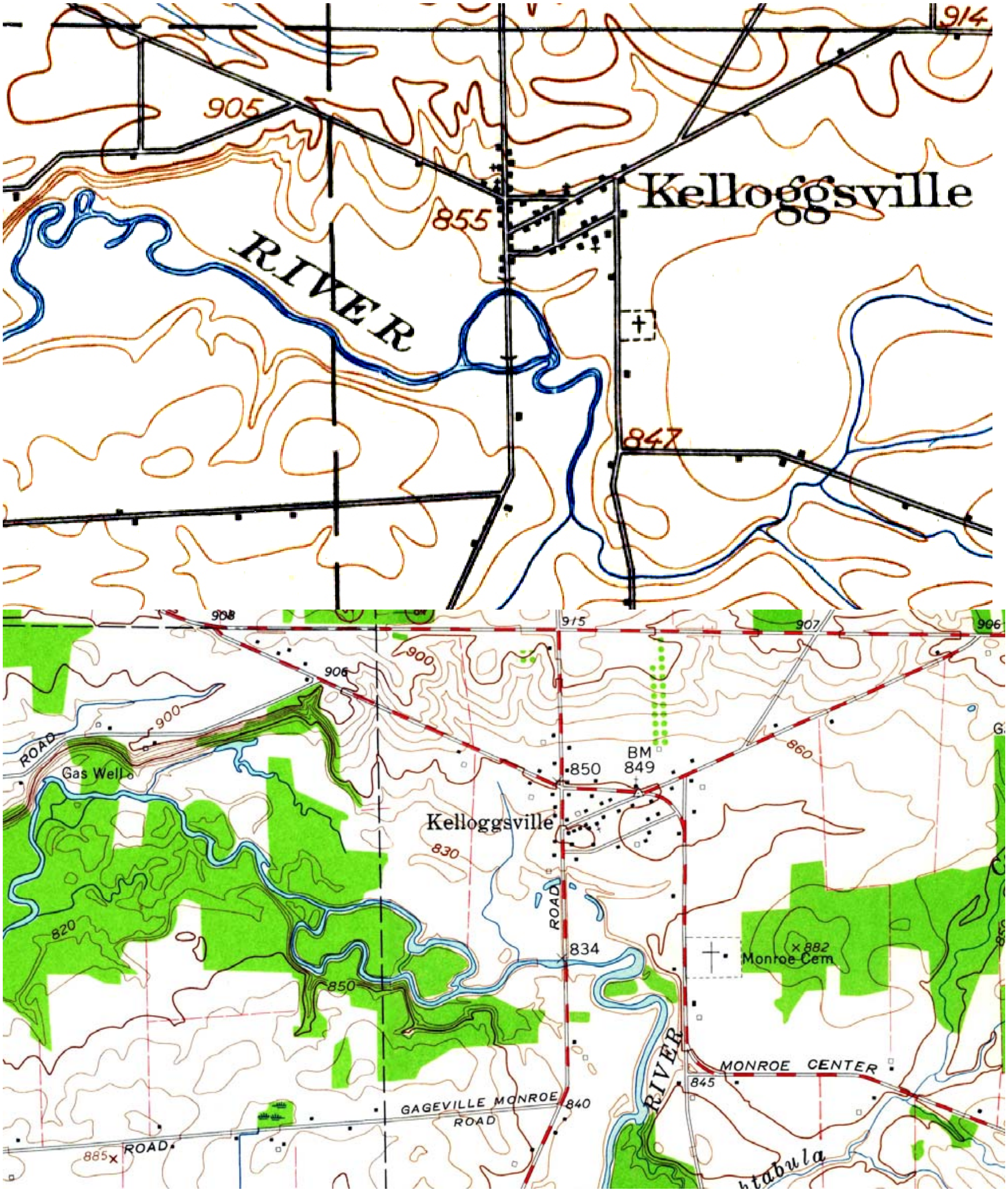


Figure 4. USGS topographic maps showing Ashtabula River changes in the Kelloggsville vicinity. Top map cropped from 1906 Conneaut quadrangle. Bottom map cropped and joined from 1960 Gageville and Pierpont quadrangles.

RECOMMENDATIONS

The majority of the streams listed in the Ohio Water Quality Standards for the study area are assigned the WWH aquatic life use designation (Table 4). These streams were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. For a number of streams in the study area, this study was the first time that biological data was used to evaluate and verify aquatic life uses.

Thirteen streams were evaluated for aquatic life use and recreation use potential during 2011. Significant findings include the following.

- Five undesignated streams were evaluated for the first time and are recommended for the WWH aquatic life use designation. Tributary to Ashtabula River at RM 16.98, Tributary to West Branch Ashtabula River at RM 3.50, East Branch of East Branch Ashtabula River, Tributary to East Branch Ashtabula River at RM 1.35 and Tributary to East Branch Ashtabula River at RM 1.35, 0.80 were supporting biological communities that were meeting or marginally meeting WWH expectations, except for E. Br. of E. Br. Ashtabula River in which the macroinvertebrate community was evaluated as fair due to natural conditions (interstitial flow). All of these streams had instream habitat sufficient to support WWH biological communities with QHEI scores between 60.0 and 89.3.

- Ashtabula Creek was evaluated for the first time during this study and its current WWH aquatic life use designation is confirmed. The stream was supporting biological communities that were meeting or marginally meeting WWH expectations and the instream habitat was sufficient to support WWH biological communities with QHEI scores of 76.5 and 86.0.

- Hubbard Run and the Tributary to Hubbard Run at RM 0.20 were evaluated for the first time during this study. Both of these streams are recommended for the Coldwater Habitat (CWH) aquatic life use designation. They both were supporting cold water macroinvertebrate communities with eight and seven cold water taxa, respectively. Reproducing populations of rainbow trout were also present in both streams.

The remaining streams in this study should retain their current aquatic life habitat, water supply and recreation uses.

Other Recommendations

The Ashtabula River watershed has a tendency toward low to intermittent summer flows which reduces the watershed’s ability to assimilate pollutants. Therefore, every effort should be made to prevent increases in pollution loadings from sources like residential on-site sewage treatment and livestock farming operations.

Biological communities in the Ashtabula River lacustuary have improved since the dredging of contaminated sediments and installation of habitat enhancements. Subsequent sediment collections by the US EPA should be evaluated to see if contaminated sediment should be removed as a cause of aquatic life use impairment. Biological communities should be periodically monitored to see if further improvements are realized.

The Hadlock Road ford on the Ashtabula River (RM 10.04) appears to be a barrier to fish migration. Twice as many fish species were found downstream (67) from the ford compared to upstream (32). Therefore, the feasibility of removing the ford and replacing it with a bridge should be investigated.

The sediments in Strong Brook were contaminated with PCBs, PAHs and metals. These findings indicate that probable periodic inputs of these contaminants continue to be a source of toxicity to aquatic life in Strong Brook and the Ashtabula River lacustuary. The Clean Harbors PPM, LLC facility was identified as the longtime source of the PCBs and needs continued scrutiny to make sure it is no longer contributing PCBs to the basin. The other contaminants may be entering the stream from industrial runoff or spills and every effort should be made to prevent further inputs and to mitigate future spills.

Table 4. Waterbody use designation recommendations for the Ashtabula River watershed. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+) and a delta (▲) indicates a new recommendation based on the findings of this report. Plus sign designations shaded in gray are to be replaced by the new recommendations (▲). Designations based on the 1978 and 1985 standards for which the results of a biological and habitat assessment are now available are displayed to the left of the existing markers.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Ashtabula River – st. rte. 11 (RM 5.8) to mouth		+			O				+	+		+		
- all other segments		+							+	+		+		
Strong Brook							+			*/+		*/+		Small drainageway maintenance
Fields Brook		+								+		+		
West Brook							+			+			+	Small drainageway maintenance
Hubbard Run		*				▲			*/+	*/+		*/+		
Tributary to Hubbard Run @ RM 0.20						▲			▲	▲		▲		
Tributary to Ashtabula River @ RM 16.98		▲							▲	▲		▲		
Ashtabula Creek		*/+							*/+	*/+		*/+		
West Branch		+							+	+		+		
Tributary to West Branch @ RM 3.50		▲							▲	▲		▲		
East Branch		+							+	+		+		
East Branch of East Branch		▲							▲	▲		▲		
Tributary to East Branch @ RM 1.35		▲							▲	▲		▲		
Trib. to Trib. to East Branch @ RM 1.35, 0.80		▲							▲	▲		▲		

RESULTS

Macroinvertebrate Community

Macroinvertebrate communities were evaluated at 26 stations in the free-flowing part of the Ashtabula River study area and at seven stations in the lacustuary (Table 6, Appendices B and C). The community performance (outside of the lacustuary) was evaluated as exceptional at 12 stations, very good at 4, good at 4, marginally good at 3, fair at 2 and poor at 1. The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was on the Ashtabula River at Green Hill Road (RM 13.9) with 35 taxa. The station with the highest number of total sensitive taxa was on the Ashtabula River at Hilldom Road (RM 27.0) with 35 taxa. Eighteen intolerant or uncommonly collected sensitive taxa were collected during this survey (Table 5) including the state listed (Species of Concern) mayfly *Maccaffertium ithaca*. Also, this was the first reported collection of the mayfly *Plauditus gloveri* from Ohio. Eight species of freshwater mussels were collected during this study and their collection locations are listed in Table 5. In addition to the freshwater mussels found during this study, Watters et al. (2009) reported *Lasmigona compressa* (creek heelsplitter, state listed Species of Concern) as recently collected from the watershed. This study area had a relatively high number of intolerant or uncommonly collected sensitive taxa which is an indication of the very good to exceptional resource quality in the Ashtabula River basin.

Ashtabula River Mainstem

The free-flowing portion of the Ashtabula River mainstem was sampled at seven stations in 2011. All of the stations were achieving the WWH macroinvertebrate biocriterion with an average ICI score (5 values) of 46.8 (exceptional) plus two stations without ICI scores that were narratively evaluated as exceptional (Figure 5, Table 6). All of the stations had highly diverse qualitative sample EPT (21-31, average 27.1) and sensitive taxa (19-34, average 26.1) diversity, meeting or greatly exceeding Exceptional Warmwater Habitat (EWH) expectations (Ohio EPA 2013). The majority of the intolerant and uncommonly collected taxa and freshwater mussel species listed in Table 5 were collected from the Ashtabula River mainstem. All of the macroinvertebrate stations sampled on the free-flowing Ashtabula River mainstem during this study were supporting communities that would be consistent with the EWH aquatic life use designation.

The Ashtabula River mainstem becomes affected by Lake Erie backwater (lacustuary) around RM 2.6. Seven stations were sampled in the lacustuary during 2011 (Tables 2 and 6, Figures 6 and 7). Outside of the upstream portion of the lacustuary, the macroinvertebrate communities were typically not meeting the interim lacustuary target (34) with an average L-ICI score of 27 (fair). The station with the lowest score (L-ICI=12 at RM 1.6 A) was located near the confluence of Strong Brook (RM 1.62) and Fields Brook (RM 1.6). These results were similar to previous years with the lowest L-ICI scores near the confluence of Strong Brook and Fields Brook. One measure of community performance used in the 2006 lower Ashtabula River report (Ohio EPA 2006: 17) was the relative abundance of toxic tolerant Chironomidae (primarily *Dicrotendipes simpsoni*) as a percentage of the total number of Chironomidae within each sample. This was used as a measure of the toxicity of the river environment. Figure 7 plots this measure for the 2011 and 2003 surveys. The 2011 data indicated considerable improvement in the vicinity of the Strong Brook and Fields Brook confluences with percentages of 14.8 (RM 1.6 A) and 21.8 (RM 1.6 B) compared to 91.7 (RM 1.65) and 34.4 (RM 1.58) in 2003.

West Branch Ashtabula River Subbasin

The West Branch Ashtabula River was sampled at four stations in 2011. All of the stations were achieving or marginally achieving the WWH macroinvertebrate biocriterion with one ICI score of 42 (very good) plus three stations without ICI scores that had evaluations ranging from marginally good to exceptional. The community at Hall Road (RM 11.28) was moderately influenced (marginally good evaluation) by fair habitat quality, sedimentation, low flow and enrichment as the result of channelization and runoff. The instream habitat and community performance improved at the remaining three downstream stations. The state listed Species of Concern mayfly *Maccaffertium ithaca* was collected at Schrambling Road (RM 6.3).

The macroinvertebrate community sampled from the Tributary to West Branch Ashtabula River (@ RM 3.50) was meeting the proposed WWH use designation based on a good evaluation.

East Branch Ashtabula River Subbasin

The East Branch Ashtabula River was sampled at three stations in 2011. All of the stations were achieving the WWH macroinvertebrate biocriterion with one ICI score of 46 (exceptional) plus two stations without ICI scores that had evaluations of good and exceptional. The state listed Species of Concern mayfly *Maccaffertium ithaca* was collected at Caine Road (RM 5.47).

The macroinvertebrate community sampled in the East Branch of East Branch Ashtabula River was limited by interstitial flow and received a narrative evaluation of fair. The rheophilic component of the community was absent due to the lack of flow. There was no discernable anthropogenic cause of the interstitial flow.

The macroinvertebrate community sampled in the Tributary to East Branch Ashtabula River (at RM 1.35) was performing in the good range with moderate to high EPT (16) and sensitive taxa (15) diversities. Indications of mild community impact were the unusually high predominance of flatworms (facultative) and absence of sensitive baetid and heptageniid mayflies in the riffle habitat. This station was sampled during an extended period of low flow when a D.O. concentration of 3.78 mg/l was recorded at this station.

The macroinvertebrate community sampled in the Tributary to Tributary to East Branch Ashtabula River (at RM 1.35, 0.80) was performing in the marginally good range with moderate

EPT (12) and low sensitive taxa (8) diversities. The community at this station was mildly impacted by low flow and runoff from open pasture.

Tributaries to the Ashtabula River Mainstem

The macroinvertebrate communities sampled in Ashtabula Creek (RMs 5.24 and 0.28) were performing in the exceptional range with high EPT (24, 28) and sensitive taxa (20, 26) diversities, respectively.

The macroinvertebrate community sampled in the Tributary to Ashtabula River at RM 16.98 was performing in the good range with moderate to high EPT (17) and moderate sensitive taxa (15) diversities.

The macroinvertebrate communities sampled in Hubbard Run (RM 0.21) and the Tributary to Hubbard Run at RM 0.20 (RM 0.1) were performing in the exceptional range with high EPT (19 and 17, respectively) and sensitive taxa (20 and 17, respectively) diversities. Both of these streams had moderately diverse cold water taxa diversities (8 and 7, respectively), which would be consistent with CWH expectations.

The macroinvertebrate community sampled in Strong Brook (RM 0.6) was performing in the poor range with very low EPT diversity (3) and without any sensitive taxa present. The EPT taxa collected were all pollution facultative and were not predominant. The predominant taxa were two types of midges in the genus *Cricotopus* including *C. bicinctus* which is documented to be tolerant to toxic concentrations of heavy metals and petroleum products pollution (Rosenberg and Wiens 1976, Surber 1959, Winner et al. 1980, Ohio EPA data). The macroinvertebrate community present at this station was consistent with a toxic impact.

Fields Brook was sampled at two stations in 2011. The station at State Road (RM 1.84) was not meeting WWH macroinvertebrate expectations with low to moderate EPT (9) and very low sensitive taxa (3) diversities and facultative and tolerant taxa predominant (Figure 8, Table 6). This station had fair habitat quality (QHEI=47) due to channelization and was located downstream from at least four major chemical plants. The community sampled at Columbus Avenue (RM 0.9) improved into the marginally good range with moderate EPT (13) and low sensitive taxa (5) diversities along with one sensitive taxon (*Chimarra obscura*) among the predominant organisms. The mayfly component of the community was still impacted with no sensitive mayflies present in the riffle or run habitats. This indicates that Fields Brook is at least mildly impacted by runoff or discharges from adjacent urban areas or upstream industries. Stream habitat at this station improved into the excellent range (QHEI=70).

Macroinvertebrate Trends

The 2011 survey was the first time that the majority of the Ashtabula River basin was systematically sampled. The Ashtabula River mainstem was sampled at four stations in 1995. The communities sampled during this study were performing substantially better than in 1995 with very good (2 sites) to exceptional (5 sites) evaluations compared to marginally good (3 sites) to exceptional (1 site) (Figure 5). A similar trend was observed at a station near the mouths of the West Branch Ashtabula River (very good in 2011 compared to marginally good in 1995 and good in 1984) and the East Branch Ashtabula River (exceptional in 2011 compared to marginally good in 1995). The macroinvertebrate communities sampled in Fields Brook during this study demonstrated moderate improvement compared to sampling in 2000 (Figure 8).

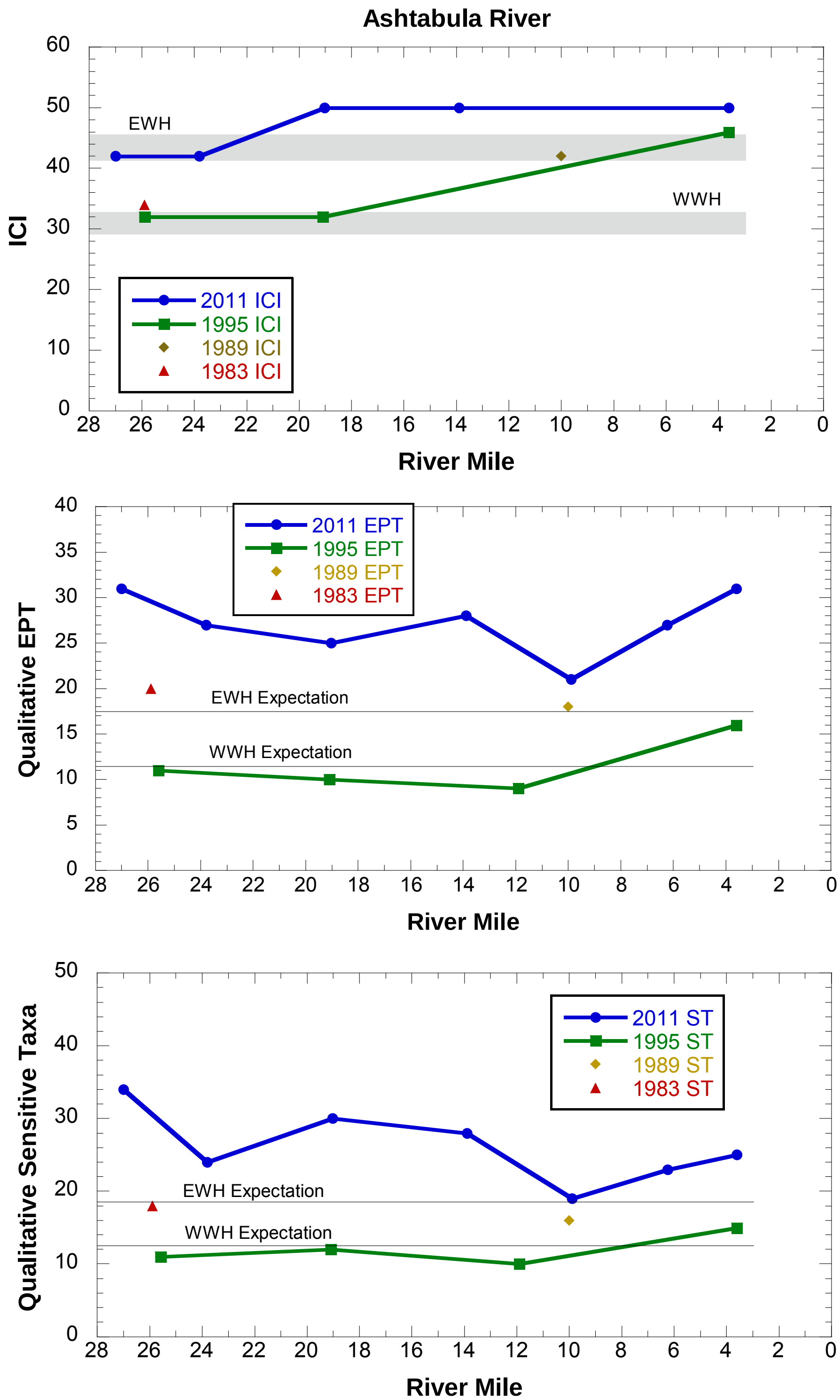


Figure 5. Longitudinal trend of the Invertebrate Community Index (ICI), number of mayfly, stonefly, and caddisfly taxa (EPT) in the qualitative samples, and number of sensitive taxa (ST) in the qualitative samples in the Ashtabula River, 1983-2011.

