NORTHEAST OHIO REGIONAL SEWER DISTRICT

2012 Cuyahoga River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2012, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys in the lower Cuyahoga River. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio Environmental Protection Agency (EPA) in Fish Community and Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2012 Cuyahoga River Environmental Monitoring* approved by Ohio EPA on May 15, 2012.

One of the purposes of this study was to determine the attainment status of the river in relation to point and nonpoint sources of pollution. The lower Cuyahoga River has been designated as one of 42 Great Lakes Areas of Concern (AOC) by the International Joint Commission. Past monitoring indicated impairment of aquatic biota in the river and was the basis of a Total Maximum Daily Load (TMDL) for the Lower Cuyahoga River (Ohio EPA, 2003). The causes of impairment to the river were classified as organic enrichment, toxicity, low dissolved oxygen, nutrients and flow alteration. During the last few years, however, many sites in the river have been in full attainment of the biological criteria. This study was completed to determine current conditions in the river, identify any spatial and temporal trends in present and historic data, and measure the magnitude of any impacts.

The fish and macroinvertebrate community in the Cuyahoga River navigation channel was also monitored in support of three grants related to habitat restoration as part of the Great Lakes Restoration Initiative. These grants include the *Cuyahoga River Larval Fish Study* funded by the U.S. Army Corps of Engineers that is being implemented by the Cuyahoga County Planning Commission, the Cuyahoga County Engineer's Office project *Cuyahoga AOC Urban Riparian Habitat Restoration*, and the Ohio Department of Natural Resource's *Cuyahoga AOC Urban Riparian Habitat Restoration Opportunities*. This was the third year of baseline data collection for these grants.

Figure 1 is a map of the sampling locations evaluated, and Table 1 indicates the sampling locations with respect to river mile (RM), latitude/longitude, description and surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance (WQIS) Division.

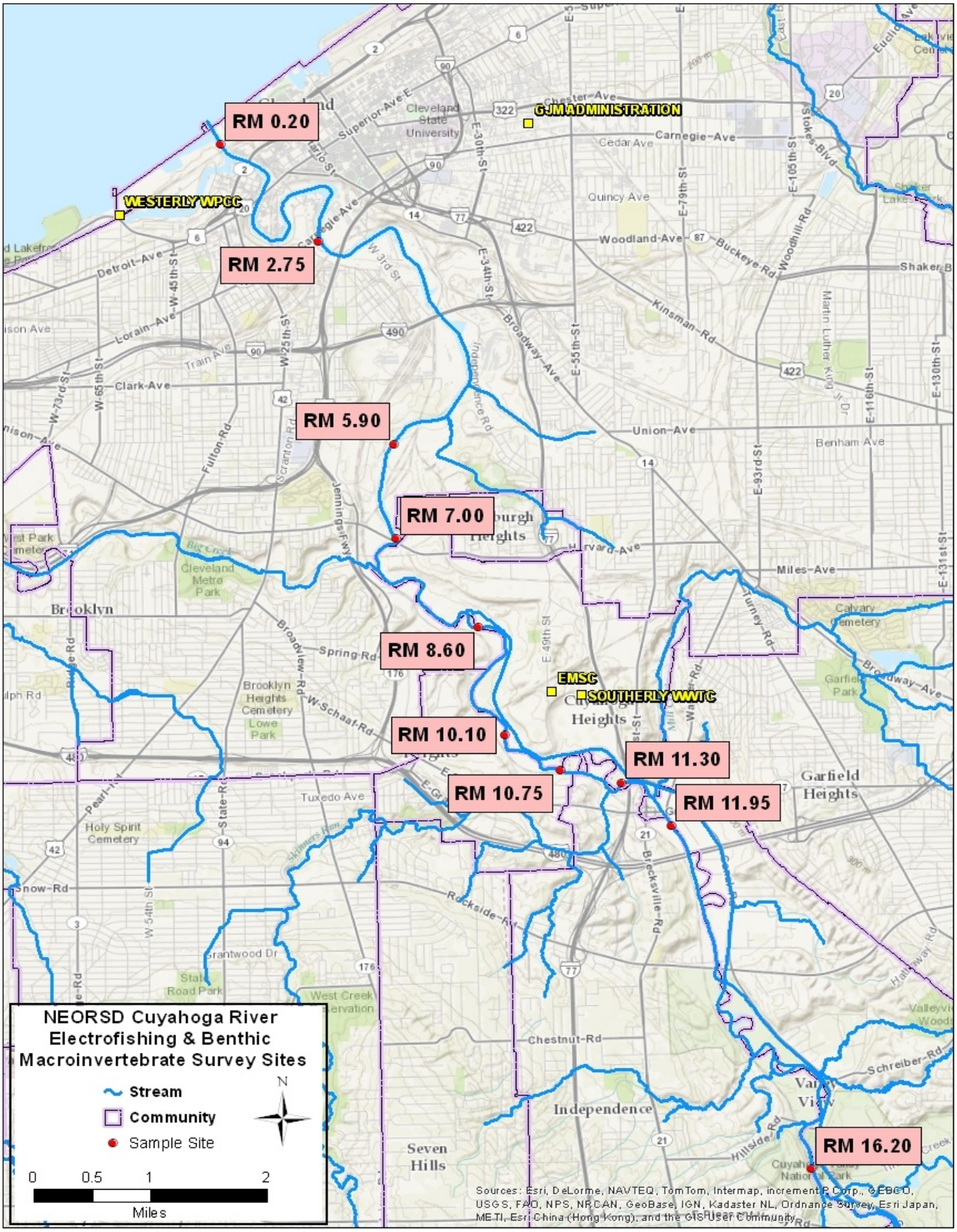


Figure 1. Sampling Locations

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
Downstream of Tinkers Creek	N41.3678°	W81.6139°	16.20	Downstream of the confluence with Tinkers Creek near Old Riverview Road	Background data for fish, habitat, macroinvertebrates, and chlorophyll *a*
Upstream of Mill Creek	N41.4123° N41.4101°	W81.6364° W81.6346°	12.10[1] 11.95	Upstream of the confluence with Mill Creek (I-480)	Evaluate Mill Creek discharge on fish, habitat and macroinvertebrates
Downstream of Mill Creek	N41.4179°	W81.6446°	11.30	Downstream of the confluence with Mill Creek	Evaluate Mill and West Creek discharges on fish, habitat and macroinvertebrates
Upstream of Southerly WWTC	N41.4196°	W81.6547°	10.75	Upstream of Southerly WWTC effluent discharge	Evaluate West Creek and Southerly WWTC discharges on fish, habitat and macroinvertebrates, and Southerly WWTC discharge on chlorophyll *a* levels.
Downstream of Southerly WWTC	N41.4242°	W81.6638°	10.10	Downstream of Southerly WWTC effluent discharge	Evaluate Southerly WWTC discharge on fish, habitat, macroinvertebrates, and chlorophyll *a* levels.
Upstream of Big Creek	N41.4381°	W81.6680°	8.60	Upstream of the confluence with Big Creek	Evaluate Big Creek discharge on fish, habitat and macroinvertebrates
Downstream of Big Creek	N41.4497°	W81.6815°	7.00	Downstream of the confluence with Big Creek/ Upstream of habitat restoration project	Evaluate Big Creek discharge on fish, habitat and macroinvertebrates; Southerly WWTC discharge on chlorophyll *a* levels; and effectiveness of habitat restoration in

