NORTHEAST OHIO REGIONAL SEWER DISTRICT

2013 Cuyahoga River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2013, 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 *2013 Cuyahoga River Environmental Monitoring* approved by Ohio EPA on July 10, 2013.

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 fourth year of 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.

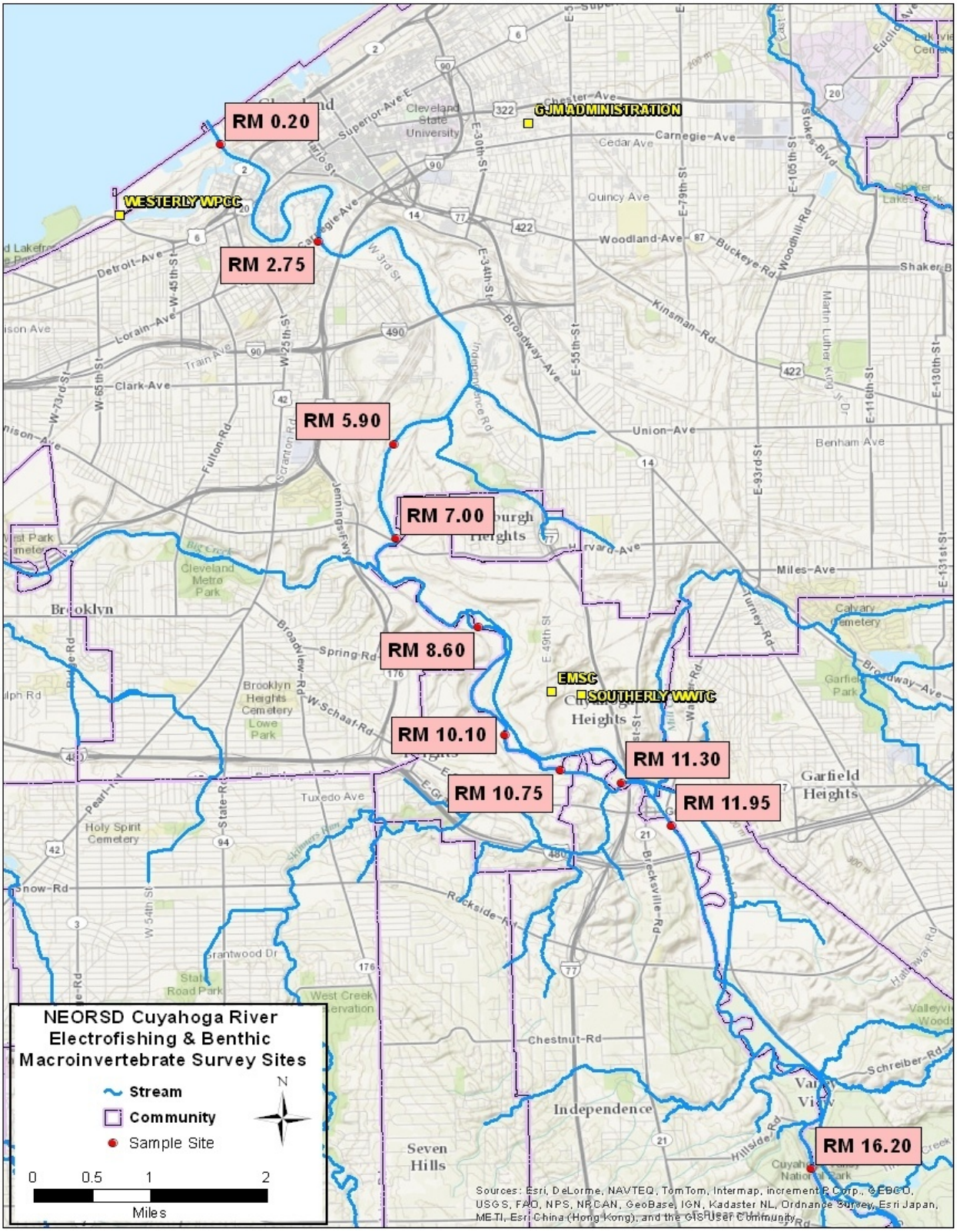


Figure 1. Sampling Locations

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
Downstream of Tinkers Creek	41.3678	-81.6139	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	41.4123 41.4101	-81.6364 -81.6346	12.10[a] 11.95	Upstream of the confluence with Mill Creek (I-480)	Evaluate Mill Creek discharge on fish, habitat and macroinvertebrates
Downstream of Mill Creek	41.4179	-81.6446	11.30	Downstream of the confluence with Mill Creek	Evaluate Mill and West Creek discharges on fish, habitat and macroinvertebrates
Upstream of Southerly WWTC	41.4196	-81.6547	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	41.4242	-81.6638	10.10	Downstream of Southerly WWTC effluent discharge	Evaluate Southerly WWTC discharge on fish, habitat, macroinvertebrates, and chlorophyll *a* levels.
Upstream of Big Creek	41.4381	-81.6680	8.60	Upstream of the confluence with Big Creek	Evaluate Big Creek discharge on fish, habitat and macroinvertebrates
Downstream of Big Creek	41.4497	-81.6815	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