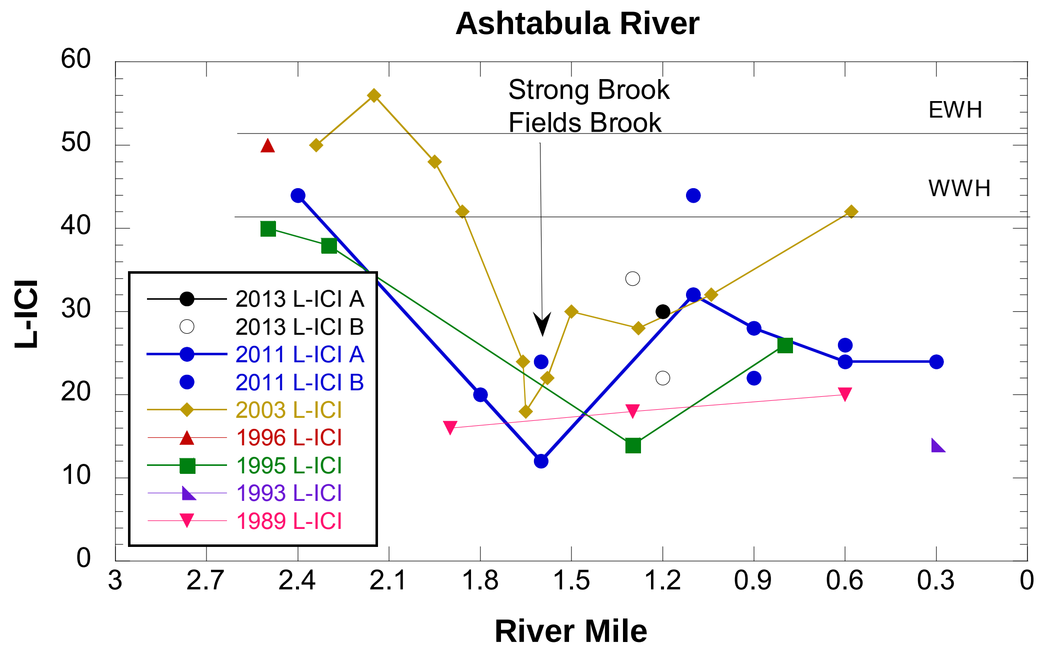


Figure 6. Longitudinal trend of the Lacustuary Invertebrate Community Index (L-ICI) in the Ashtabula River lacustuary, 1989-2013. The A samples were collected from mid-channel and the B samples were collected near the margin.

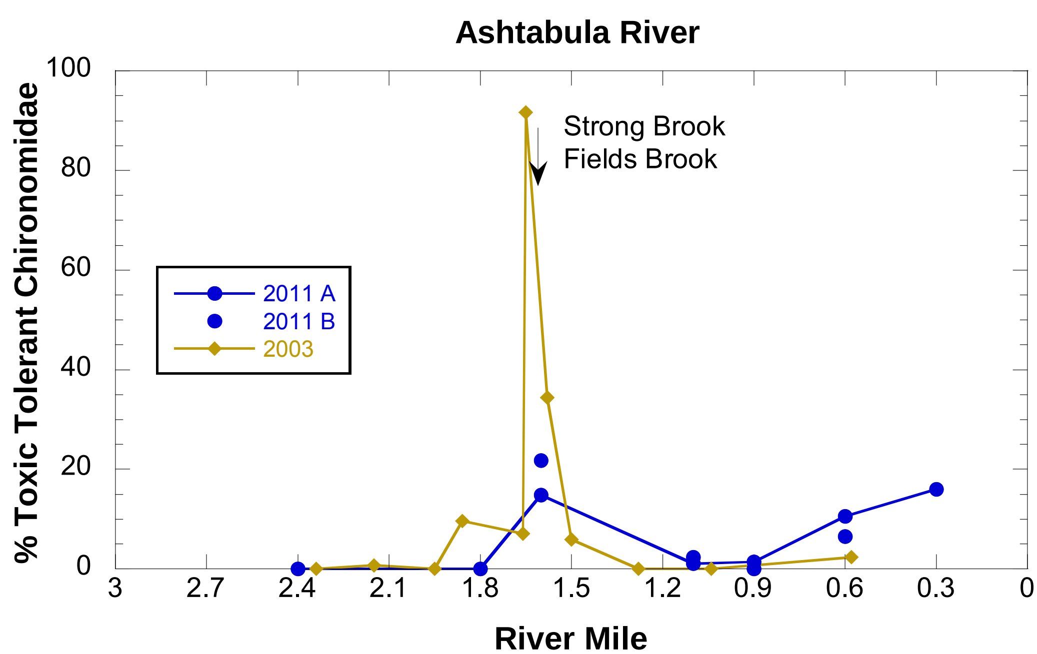
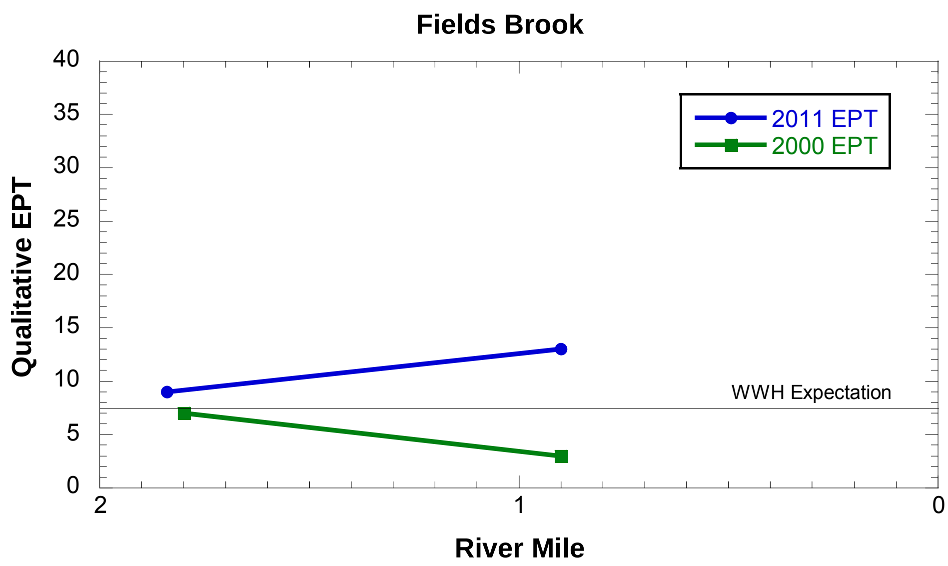


Figure 7. Longitudinal trend of the percent insect family Chironomidae (midges) that were toxic tolerant in the Ashtabula River lacustuary, 2003-2011. The A samples were collected from mid-channel and the B samples were collected near the margin.



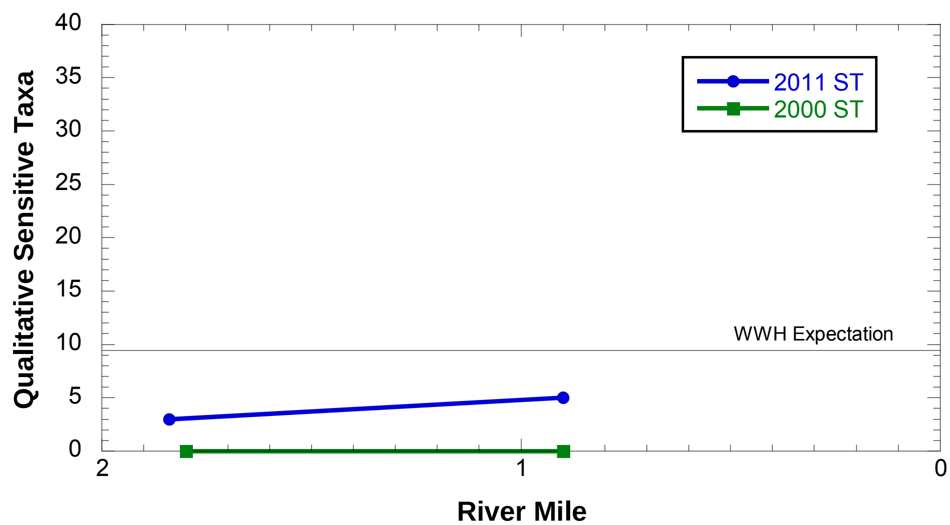


Figure 8. Longitudinal trend of the number of mayfly, stonefly, and caddisfly taxa (EPT) and number of sensitive taxa (ST) in the qualitative samples in Fields Brook, 2000-2011.

Table 5. Intolerant or uncommonly collected sensitive macroinvertebrate taxa and all freshwater mussel collection locations in the Ashtabula River basin, 2011. State listed species: **SC**=Species of Concern.

Taxa	Collection Location by River Mile
Mayflies	
Acentrella parvula	Ashtabula R. 13.9, 9.9
Acentrella turbida	Ashtabula R. 27.0, 23.8, 19.03, 13.9, 9.9, 6.24, 3.6
Acerpenna macdunnoughi	Ashtabula Cr. 5.24
Baetis tricaudatus	Hubbard Run 0.21; Trib. to Hubbard Run (at 0.20) 0.1
Plauditus dubius/virilis	Ashtabula R. 13.9, 9.9, 6.24, 3.6
Plauditus gloveri	Ashtabula R. 3.6
Maccaffertium ithaca (**SC**)	W. Br. Ashtabula R. 6.3; E. Br. Ashtabula R. 5.47
Teloganopsis deficiens	Ashtabula R. 27.0, 23.8, 13.9, 6.24, 3.6
Stoneflies	
Agnetina flavescens	Ashtabula R. 19.03, 13.9
Caddisflies	
Wormaldia moesta	Hubbard Run 0.21
Macrostemum zebratum	Ashtabula R. 23.8, 19.03, 6.24
Glossosoma sp.	Hubbard Run 0.21; Trib. to Hubbard Run (at 0.20) 0.1
Oecetis avara	Ashtabula R. 23.8
Beetles	
Microcylloepus pusillus	Ashtabula R. 27.0
Midges	
Trissopelopia ogemawi	Hubbard Run 0.21
Nanocladius (P.) downesi	Ashtabula R. 27.0, 13.9, 9.9; E. Br. Ashtabula R. 5.47, 2.4; Ashtabula Cr. 0.28
Polypedilum (C.) ontario	Ashtabula R. 6.24, 3.6
Cladotanytarsus vanderwulpi group sp. 4	Ashtabula R. 27.0
Freshwater Mussels	
Anodontoides ferussacianus	W. Br. Ashtabula R. 11.28, 2.7; Trib. to W. Br. Ashtabula R. (at 3.50) 0.92; E. Br. Ashtabula R. 2.4
Elliptio dilatata	Ashtabula R. 19.03
Lampsilis cardium	Ashtabula R. 27.0, 23.8, 19.03
Lampsilis radiata luteola	Ashtabula R. 23.8, 19.03; Trib. to W. Br. Ashtabula R. (at 3.50) 0.92
Lasmigona costata	Ashtabula R. 23.8, 19.03
Pyganodon grandis	W. Br. Ashtabula R. 11.28, 9.04, 2.7
Strophitus undulatus	Ashtabula R. 19.03; E. Br. Ashtabula R. 2.4
Villosa iris	Ashtabula R. 27.0, 23.8, 19.03; Ashtabula Cr. 0.28

Table 6. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Ashtabula River study area, July to October, 2011.

Stream RM[a]	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[b]	Narrative Evaluation
Ashtabula River (07-001)										
27.0	65.2	-	85	31 / 32	34 / 35	L / 836	0	*Chimarra* caddisflies (MI), mayflies (MI,F), riffle beetles (F,MI)	42	
23.8	88.4	-	75	27 / 29	24 / 28	H / 945	0	Caddisflies (MI,F), midges (F), flatworms (F)	42	
19.03	94	-	75	25 / 30	30 / 34	L-M / 442	0	Riffle beetles (F,MI), midges (F), caddisflies (I,MI)	50	
13.9	113	-	66	28 / 35	28 / 34	L-M / 1163	0	Midges (F), caddisflies (MI), baetid mayflies (I,F,MI)	50	
9.9	118	-	56	21	19	L	0	Midges (F), caddisflies (MI), mayflies (MI,F)	-	Exceptional
6.24	121	-	60	27	23	L	0	*Chimarra* caddisflies (MI), midges (F)	-	Exceptional
3.6	127	-	61	31 / 33	25 / 30	M / 1060	2	Caddisflies (MI,F), baetid mayflies (I,F), midges (F)	50	
Ashtabula River (Lacustuary) (07-001)										
2.4 A	132	8,11	38	6 / 10	2 / 5	M / 236	0	Midges (MT,T,F), heptageniid mayflies (F)	44	
1.8 A	132	8,11	14	0 / 1	1 / 1	L / 1033	0	Midges (F), damselflies (T)	20	
1.6 A	132	8,11	10	0 / 3	0 / 0	L-M / 571	0	Midges (MT,T), oligochaet worms (T)	12	
1.6 B	132	8,11	-	0 / 4	0 / 2	694	0	-	26	
1.1 A	137	8,11	22	3 / 5	0 / 1	M / 175	0	Snails (T), midges (MT)	32	
1.1 B	137	8,11	-	3 / 5	0 / 1	414	0	-	44	
0.9 A	137	8,11	26	4 / 6	0 / 1	L-M / 451	0	Midges (F)	28	
0.9 B	137	8,11	-	4 / 5	0 / 0	853	0	-	22	
0.6 A	137	8.11		2 / 4	0 / 1	311	0		24	

Stream RM[a]	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[b]	Narrative Evaluation
0.6 B	137	8,11	-	2 / 4	0 / 1	490	0	-	26	
0.3 A	137	8,11	7	0 / 3	0 / 0	L / 447	0	Midges (MT), flatworms (F)	24	
West Branch Ashtabula River (07-004)										
11.28	7.6	-	64	11	5	L-M	0	Scuds (F,MT), sowbugs (T), flatworms (F)	-	Marg. Good
9.04	12.9	-	60	21	14	L-M	0	Hydropsychid caddisflies (F), midges (F)	-	Very Good
6.3	15.1	-	64	23	18	L-M	3	Hydropsychid caddisflies (F), midges (F), baetid mayflies (F)	-	Exceptional
2.7	31	-	73	23 / 23	19 / 19	L / 462	1	Caddisflies (MI,F), midges (F), riffle beetles (F,MI)	42	
Tributary to West Branch Ashtabula River at RM 3.50 (07-026 / 07-004-001)										
0.92	6.8	9	53	15	11	L	1	Heptageniid mayflies (F), caddisflies (MI), midges (F,T)	-	Good
East Branch Ashtabula River (07-005)										
7.97	9.3	-	58	15	12	L	1	Midges (F), caddisflies (MI)	-	Good
5.47	13.0	-	63	24	27	L-M	3	Caddisflies (MI,F), mayflies (MI,F), midges (F,MI)	-	Exceptional
2.4	21.0	-	69	25 / 27	21 / 26	L / 1457	0	Caddisflies (MI,F), baetid mayflies (MI,F), midges (F,T,MI)	46	
East Branch of East Branch Ashtabula River (07-027 / 07-005-001)										
0.39	2.5	9	28	6	5	L	1	Heptageniid mayflies (F), *Nyctiophylax* caddisflies (MI), limpets (F)	-	Fair
Tributary to East Branch Ashtabula River at RM 1.35 (07-028 / 07-005-002)										
1.1	4.9	-	58	16	15	-	0	Caddisflies (F,MI), midges (F), flatworms (F)	-	Good
Tributary to Tributary to East Branch Ashtabula River at RM 1.35, 0.80 (07-029 / 07-005-003)										
0.3	8.9	-	48	12	8	L	1	Flatworms (F), midges (MT,T)	-	Marg. Good

Stream RM[a]	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[b]	Narrative Evaluation
Ashtabula Creek (07-003)										
5.24	10.0	-	75	24	20	L-M	0	Hydropsychid caddisflies (F), midges (F), baetid mayflies (MI)	-	Exceptional
0.28	17.3	-	78	28 / 28	26 / 27	L / 432	1	Chimarra caddisflies (MI), riffle beetles (F), water penny beetles (MI)	48	
Tributary to Ashtabula River at RM 16.98 (07-025 / 07-001-002)										
0.43	17.3	-	52	17	15	M	0	Caddisflies (F,MI), midges (F)	-	Good
Hubbard Run (07-002)										
0.21	2.7	-	57	19	20	L	8	Baetid mayflies (F,MI), blackflies (F), hydropsychid caddisflies (MI)	-	Exceptional
Tributary to Hubbard Run at RM 0.20 (07-016 / 07-002-001)										
0.1	2.1	-	42	17	17	L-M	7	Midges (F,MI), baetid mayflies (MI), hydropsychid caddisflies (MI,F)	-	Exceptional
Strong Brook (07-013, 07-001-001)										
0.6	2.7	-	18	3	0	L-M	0	Midges (T,MT)	-	Poor
Fields Brook (07-010)										
1.84	1.5	-	50	9	3	M	0	Midges (T,F), caddisflies (F), scuds (F)	-	Fair
0.9	3.4	-	47	13	5	M	0	Caddisflies (MI,F), scuds (F), flatworms (F)	-	Marg. Good

RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 8=Non-Detectable Current, 9=Intermittent or Near-Intermittent Conditions, 11=Lake Erie Influence (Lacustuaries).
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 square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Cold Water.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant
[a] A=artificial substrates located in mid-channel, B=artificial substrates located near shore.
[b] Stations located in the Lake Erie lacustuary were evaluated with the lacustuary ICI (L-ICI).