[1] HD and Water Chemistry Collection Site

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
					navigation channel on fish.
Head of Navigation Channel	N41.4619°	W81.6816°	5.90	Head of navigation channel/Upstream of artificial habitat near ArcelorMittal	Evaluate effectiveness of habitat restoration in navigation channel on fish.
Abandoned Marina (formerly Scaravelli's)	N41.4881°	W81.6938°	2.75	Mid-navigation channel/Proposed site of GLRI habitat restoration project	Evaluate effectiveness of habitat restoration in navigation channel on fish.
Cuyahoga River Mouth	N41.5008°	W81.7098°	0.20	Near mouth of river in navigation channel	Evaluate effectiveness of habitat restoration in navigation channel on fish.

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted six times between June 20 and July 18, 2012, on the Cuyahoga River between RMs 16.20 and 0.20. Techniques used for sampling and analyses followed the Ohio EPA *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2012) and *Surface Water Field Sampling Manual* (2013). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

Formula 1: $$RPD = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2013).

Formula 2: $$\text{Acceptable \% RPD} = [(0.9465X^{-0.344})*100] + 5$$

X = sample/detection limit ratio

Those RPDs that were higher than acceptable may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards.

Mercury analysis for all of the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if the Cuyahoga River was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the river.

Water chemistry analysis sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

Five field blanks and five duplicate samples were collected as part of this study in 2012. For the field blanks, there were fourteen parameters that showed possible contamination. It is unclear how the field blanks became contaminated and may be due to inappropriate sample collection, handling, contaminated blank water and/or interference during turbidity analysis. Table 2 lists water quality parameters that were rejected, estimated, or downgraded from Level 3 to Level 2 data based on Ohio EPA data validation protocol.

Table 2. Parameters affected by possible blank contamination			
Cd	COD	Cr	DRP
Fe	Hg	Mo	NH3
Ni	NO2	Tl	TP
Turbidity	Zn		

For the duplicate samples, one of the sets had three parameters (Al, Fe, Ti) with RPDs greater than acceptable, resulting in the data being rejected (Table 3). This set of samples was collected during a wet weather event at RM 8.60. The increased flow during this sampling may have resulted in less homogenization of the river than during dry weather, due to runoff, and therefore could have resulted in the differences observed between the two samples. The other three instances with RPDs high enough to result in data being rejected did not occur during wet weather sampling and the reason for the unacceptable differences between the samples remains unknown.

Table 3. Duplicate samples with RPDs greater than acceptable					
Site	Date	Parameter	Qualifier	Acceptable RPD	Actual RPD
RM 16.20	7/11/2012	Tl	R	99.7	102.4
RM 8.60	6/20/2012	Al	R	24.8	52.1
RM 8.60	6/20/2012	Fe	R	15.3	44.1
RM 8.60	6/20/2012	Ti	R	38.5	61.3
RM 7.00	7/18/2012	NH3	R	35.4	58.0
RM 0.20	6/27/2012	Tl	R	69.5	101.1

R = data rejected

The final QA/QC check for the samples that were collected was for paired parameters. Based on these comparisons, all of the data for chromium and hexavalent chromium except for one sample were qualified as being estimated or rejected. Because none of the measured values were close to the applicable criteria, rejection of those data points did not affect whether the criteria were met.

The sites upstream of the navigation channel are all designated warmwater habitat, agricultural water supply, industrial water supply, and Class A primary contact recreation. Those in the navigation channel are designated limited resource water-navigation maintenance from June through January and whenever the river flow is less than 703 ft^3/s during the rest of the year and fish passage during the months of February through May when flow is equal to or greater than 703 ft^3/s. They are also designated industrial water supply and Class A primary contact recreation.

The majority of parameters measured during the study met the applicable criteria within and upstream of the navigation channel. One of the exceptions to this was *Escherichia coli* (*E. coli*). The bacteriological criteria for *E. coli* consist of two components: a seasonal geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 30-day period (single sample maximum). For those streams designated Class A primary contact recreation, these criteria are 126 colony-forming units (CFU)/100mL and 298 CFU/100mL, respectively. The seasonal geometric mean criterion was exceeded at all of the sites in 2012 (Table 4). Also, the single sample maximum criterion was exceeded at all of the sites for the 30-day periods beginning with the first three samples collected during the study and one additional 30-day period at RM 5.90. That site also had the highest seasonal geometric mean. The exceedances that occurred were generally due to wet weather events[2]; during dry weather, most of the measured densities were relatively low. Potential sources of bacteria to the river could include stormwater runoff and CSOs.

Table 4. 2012 Cuyahoga River *E. coli* Densities (colony-forming units/100mL)

Date	RM 16.20	RM 12.10	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90	RM 2.75	RM 0.20
6/20/2012*	933	504	767	632	426	461	526	1100	491	500
6/27/2012	66	41	50	51	73	57	135	170	150	33.5
7/5/2012*	1183	1533.5	2650	5800	2971	967	14954	5400	5600	967
7/11/2012	58	56	44	67	62	105	71	250	150	162
7/18/2012	33	65	125	47	66	125	117.5	390	120	158
Seasonal Geomean	169	163	224	226	207	202	389	629	375	211

* Wet weather event

Exceeds single sample maximum criteria for 30-day period starting on that date

Mercury was another parameter that failed to meet the applicable criteria during the sampling that was conducted at these sites. Exceedances of the aquatic life and wildlife outside mixing zone averages (OMZA) occurred at all of the sites during the sampling (Table 5). It is expected that the use of EPA Method 1631E, a low level method, instead of EPA Method 245.1 would have resulted in exceedances of the criteria throughout the sampling period.

[2] Wet weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following day are considered wet weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet weather samples.

Table 5. 2012 Cuyahoga River Mercury Results (ug/L)										
	RM 16.20	RM 12.10	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90	RM 2.75	RM 0.20
6/20/12	<0.005	<0.005	<0.005	<0.005	j0.018	j0.0055	j0.006	j0.015	j0.017	<0.005
6/27/12	<0.005	<0.005	j0.006	<0.005	<0.005	<0.005	j0.012	j0.014	j0.008	j0.0056
7/5/12	<0.005	<0.005	j0.006	j0.006	<0.005	<0.005	j0.036	<0.005	<0.005	<0.005
7/11/12	j0.0135	j0.015	j0.014	j0.014	j0.017	j0.013	j0.015	j0.014	j0.014	j0.015
7/18/12	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Exceedance of Wildlife OMZA for 30-day period beginning with that date, assuming "j" values are actual values and concentrations below the MDL are zero.