Physical Habitat for Aquatic Life

Stream habitat conditions were assessed at 26 Ashtabula River basin fish sampling sites (upstream from RM 2.5) in 2011 (Table 8). Based on the functional ability to support fish, each site's substrate, instream cover, and channel characteristics were graded and composited using the Qualitative Habitat Evaluation Index (QHEI, Rankin 1989). Generally, good QHEI scores (above 60) are typical of habitat conditions associated with WWH aquatic communities. Poor QHEI scores (less than 45) are consistent with the Modified Warmwater Habitat (MWH) aquatic life use, while excellent QHEI values (above 75) are correlated with EWH aquatic life use. QHEI scores are most meaningful when considered in aggregate groups. For instance, an average of several QHEI scores from a river reach or the trend among many small streams in close proximity is more informative than relying on any single location QHEI score. It's unlikely for any site with particularly good or poor habitat to exert the same extreme influences on its resident aquatic community. Instead, aquatic assemblages at unique habitat locations tend to reflect the wider ambient condition.

Good habitat conditions were typical throughout the Ashtabula River basin. The average QHEI score for the seven Ashtabula River sites (QHEI=71.6) was similar to the average habitat condition at smaller drainage locations (QHEI=70.0, n=19). Substrate quality was very good across the watershed, with boulders, cobbles, and smaller aggregate at all but two sites. Bedrock was more prevalent at the Ashtabula River Hadlock Road ford (RM 10.1) and at Tributary to Ashtabula River at RM 16.98 (RM 0.4) downstream from Plymouth Gageville Road. This latter site and locations on Fields and Strong brooks were unusual for limited cover components. All other sampled sites exhibited moderate or extensive amounts of cover often comprised by aquatic plants and woody debris. Root mats were more common than root wads, but both cover types were frequent along with overhanging vegetation at many locations. Good perennial pool depth (> 40 cm) was universal at all sites in the study area.

With good watershed wide aquatic habitat conditions, there is a low likelihood that failure to achieve a biocriterion is due to habitat limitations. Instead, point sources of pollution or other water quality influences are more probable stressors. The QHEI was specifically calibrated to empower this observation for Ohio streams. Since its development over 20 years ago, the QHEI has been adopted for uses somewhat different than this objective. In those situations it is proper to be forthright with appropriate qualifications about the suitability and interpretation of results and to clarify possible cross purposes.

Ohio EPA adopted the term "lacustuary" to describe freshwater estuary areas where rivers meet Lake Erie. Herein the Ashtabula lacustuary is the reach of Ashtabula River downstream from East 24th Street (RM 2.5) to the Lake Erie confluence. The Ashtabula River AOC encompasses this historically polluted region. Lacustuary habitat conditions were evaluated at seven locations in 2011 (Table 7). The Lake QHEI (L-QHEI) was developed analogous to the stream version in 2004 (Thoma). Like the QHEI, L-QHEI scores provide a similar means to interpret habitat factors in regard to biological community index performance. Prior Ohio EPA Ashtabula lacustuary assessments reported QHEI values recognizing the limitations of a stream measurement in a lake like system. Because studies now in progress may lead to the further refinement of the L-QHEI, scores reported here should be considered in context and not in comparison to a specific benchmark.

The influence of recently installed habitat improvements were apparent in 2011 Ashtabula lacustuary L-QHEI scores. Cover types were more numerous and overall more extensive in the vicinity of the projects. Aquatic vegetation was common in the 5½ slip vicinity, but nearly absent in the upstream lacustuary reach. Substrate types and silt quantities varied between sites. Shale bedrock and gravel were most functional upstream where normal amounts of silt were observed. Substrates were limited downstream grading from sand to mostly silt in the more lake influenced reach. Rip rap and larger aggregates provided better substrate conditions in the fish shelf vicinity.

As with stream QHEI scores, the aggregate condition in the lacustuary is more important than values from individual sites. Overall, the 2011 Ashtabula lacustuary average L-QHEI score was 50.9. The positive attributes provided by habitat enhancement projects buoyed the previously depauperate conditions. With more time for planted vegetation to colonize adjacent reaches, less shifting sediment in consequence to dredging, and proposed new habitat improvements, it was apparent that effective measures are being made to rectify AOC beneficial use concerns.

Table 7. Ashtabula River lacustuary L-QHEI, 2011.

Ashtabula Lacustuary		L-QHEI Metrics					**L-QHEI Score**
RM	Location	Substrate	Cover	Shoreline	Riparian	Vegetation	
2.3	At 24th Street	12	11	20	10	1	**53.0**
1.6	Ust. Fields Brook	14	11	8	3.5	2	**38.5**
1.3	Dst. Fields Brook	4	9	12	7	1	**33.0**
1.2	At fish shelf	14	16	20	6	9	**65.0**
1.1	At 5½ slip	3	14	13	7.5	17	**54.5**
0.9	Dst. 5½ slip	3	16	20	5	23	**67.0**
0.6	At Coast Guard Station	4	14	10	3	14	**45.0**

Table 8. QHEI attributes for the Ashtabula River basin, 2011.

Key: QHEI Components

River Mile	QHEI	Gradient (ft/mi)	WWH Attributes: Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	MWH Attributes – High Influence: Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	MWH Attributes – Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	M.I. Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
07-001-000			**Ashtabula River**																															
Year:	**2011**																																	
27.2	75.0	8.55	X	X		X	X	X		X	X	X	8						0								X	X				2	0.11	0.33
23.7	73.5	8.26	X	X		X	X	X			X		6						0				X					X	X		X	4	0.14	0.71
19.0	75.0	9.43	X	X		X	X	X		X	X		7						0					X				X			X	3	0.13	0.50
14.0	67.0	10.75	X	X			X	X		X	X	X	7						0					X			X	X				3	0.13	0.50
10.1	64.0	15.15	X	X			X	X		X	X		6						0					X				X			X	3	0.14	0.57
5.8	71.0	9.52	X			X	X	X		X	X	X	7						0									X				1	0.13	0.25
3.6	76.0	12.50	X	X		X	X	X		X	X	X	8						0									X				1	0.11	0.22
07-001-001			**Strong Brook**																															
Year:	**2011**																																	
0.6	58.3	26.47		X							X	X	3			X	X		2	X	X			X	X		X	X	X	X		8	1.00	2.25
Year:	**2012**																																	
0.7	58.8	25.00		X	X				X	X	X	X	6			X	X		2	X				X			X					3	0.57	0.71
0.4	69.5	26.47	X	X	X	X	X	X	X	X	X	X	10						0					X			X					2	0.09	0.27
07-001-002			**Trib. to Ashtabula R. (RM 16.98)**																															
Year:	**2011**																																	
0.4	60.0	24.39	X				X			X	X	X	5				X		1					X				X				2	0.33	0.50
07-002-000			**Hubbard Run**																															
Year:	**2011**																																	
0.3	82.5	40.00	X	X		X	X	X	X	X	X	X	9						0													0	0.10	0.10
07-002-001			**Trib. to Hubbard Run (RM 0.20)**																															
Year:	**2011**																																	
0.1	69.3	41.67	X	X		X	X	X	X	X	X	X	9						0								X				X	2	0.10	0.30
07-003-000			**Ashtabula Creek**																															
Year:	**2011**																																	
5.3	76.5	5.81	X	X		X	X	X		X	X	X	8						0									X			X	2	0.11	0.44
0.3	86.0	21.28	X	X		X	X	X		X	X	X	8						0									X				1	0.11	0.22

Table 8. Continued.

Key: QHEI Components

			WWH Attributes											MWH Attributes – High Influence						MWH Attributes – Moderate Influence														
River Mile	QHEI	Gradient (ft/mi)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	M.I. Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
07-004-000			**West Branch Ashtabula River**																															
Year:	**2011**																																	
11.2	49.5	4.35		X				X			X		3			X	X		2	X	X			X				X	X		X	6	1.00	2.00
8.8	62.0	8.40	X	X				X		X	X		5						0	X	X			X	X			X			X	6	0.33	1.17
6.3	70.5	40.00	X	X		X	X	X		X	X	X	8						0		X							X				2	0.11	0.33
2.7	67.8	19.61	X	X		X	X	X		X	X	X	8						0		X			X			X	X				4	0.11	0.56
07-004-001			**Trib. to W. Br. Ashtabula R. (RM 3.50)**																															
Year:	**2011**																																	
1.0	67.5	12.50	X	X		X	X	X		X	X	X	8				X		1		X				X		X	X			X	5	0.22	0.67
07-005-000			**East Branch Ashtabula River**																															
Year:	**2011**																																	
8.0	75.0	8.47	X	X			X	X		X	X	X	7						0		X		X	X				X	X	X		6	0.13	0.88
5.5	72.0	16.39	X	X			X	X		X	X	X	7						0		X			X			X	X	X			5	0.13	0.75
2.4	75.5	19.61	X	X		X	X	X		X	X	X	8						0									X				1	0.11	0.22
07-005-001			**E. Br. of East Branch Ashtabula R.**																															
Year:	**2011**																																	
0.4	76.5	43.48	X	X		X	X	X	X	X	X	X	9						0													0	0.10	0.10
07-005-002			**Trib to E. Br. Ashtabula R. (RM 1.35)**																															
Year:	**2011**																																	
1.1	72.0	17.54	X	X	X		X	X		X	X		7				X		1					X				X			X	3	0.25	0.63
07-005-003			**Trib to E. Br. Ashtabula R (1.35/0.8)**																															
Year:	**2011**																																	
0.3	89.3	14.93	X	X		X	X	X	X	X	X	X	9						0													0	0.10	0.10
07-010-000			**Fields Brook**																															
Year:	**2011**																																	
1.8	47.0	29.41		X					X	X	X	X	5				X		1	X	X			X	X		X					5	0.50	1.00
0.5	70.0	16.67	X	X		X		X			X		5				X		1		X				X			X	X	X		5	0.33	1.00

Fish Community

Fish communities in the Ashtabula watershed (excluding the lacustuary) were evaluated at 26 sites in 2011 (Appendices D and E). Very good mainstem fish assemblages were present at seven locations (IBI $\bar{x}$=50, MIWb $\bar{x}$=9.2) (Figure 10). Good assemblages were typical at smaller drainage locations (IBI $\bar{x}$=40, n=19). Fish communities achieved the relevant biocriteria at all but two sites. The two sites which did not meet the relevant biocriterion, Strong Brook RM 0.6 and Fields Book RM 1.8, were within the Area of Concern (AOC).

Ashtabula lacustuary fish communities were assessed at seven sites in 2011 (Figure 11). Good community scores (L-IBI $\bar{x}$=43, MIwb $\bar{x}$=9.1) were typical, although variable results downstream from Fields Brook (RM 1.3) suggested it remains a source of perturbation. Fewer fish were present at RM 1.3 in June (192) compared to a September collection (254). The early sample included two brown bullheads with external lesions and no minnow species. No brown bullhead or external anomalies were present in the second pass when three types of minnows were collected. These factors, along with less piscivorous fish (17% vs. 31%, respectively) and slightly lower species richness (18 vs. 20 total species, respectively), resulted in a wide difference between L-IBI scores (37 vs. 48, respectively). Ironically, a better MIwb score (8.8) was registered by the first sample compared to the second sample (MIwb=8.3).

Both disparities suggest this area was unsuitable to support a stable aquatic community. This inference is furthered by the alternatively close range of fish index scores recorded at other Ashtabula lacustuary sites. The temporal impermanence of the species assemblage downstream from Fields Brook challenges interpretation that might otherwise be drawn from a more resilient community. Instead, fish from this location seem transitory in possible response to pulsed flow from the upstream tributary.

Fields Brook was evaluated at State Road (RM 1.8) and at Columbus Avenue (RM 0.5) in 2011, 2007 and in 2000 (Figure 12). Significant improvement has occurred at the downstream site. The upstream less responsive location was remediated more recently. In 2000, a fair (IBI=32) upstream fish assemblage was comprised by 227 fish among six species. Downstream, the poor (IBI=22) assemblage of 176 fish was represented by 12 species. In 2007, the upstream collection of seven species (515 fish) declined to poor (IBI=26) while the downstream assortment of 18 species (1,120 fish) improved to good (IBI=44). In 2011, the upstream assemblage recovered to fair status (IBI=32, 9 species, 653 fish) while the downstream community achieved a very good IBI score (IBI=48, 21 species, 781 fish).

Discovery in 2007 of pockets of pure Therminol (1,000,000 ppm Aroclor 1248) on the Millennium property and PCB concentrations in Fields Brook above 1,000 ppm led the US EPA to issue an Administrative Order to clean up the contamination and insure previously mitigated areas were protected (US EPA 2007). The subsequent actions and an accounting of recent remedial work are discussed in *Second Five-Year Review Report for Fields Brook Site* http://www.epa.gov/region5/cleanup/fieldsbrook/pdfs/fieldsbrook_second_5yr_200906.pdf (US EPA 2009). Reconstruction of the Fields Brook State Road bridge in 2009 completed the stream channel restoration in the immediate area. The Fields Brook corridor was used as a right of way for large pipes to convey suspended sediment during the Ashtabula Harbor dredging project completed in 2008. Most of Fields Brook was previously reconstructed in 2002 when PCB-laden sediment and floodplain soils were rectified.

In 2000, Ohio EPA completed a *Biological and Aquatic Life Use Attainment Study of Fields Brook* (Ohio EPA 2001). Modified wetland habitat qualities in the upper reach of Fields Brook in

2000 (QHEI=51.5) became more riffle-run oriented downstream (QHEI=69.0). Strong solvent and combined sewer overflow (CSO) odors were prevalent in the area. These conditions were improved by the 2001 remedial work. In 2007, upstream habitat prior to the Therminol detection was more natural with better substrate and cover (QHEI=64.5). Better substrates were also documented downstream (QHEI=73.0). In 2011, following recent remedial work to remove PCB contamination and new bridge installation, habitat quality was degraded by silty substrates and noticeably less functional cover at the upstream site (QHEI=47.0). Increased silt downstream was offset by channel heterogeneity including good pool depth and numerous types of cover (QHEI=70.0).

Fields Brook is a small stream (4 mi^2). While perceptible changes in the fish community have likely been influenced by ongoing restoration, the more compelling condition is the stream's atypical flow. Unlike most small streams in the Ashtabula watershed, Fields Brook receives continuous flow as treated wastewater from extraction wells. The wells are used to lower the area water table to facilitate the capture of volatile organic compounds (VOCs) and other hazardous substances.
(http://www.clu-in.org/techfocus/default.focus/sec/Multi-Phase_Extraction/cat/Overview)
The flow augmentation in Fields Brook supports an array of pollution tolerant fish. Juvenile sunfish were also common. Creek chub and green sunfish were most abundant in the upstream 2007 and 2011 samples. These pioneer species are well adapted to reinvade streams following periods of desiccation or other stress. Downstream, the 2011 first time collection of stonecat madtom, sand shiner, and greenside darter imply improving environmental stability as these species are intolerant to water pollution. Their presence along with an increased abundance of pool inhabitant common shiners accounted for the notably improved IBI score.

The upstream fish assemblage failed to achieve the WWH biocriterion in 2011. Recognizing that this reach was recently restored, perhaps the improving trend since 2007 should be considered in expectation that with more time the fish community will eventually meet expectations. Alternatively, QHEI scores and avoidance of the upper reach by lithophilic fish suggest the post 2007 remedial activities have contributed to excess silt in Fields Brook. Unlike nest building creek chubs and sunfish, lithophilic fish rely on interstitial voids in stream substrates to protect their randomly broadcast eggs. The differential presence of lithophils downstream but not upstream implies upper reach substrates are degraded.

Environmental restoration is a fundamental goal of the Fields Brook Superfund site. Removal or proper sequestration of cancerous contaminants is an obvious priority. Numerous documents delineate the procedures which have been followed to achieve this objective at Fields Brook. However, recognition that the creek's physical condition and its water quality are related seems poorly understood. A single paragraph summarizes much of this concern (US EPA 2009, 13):

> Site restoration in the brook and floodplain was performed in late 2002 and completed in March 2003. In addition to the normal seeding and planting of impacted areas, the PRPs worked with the EPA and the Ohio EPA to determine what additional activities would be necessary to allow the stream and floodplain system to return to a natural state. Restoration activities included the addition of willow snags in the brook, the placement of logs horizontally on the ground to provide habitat, and the vertical placement of logs to provide perches for raptors. Vegetation and wildlife have begun to return to the area. Unfortunately, some of the logs that were placed at the site ended up being utilized by residents as firewood.

Vandalized logs aside, there is more to habitat restoration than willow snags. Another way to appreciate this concern is the vigilance expressed toward achieving “cleanup standards.” Millions of dollars have been spent to protect the public interest in contaminant removal while a pittance was paid for stream habitat improvement. Essentially, more attention and money invested toward improving stream habitat in Fields Brook would greatly improve the overall success of this environmental initiative.

Strong Brook joins the Ashtabula River opposite from Fields Brook. A minimum IBI score (12) was recorded at Lake Ave. (RM 0.6) in 2011. Although Strong Brook is highly modified and portions of it are contained within storm sewers, the failure to achieve the LRW biocriterion (18) suggests water quality is affected by some toxicity. Only 13 fish among three species were collected at the site.

The East Branch of the East Branch Ashtabula River was assessed at SR 7 (RM 0.4). The marginally good fish community performed within the range of non-significant departure (IBI=38) but the fair macroinvertebrate assemblage failed to meet the WWH goal. Good fish species richness (16) was offset by an overabundance of pollution tolerant (79%) pioneering (73%) fish. The modest number of insectivorous fish (25%) was uncommon at small drainage sites but may have been related to the lack of macroinvertebrates. The East Branch of the East Branch Ashtabula River was unique as one of three streams in the upper watershed where blacknose dace were present. As this fish requires flowing water its presence was unusual for a stream with intermittent flow.

The limited flow conditions throughout the Ashtabula watershed in combination with a barrier at the Hadlock Road ford (Figure 9) have conspired to create a rather isolated fish assemblage. Ohio EPA has only recorded 32 resident fish species in the Ashtabula River upstream from Hadlock Road (22 samples, 16,498 total fish). Two additional species, present in upper watershed tributaries, were not collected in the mainstem. Downstream from Hadlock Road, Ohio EPA has documented 67 species (77 samples, 20,279 total fish). Two additional species were present in a lower reach tributary.

Built by the Works Progress Administration (1935-1943), the Hadlock Road ford shunts most normal summer water flow through two culverts so that little water actually passes over the single lane concrete road surface. From downstream, the face of the ford appears similar to a low head dam. Upstream, the lack of an appreciable pool makes the ford seem more like a ledge. Considering the disparity between fish species from either side of the ford, it’s apparent that Hadlock Road is the upstream limit for many fish species.

In 2011, 30 northern brook lamprey were documented at four Ashtabula River sites upstream from Hadlock Road. This Ohio endangered species is otherwise known from the adjacent Grand River basin and from just a few other disparate locations across the State. Brook lamprey ammocoetes can be challenging to identify. Ohio EPA had previously reported two other lamprey species in the Ashtabula River basin, both upstream from Hadlock Road (3 individuals). Recognizing the isolation created at the Hadlock Road ford and the uncertainty of identification without voucher specimens, the prior Ashtabula River lamprey records must be considered erroneous (more practically, the previous records were misidentifications of northern brook lamprey).

Figure 9. Photo of the Hadlock Road ford on the Ashtabula River.

Redfin shiners were the only other species collected upstream but not downstream from the ford. Redfin shiners are pool inhabitants with some tolerance to turbidity but require clean well swept substrates for spawning. Downstream from Hadlock Road, bedrock substrate becomes more prevalent and the Ashtabula River has few quiet pools. Pools in the lower reach are linear with larger aggregate margins. During high flow, these pools demonstrate run like functions. Redfin shiners are well distributed in the adjacent Grand River basin and a smaller population is present in Conneaut Creek.

Rosyface shiners were present downstream from Hadlock Road but not upstream in 2011 or previously. Rosyface shiners inhabit steeper gradient mid-size streams. Intolerant of water pollution, rosyface shiners prefer pools with clear water. Their absence upstream may be natural. However, the species is abundant throughout Conneaut Creek and one or two are routinely found in upper Grand River basin samples.

Since twice as many fish species reside downstream, compared to upstream from Hadlock Road, it's easy to speculate that many fish could find suitable upper reach habitat if they could migrate to it. From a sport fish perspective, the upper Ashtabula River falls short of its purported Native American name implying "river of many fish." Smallmouth bass and rock bass were the only upstream species likely to garner angling interest. Not intending to disparage this fishery, but Ohio EPA has only encountered a few "keeper" size fish upstream. The lack of fish suitable to fillet prevented upstream assessment for consumption advisory needs in 2011.

Many fish have migratory propensities. Smallmouth bass and rock bass are known to travel distances longer than the Ashtabula River to overwinter or for spawning needs. Minnow and darter species also migrate. Because our contemporary experience informs most opinions, it's difficult to appreciate how diverse stream fisheries should be. The first development in most Ohio settlements included erection of a dam for saw or grain milling. That heritage left barriers to fish movement that remain throughout Ohio, today. The Hadlock Road ford may seem quaint but it continues a form of impoverishment under a guise of historical precedent. The tradeoff was better understood by those who witnessed it. Dr. Jared Kirtland, a preeminent Ohioan and naturalist, commented in 1842:

> Before our streams were interrupted by the construction of mill-dams, it was common in most of the permanent rivulets in Ohio, but it is now becoming scarce. As an article of food it is not much esteemed, and is not often eaten.

Most observers would notice a longnose gar in a modest size stream. The fish has an ancient lineage and looks like it with a mouth full of teeth. Its ability to breathe atmospheric air has enabled it to survive in many hostile aquatic environments. The low flow conditions of the Ashtabula River would not deter it. As Kirtland noted, dams and a lack of esteem have challenged this evolutionary marvel.

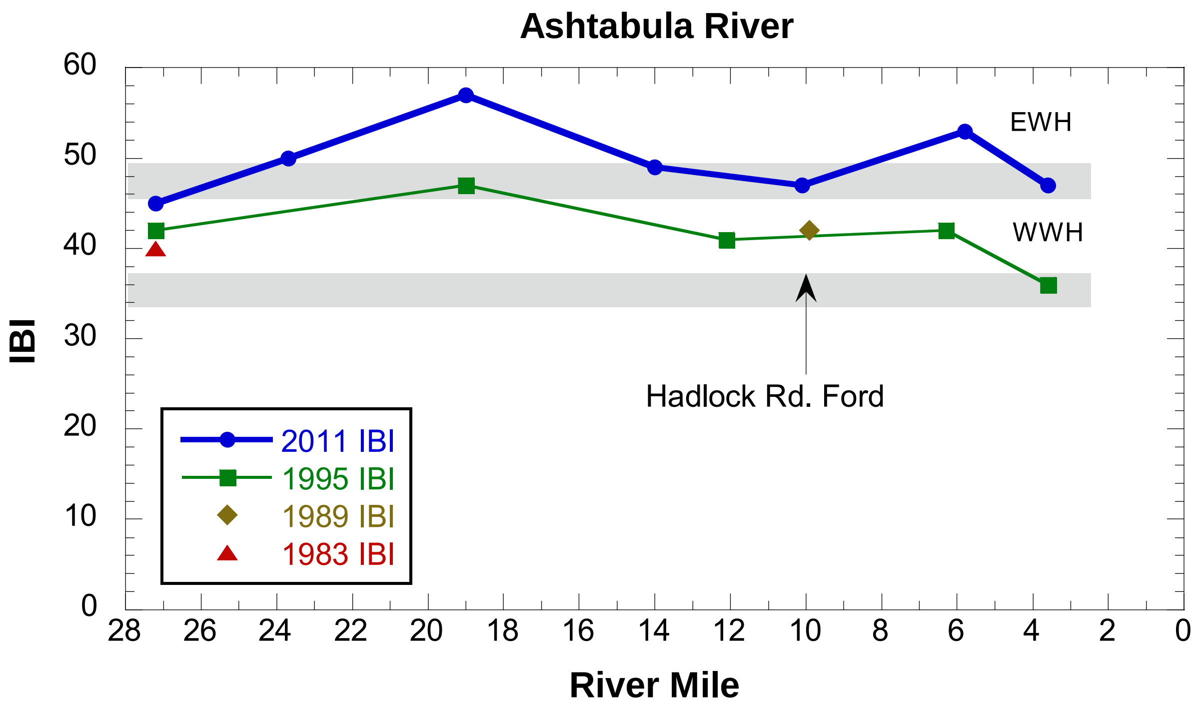
Adult longnose gar were present in the Ashtabula lacustuary in prior Ohio EPA surveys and in the concurrent GLRI survey conducted in 2011. In 2011, juvenile longnose gar were first recorded at Ashtabula River locations downstream from Hadlock Road. None are known upstream. Likewise longnose gar are absent from the Grand River upstream from the Harpersfield dam. Conneaut Creek, without a dam, is home to longnose gar throughout the Ohio reach.

If esteem for any particular fish is necessary regarding future decisions about the maintenance or fate of the Hadlock Road ford, it's improbable that any potentially migratory species could be suggested that would garner much consideration. Alternatively, some might argue the status quo prevents unwanted species dissemination. Round gobies, sea lamprey and common carp are just a few fish not wanted in the upper Ashtabula River basin. This threat actually provides another justification to restore natural systems as much as possible.

Mill waste, tannery offal, sewage, etc. were routinely dumped in Ohio streams after settlement. By 1890, the scarcity Kirtland predicted extended to most fish. Thus, the common carp was selected for fish stocking. This large bodied, pollution tolerant, omnivorous fish was able to thrive in streams then devoid of competition with displaced native fish. As Ohio stream water quality has improved especially in the past 20 years, common carp populations have plummeted.

Stable ecosystems resist alien species invasion. With its limited diversity, the upper Ashtabula River watershed seems vulnerable. In 2011, a common carp was collected near Kellogsville. This is the only one documented in the upper drainage and it was not counted among those deemed to be a resident fish species. Several yellow perch and two black crappie were also present for the first time in 2011 collections. These non-resident smaller fish might have escaped from a pond or were put in the stream purposefully.

As much as the Ashtabula River is a resource held in common, it is subject to the associated dilemmas. Within the lacustuary, people have come together to implement solutions to numerous issues. The recent Scenic River designation for the Ashtabula River formalizes a means to consider upstream concerns. The significant challenges posed by annual low flow conditions and an artificially isolated biological assemblage are worthy tasks for stakeholder resolution.



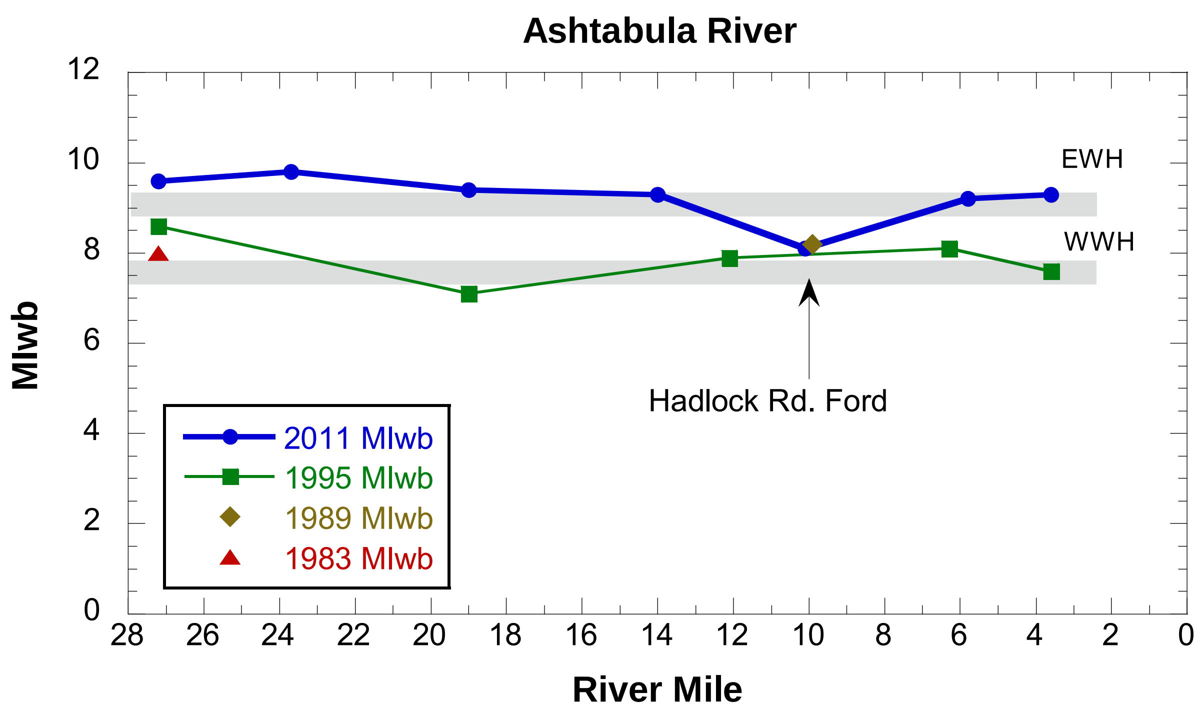


Figure 10. Longitudinal trend of the IBI and the MIwb in the Ashtabula River, 1983-2011.

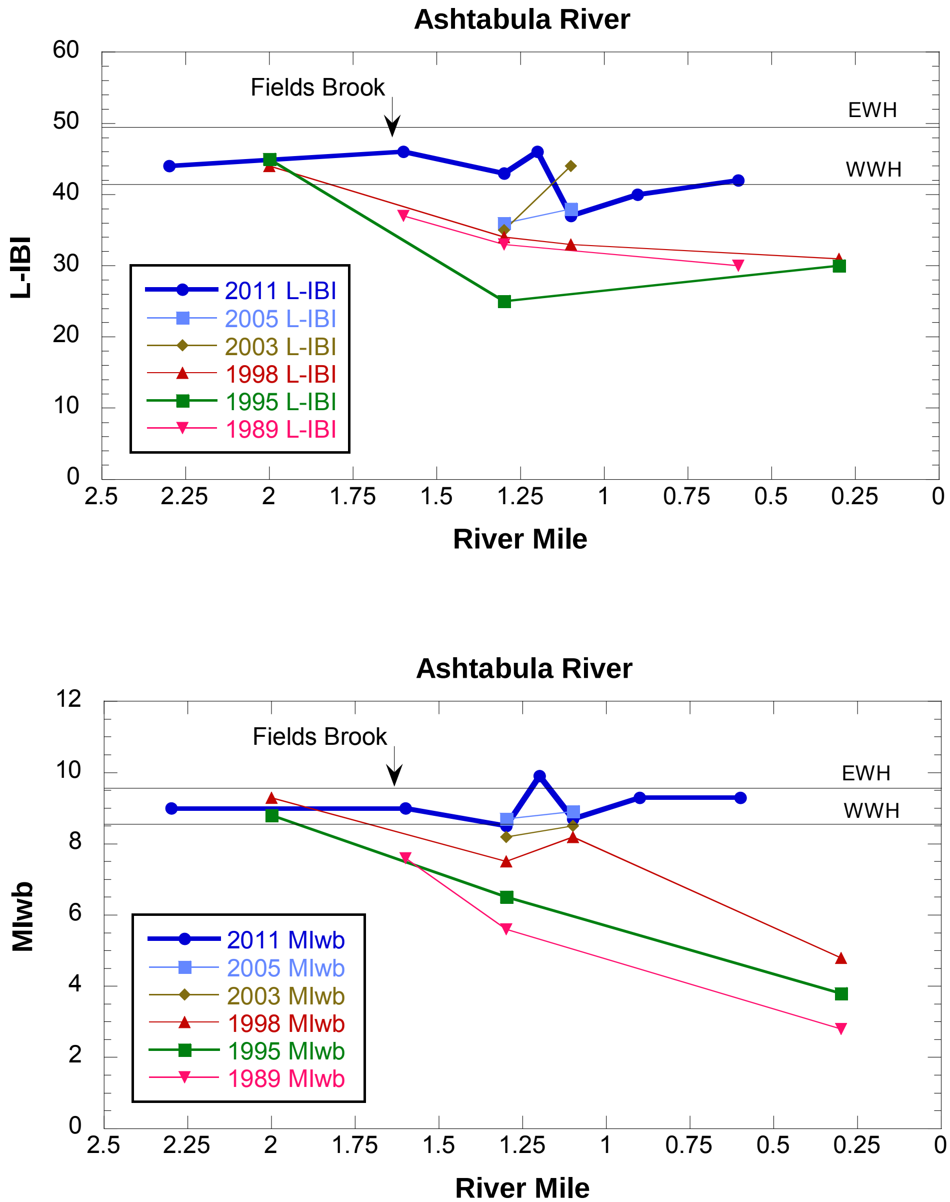


Figure 11. Longitudinal trend of the L-IBI and the MIwb in the Ashtabula River lacustuary, 1989-2011.

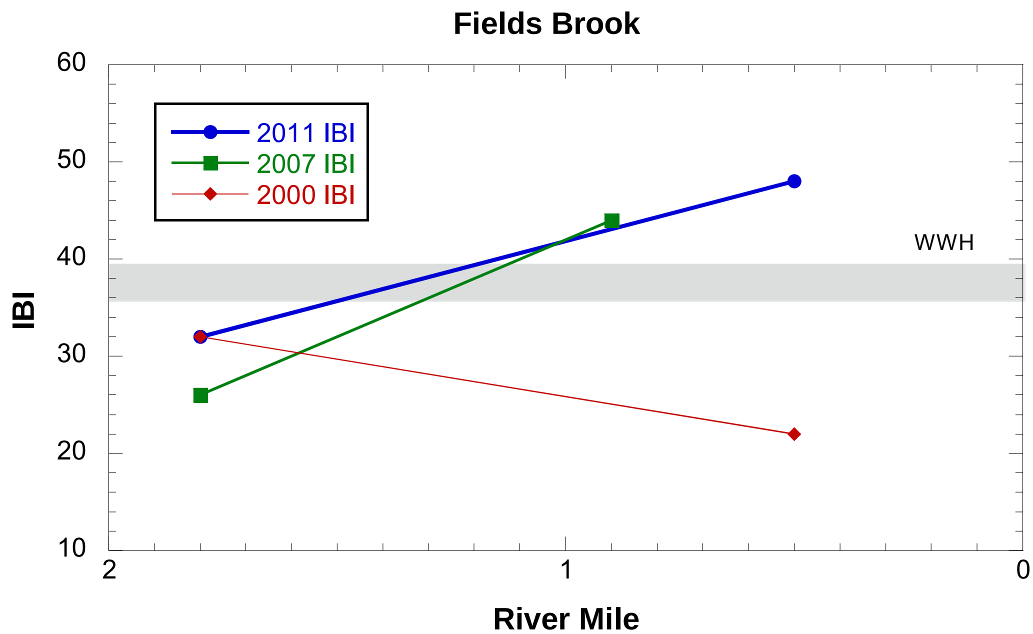


Figure 12. Longitudinal trend of the IBI in Fields Brook, 2000-2011.

Water Chemistry

Surface water chemistry samples were collected from the Ashtabula River study area from June through August 2011 at twenty-seven locations (Figure 1, Table 1, Appendices F, G, H). Seven of the locations designated as sentinel sampling sites were sampled more frequently from March through October 2011. Stations were established in free-flowing sections of the stream and were primarily collected from bridge crossings. Surface water samples were collected directly into appropriate containers, preserved and delivered to Ohio EPA's Environmental Services laboratory. Collected water was preserved using appropriate methods, as outlined in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2009). For water chemistry analysis, data was compared to Ohio Water Quality Standards (WQS) and to the Erie-Ontario Lake Plane ecoregion (EOLP) reference values (Ohio EPA 1999b). Interactive maps of surface water chemical data, downloadable to excel files, are available at the following link: http://wwwapp.epa.ohio.gov/dsw/gis/wq/index.php .

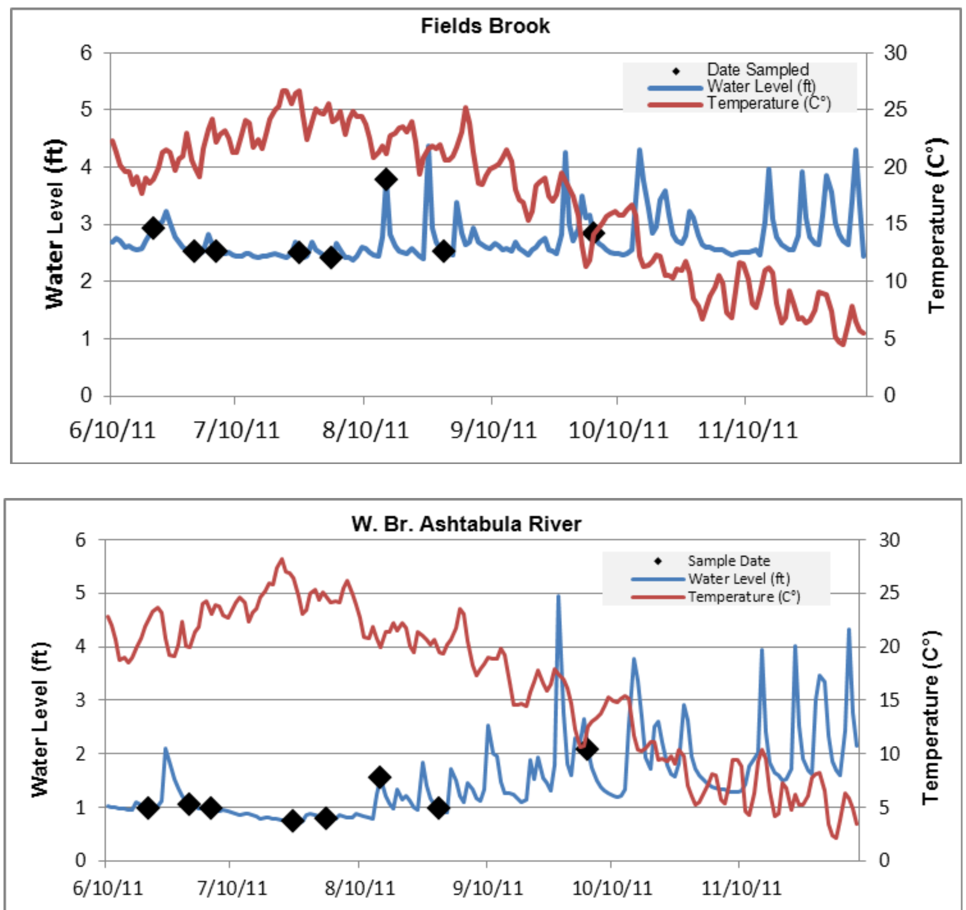


Figure 13. Flow conditions at Fields Brook and W. Br. Ashtabula River, 2011.