Exceedance of Wildlife and Aquatic Life OMZAs for 30-day period beginning with that date, assuming "j" values are actual concentrations and concentrations below the MDL are zero.

The only other exceedance measured at these sites in 2012 was for the copper aquatic life outside mixing zone maximum at RM 7.00 on July 5th. This sample was collected during a wet weather event. Because no other copper exceedances occurred at any of the other sites, it is possible that the source may have come from Big Creek, which is located just upstream of RM 7.00. It may have also originated from stormwater runoff coming in at some point between RM 8.60 and the affected site.

Habitat Assessment

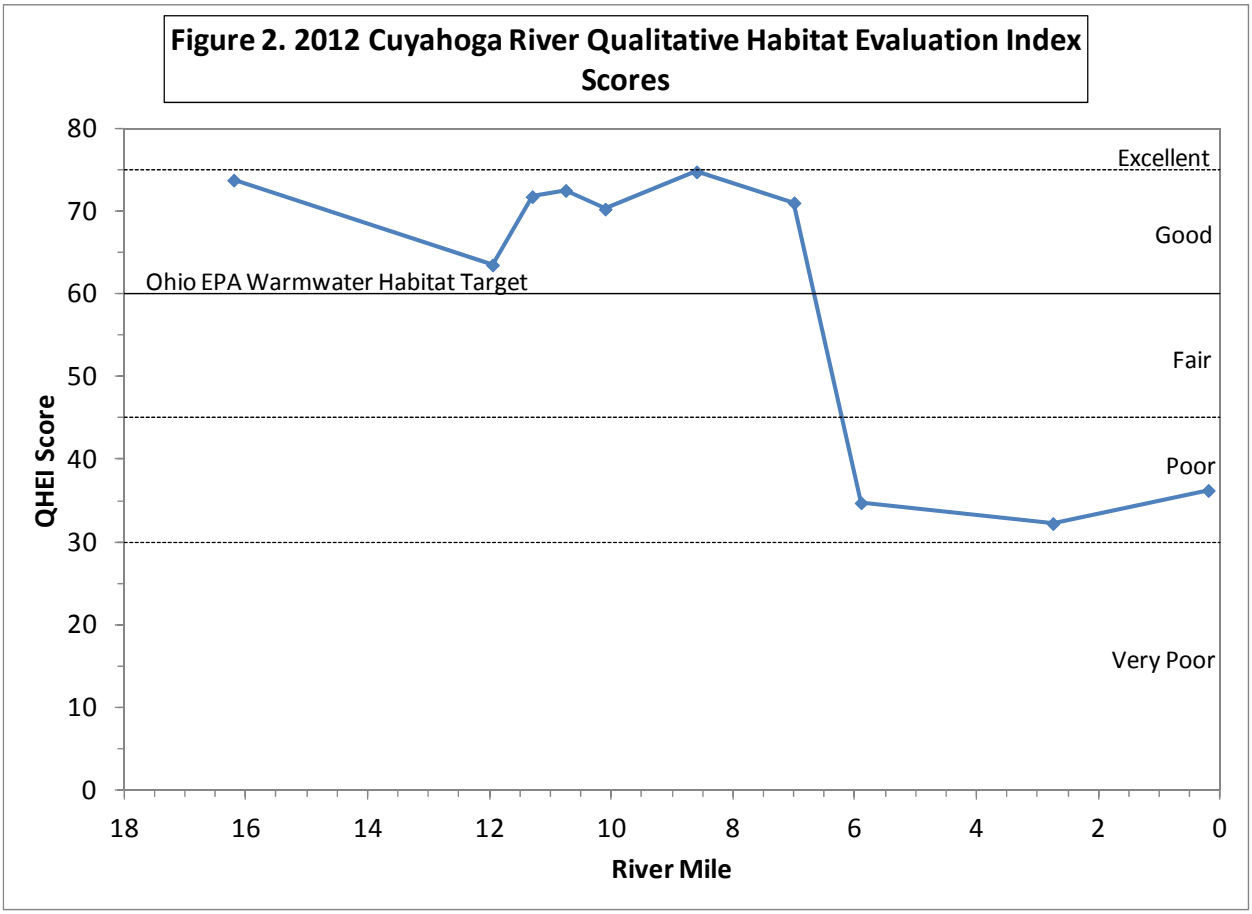
Methods

Instream habitat assessments were conducted once at each site on the Cuyahoga River in 2012 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score of 60 or more suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2003). A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

All of the sites upstream of the navigation channel were rated *Good*, meeting the target goal of 60 set by the Ohio EPA (Figure 2) (Ohio EPA, 2003). Sites meeting this goal are expected to meet the warmwater habitat (WWH) designated use. The sites within the navigation had much lower scores and were all rated *Poor*.

Individual components of the QHEI can also be used to evaluate whether a site is capable of meeting the WWH designated use. This is done by categorizing specific attributes as indicative of either a WWH or modified warmwater habitat (MWH) (Rankin, 1995). Attributes that are considered characteristic of MWH are further classified as being of moderate or high influence to fish communities. The presence of one high or four moderate influence characteristics has been found to result in lower IBI scores, with a greater prevalence of these characteristics usually preventing a site from meeting WWH attainment (Ohio EPA, 1999).



Upstream of the navigation channel, the sites all had the WWH characteristics of fast currents and eddies, maximum depths greater than 40 cm, and either had never been channelized or had recovered from it (Table 6). Some of the sites had one high influence MWH characteristic, either no sinuosity or sparse instream cover. The total number of moderate influence MWH attributes at each site ranged from four to six; common characteristics shared by most or all of the sites included a sand substrate, moderate-to-high embeddedness, moderate-to-heavy silt cover, and low sinuosity. Based on the number of the MWH attributes at these sites, it would be more difficult for them to meet the WWH fish criteria, even though they are higher than the overall target score of 60.

The sites in the navigation channel exhibited a much higher number of both moderate and high influence MWH characteristics including channelization, muck substrates, sparse instream cover, poor development, slow currents, and high silt cover and embeddedness. The presence of these characteristics makes it highly unlikely that these sites would be able to meet the WWH criteria for fish and is consistent with their designation as limited resource waters.