The Ashtabula River does not have a United States Geological Survey (USGS) gage station. Solinst Leveloggers® were deployed at three sampling locations within the study area [West

Branch Ashtabula River at Graham Road (RM 2.7), Ashtabula Creek at Reger Road (RM 0.28), and Fields Brook at 15th Street (RM 0.33)] to monitor water level and temperature every 15 minutes. The data from Ashtabula Creek at Reger Road was similar to West Branch Ashtabula River at Graham Road; therefore, the Ashtabula Creek flow and temperature data was not included with this report and is available upon request. Fields Brook flow differed due to its proximity to the lake and influence of enhanced storm precipitation that forms over Lake Erie. The data is reported in daily averages for flow and temperature (Figure 13) with the sampling dates noted. Bacteria was collected during the recreation use season (May 1 through October 31) and was typically collected during low flows.

Surface water samples were analyzed for metals, nutrients, polychlorinated biphenyls (PCBs), semi-volatile organic compounds, organochlorinated pesticides, bacteria, pH, temperature, conductivity, D.O., percent D.O. saturation, and suspended and dissolved solids. Box and whisker plots of D.O., specific conductivity and temperature are presented by HUC-12 in Figure 14. Parameters which were in exceedance of the Ohio water Quality Standards (WQS) criteria are reported in Table 9. Bacteriological samples were collected from twenty-seven locations, and the results are reported in the Recreation Use section.

Nutrients were measured at each water sampling location. Summary statistics for ammonia-N, nitrate+nitrite-N, total phosphorus, and total Kjeldahl nitrogen (TKN) measured in the Ashtabula River are detailed in Table 10. The averaged site results were compared to target values for nitrate+nitrite-N and total phosphorus and the EOLP ecoregion reference values for ammonia-N and total Kjeldahl nitrogen (Ohio EPA 1999a, 1999b). Two stations exceeded the nitrate+nitrite-N target value and two stations exceeded the total phosphorus target value.

Water samples were collected for analysis of organic compounds from one location on Strong Brook (RM 0.60) and three locations on Fields Brook (RM's 1.80, 0.89, and 0.33) in 2011. Analyses were conducted for 52 semi-volatile organic compounds and 7 polychlorinated biphenyl (PCB) aroclors. Two rounds of sampling were conducted at the RM 1.80 (State Road) and RM 0.89 (Columbus Avenue) sites on Fields Brook, and four rounds of sampling were conducted at the RM 0.60 site (Lake Avenue) on Strong Brook site and at the RM 0.33 site (15th Street) on Fields Brook. At the latter two sites, one round of analyses was also conducted for 18 priority pollutant pesticide compounds. Results from this sampling are provided in Appendix G of this report.

Only one detectable result of an organic compound was reported from the water samples collected in 2011. A sample collected from the RM 0.60 site on Strong Brook was found to contain 2.5 µg/l of butylbenzylphthalate on June 20, 2011. This reported concentration is very close to the analytical detection limit for this compound (2.1 µg/l), and is unlikely to be associated with any ecological response in the stream. All other analyses were found to be below the reported analytical detection limits.

DataSonde® continuous recorders were deployed for 48 hours at seven stations on 14 June and 5 July and at two other stations on 14 June only within the Ashtabula River study area (Appendix H). The D.O. concentrations remained above the applicable minimum WQS criterion and the 24 hr. averages of the concentrations remained above the average criterion at all the stations. The D.O. diel swings were normal or modest at all of the deployments except on the West Branch Ashtabula River at Graham Road (RM 2.7) in July which had a wide swing of 8.04 mg/l and on the East Branch Ashtabula River at Adams Road (RM 2.4) in July which had a very wide swing of 10.16 mg/l. The maximum temperature readings were above the WQS criterion at four stations, especially during the July deployments. The July deployments were at the beginning of an extended period without significant rainfall which lasted from about 4 July to 12 August (Figure 11). Low to negligible flow was noted during water chemistry sampling at 13 stations during this period.

East Branch Ashtabula River Watershed
Water quality in the East Branch of the Ashtabula River watershed was influenced by failing septic systems and low flow. The East Branch of the East Branch Ashtabula River at SR 7 (RM 0.39) had elevated conductivity and sodium (Table 11) suggesting failing septic systems as a source. Individual dissolved oxygen concentrations fell below the WWH minimum criterion resulting in WQS exceedances in the East Branch Ashtabula River (RM 2.4) and the tributary to East Branch Ashtabula River at RM 1.35 (RM 1.1) (Table 9). However, all the dissolved oxygen WQS exceedances occurred during a prolonged dry period, and site averaged dissolved oxygen levels were above ecoregion reference values (Table 11) at all sampling locations.

West Branch Ashtabula River Watershed
Channelization, land use, and low gradient in the West Branch of the Ashtabula River are the dominant influences on water chemistry. Low dissolved oxygen levels in the West Branch Ashtabula River (RMs 11.8 and 9.04) resulted in WQS criterion exceedances (Table 9). Total phosphorus in the West Branch Ashtabula River at Scrabmling Road (RM 6.3) and at the tributary to West Branch Ashtabula River at RM 3.5 (RM 0.92) were at or above ecoregion targets, and total phosphorus levels throughout the West Branch Ashtabula River were higher than any other assessment unit in this study.

Although below the WQS criterion, site averaged arsenic levels were elevated in relation to other areas of the watershed and were above the ecoregion reference values for three out of four sampling locations within this assessment unit (Table 11).

Upper Ashtabula River and Tributaries
This section of the watershed had mostly good water quality. There were three WQS criterion exceedances (Table 9) for individual dissolved oxygen with one documented in Ashtabula Creek at Middle Rd. (RM 5.24) and two recorded at Ashtabula Creek at Reger Rd. (RM 0.28), but site averaged dissolved oxygen levels were all above the ecoregion reference value. Also, all of the values recorded below the WQS criterion for dissolved oxygen were during an extended period of low flow.

Table 9. Exceedances of Ohio Water Quality Standards criteria (OAC3745-1) for chemical/physical parameters measured in the Ashtabula River study area, 2011. Bacteria exceedances are presented in Table 12 in the Recreation Use Section.

Stream/RM	**Location**	**Parameter (value)**
East Branch Ashtabula River Subbasin		
7.97	East Branch Ashtabula R. at Turner Road	D.O. (4.59 mg/l[b])
2.40	East Branch Ashtabula River at Adams Road (upper crossing)	D.O. (3.90 mg/l [a]), Temperature (29.64°C[e])
1.10	Trib. to East Branch Ashtabula River at RM 1.35, at Scribner Road	D.O. (3.78 mg/l[a])
0.30	Trib. to Trib. to E. Br. Ashtabula River at RM 1.35, 0.80; at Hilldom Road	D.O. (4.43 mg/l[b]), Temperature (27.95°C[d])
West Branch Ashtabula River Subbasin		
11.28	West Branch Ashtabula River at Hall Road	D.O. (1.81, 3.44, 3.89 mg/l[a])
9.04	West Branch Ashtabula River at North Richmond Road	D.O. (3.52 [a]), (4.77, 4.88 mg/l[b])
2.70	West Branch Ashtabula River at Graham Road	Temperature (29.35°C[d])
0.92	Trib. to West Branch Ashtabula River at RM 3.50, at Caine Road	D.O. (4.92 mg/l[b])
Upper Ashtabula River Subbasin		
5.24	Ashtabula Creek at Middle Road	D.O. (1.69 mg/l[a])
0.28	Ashtabula Creek at Reger Road (TR 417)	D.O. (3.96, 3.00 mg/l[a])
Middle Ashtabula River Subbasin		
23.80	Ashtabula River at Kelloggsville Road	D.O. (4.34 mg/l[b])
19.03	Ashtabula River at Benetka Road	D.O. (4.58 mg/l [b]), Temperature (30.65°C[e])
0.43	Trib. Ashtabula River at RM 16.98, upst Gageville Road	D.O. (2.52 mg/l[a]), Iron (8,000 µg/l[c])
Lower Ashtabula River Subbasin		
6.24	Ashtabula River at State Road	Temperature (28.54°C[d])
3.42	Ashtabula River at Tannery Hill Road	Iron (15,400 µg/l[c]), Lead (8.7 µg/l[f]), Temperature (30.5°C[e])
0.33	Fields Brook at 15th Street	Temperature (26.81, 31.3°C[e])

[a] Exceedance of the aquatic life Outside Mixing Zone Maximum water quality criterion (for D.O., below minimum).
[b] Exceedance of the aquatic life Outside Mixing Zone Average water quality criterion (for D.O., below 24 hour average).
[c] Exceedance of the statewide water quality criteria for the protection of agricultural uses.
[d] Exceedance of the aquatic life Lake Erie basin water quality criterion (for temperature above 30 day average).
[e] Exceedance of the aquatic life Lake Erie basin water quality criterion (for temperature above daily maximum).
[f] Exceedance of the aquatic life water hardness dependent criterion.

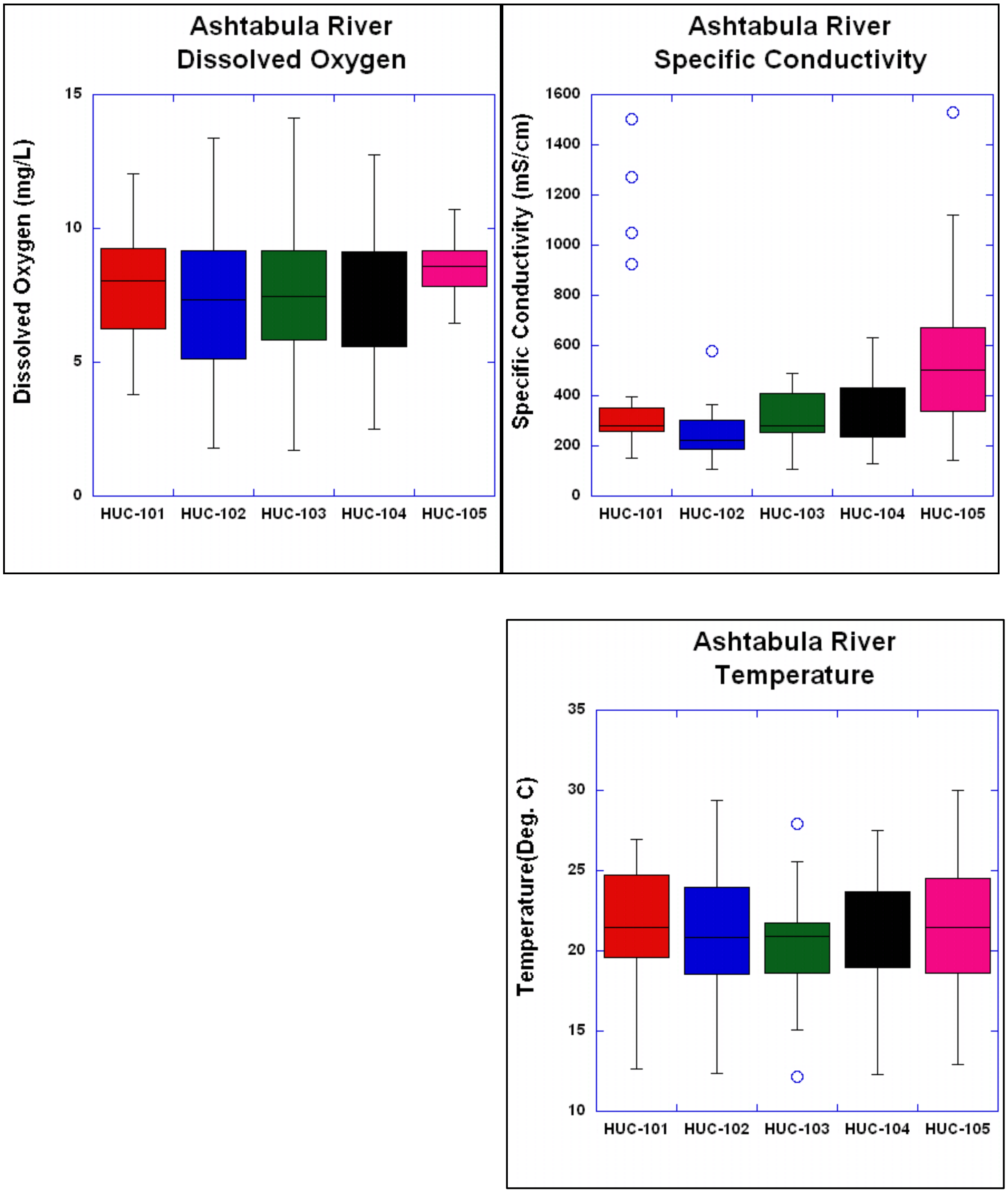


Figure 14. Box and whisker plots of dissolved oxygen, specific conductivity, and temperature from the Ashtabula River, 2011.

Table 10. Summary statistics for nutrients sampled in the Ashtabula River, 2011 (average per site). Values greater than the target values (Ohio EPA 1999a) or the 90th percentile values from Erie-Ontario Lake Plain (EOLP) ecoregion reference sites (Ohio EPA 1999b) are highlighted.

Sampling Location	River Mile	Ammonia-N (mg/l)	Nitrate+Nitrite-N (mg/l)	TKN (mg/l)	Phosphorus-T (mg/l)
HUC 041100030101 East Branch Ashtabula River					
E. Br. Ashtabula River at Turner Road	7.97[H]	0.05	0.81	0.79	0.05
E. Br. Ashtabula River at Caine Road	5.47[H]	0.03	0.48	0.54	0.04
E. Br. Ashtabula River at Adams Road	2.40[W]	0.03	1.81	0.72	0.05
East Branch of E. Br. Ashtabula River at SR 7	0.39[H]	0.06	0.75	0.78	0.03
Trib. to E. Br. Ashtabula River at RM 1.35, at Scribner Road	1.1[H]	0.03	0.38	0.56	0.02
Trib. to Trib. to E. Br. Ashtabula River at RM 0.80, 1.35, at Hilldom Road	0.3[H]	0.06	0.31	0.75	0.02
HUC 041100030102 West Branch Ashtabula River					
W. Br. Ashtabula River at Hall Road	11.28[H]	0.03	0.50	0.67	0.07
W. Br. Ashtabula River at North Richmond Road	9.04[H]	0.04	0.53	0.62	0.06
W. Br. Ashtabula River at Schrambling Road	6.3[H]	0.03	0.52	0.87	0.08
W. Br. Ashtabula River at Graham Road	2.7[W]	0.08	0.67	0.86	0.06
Trib. to W. Br. Ashtabula River at RM 3.50, at Caine Road	0.92[H]	0.05	0.59	0.98	0.09
HUC 041100030103 Upper Ashtabula River					
Ashtabula River at Hilldrom Road	27.0[W]	0.03	0.70	0.69	0.02
Ashtabula Creek at Middle Road	5.24[H]	0.05	0.73	0.65	0.04
Ashtabula Creek at Reger Road	0.28[H]	0.03	0.97	0.66	0.03
HUC 041100030104 Middle Ashtabula River					
Ashtabula River at Kelloggsville Road	23.8[W]	0.03	0.70	0.62	0.03
Ashtabula River at Benetka Road	19.03[W]	0.03	0.81	0.65	0.04
Ashtabula River at Green Hill Road	13.9[W]	0.03	1.29	0.66	0.01
Trib. to Ashtabula River at RM 16.98, upst. Gageville Road	0.43[H]	0.03	0.87	0.71	0.03
HUC 041100030105 Lower Ashtabula River					
Ashtabula River at Hadlock Road	10.0[W]	0.03	0.18	0.54	0.01
Ashtabula River at State Road	6.24[W]	0.03	0.15	0.63	0.01
Ashtabula River at Tannery Hill Road	3.42[W]	0.03	0.39	0.49	0.03
Hubbard Run upst. RM 0.20 Trib.	0.21[H]	0.03	0.33	0.34	0.01
Trib. to Hubbard Run at RM 0.20	0.1[H]	0.03	0.29	0.32	0.01
Strong Brook at Lake Avenue	0.46[H]	0.05	0.83	0.67	0.04

Sampling Location	River Mile	Ammonia-N (mg/l)	Nitrate+Nitrite-N (mg/l)	TKN (mg/l)	Phosphorus-T (mg/l)
Fields Brook at State Road	1.84[H]	0.03	0.31	0.45	0.02
Fields Brook at Columbus Avenue	0.89[H]	0.03	0.18	0.64	0.02
Fields Brook at 15th Street	0.33[H]	0.03	0.40	0.70	0.02
Average		0.03	0.61	0.65	0.03
Maximum		0.603	10.1	1.85	0.24
Target values (OEPA 1999a): Headwater([H])/Wading([W])		**-**	**1.0/1.0**	**-**	**0.08/0.10**
EOLP reference values (OEPA 1999b): Headwater([H])/Wading([W])		**0.19/0.125**	**-**	**1.08/.9**	**-**

Middle Ashtabula River and Tributaries

Dissolved oxygen levels were below Ohio's WQSs once at all three middle Ashtabula River sampling locations resulting in three WQSs exceedances. However, the site averaged values for dissolved oxygen were all above the EOLP reference values in this section of river, and the recordings were again during the drought conditions in summer 2013. Site averaged values at the tributary to Ashtabula River at RM 16.98 sampled at Gageville Road (RM 0.43) had elevated sodium indicating possible failing septic systems discharging in this area.

Lower Ashtabula River and Tributaries

The water chemistry of the lower Ashtabula River basin is influenced by urban runoff and a variety of dischargers. The state WQS exceedances (Table 9) documented were for individual results of temperature in the Ashtabula River at State Road (RM 6.24) and Tannery Hill Road (RM 3.42) and in Fields Brook at 15th Street (RM 0.33) and for iron and lead in the Ashtabula River at Tannery Hill Road. Many sodium site averaged values were above the EOLP reference values.

Chemical Water Quality Trends, 1997-2011

For water quality trends, nitrate-nitrite, ammonia, total phosphorus, and dissolved oxygen from the 2011 survey was compared to 1997 survey data. Figure 15 shows longitudinal trends comparing 1997 to 2011 sampling results from the East Branch Ashtabula River (RM 2.4) and West Branch Ashtabula River (RM 2.7), and starting in the mainstem from just below the confluence of the East and West branches at RM 27 continuing downstream to RM 6.3. Ammonia concentrations were down from the 1995 survey, except at the East Branch Ashtabula River location. This location also had an increase in nitrate-nitrite levels, which may suggest an increase in failing septic systems. Also, nitrate-nitrite values increased in the Ashtabula River mainstem from the 1997 survey levels. Longitudinal trends show a reduction in phosphorus concentrations for all survey locations in 2011. Dissolved oxygen levels have increased compared to 1997.