Table 6. Qualitative Habitat Evaluation Index scores and physical attributes

			MWH Attributes																												
			WWH Attributes											High Influence						Moderate Influence											
River Mile	QHEI Score	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinousity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or no Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max. Dept <40 cm (WD, HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attribute**
16.20	73.75	Good	x			x		x	x		x		5						0		x	x			x				x	x		5
11.95	63.50	Good	x					x	x		x		4			x			1		x	x		x					x		x	5
11.30	71.75	Good	x					x	x		x		4						0		x	x		x	x				x	x		6
10.75	72.50	Good	x					x	x		x		4						0		x	x		x	x				x	x		6
10.10	70.25	Good	x			x			x		x		4				x		1		x	x			x				x	x		5
8.60	74.75	Good	x			x			x		x		4				x		1			x			x				x	x		4
7.00	71.00	Good	x						x		x		3				x		1		x	x		x	x				x	x		6
5.90	34.75	Poor									x		1	x	x		x		3		x			x	x			x	x		x	6
2.75	32.25	Poor									x		1	x	x	x	x		4		x			x				x	x		x	5
0.20	36.25	Poor									x		1	x	x	x	x		4		x			x				x	x		x	5

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2012, except at RM 16.20. No surveys were conducted there due to flow conditions in the river that prevented boat launching. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station in either Independence or Newburgh Heights, is given in Table 7. Sampling was conducted using boat electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from upstream to downstream by slowly and steadily maneuvering the boat as close to shore and submergent objects as possible. The sampling zone was 0.5 kilometers for each site. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 7. Sampling Dates and River Flows

Date	Sites sampled (RMs)	Daily Mean Flow (CFS*)
6/28/12	5.90	453**
6/29/12	2.75, 0.20	407**
7/26/12	11.95, 11.30	204
8/3/12	8.60, 7.00	216
8/8/12	10.75, 10.10	211
8/13/12	5.90, 2.75	576**
8/15/12	0.20	607**
9/17/12	11.95, 11.30	297
10/10/12	11.30, 8.60	408
10/11/12	10.75, 10.10, 7.00	369

*Provisional data
**Measured at Newburgh Heights gage station; all other flows measured at Independence.

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb). The IBI incorporates 12

community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor* or *Very Poor*. Sites at River Miles 5.90, 2.75, and 0.20 were also evaluated using the lacustuary IBI (LIBI). The LIBI is intended to be used in those areas near the mouths of rivers that may be affected by lake levels. The 12 metrics utilized for boat and lacustuary sites are listed in Table 8.

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 1 below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 2 below) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 1: $$MIwb = 0.5\ lnN + 0.5\ lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

N = Relative numbers of all species excluding species designated as highly tolerant, hybrids, or exotics

B = Relative weights of all species excluding species designated as highly tolerant, hybrids, or exotics

$\overline{H}(No.)$ = Shannon Diversity Index based on numbers

$\overline{H}(Wt.)$ = Shannon Diversity Index based on weight

Formula 2: $$\overline{H} = -\sum\left[\left(\frac{n_i}{N}\right)log_e\left(\frac{n_i}{N}\right)\right]$$

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

Table 8. Index of Biotic Integrity Metrics

Boat	Lacustuary
Number of native species	Number of native species
Percent round-bodied suckers	Number of sunfish species
Number of sunfish species	Number of cyprinid species
Number of sucker species	Number of benthic species
Number of intolerant species	Percent phytophilic
Percent tolerant	Percent top carnivores

Table 8. Index of Biotic Integrity Metrics	
Boat	Lacustuary
Percent omnivores	Number of intolerant species
Percent insectivores	Percent omnivores
Percent top carnivores	Percent non-indigenous
Number of individuals	Percent tolerant
Percent simple lithophils	Percent DELTs
Percent DELTs	Number of individuals

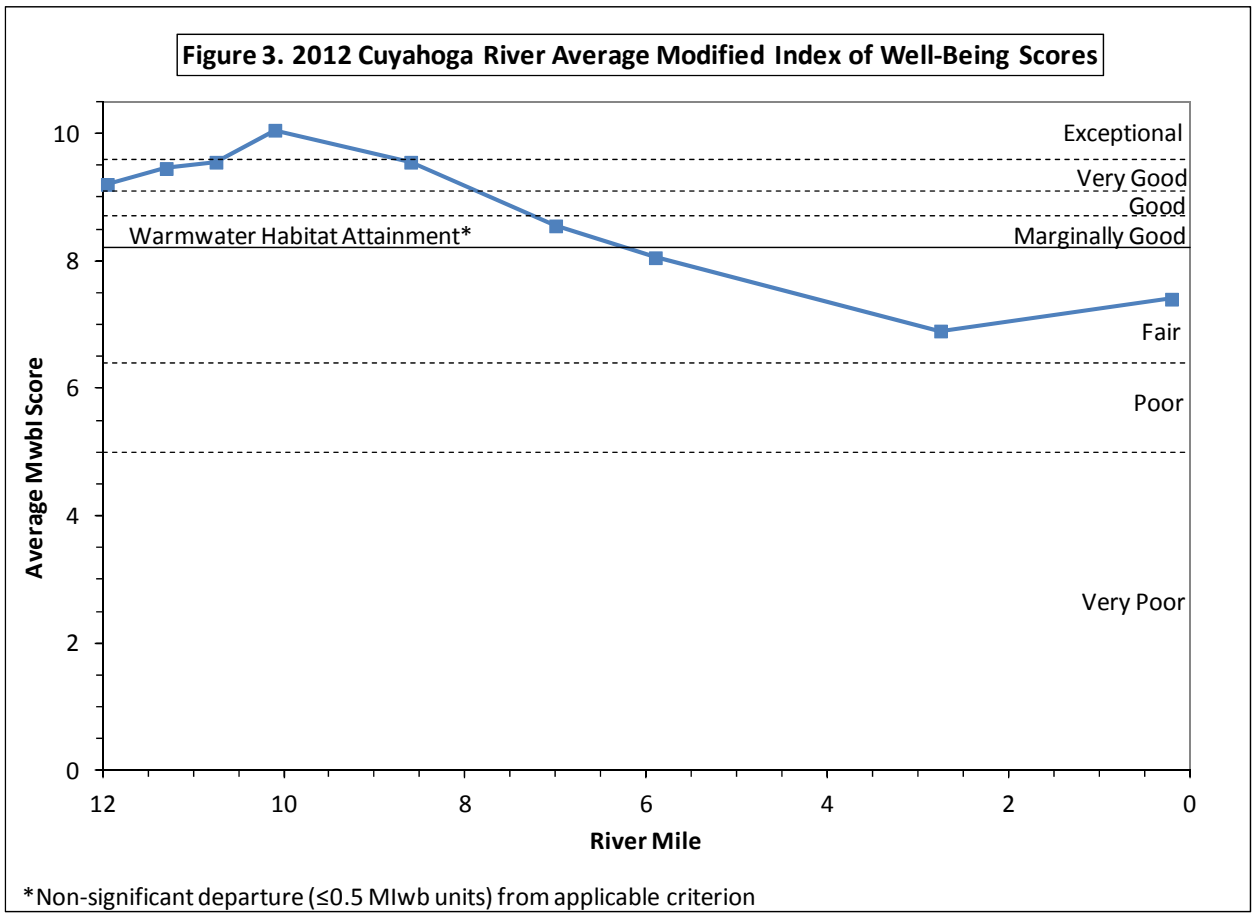
Lists of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

The sites upstream of the navigation channel all had average MIwb scores that met or were within non-significant departure from the warmwater habitat criterion (Table 9 and Figure 3). All of the scores were also higher than in 2011 and for the sites at RMs 11.95, 10.10, and 8.60, were the highest ever received since NEORSD began conducting sampling (Table 10).