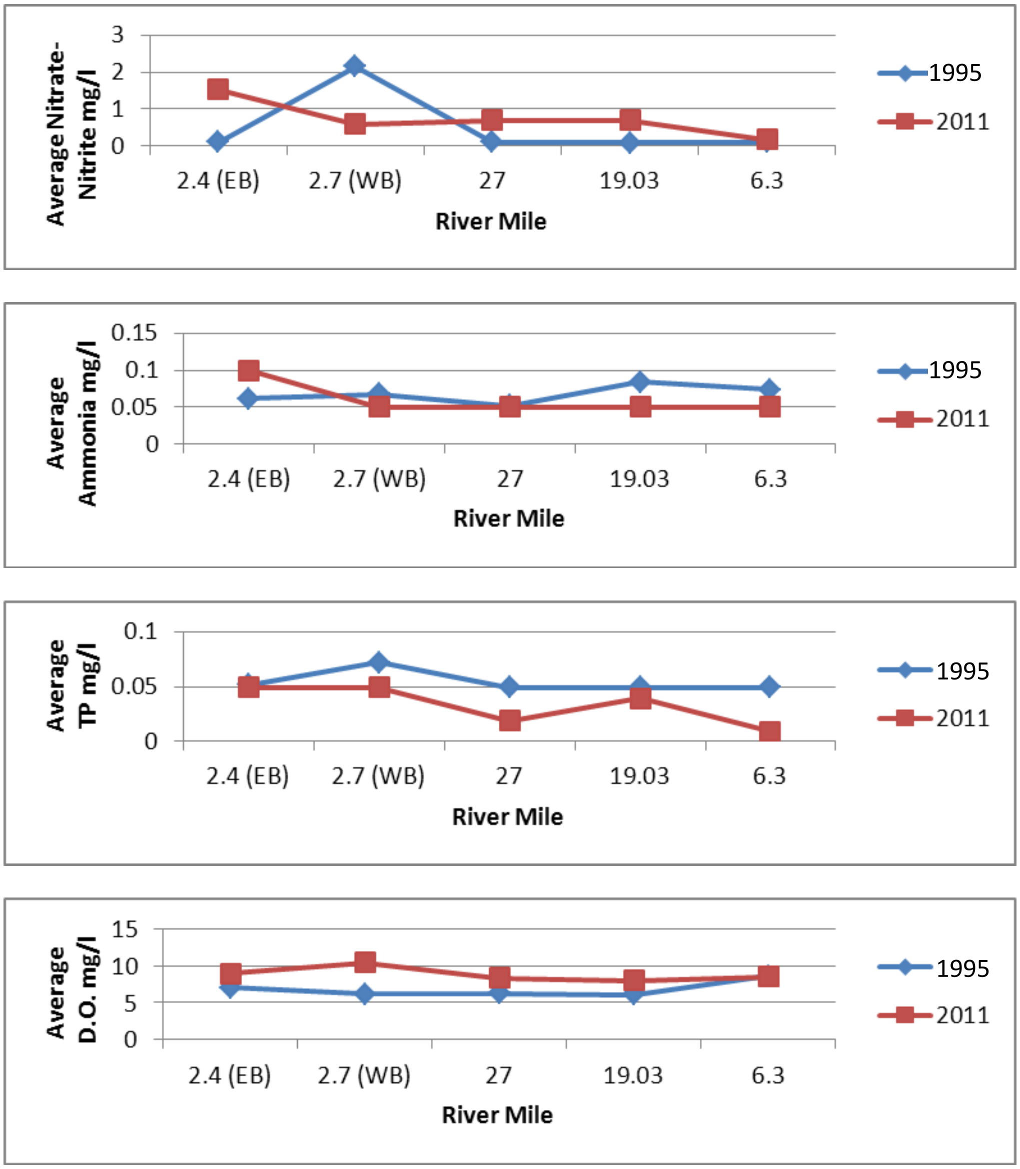


Figure 15. Longitudinal plots for averaged concentrations of nitrate-nitrite, ammonia, total phosphorus, and dissolved oxygen for the East Branch (EB), West Branch (WB), and the mainstem of the Ashtabula River, 1995 and 2011.

Table 11. Summary statistics for selected parameters sampled in the Ashtabula River, 2011. Values greater than the 90th percentile values from reference sites in the EOLP ecoregion (Ohio EPA 1999b) are highlighted.

Sampling Location	River Mile	Conductivity (µmhos/cm)	TSS (mg/l)	Chloride (mg/l)	Sulfate (mg/l)	Aluminum (µg/l)	Arsenic (µg/l)	Copper (µg/l)	Iron (µg/l)	Manganese (mg/l)	Sodium (mg/l)	DO (mg/l)
E. Br. Ashtabula R. at Turner Road	7.97[H]	296.0	3.8	14.4	13.7	244.6	2.8	1.2	570.2	350.4	8.2	6.3
E. Br. Ashtabula R. at Caine Road	5.47[H]	278.0	5.3	19.9	14.4	100.0	1.8	1.7	318.2	106.6	11.4	9.0
E. Br. Ashtabula R. at Adams Road	2.40[W]	247.7	5.3	21.0	15.7	204.6	2.4	1.4	511.1	52.2	11.8	8.9
East Branch of E. Br. Ashtabula R. at SR 7	0.39[H]	992.0	10.8	201.3	39.2	148.6	3.1	3.8	384.0	197.0	101.2	8.2
Trib. to E. Br. Ashtabula R. at RM 1.35, at Scribner Road	1.1[H]	348.8	2.5	29.2	19.4	100.0	2.1	1.0	441.2	191.0	14.8	6.2
Trib. to Trib. to E. Br. Ashtabula R. at RM 0.80, 1.35; at Hilldom Road	0.3[H]	295.2	5.1	29.5	13.5	100.0	2.4	1.0	442.2	298.6	15.0	7.8
W. Br. Ashtabula R at Hall Road	11.28[H]	357.0	14.9	18.2	17.0	506.2	5.0	1.6	1231.2	384.2	10.0	4.3
W. Br. Ashtabula R. at N. Richmond Road	9.04[H]	173.8	13.0	10.6	10.9	498.0	3.2	2.8	1072.4	245.0	6.6	4.7
W. Br. Ashtabula R. at Schrambling Road	6.3[H]	204.4	10.1	14.7	13.9	254.2	2.3	2.7	616.0	110.8	9.0	8.1
W. Br. Ashtabula R. at Graham Road	2.7[W]	211.1	10.3	23.3	15.6	319.6	2.3	2.4	843.7	50.5	12.7	10.4
Trib. to W. Br. Ashtabula R. at RM 3.50, at Caine Road	0.92[H]	302.4	12.7	36.8	14.7	179.0	6.9	2.7	881.0	312.6	21.0	6.8
Ashtabula River at Hilldom Road	27.0[W]	314.0	3.4	22.5	17.2	100.0	2.0	1.2	338.6	61.8	12.4	8.3
Ashtabula Creek at Middle Road	5.24[H]	373.0	21.5	13.7	41.0	410.6	1.0	1.3	950.8	254.6	7.6	7.3

Table 11. Summary statistics for selected parameters sampled in the Ashtabula River, 2011. Values greater than the 90th percentile values from reference sites in the EOLP ecoregion (Ohio EPA 1999b) are highlighted.

Sampling Location	River Mile	Conductivity (µmhos/cm)	TSS (mg/l)	Chloride (mg/l)	Sulfate (mg/l)	Aluminum (µg/l)	Arsenic (µg/l)	Copper (µg/l)	Iron (µg/l)	Manganese (mg/l)	Sodium (mg/l)	DO (mg/l)
Ashtabula Creek at Reger Road	0.28[H]	275.4	6.2	29.4	16.2	373.5	1.5	1.4	911.6	120.2	14.8	7.0
Ashtabula River at Kelloggsville Rd.	23.8[W]	300.8	4.0	21.5	16.1	100.0	2.5	1.8	540.2	149.6	11.8	6.6
Ashtabula River at Benetka Road	19.03[W]	234.4	8.3	20.5	15.7	266.8	1.9	1.6	753.5	89.2	11.1	8.0
Ashtabula River at Green Hill Road	13.9[W]	354.4	4.7	34.2	34.8	122.2	1.5	1.7	359.4	60.0	19.6	8.5
Trib. to Ashtabula R. at RM 16.98, upst Gageville Rd.	0.43[H]	523.4	40.5	54.6	111.5	1285.6	2.0	3.3	2475.0	174.6	33.4	6.2
Ashtabula River at Hadlock Road	10.0[W]	302.4	5.9	32.1	42.4	201.2	1.5	2.2	370.0	58.6	18.4	8.0
Ashtabula River at State Road	6.24[W]	294.9	3.5	30.2	47.9	100.0	1.5	1.8	287.4	46.4	18.2	8.6
Ashtabula River at Tannery Hill Rd.	3.42[W]	340.6	37.1	44.8	43.4	945.4	1.6	3.3	2118.9	88.9	30.0	8.8
Hubbard Run upst RM 0.20 Trib.	0.21[H]	773.2	2.5	125.2	96.7	100.0	1.4	2.3	103.0	22.8	69.6	8.6
Trib. to Hubbard Run at RM 0.20	0.1[H]	831.6	2.5	166.3	80.8	100.0	1.0	3.0	88.6	16.8	98.6	8.9
Strong Brook at Lake Avenue	0.46[H]	620.7	8.7	83.2	90.0	326.9	1.3	4.2	1135.8	108.2	51.3	8.4
Fields Brook at State Road	1.84[H]	472.4	4.1	86.6	43.3	120.8	1.2	3.0	472.0	98.2	49.4	8.5
Fields Brook at Columbus Avenue	0.89[H]	627.4	3.9	132.7	51.4	100.0	1.7	2.8	417.2	253.8	72.0	8.7
Fields Brook at 15th Street	0.33[H]	590.1	7.5	114.0	58.2	174.3	1.3	3.1	648.7	100.8	65.9	8.5
Average		405.0	9.6	53.0	36.8	277.1	2.2	2.2	714.1	148.3	29.8	7.8
Maximum		1530	330	382	200	7700	13.6	10	15400	916	256	1.69*
EOLP Reference Values: Headwater([H])/Wading([W])		**940/729.8**	**43.2/42.3**	**436.5/63.1**	**138.2/95**	**-**	**2.3/3.0**	**10/10**	**2849/1872**	**844/282**	**31.8/45.6**	**5.4/5.6**

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 3745-1-07) based upon the quantities of bacteria indicators (*Escherichia coli*) present in the water column.

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. *E. coli* bacteria can also become entrained within stream sediments and may remain viable for some time. Therefore, sediment re-suspension during storm events can also result in elevated numbers of *E. coli* bacteria in the water column.

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.

Streams in the Ashtabula River watershed are designated as primary contact recreation (PCR) and/or secondary contact recreation (SCR) use in OAC Rule 3745-1-14. 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. Streams designated as PCR class C support, or potentially support, infrequent primary contact recreation activities. Streams designated as SCR use are rarely used for water-based recreation. All of the streams sampled during the 2011 Ashtabula River watershed water quality survey are currently designated with the PCR recreation use in OAC 3745-1-14.

In addition, some waters that are used heavily for swimming can be designated as bathing waters. The geometric mean criterion for bathing waters is ≤126 colony forming units (cfu) per 100 ml. There are no waters designated as bathing waters in the Ashtabula River study area.

The *E. coli* criterion that applies to PCR class A streams is a geometric mean of ≤126 cfu/100 ml. The *E. coli* criterion that applies to PCR class B streams is a geometric mean of ≤161 cfu/100 ml. The criterion that applies to PCR class C streams is a geometric mean of ≤206 cfu/100 ml. The criterion that applies to SCR streams is ≤1,030 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.

Summarized bacteria results including the calculated geometric mean for each station are listed in Table 12. The complete datasets of bacteria results for each station are reported in Appendix I. Twenty-seven locations in the watershed were tested for *E. coli* levels between five and twelve times from May 5 to October 12, 2011. Recommended PCR classes (A, B, or C) for each monitored location are also provided in Table 11. The PCR class A designation is recommended for all sites located along the free-flowing portions of the Ashtabula River mainstem in light of the river's state scenic river and seasonal salmonid habitat designations.

Evaluation of *E. coli* results revealed that 22 of the 27 locations (81.5%) sampled failed to attain the applicable geometric mean criterion, indicating impairment of the recreation use on a watershed-wide scale. The locations not attaining the recreation use in the upper watersheds (East Branch, West Branch, and the upper Ashtabula River assessment unit) were most likely not attaining because of a variety of impacts associated with agricultural runoff (livestock, manure application), unsewered areas, and failing home sewage treatment systems (HSTS). There are no permitted wastewater treatment discharges regulated under individual NPDES permits in these three watersheds.

In the lower Ashtabula River assessment unit, the mainstem of the Ashtabula River was in full attainment of the recreational use criteria at locations immediately upstream of the City of Ashtabula. Sites within the City of Ashtabula were all in non-attainment except for the uppermost site on Fields Brook (at State Road, RM 6.24). Only one NPDES discharger in the lower Ashtabula River assessment unit reported an exceedance of their NPDES limit for fecal coliform bacteria (another indicator of potential pathogens) during the study period. Ryber Development, LLC (NPDES permit 3IE00011) reported 4,300 cfu/100 ml of fecal coliform in their discharge in one out of the two samples collected during the 2011 recreation season. The permit limit for fecal coliform bacteria in their permit is a maximum of 2,000 cfu/100 ml. This discharge is located on West Brook, a tributary to Fields Brook at river mile 1.34. Based upon the sampling results from the present study, it appears that this discharger could be a major source of *E. coli* contamination of the sites located along the lower reach of Fields Brook. Review of this entity's self-monitoring data indicates that three out of the eleven quarterly monitoring events (27%) exceeded both the average and maximum permitted limits for fecal coliform during the period of 2006-2011.

The causes of non-attainment within the City of Ashtabula are most likely the result of urban runoff, failing HSTSs, and SSOs from the sewage collection system for the City of Ashtabula WWTP. The City of Ashtabula is currently in the process of identifying and monitoring SSOs within the WWTP service area. The locations of known SSOs identified within the collection system at this time are summarized in Table 13. Of the SSOs currently identified, three discharge directly to the Ashtabula River, three to Fields Brook, and two to Strong Brook. In addition to areas within the city limits, the Ashtabula WWTP service area also includes 6,594 acres outside of the city with access to sanitary sewers. Within this area, there are a total of 17 pump stations which have not yet been fully evaluated with respect to SSOs. Only one of these pump stations is equipped with flow equalization capacity (Paler Avenue, Ashtabula Twp., 350,000 gal. capacity). Therefore, it is possible that additional SSO incidents are occurring which add to the stream bacteria loads and which will have to be addressed as work continues to identify and alleviate SSOs in the future.

In conjunction with the SSO identification and elimination process, the City has been required to report known SSO discharges to the Ohio EPA, and is developing plans for the control and elimination of these discharges through improved sewer maintenance and upgrades to the sewage collection system. This includes the installation of flow equalization equipment where warranted. Ongoing oversight of this process by the Ohio EPA through the NPDES discharge permit for the WWTP is necessary to ensure that appropriate measures are taken to eliminate these discharges.

Outside of the City of Ashtabula WWTP service area, bacterial contamination was present during both wet and dry weather periods. This indicates that strategies to reduce bacteria levels in the streams should include both nonpoint source and point source reduction measures. It should be noted that identification of specific sources of bacteria loading to the streams in the watershed is beyond the scope of this study. Future evaluation of the potential contributions of the various sources mentioned above is recommended, as well as more in-depth identification of other potential pollution sources which also may be present.

Table 12. Recreation beneficial use attainment table for 27 locations in the Ashtabula River watershed, May 1 through October 31, 2011.

Assessment Unit/Site Name	River Mile	Recreation Class*	Number of Samples	Geometric Mean	Attainment Status†	Potential Source(s) of Bacteria
041100030101 East Branch Ashtabula River						
East Branch Ashtabula River at Turner Road	7.97	B	5	623	**NON**	Agriculture, failing HSTSs
East Branch Ashtabula River at Caine Road	5.47	B	5	462	**NON**	Agriculture, failing HSTSs
East Branch Ashtabula River at Adams Road (upper crossing)	2.40	B	12	1,038	**NON**	Agriculture, failing HSTSs
East Branch of E. Br. Ashtabula River at S.R. 7	0.39	B	5	550	**NON**	Agriculture, failing HSTSs
Trib. to Trib. to E. Br. Ashtabula River at RM 0.80, 1.35; at Hilldom Road	0.30	B	5	731	**NON**	Agriculture, failing HSTSs
Trib. to E. Branch Ashtabula River at RM 1.35, at Scribner Road	1.10	B	5	400	**NON**	Agriculture, failing HSTSs
041100030102 West Branch Astabula River						
West Branch Ashtabula River at Hall Road	11.28	B	5	443	**NON**	Agriculture, failing HSTSs
West Branch Ashtabula River at N. Richmond Rd.	9.04	B	5	342	**NON**	Agriculture, failing HSTSs
West Branch Ashtabula River at Schrambling Rd.	6.30	B	5	135	**FULL**	
W Branch Ashtabula River at Graham Road	2.70	B	12	614	**NON**	Agriculture, failing HSTSs
Trib. to W. Br. Ashtabula River at RM 3.50, at Caine Road	0.92	B	5	439	**NON**	Agriculture, failing HSTSs

Table 12. Recreation beneficial use attainment table for 27 locations in the Ashtabula River watershed, May 1 through October 31, 2011.

Assessment Unit/Site Name	River Mile	Recreation Class*	Number of Samples	Geometric Mean	Attainment Status†	Potential Source(s) of Bacteria
041100030103 Ashtabula Creek						
Ashtabula Creek at Middle Road	5.24	B	5	337	**NON**	Agriculture, failing HSTSs
Ashtabula Creek at Reger Road (Twp. Rd. 417)	0.28	B	12	697	**NON**	Agriculture, failing HSTSs
Ashtabula River at Hilldom Road	27.00	A	5	100	**FULL**	
041100030104 Upper Ashtabula River						
Ashtabula River at Kelloggsville Road	23.80	A	5	148	**NON**	Agriculture, failing HSTSs
Ashtabula River at Benetka Road	19.03	A	12	572	**NON**	Agriculture, failing HSTSs
Ashtabula River at Green Hill Road	13.90	A	5	277	**NON**	Agriculture, failing HSTSs
Trib. to Ashtabula River at RM 16.98, upst. Gageville Road	0.43	B	5	257	**NON**	Agriculture, failing HSTSs
041100030105 Lower Ashtabula River						
Ashtabula River at Hadlock Road	10.00	A	5	79	**FULL**	
Ashtabula River at State Road	6.24	A	5	92	**FULL**	
Ashtabula River at Tannery Hill Road	3.42	A	12	1,094	**NON**	Agriculture, failing HSTSs

Table 12. Recreation beneficial use attainment table for 27 locations in the Ashtabula River watershed, May 1 through October 31, 2011.

Assessment Unit/Site Name	River Mile	Recreation Class*	Number of Samples	Geometric Mean	Attainment Status†	Potential Source(s) of Bacteria
Fields Brook at State Road	1.84	B	5	86	**FULL**	
Fields Brook at Columbus Avenue	0.89	B	5	331	**NON**	Urban runoff; SSOs, failing HSTSs
Fields Brook at 15th Street	0.33	B	12	1,176	**NON**	Urban runoff; SSOs; failing HSTSs
Hubbard Run upst. RM 0.20 trib. (Plymouth Ridge Road)	0.21	B	5	248	**NON**	Urban runoff; SSOs; failing HSTSs
Trib. to Hubbard Run at RM 0.20, upst. mouth	0.10	B	5	337	**NON**	Urban runoff; SSOs; failing HSTSs
Strong Brook at Lake Avenue	0.46	B	12	2,289	**NON**	Urban runoff; SSOs; failing HSTSs

* Recreation class may include primary contact recreation classes (A, B or C); bathing waters (BW); or secondary contact recreation (SCR).