Table 9. 2012 Cuyahoga River IBI and MIwb Results							
		1st Pass		2nd Pass		Average	
Location	River Mile	IBI	MIwb	IBI	MIwb	IBI	MIwb
Upstream from Mill Creek	11.95	*36*	**8.8**	*36*	**9.6**	*36*	**9.2**
Downstream from Mill Creek	11.30	*38*	**9.6**	32	**9.3**	35	**9.5**
Upstream from Southerly WWTC	10.75	**40**	**9.9**	*36*	**9.2**	*38*	**9.6**
Downstream from Southerly WWTC	10.10	34	**10.1**	34	**10.0**	34	**10.1**
Upstream from Big Creek	8.60	**42**	**9.4**	34	**9.7**	*38*	**9.6**
Downstream from Big Creek	7.00	32	**9.1**	26	8.0	29	*8.6*
US of Newburgh SS RR Bridge*	5.90	30 (19)	7.6	32 (32)	*8.5*	31 (26)	8.1
Scaravelli's Marina*	2.75	20 (17)	5.6	26 (24)	*8.2*	23 (21)	6.9
Upstream of Confluence w/ Lake Erie*	0.20	28 (35)	7.4	32 (29)	7.4	30 (32)	7.4

Bold = meets WWH criterion [IBI ≥40; MIwb ≥8.7]
Italics = non-significant departure from WWH criterion [IBI ≥36; MIwb ≥8.2]
Scores in parentheses are those calculated using the lacustuary IBI
* Biological criteria do not apply



Within the navigation channel, the biological criteria do not apply. However, based on the sampling that was conducted, the average MIwb scores there would not have met the WWH criterion, although the scores for the second pass at two of the sites were within non-significant departure from it. The average scores at RMs 5.90 and 0.20 were higher than 2011, while the score at RM 2.75 was lower. Generally, a relatively low number of fish resulted in the low scores at RMs 5.90 and 2.75; lower diversity was the main reason at RM 0.20.

Table 10. Cuyahoga River Historic MIwb Scores (1990-2012)

	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90*	RM 2.75*	RM 0.20*
1990	-	-	-	4.5	4.6	-	-	-	-	-
1991	-	-	-	5.5	5.6	-	6.1	-	-	-
1992	-	-	-	5.6	6.6	-	5.8	-	-	-
1997	-	-	-	7.5	6.1	-	6.1	-	-	-
1998	-	-	-	7.8	7.6	-	5.5	-	-	-
1999	-	-	-	8.2	*8.6*	-	7.0	-	-	-
2001	-	-	-	7.4	*8.2*	-	6.1	-	-	-

Table 10. Cuyahoga River Historic MIwb Scores (1990-2012)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90*	RM 2.75*	RM 0.20*
2003	-	-	-	7.6	7.8	-	7.0	-	-	-
2004	-	-	-	8.0	*8.4*	-	-	-	-	-
2006	-	-	-	**8.8**	*8.5*	-	7.8	-	-	-
2007	*8.6*	*8.5*	*8.3*	**9.4**	**9.7**	-	*8.3*	-	-	-
2008	**9.9**	*8.2*	**9.1**	**8.9**	**9.4**	-	*8.5*	-	-	-
2009	**9.9**	**8.8**	**9.5**	**9.1**	**9.2**	**9.0**	*8.5*	-	-	-
2010	**9.5**	**9.0**	**9.7**	**9.7**	**9.5**	**9.2**	**8.8**	6.2	7.2	6.3
2011	**9.6**	**8.7**	**8.9**	**9.5**	**9.1**	**8.8**	*8.4*	7.3	8.1	6.8
2012	-	**9.2**	**9.5**	**9.6**	**10.1**	**9.6**	*8.6*	8.1	6.9	7.4

Bold = meets WWH criterion [≥8.7]
Italics = non-significant departure from WWH criterion [≥8.2]
* WWH criterion does not apply

In 2012, the sites at RMs 11.95, 10.75, and 8.60 had average IBI scores that were in non-significant departure (≤4 IBI units) of the WWH criterion of 40; the scores at the other sites upstream of the navigation channel failed to meet it (Table 9 and Figure 4). The lowest score in this section of the river was for the site immediately downstream of Big Creek (RM 7.00). For almost all of the sites, the 2012 IBI scores were less than in 2011; the exception was the site at RM 11.30, which had the same score (Table 11).

Site-specific habitat characteristics could be a key determinant in some of the poor individual metric scores ("1") received in 2012. The site at RM 8.60 scored poorly for the metric looking at the proportion of top carnivores, which it has done on every pass since NEORSD began sampling there in 2009. Smallmouth bass and rock bass, two of the carnivores collected most frequently on the Cuyahoga River, prefer deeper pools and steep drop offs (Trautman, 1981). Because the site at RM 8.60 lacks a significant number of these features, a higher score for that metric is unlikely.

All of the sites scored poorly for the percentage of round-bodied suckers for at least one of the electrofishing passes. Subsequently, because those types of suckers are also all simple lithophils, that metric typically scored poorly at the same time. Habitat could also be the main factor affecting those two metrics at some of the locations. For instance, the site at RM 11.95 lacked a functional riffle, which is where round-bodied suckers are generally found. Likewise, the riffle at RM 10.10 was deep enough that it was similar in function to a run, also likely limiting the number of suckers that were collected there. For the other sites, it is uncertain what the causes were for the low scores. The site at RM 7.00 may be impacted by pollutants coming from Big Creek or some other source downstream of RM 8.60. At two of the locations, RMs 10.75 and

8.60, there was a decrease in the overall number of round-bodied suckers from the first to second electrofishing passes that led to a decrease in the metric score. Flows were higher during the second round of passes. Possibly, the increased flow resulted in less effective electrofishing in the areas with faster moving water or the fish were more dispersed throughout the water column.

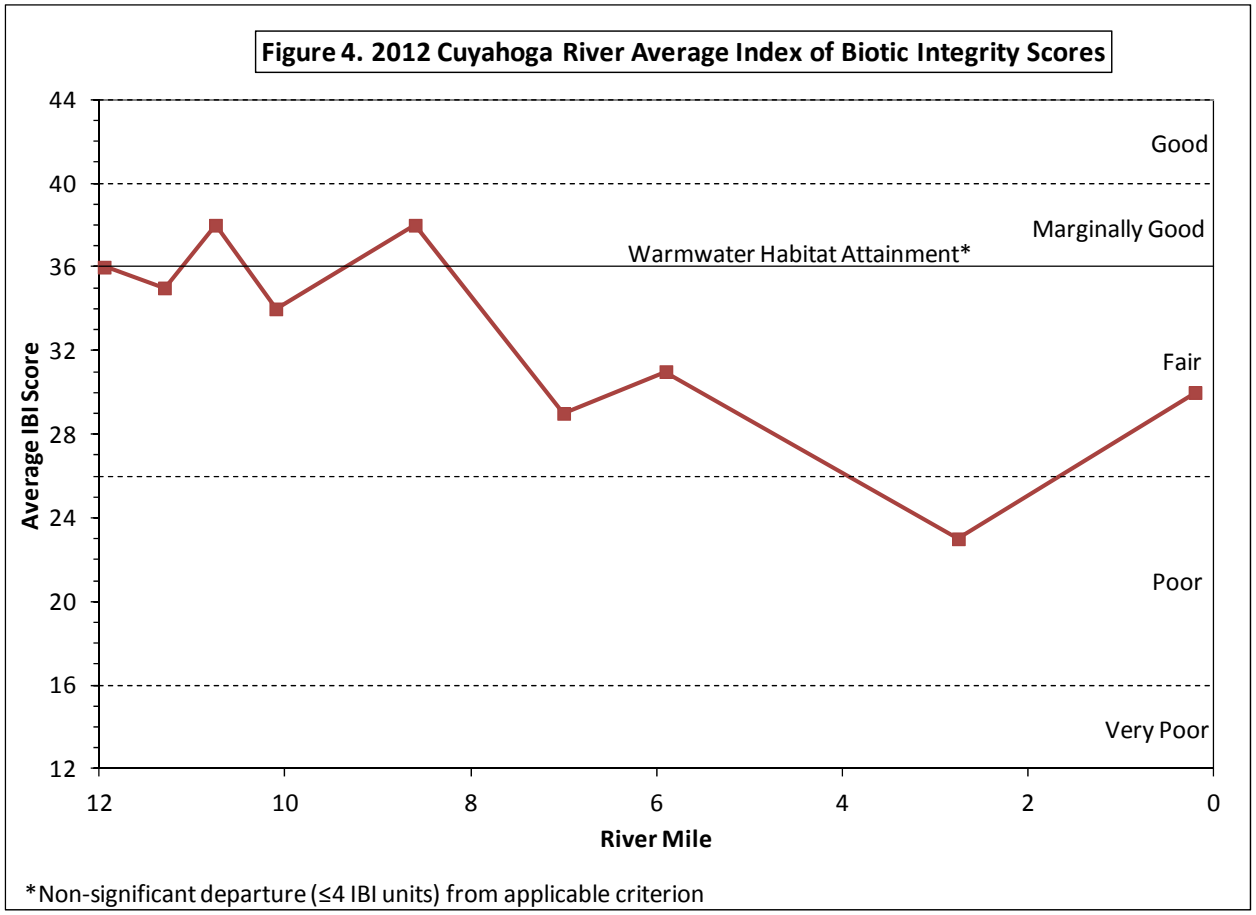


Table 11. Cuyahoga River Historic IBI Scores (1990-2012)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90*	RM 2.75*	RM 0.20*
1990	-	-	-	15	15	-	-	-	-	-
1991	-	-	-	17	16	-	18	-	-	-
1992	-	-	-	20	19	-	21	-	-	-
1997	-	-	-	25	17	-	18	-	-	-
1998	-	-	-	26	27	-	21	-	-	-
1999	-	-	-	31	31	-	24	-	-	-
2001	-	-	-	30	29	-	22	-	-	-
2003	-	-	-	34	28	-	23	-	-	-
2004	-	-	-	35	35	-	-	-	-	-

Table 11. Cuyahoga River Historic IBI Scores (1990-2012)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90*	RM 2.75*	RM 0.20*
2006	-	-	-	*39*	*36*	-	31	-	-	-
2007	*39*	30	*38*	34	35	-	33	-	-	-
2008	**44**	34	*38*	*37*	*36*	-	34	-	-	-
2009	**45**	*38*	**44**	*36*	31	**40**	31	-	-	-
2010	**43**	*39*	*39*	33	*37*	**41**	31	23 (19)	25 (29)	27 (30)
2011	**47**	*39*	35	**44**	*36*	**40**	32	31 (30)	29 (25)	30 (32)
2012	-	*36*	35	*38*	34	*38*	29	31 (26)	23 (21)	30 (32)

Bold = meets WWH criterion [≥40]
Italics = non-significant departure from WWH criterion [≥36]
Scores in parentheses are those calculated using the lacustuary IBI
* WWH criterion does not apply

One aspect of the fish community that may be directly impacted by current water quality issues in the river is the number of pollution intolerant species present. The overall bacteriological water quality criteria exceedances indicate that there is some pollution, likely related to wet weather sources, present in the river. This pollution may be acting as a stressor and thereby preventing the establishment of those species that are more sensitive to its effects. In 2012, the only pollution intolerant species that were collected were the stonecat madtom (*Noturus flavus*) at two locations and the mimic shiner (*Notropis volucellus*) at one. It is expected that a reduction in bacterial contamination and other pollutants associated with such contamination would result in an increase in the scores for the pollution intolerant species metric, which currently have never been above a "1" in the Cuyahoga River based on NEORSD sampling.

Within the navigation channel, the electrofishing results were, as in years past, indicative of a highly impacted fish community. Using both the IBI and the LIBI, the sites at RMs 5.90 and 0.20 rated *Fair* and received scores that were similar to those from 2011; the site at RM 2.75 rated *Poor* and was slightly lower than 2011. Individual metric scores typically varied between the electrofishing passes at each site. The metrics that scored poorly for all three sites during both passes were the percentage of round-bodied suckers, the number of intolerant species, and the percentage of omnivores. The relatively high number of gizzard shad collected is what led to the relatively high percentage of omnivores at these locations. For the other two metrics, habitat and water quality conditions may be the main limiting factors preventing higher scores.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly), also referred to as EPT taxa, inhabiting available habitats at the time of HD retrieval. Sampling was conducted at all of the locations listed in 1. Methods for sampling followed the Ohio EPA's Biological Criteria for the Protection of Aquatic Life, Volume III (1987b). HDs within the navigation channel were floated at a depth of approximately two feet below the surface. The recommended period for HDs to be installed is six weeks.

The macroinvertebrate samples were sent to Midwest Biodiversity Institute (MBI) of Columbus, Ohio, for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b). Lists of the species collected during the quantitative and qualitative sampling at each site are available upon request from WQIS.