† 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.

Table 13. Approximate location information for identified sanitary sewer overflows within the City of Ashtabula WWTP service area. Other SSOs may exist which have not yet been identified.

SSO Location	**Discharge Stream**	**Approx. River Mile of SSO Outlet**	**Latitude**	**Longitude**
W. 9th St. Overflow Weir	Ashtabula River	1.25	41.89624	-80.79568
State Rd. and E. 42nd St., Edgewood Cemetery	Ashtabula River	4.02	41.86804	-80.77477
Center St. at RR underpass	Ashtabula River	4.44	41.86306	-80.78162
E. 16th St. and Fields Brook	Fields Brook	0.40	41.89286	-80.79224
Columbus Ave. at Fields Brook bridge	Fields Brook	0.88	41.88900	-80.78675
W. 14th and Lake Ave.	Strong Brook	0.45	41.88629	-80.80348
Ohio Ave. and Carpenter Rd.	Strong Brook	0.77	41.88253	-80.80849

Sediment

Sediment sampling in the Ashtabula River basin was conducted in 2012 and was limited to the Strong Brook watershed (Table 14 and Figure 16). Strong Brook has a drainage area of 2.81 mi^2 and its confluence is located at RM 1.62 of the Ashtabula River. Strong Brook is designated as a Limited Resource Water (LRW) stream in OAC 3745-1-14 based upon a use attainability analysis conducted in 1990 (Ohio EPA 1990). The primary data quality objective of the sediment sampling in Strong Brook was to determine if releases of PCB oils from the Clean Harbors PPM, LLC facility located at 1302 West 38th Street, Ashtabula were continuing to have an effect on sediment quality and potential impacts on aquatic life in Strong Brook as well as the potential for contributing to sediment contamination in the Ashtabula River lacustuary.

Releases of PCB contaminated oil from the processing of electrical transformers at the Clean Harbors PPM facility to Strong Brook were documented in 2007. The releases resulted in contamination of both surface water and sediment along the stream. The method of conveyance to the stream was through the discharge of contaminated storm water to a storm sewer system that connects to Strong Brook. Clean Harbors PPM, LLC conducted a remediation of the storm sewer system and the sediments and banks of Strong Brook in late 2007 under a Consent Agreement and Final Order (CAFO) issued by US EPA Region 5 (Clean Harbors PPM, LLC, 2007). Follow up sampling indicated that the goals of the CAFO had been met for clean-up In 2012 deposited materials from a storm sewer catch basin just down-gradient from the Clean Harbors PPM, LLC facility and four surficial sediment samples from Strong Brook were collected. In addition, two small tributaries to Strong Brook were also sampled to provide controls to rule out other potential sources of any contamination.

Sediment samples were conservatively sampled by focusing on depositional areas of fine grain material (silts and clays) (Ohio EPA 2012). These areas typically are represented by higher contaminant levels, compared to coarse sands and gravels. Fine grained depositional areas were not a predominant substrate type at any of the sites. However, fine substrates were found in some areas along the stream margins and as thin deposits in pool areas for sample collection. Sediment samples were analyzed for 17 metal analytes, 112 organic compounds, percent solids, and percent total organic carbon (TOC). The analyte list included 66 of the 110 priority pollutant compounds listed in Appendix A of 40 CFR Part 423, including 13 polycyclic aromatic hydrocarbon (PAHs) compounds, and 7 PCBs compounds. No analyses were performed for legacy pesticides or volatile organic compounds (VOCs). Complete results for the chemical analysis of the sediment samples can be found in Appendix H.

Sediment data were evaluated using Ohio Sediment Reference Values (SRVs; Ohio EPA 2008b), along with guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2008), and *Ecological Screening Levels (ESLs)* (US EPA 2003). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. ESL values, considered protective benchmarks, were derived by US EPA, Region 5 using a variety of sources and methods.

Table 14. Sediment sampling locations in the Strong Brook watershed, 2012.

Site Location (RM)	Site Type	Date Sampled	Parameters	Latitude	Longitude
W. 38th Street storm sewer	Catch Basin	1/25/2012	PCBs	41.86865	-80.80509
Strong Brook: downstream Ohio Avenue (0.66)	Stream	2/15/2012	PCBs, semi-volatile organics, metals, TOC	41.88345	-80.80737
Strong Brook: downstream Michigan Avenue (0.63)	Stream	1/25/2012	PCBs	41.88472	-80.80600
Strong Brook: downstream Michigan Avenue (0.62)	Stream	2/15/2012	PCBs, semi-volatile organics, metals, TOC	41.88473	-80.80587
Strong Brook: downstream Lake Avenue (0.43)	Stream	2/15/2012	PCBs, semi-volatile organics, metals, TOC	41.88633	-80.80342
Strong Brook: downstream Lake Avenue (0.40)	Stream	1/25/2012	PCBs	41.88787	-80.80347
Trib. to Strong Brook at RM 1.08 (0.20)	Stream	1/25/2012	PCBs	41.87666	-80.80930
Jack's Marina Ditch (0.01)	Ditch	1/25/2012	PCBs	41.88868	-80.80182

Total sediment PCB concentrations exceeded the TEC and the PEC at all of the stream sites sampled in Strong Brook upstream of Lake Avenue (Table 15, Figure 16). One of the two samples collected downstream of Lake Avenue also exceeded the TEC for total PCBs. The source of the PCB contamination in the stream can conclusively be assigned to the Clean Harbors PPM facility. The PCB arochlors present in the sediment samples collected in 2012 (PCB-1242 and PCB-1260) precisely match those detected in storm water discharged from the site and catch basins sampled in 2007. No PCBs were detected in either of the sediment samples collected from tributaries entering the Strong Brook drainage system, but a very high concentration of PCBs was found in the catch basin at the end of West 38th Street, just downstream of the discharge point from the Clean Harbors PPM, LLC facility storm water collection system to the City of Ashtabula storm sewer.

All of the additional detectable organic compounds in the sediments of Strong Brook were PAHs. A total of eleven PAH compounds were detected in the samples from the free-flowing portions of Strong Brook (Table 16). The concentrations of PAHs in sediment samples collected from Strong Brook upstream of Lake Avenue were six to seven times higher than what was found downstream of Lake Avenue, with the highest concentrations found at the most upstream site (RM 0.66). Correspondingly, the number of analytes with concentrations exceeding the PEC and the TEC was higher at the upstream locations (7 analytes, with total PAH concentrations also exceeding the PEC) than downstream of Lake Ave., where none of the analytes exceeded their PEC's. Higher concentrations of PAHs are typically observed in urban streams such as Strong Brook. Potential sources include runoff from asphalt and asphalt sealants, fuel oil or diesel fuel spills, coal piles, etc. During the collection of sediment samples for PCB analysis on January 25, 2012, it was noted that the stream bank soils and an adjacent sediment accumulation in the stream both had strong fuel oil odor and noticeable oil sheen.

Data for heavy metals in the sediment samples are presented in Table 17. All samples used for metals analyses were collected from open (free-flowing) portions of Strong Brook located downstream of Ohio Avenue (RM 0.77). The longitudinal pattern of sediment metal concentrations in the sample data is reflective of the channel condition with respect to potential for deposition. The free-flowing portions in the upstream and downstream reaches of Strong Brook (RM 0.77 – RM 0.64 between Ohio Avenue and Michigan Avenue and RM 0.45 – RM 0.33 between Lake Avenue and the railroad culvert) have a higher potential for sediment deposition than the middle reach located between Michigan Avenue and Lake Avenue which was excavated to bedrock and straightened during the installation of a sewage flow equalization tank near the Michigan Avenue culvert. The middle reach experiences very high velocity flows during storm events and sediments do not accumulate appreciably in this section of the stream.

Metals analytes in the sediments from Strong Brook which exceeded the SRVs or typical background concentrations (Ohio EPA 2008a) were cadmium and lead (in the upstream sample only) and calcium and magnesium (at all three locations). Of these, cadmium and lead may pose meaningful toxicity risk to aquatic life at higher concentrations. The observed cadmium concentration in the sediment at RM 0.66 was below both the TEC of 0.99 mg/kg and the PEC of 4.98 mg/kg. The concentration of lead in the RM 0.66 sample exceeded the TEC of 35.8 mg/kg, but was below the PEC of 128 mg/kg. Other metals that exceeded their respective TEC values were arsenic (TEC = 9.79 mg/kg) in the upstream and downstream sample, copper (TEC = 31.6 mg/kg) in the downstream sample, nickel (TEC = 22.7 mg/kg) in the upstream sample, and zinc (TEC = 121 mg/kg) also in the upstream sample. Again, none of these analytes exceeded their respective PEC concentrations. Therefore the risk of toxicity to aquatic life stemming from sediment metals contamination appears to be low in Strong Brook. The potential sources for these compounds in the stream sediments are general urban runoff, SSOs, and industrial storm water runoff from upstream commercial areas of the watershed.

The results of the 2012 sampling indicate that a continuing potential source of toxicity to aquatic life exists in Strong Brook based primarily upon releases of PCBs to the stream. Concentrations of PAHs and heavy metals also contribute to the potential for toxic effects. Given the flow regimes and channel characteristics of Strong Brook, sediment deposits in the stream must be considered extremely transitory. Therefore, it can be concluded that the source loading for the sediment contamination is ongoing. Analysis of the surface water data does not reveal any elevated PCB, PAH, or metals concentrations in the water column that could attribute to the concentrations observed in the sediment. However, the detection limits for the water column testing of PCBs conducted during the 2011 water quality survey may be too high to detect low-level continuing loads. High volume PCB sampling with much lower detection limits may be necessary to thoroughly evaluate whether there is continued loading of PCBs in the stream flow. Further investigation of the extent and nature of the sediment PCB contamination, potential sources, and the potential effect on the biota is warranted to determine if additional actions are necessary to remedy the situation.

Table 15. Concentrations of PCB compounds in sediment samples collected from the Strong Brook basin, 2012. All results expressed in µg/kg dry weight.

		Parameter: **CAS No.:**							
Sampling Location	**River Mile**	**PCB-1016 012674-11-2**	**PCB-1221 011104-28-2**	**PCB-1232 011141-16-5**	**PCB-1242 053469-21-9**	**PCB-1248 012672-29-6**	**PCB-1254 011097-69-1**	**PCB-1260 011096-82-5**	**Total PCB's**
38th Street manhole	N/A	<24.5	<24.5	<24.5	3,010	<24.5	<24.5	36,600	**39,610**
Strong Brook, dst. Ohio Avenue	0.66	<26.3	<26.3	<26.3	171	<26.3	<26.3	975	1,146
Strong Brook, dst. Michigan Avenue	0.63	<27.5	<27.5	<27.5	1,160	<27.5	<27.5	1,210	2,370
Strong Brook, dst. Michigan Avenue	0.62	<26.5	<26.5	<26.5	247	<26.5	<26.5	4,250	4,497
Strong Brook, dst. Lake Avenue	0.43	<29.4	<29.4	<29.4	<29.4	<29.4	<29.4	37	37
Strong Brook, dst. Lake Avenue	0.40	<29.8	<29.8	<29.8	34	<29.8	<29.8	343	377
Trib. to Strong Brook at RM 1.08, at Ohio Avenue	0.20	<97.1	<97.1	<97.1	<97.1	<97.1	<97.1	<97.1	ND
Jack's Marina Ditch	N/A	<43	<43	<43	<43	<43	<43	<43	ND

Data key:

1. Red shaded values indicate concentrations exceeding both the TEC and PEC for total PCBs.
2. Yellow shaded values indicate concentrations exceeding TEC for total PCBs.
3. **Bold** values indicate concentrations exceeding the Severe Effect Level as calculated by Persaud et al. (1993).
4. CAS No. = Chemical Abstract Service Registry Number

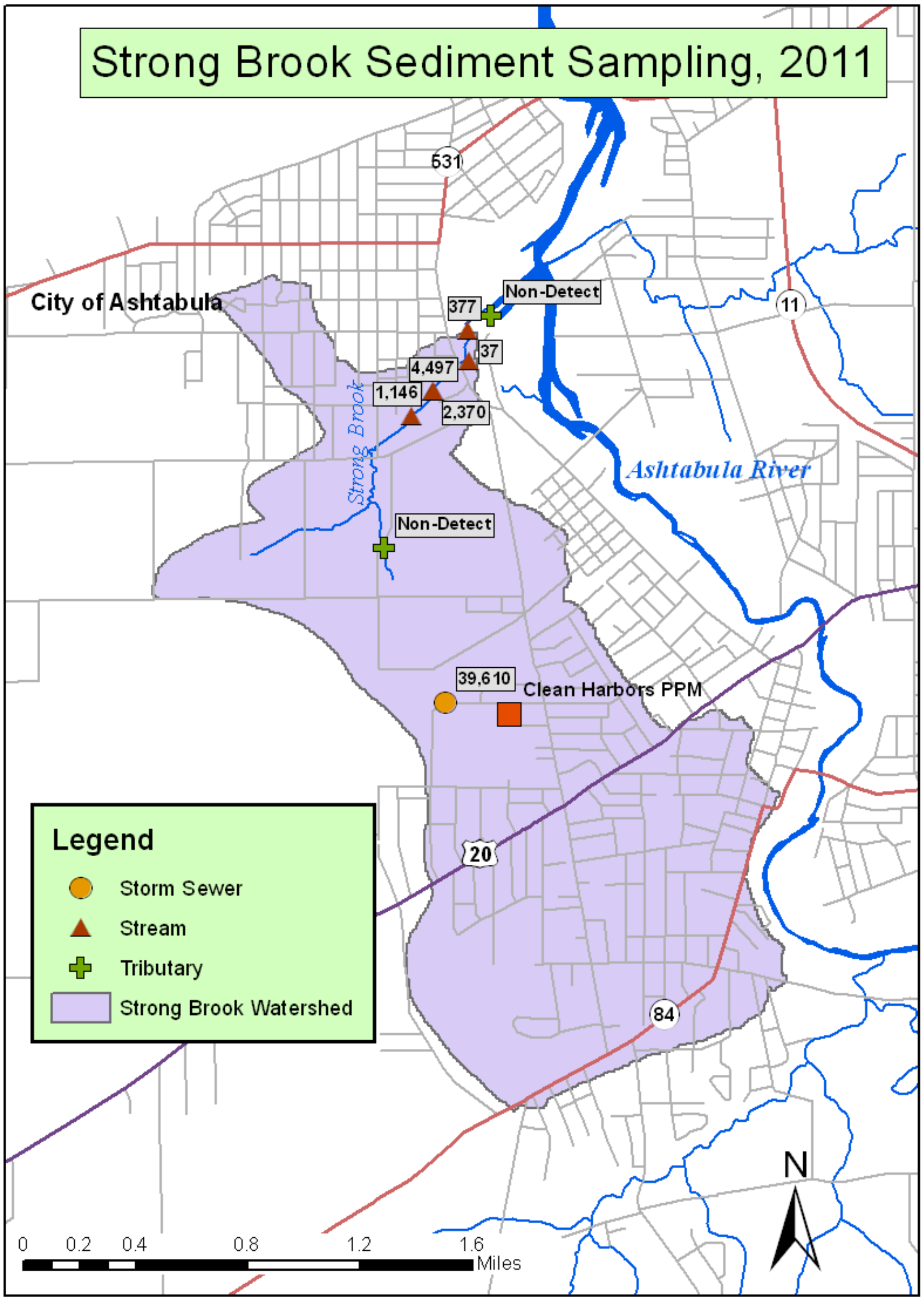


Figure 16. Sediment sampling locations in the Strong Brook watershed, 2012. Total PCB concentrations (μg/kg dry weight) are indicated for each sampling location.

Table 16. Concentrations of semi-volatile organic compounds and total PAHs found at detectable levels in sediment samples from Strong Brook, 2012. All concentrations are expressed in mg/kg dry weight.

	Location: (River Mile)	**Downstream Ohio Avenue (RM 0.66)**	**Downstream Michigan Ave. (RM 0.63)**	**Downstream Lake Avenue (RM 0.43)**
Parameter	**CAS No.**			
Benz[a]anthracene	000056-55-3	1.53	1.63	<0.60
Benzo[a]pyrene	000050-32-8	2.05	1.94	<0.60
Benzo[b]fluoranthene	000205-99-2	1.89	1.83	<0.60
Benzo[g,h,i]perylene	000191-24-2	1.32	1.11	<0.60
Benzo[k]fluoranthene	000207-08-9	1.56	1.30	<0.60
bis(2-Ethylhexyl)phthalate	000117-81-7	<0.53	<0.52	0.65
Chrysene	000218-01-9	2.12	1.92	0.64
Fluoranthene	000206-44-0	4.84	4.22	1.08
Indeno[1,2,3-cd]pyrene	000193-39-5	1.16	1.02	<0.60
Phenanthrene	000085-01-8	2.96	1.72	0.66
Pyrene	000129-00-0	3.71	3.34	0.90
Total PAHs		23.14	20.03	3.28

Data key:

1. Yellow shading indicates results above the TEC for the analyte.
2. Red shading indicates results above both the TEC and the PEC for the analyte.
3. CAS No. = Chemical Abstract Service Registry Number

Effects of instream toxicity in Strong Brook from sediment contamination should not be over-stated. In context, Strong Brook continues to be a highly urbanized stream with limited potential for ever maintaining a WWH biological community of fish and macroinvertebrates. The great majority of Strong Brook has been placed underground in culverts and storm sewers, and the likelihood of daylighting the stream to the extent that would result in restoration is minimal. Highly variable flow regimes and permanent habitat modifications continue to make the LRW designation of the stream appropriate. However, from the context of protection of the Ashtabula River watershed, the primary concern for long-term management of Strong Brook is to protect the Ashtabula River lacustuary from sediment loads that will degrade the investments made to remove contaminated sediments and to restore habitat there.

Table 17. Results for metals analytes and TOC for sediment samples from Strong Brook, 2012. All results are in mg/kg dry weight unless otherwise specified.

Analyte	Downstream Ohio Avenue (RM 0.66)	Downstream Michigan Ave. (RM 0.62)	Downstream Lake Avenue (RM 0.43)
Arsenic	11.6	2.37	12.1
Barium	77.2	33.3	99.1
Cadmium	**0.867**	0.243	0.611
Calcium	**44,200**	**37,200**	**28,200**
Chromium	20.5	7.06	14.6
Copper	26.2	5.58	**48.2** J
Iron	33,300	6,030	24,900 J
Lead	**56.9**	10.6	40.6
Magnesium	**10,900**	**12,400**	**7,350**
Manganese	1000	135	456
Mercury	<0.033	<0.02	0.079 J-
Nickel	24.0	6.2	19.2
Potassium	1,380	<1,000	<1,400
Selenium	<1.33	<1.00	<1.40
Sodium	<3,320	<2,500	<3,490
Strontium	52	**163**	45
Zinc	**336**	22.1	99.4
TOC (%)	2.5	2.0	3.5

Data key:

1. Yellow shading indicates results that exceed the TEC for the analyte.
2. J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
3. J- The result is an estimated quantity, but the result may be biased low.
4. **Bold** font indicates that the result exceeds the ecoregional SRV for the analyte.

NPDES Permitted Facilities

A total of eight National Pollutant Discharge Elimination System (NPDES) permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the Ashtabula River watershed (Table 18). Below, three major discharge facilities and their wastewater treatment are described in detail. The other five dischargers documented in Table 18 appear to have minimal impact of water quality of receiving streams in the Ashtabula River basin. Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in the individual NPDES permit and report results to the Ohio EPA in a Discharge Monitoring Report (DMR). Each permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. The DMR data can be used to track compliance as well as to evaluate historic trends.

Detrex Corporation

The Detrex Corporation manufactures hydrochloric acid and pharmaceutical intermediates like pyrroles and zinc dialkyldithiophosphates. Detrex has two internal outfalls, 601 and 602. Station 601 is the sanitary treatment effluent. Sanitary wastewater (601) goes through extended aeration, settling, surface sand filtration and chlorination. The discharge from station 602 consists of process wastewater, cooling tower blowdown, boiler blowdown, contaminated stormwater & ground water, and laboratory wastewater. Station 602 goes through equalization & settling, multimedia filtration, and carbon absorption. Detrex actually discharges through outfall 002 to Fields Brook. Outfall 002 consists of station 601, station 602, non-contact cooling water, and reverse osmosis blowdown (Table 19). NPDES permit violations were common through 2005. However, since 2005, the treatment system has been in compliance with permit limitations, and it does not appear to be causing a negative water quality impact.

Gabriel Performance Products LLC

Gabriel Performance Products' Ashtabula plant does process development for specialty organic chemicals. Current permit limits are based on Best Conventional Pollutant Control Technology (BCT) / Best Available Technology Economically Achievable (BAT) values for the organic chemicals, plastics and synthetic fibers industry, or Ohio Water Quality Standards. Process wastewater, cooling water, collected storm water and groundwater, and sanitary wastewater are treated by neutralization (secondary and final pH treatment), equalization and settling, multimedia filtration, air stripping and carbon adsorption prior to discharge via outfall 001. Treated discharge waters are recycled and tested before used as a sanitary wastewater source at internal station 600. Sanitary wastewater is treated at an activated sludge package plant prior to this treatment. Sanitary wastewater is measured at internal station 601. Process wastewater is tested at internal station 602 prior to further treatment and discharge to Fields Brook at 001.

The current permit contains monitoring and limits at internal stations 600, 601, and 602. Effluent guideline limits are applied at these stations to ensure that the treatment standards are met prior to combining with other waste streams. If monitoring was not done at these locations, it would not be possible to verify compliance with these standards due to dilution.

Clean Harbors PPM LLC

Clean Harbors facility treats PCB waste and has an NPDES permit to discharge storm water to Strong Brook. The storm water is collected and filtered onsite. Currently, Clean Harbors is not operating and is under investigation, due to the documented historical PCB contamination to

Jack Marine in the Ashtabula River harbor area. Clean Harbors has a sampling plan into Toxic Substance Control Act (TSCA) to reevaluate the facility for PCBs.

Table 18. Facilities regulated by an Individual NPDES permit in the Ashtabula River watershed.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Wastewater Type and Treatment System
ASHTA	3IE00016	Fields Brook	3.1	Storm water
Clean Harbors PPM LLC	3II00202	Strong Brook	1.1	Storm water
Detrex Corporation	3IF00017	Fields Brook	1.84	Sanitary, 0.548 gpd package plant
Gabriel Performance Products LLC	3IF00002	Fields Brook	1.83	Sanitary, 0.22 gpd package plant
Millennium Inorganic Chemicals Inc Plant 2	3IE00017	Fields Brook	2.2	Storm water
Mobile Acres Park & Sales	3PV00083	Fields Brook	2.4	Sanitary, 0.02 gpd package plant
Ridge View Estates	3PW00034	Trib. to Ashtabula River at RM 7.55	0.5	Sanitary, 0.01 gpd package plant
Ryber Development LLC	3IE00011	West Brook (Fields Brook)	9.36	Storm water

Table 19. Concentrations of monitored chemicals in effluent discharged from two facilities in the Ashtabula River study area. Results are reported for the time period 1995-2011.

Discharger / Parameter	**50th Percentile**	**95th Percentile**	**Permit Limit -Monthly Avg.-**	**Permit Limit -Maximum-**
Detrex Corporation (3IF00017)				
Outfall 002 to Fields Brook (RM 1.84)				
Biochemical Oxygen Demand, 5 Day (mg/l)	2.37	28.84	-	-
Flow (mgd)	0.472	0.7093	-	-
Free Cyanide (mg/l)	0	0	0.0052	0.022
Trichloroethylene (µg/l) – Station 602	0	0	5	10
Gabriel Performance Products LLC				
Outfall 001 to Fields Brook (RM 1.83)				
Flow (mgd)	0	0.203	-	-
Total Dissolved Solids (mg/l)	640	1100	-	-
Zinc (µg/l)	54.5	215.2	-	117

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 2010) (http://www.epa.state.oh.us/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf).

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

Fish tissue in 15 samples comprised by 38 fish either singularly or in combination was collected from the study area in 2011. All tissue samples were collected from the lower reach of the Ashtabula River stretching from US Route 20 (Prospect Road) to the mouth (Lake Erie). Consequently, all advisories and attainment/non-attainment status apply to this stretch of river.

Fish Advisories

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

The minimum data requirement for issuing a fish advisory is 3 samples from within the past 10 years. For the lower stretch of the Ashtabula River, fish tissue data collected in 2002 has been excluded from the calculations for the current fish advisories. Since 2002, significant remedial efforts were undertaken that involved dredging contaminated sediment from the river in an effort to reduce ambient concentrations of contaminants to safe levels. Levels of contaminants present in fish tissue prior to the 2011 sampling were not representative of post-dredging conditions. For more information about the remediation efforts in the Ashtabula River see
http://www.epa.gov/greatlakes/aoc/ashtabula/pdfs/2008_ashtabula_rap.pdf .

From Prospect Road (US 20, RM 3.7) to the mouth of the Ashtabula River, there is sufficient data to support a one meal per week advisory for largemouth bass due to arsenic and mercury and smallmouth bass due to arsenic, mercury and PCBs. Common carp and freshwater drum also showed elevated levels of PCBs. However, only two samples were collected for each species so according to Ohio EPA protocol there is insufficient data to issue an advisory for these species. Nonetheless, PCB concentrations in each sample exceeded the once per month concentration threshold. All other statewide advisories are still applicable, and include: two meals a week for sunfish (e.g., bluegill) and yellow perch, one meal a week for most other fish, and one meal a month for flathead catfish 23” and over, and northern pike 23” and over. Tables

20 and 21 summarize the concentrations of detected metals and PCBs respectively. Results for other typical tissue parameters not presented in these tables were either less than detection limits or below the unrestricted consumption level.

Fish tissue/human health use attainment

In addition to determining safe meal frequencies, fish contaminant data are also used to determine attainment with the human health water quality criteria pursuant to OAC Rules 3745-1-33 and 3745-1-34. The human health water quality criteria are presented in water column concentrations of µg/Liter, and are then translated into fish tissue concentrations in mg/kg. See Ohio's 2010 Integrated Report (Ohio EPA 2010b) Section E for further details of this conversion (http://www.epa.state.oh.us/portals/35/tmdl/2010IntReport/Section%20E.pdf).

In order to be considered in attainment of the water quality standards, the sport fish caught within a HUC12 in the Lake Erie drainage basin must have a weighted average concentration of the geometric means for all species below 0.350 mg/kg for mercury, and below 0.023 mg/kg for PCBs. At least 2 samples from each trophic level 3 and 4 are needed to evaluate attainment status, and fish tissue samples collected in the Ashtabula River met this requirement.

Fish tissue data were adequate to determine partial attainment status for the lower portion of the Ashtabula River watershed (HUC 04110003 01 05). PCBs were detected in all samples of common carp, freshwater drum, white sucker, yellow bullhead, and in 3 of the 5 samples of smallmouth bass. No PCBs were detected in largemouth bass samples. The weighted concentration for PCBs from trophic levels 3 and 4 was 0.138 mg/kg. This value exceeds the water quality criterion of 0.023 mg/kg for PCBs and thus, this HUC 12 is in non-attainment status due to PCBs. The weighted concentration for mercury was 0.149 mg/kg. This meets the OEPA water quality criterion of 0.350 mg/kg and the US EPA's threshold of 0.3 mg/kg (Table 22).

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 data results from the survey presented in this report with the results of previous data collected 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.

Historically, the lower stretch of the Ashtabula River (US Route 20 to the mouth) has been affected by unregulated discharges and mismanagement of hazardous waste which caused the river's sediments to become contaminated with PCBs, heavy metals, and other organic pollutants. This has resulted in unusually high concentrations of these contaminants in fish tissue, and at one point in time warranted a do not eat advisory on all fish. In order to address this issue, remedial dredging efforts began in 2006 to remove over 500,000 cubic yards of contaminated sediment containing approximately 12.5 tons of hazardous PCBs (Ashtabula

River RAP 2008). Fish tissue data had previously been collected from the lower stretch of the Ashtabula River in 2002 within the same stretch reaching from US Route 20 to the mouth. The 2002 fish tissue samples were collected prior to any remedial dredging efforts which, when compared to the 2011 fish tissue results, provide a unique opportunity to compare pre and post-dredging contaminant levels in fish tissue, particularly PCBs.

PCB concentrations in fish tissue showed a drastic decrease between sampling periods for all species sampled. For common carp, average tissue PCB concentrations decreased from about 1.99 mg/kg in 2002 to 0.642 mg/kg in 2011. Average freshwater drum tissue concentrations decreased from about 1.36 mg/kg to 0.367 mg/kg in the same time period. Average largemouth bass and yellow bullhead tissue concentrations decreased to undetectable limits during the same time period from 0.286 mg/kg and 0.604 mg/kg, respectively. There were several other species collected during the 2002 sampling period that were not collected during 2011, so decreases in PCB tissue concentrations for these particular species could not be quantified. However, decreases in tissue concentrations similar to those highlighted above could be expected. Such a drastic decrease in PCB tissue concentrations coinciding with the dredging efforts to remove PCB contaminated sediments highlight the effectiveness of removing PCBs from the environment.

Trends for mercury tissue concentrations were more variable for individual species. Largemouth bass tissue concentrations decreased from 0.270 mg/kg to 0.136 mg/kg from 2002 to 2011; average size for largemouth bass sampled decreased from about 346 mm to 318 mm. The decrease of mercury can be partly attributed to the smaller sizes collected because mercury concentration increases with average fish size. Mercury tissue concentrations in common carp decreased from 0.183 mg/kg in 2002 to 0.069 mg/kg in 2011, while average size actually increased from 539mm to 564mm. This is in contrast to largemouth bass where both mercury tissue concentrations and average size decreased. Average mercury tissue concentrations remained about the same for freshwater drum and actually increased slightly for yellow bullhead. It is probable that the remedial dredging directed at PCBs also reduced mercury concentrations in the sediments, and consequently fish tissue mercury concentrations as well.

Selenium, cadmium, and lead concentrations have remained relatively similar from 2002 to 2011. In contrast, arsenic concentrations in fish tissue showed an abrupt spike. Historically, arsenic concentrations in fish tissue were below detectable limits, but in 2011 concentrations ranged from 0.054 mg/kg to 0.531 mg/kg, with 9 of the 15 samples exceeding the unrestricted consumption concentration level (0.150-0.656 mg/kg). There have been no additional permits for the release of arsenic since 2002 sampling, so the sudden appearance in fish tissue is likely due to the resuspension of deposits during the remedial dredging process.

Table 20. Selected metals concentrations (mg/kg) in fish tissue samples collected from the Ashtabula River (US Route 20 to mouth) in 2011. Shading indicates the advisory category that would apply, though as discussed in the text, several sites have insufficient data for issuing additional advisories beyond the statewide advisory. Green= two meals per week, yellow= one meal per week, orange= one meal per month. **Bold and highlighted** values indicate sufficient data for issuing an advisory. Values preceded by a less than sign (<) indicate results below method detection limits. RM indicates river mile. Sample types are: SFF=skin off filet, SFFC=skin off filet composite and WBC= whole body composite.

Species	# fish/type	Year	RM	Location	Arsenic	Selenium	Cadmium	Mercury	Lead
Largemouth Bass	3/SFFC	2011	1.3	Fields Brook Area	0.189	0.588	<.0039	0.127	<.039
	4/SFFC	2011	1.3	Fields Brook Area	0.116	0.392	<.0039	0.188	<.039
	3/SFFC	2011	0.5	Near 5th Ave.	0.113	0.517	<.0039	0.096	<.039
	3/SFFC	2011	0.5	Near 5th Ave.	0.251	0.669	<.0039	0.132	<.039
				Mean Values	**0.167**	0.542	--	**0.136**	--
Smallmouth Bass	3/SFFC	2011	3.7	US Route 20	0.087	0.464	<.0040	0.185	<.040
	1/SFF	2011	3.7	US Route 20	0.090	0.424	<.0039	0.227	<.039
	2/SFFC	2011	1.3	Fields Brook Area	0.531	0.920	<.0039	0.273	<.039
	2/SFFC	2011	1.3	Fields Brook Area	0.394	0.844	<.0040	0.134	<.040
	2/SFFC	2011	0.5	Near 5th Ave.	0.302	0.798	<.0039	0.138	<.039
				Mean Values	**0.281**	0.690	--	**0.191**	--
Common Carp	3/SFFC	2011	1.3	Fields Brook Area	0.231	0.646	<.0039	0.075	<.039
	4/SFFC	2011	0.5	Near 5th Ave.	0.238	0.713	<.0040	0.063	<.040
				Mean Values	0.235	0.680	--	0.069	--
Freshwater Drum	2/SFFC	2011	1.3	Fields Brook Area	0.208	0.56	0.0158	0.192	<.039
	2/SFFC	2011	0.5	Near 5th Ave.	0.206	0.681	0.0099	0.103	0.075
				Mean Values	0.207	0.621	0.013	0.148	0.056
Yellow Bullhead	2/SFFC	2011	3.7	US Route 20	0.054	0.265	<.0039	0.194	<.039
White Sucker	2/WBC	2011	3.7	US Route 20	0.110	0.542	0.0054	0.063	0.09

Table 21. PCB concentrations (mg/kg) in fish tissue samples collected from the Ashtabula River (US Route 20 to mouth) in 2011. The shading indicates the advisory category that would apply, though as discussed in the text, several sites have insufficient data for issuing additional advisories beyond the statewide advisory. Yellow= one meal per week, orange= one meal per month. **Bold and highlighted** values indicate sufficient data for issuing an advisory. Values preceded by a less than sign (<) indicate results below method detection limits. RM indicates river mile. Sample types are: SFF=skin off filet, SFFC=skin off filet composite and WBC= whole body composite.

					PCB Aroclors		
Species	**# fish/type**	**Year**	**RM**	**Location**	**1254**	**1260**	**Total PCBs**
Largemouth Bass	3/SFFC	2011	1.3	Fields Brook Area	<.0500	<.0500	--
	4/SFFC	2011	1.3	Fields Brook Area	<.0500	<.0500	--
	3/SFFC	2011	0.5	Near 5th Ave.	<.0500	<.0500	--
	3/SFFC	2011	0.5	Near 5th Ave.	<.0500	<.0500	--
					Mean Values		--
Smallmouth Bass	3/SFFC	2011	3.7	US Route 20	<.0500	0.0558	0.0808
	1/SFF	2011	3.7	US Route 20	<.0500	<.0500	0.0500
	2/SFFC	2011	1.3	Fields Brook Area	0.0737	0.1190	0.1927
	2/SFFC	2011	1.3	Fields Brook Area	<.0500	<.0500	0.0500
	2/SFFC	2011	0.5	Near 5th Ave.	<.0500	0.0544	0.0794
					Mean Values		**0.0906**
Common Carp	3/SFFC	2011	1.3	Fields Brook Area	0.1120	0.2700	0.3820
	4/SFFC	2011	0.5	Near 5th Ave	0.0908	0.8120	0.9028
					Mean Values		0.6424
Freshwater Drum	2/SFFC	2011	1.3	Fields Brook Area	0.0552	0.2540	0.3092
	2/SFFC	2011	0.5	Near 5th Ave.	0.1370	0.2880	0.4250
					Mean Values		0.3671
Yellow Bullhead	2/SFFC	2011	3.7	US Route 20	<.0500	<.050	--
White Sucker	2/WBC	2011	3.7	US Route 20	0.0921	0.1440	0.2361

Table 22. Non-drinking human health use attainment status based on fish tissue samples collected from the Ashtabula River in 2011. All units are in mg/kg. **Bolded** values in the table are used to calculate weighted contaminant concentrations for each trophic level. **Red bold** highlighted values violate the criteria and signify impairment. Values preceded by a less than sign (<) indicate concentration results below the method detection limit. RM indicates river mile. Sample types are: SFF=skin off filet, SFFC=skin off filet composite and WBC= whole body composite.

Species	# fish/type	RM	Location	Trophic Level	Mercury	PCB Aroclors 1254	PCB Aroclors 1260	Total PCBs
Common Carp	3/SFFC	1.3	Fields Brook Area	3	0.075	0.1120	0.2700	0.3820
	4/SFFC	0.5	Near 5th Ave.	3	0.063	0.0908	0.8120	0.9028
			Geometric Mean		**0.0687**			**0.5873**
Freshwater Drum	2/SFFC	1.3	Fields Brook Area	3	0.192	0.0552	0.2540	0.3092
	2/SFFC	0.5	Near 5th Ave.	3	0.103	0.1370	0.2880	0.4250
			Geometric Mean		**0.141**			**0.3625**
White Sucker	2/WBC	3.7	US Route 20	3	**0.063**	0.0921	0.1440	**0.2361**
Yellow Bullhead	2/SFFC	3.7	US Route 20	3	**0.194**	<.0500	<.0500	**0.0500**
Largemouth Bass	3/SFFC	1.3	Fields Brook Area	4	0.127	<.0500	<.0500	0.0500
	4/SFFC	1.3	Fields Brook Area	4	0.188	<.0500	<.0500	0.0500
	3/SFFC	0.5	Near 5th Ave.	4	0.096	<.0500	<.0500	0.0500
	3/SFFC	0.5	Near 5th Ave.	4	0.132	<.0500	<.0500	0.0500
			Geometric Mean		**0.132**			**0.0500**
Smallmouth Bass	3/SFFC	3.7	US Route 20	4	0.185	<.0500	0.0558	0.0808
	1/SFF	3.7	US Route 20	4	0.227	<.0500	<.0500	0.0500
	2/SFFC	1.3	Fields Brook Area	4	0.273	0.0737	0.119	0.1927
	2/SFFC	1.3	Fields Brook Area	4	0.134	<.0500	<.0500	0.0500
	2/SFFC	0.5	Near 5th Ave.	4	0.138	<.0500	0.0544	0.0794
			Geometric Mean		**0.184**			**0.0791**

	Weighted Mercury Conc.	Mercury Weighted Product	Weighted PCB Conc.	PCB Weighted Product
Mean 3 Value (3.6)	0.113	0.405	0.3643	1.311
Mean 4 Value (11.4)	0.161	1.83	0.0661	0.754
Sum		2.24		2.065
Divided by /15	Weighted Concentration	0.149		**0.138**
	Impairment Threshold	0.350		0.023

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