The overall aquatic macroinvertebrate community in the stream was evaluated using either Ohio EPA's Invertebrate Community Index (ICI) (OEPA 1987a, Ohio EPA undated) or Lacustuary Invertebrate Community Index (LICI) (OEPA 1987a, Ohio EPA undated). The ICI and LICI both consist of ten community metrics (Table 12), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa. The total of the individual metric scores result in the overall score. This scoring evaluates the community against Ohio EPA's reference sites for each specific eco-region.

Table 12. Metrics

ICI	LICI
Total number of taxa	Total number of taxa
Number of mayfly taxa	Number of dipteran taxa
Number of caddisfly taxa	Number of sensitive taxa
Number of dipteran taxa	Percent predominant taxon
Percent mayflies	Percent other diptera and non-insects
Percent caddisflies	Percent mayflies and caddisflies
Percent Tanytarsini midges	Percent sensitive taxa (excluding Dreissinids)
Percent other diptera and non-insects	Percent collector-gatherers
Percent tolerant organisms (as defined)	Dipteran abundance
Number of qualitative EPT taxa	Number of qualitative EPT taxa

Results and Discussion

The ICI scores at all of the sites upstream of the navigation channel were in attainment or non-significant departure (≤4 ICI units) of the WWH criterion of 34. The highest score was at the site immediately upstream of Mill Creek, while the lowest one was the site immediately downstream of Big Creek (Table 13). The scores were higher or at least equal to the scores from 2011 (Figure 5), which may be due, in part, to the lower flows in the river in 2012. It has been found that there is less disruption of the macroinvertebrate community when flows are not elevated (Holomuzki & Biggs, 2000). As a result, the scores obtained in 2012 may be more indicative of the actual condition of the river than in previous years.

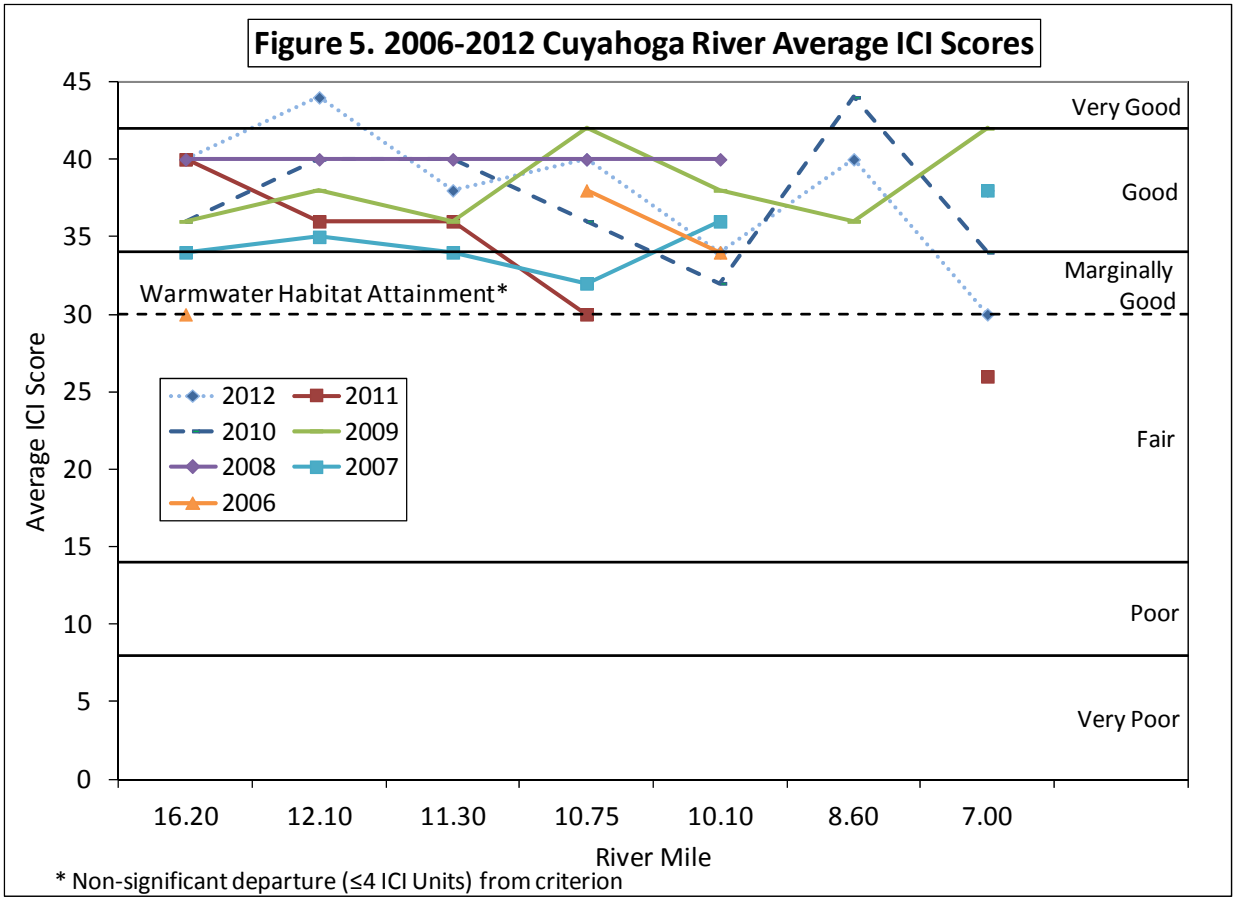
There was generally a low percentage of pollution-tolerant organisms in 2012 at the sites upstream of the navigation channel (Table 13). The highest percentage occurred at the site immediately downstream of Big Creek. As indicated by the overall ICI score and the fish results, it appears that flow from Big Creek or some other source downstream of RM 8.60 may be having some of an impact on the biological community. The percentage of tolerant organisms at the site on Big Creek at RM 0.15 was also relatively high in 2012.

Table 13. Macroinvertebrate Results

Location	River Mile	ICI Score	LICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of Qualitative EPT Taxa	% Tolerant (as defined)	Narrative Rating
Downstream of Tinkers Creek	16.20	**40**	---	916	51	11	0.31	Good
Upstream of Mill Creek	12.10	**44**	---	904	49	7	0.67	Very Good
Downstream of Mill Creek	11.30	**38**	---	951	52	10	3.05	Good
Upstream of Southerly WWTC	10.75	**40**	---	1654	56	9	1.15	Good
Downstream of Southerly WWTC	10.10	**34**	---	847	51	13	3.85	Good
Upstream of Big Creek	8.60	**40**	---	1273	47	9	1.37	Good

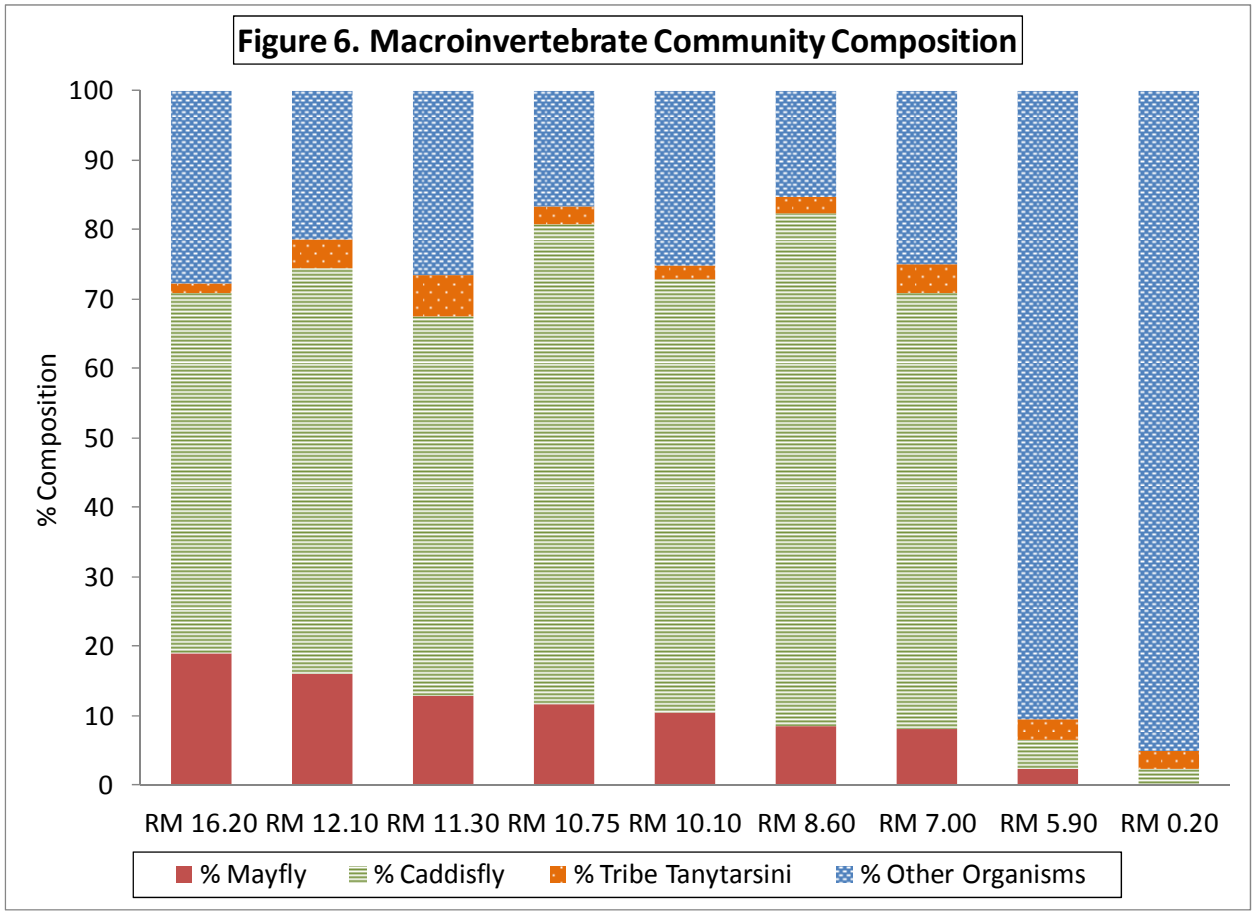
Table 13. Macroinvertebrate Results								
Location	River Mile	ICI Score	LICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of Qualitative EPT Taxa	% Tolerant (as defined)	Narrative Rating
Downstream of Big Creek	7.00	*30*	---	970	50	10	6.89	Marginally Good
Head of Navigation Channel	5.90	---	28	486	40	2	14.01	Fair
Cuyahoga River Mouth	0.20	---	16	212	29	0	25.80	Poor

Bold indicates attainment of WWH criterion
Italics indicates non-significant departure (≤4 ICI units) from criterion
* ICI score and rating not considered to be accurate representation of site conditions
** Meets final LICI performance goal of 42



For most of these sites, there was a similar number of organisms belonging to pollution-sensitive taxa groups (mayflies, caddisflies, and tribe Tanytarsini midges) (Figure 6). The exceptions to this were the sites at RMs 10.75 and 8.60, which were higher; these sites also had the highest overall organism densities. Better habitat could be one reason why more pollution-sensitive organisms were collected at these locations. The site at RM 16.20 also had relatively good habitat in terms of development. However, that site was located immediately downstream of Tinkers Creek, which due to construction activities in recent years and a change in the bedload, could have been a source of silt and sediment to the river that impacted the macroinvertebrate community to some extent.

The macroinvertebrates collected from RMs 5.90 and 0.20 in the navigation channel were analyzed using the LICI; the ones from RM 2.75 will be identified at a later date. In doing so, it was found that the macroinvertebrate community would have rated either *Fair* (RM 5.90) or *Poor* (RM 0.20) using this index and was below the target score of 42. These scores were also lower than the ones in 2011 that resulted in ratings of *Good* and *Fair*, respectively. Based on the qualitative sample and location conditions, the site at RM 2.75 is expected to rate either *Poor* or *Very Poor*.



Only a small percentage of organisms at RMs 5.90 and 0.20 belonged to pollution-sensitive taxa groups. The dominant organisms at both sites were of the midge genus *Glyptotendipes*. The prevalence of these organisms may be due to the habitat conditions present in the navigation channel or an indication of organic pollution (Yoder & Rankin, 1995).

Conclusions

Sampling was conducted in 2012 in the Cuyahoga River to determine the attainment status in terms of water quality and the biological community and identify any potential point and nonpoint sources that may be impacting the river. From this sampling, it was found that, similar to the past couple of years, water quality exceedances occurred for bacteria and mercury. There was also an aquatic life exceedance for copper at one location. Potential sources of pollution include illicit discharges, CSOs, stormwater runoff, flow from Big Creek, and for mercury, atmospheric deposition; effluent from Southerly WWTC did not appear to significantly contribute to these exceedances.

Biological assessments that were conducted upstream of the navigation channel showed that three of the sites (RMs 11.95, 10.75 and 8.60) were in full attainment of the biological criteria, while three (RMs 11.30, 10.10 and 7.00) were in partial attainment of them. The site at RM 16.20 met the WWH criterion for the ICI; it is expected that it would have met the fish criteria as well if sampling could have been conducted there. Site-specific habitat characteristics appeared to be the major limiting factor affecting full attainment at most of the locations, while Big Creek may also be having an effect on the site at RM 7.00.

The three sites within the navigation channel evaluated in support of restoration activities there show degraded fish and macroinvertebrate communities that are mostly limited by habitat. Restoration at RM 2.75 is expected to be completed in 2013 and will result in the introduction of fish habitat within the area. Post-construction monitoring, possibly in 2013, depending on when construction is completed, will help determine if the introduced habitat is having a positive impact on the fish community. For the other two sites, improvements in the biological community are not expected unless significant changes are made to the current habitat.

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