[a] HD and Water Chemistry Collection Site

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
					habitat restoration in 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 five times between July 22 and August 19, 2013, on the Cuyahoga River between RMs 16.20 and 0.20. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual* (2013). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and a 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (Dissolved Reactive Phosphorus) was filtered using a 0.45-µm PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. 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 each collected at randomly selected sites, at a frequency not less than 5% 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

Three field blanks and three duplicate samples were collected as part of this study in 2013. For the field blanks, there were four 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
Cr
Sn
DRP
NH_3

For the duplicate samples, six instances occurred in which the acceptable RPD was exceeded (Table 3). Two of the dates in which these samples were collected were considered wet weather[1]. The increased flow during these sampling events 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 final occurrence of an RPD high enough to result in data being rejected did not occur during wet weather sampling and the reason for the unacceptable difference between the samples remains unknown.

Table 3. Duplicate samples with RPDs greater than acceptable				
Site	Date	Parameter	Acceptable RPD	Actual RPD
RM 0.20	7/22/13	Al	29.1	31.0
RM 0.20	7/22/13	Fe	21.2	22.9
RM 0.20	7/22/13	NH_3	33.4	81.8
RM 7.00	7/29/13	Cu	53.0	55.3
RM 7.00	7/29/13	Sn	46.3	180.4
RM 2.75	8/5/13	Al	24.9	56.9

The final QA/QC check for the samples that were collected was for paired parameters, or those parameters in which one is a subset of the other. Based on these comparisons, none of the data needed to be qualified as estimated or rejected.

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

[1] 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.

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 two 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 2013 (Table 4). For the sites located upstream of Southerly WWTC, the seasonal geomeans were slightly higher than in 2012; those downstream of Southerly WWTC were lower. The single sample maximum criterion was exceeded at all of the sites for most of the 30-day periods during the study. Three of the sampling dates occurred during wet weather, which could account for the exceedances. Potential sources of bacteria to the river could include stormwater runoff and CSOs.

Table 4. 2013 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
7/22/2013*	270	325	320	360	270	250	324	404	150	47
7/29/2013*	180	248	180	200	170	165	165	140	105	250
8/5/2013	360	424	520	540	392	308	480	1080	458	660
8/12/2013*	380	380	375	370	350	180	290	478	205	108
8/19/2013	69	70	69	175	115	75	87	84	35	270
Seasonal Geomean	215	246	239	302	235	178	230	301	138	186

* Wet weather event

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

Mercury was the second 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 most 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 at all of the sites.

Table 5. 2013 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
7/22/2013	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
7/29/2013	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
8/5/2013	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
8/12/2013	j0.011	j0.009	j0.01	j0.015	j0.015	j0.011	j0.008	j0.008	<0.008	j0.009
8/19/2013	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008

Exceedance of Wildlife OMZA (0.0013 ug/L) for 30-day period beginning with that date, assuming "j" values are actual values and concentrations below the MDL are zero.

Exceedance of Wildlife (0.0013 ug/L) and Aquatic Life (0.0031 ug/L) OMZAs for 30-day period beginning with that date, assuming "j" values are actual concentrations and concentrations below the MDL are zero.

In 2013, the Ohio EPA released a draft Trophic Index Criterion designed to determine the degree of nutrient enrichment in a stream. Under the draft document, nutrient target values are based on designated use and Qualitative Habitat Evaluation Index scores. For warmwater habitat sites with QHEI scores between 12 and 64, the targets are 0.13 mg/L for total phosphorus (TP) and 3.0 mg/L for dissolved inorganic nitrogen (DIN), which includes ammonia, nitrate and nitrite. For all other aquatic life uses and QHEI scores, the targets for TP and DIN are 0.30 mg/L and 3.0 mg/L, respectively; the sites in the Cuyahoga River all fall under this category. Based on the average concentrations that were measured in 2013, the TP target was met at all of the sites, while the DIN target was only met at the sites upstream of Southerly WWTC.

Table 6. 2013 Cuyahoga River Average Nutrient Concentrations (mg/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
TP	0.12	0.12	0.12	0.11	0.15	0.14	0.14	0.15	0.12	0.10
DRP	0.07	0.06	0.06	0.06	0.09	0.08	0.08	0.07	0.06	0.05
DIN	2.49	2.44	2.40	2.33	4.47	4.42	4.41	4.46	3.95	3.74

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site upstream of the Cuyahoga River navigation channel in 2013 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.

The habitat at the sites in the navigation channel were evaluated one time each in 2013 using the lacustuary QHEI (L-QHEI). Similar to the QHEI, the L-QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species, but in lacustuary zones or along the lake shoreline. The index is based on the metrics of substrate, cover types, shoreline morphology, riparian zone/bank erosion, and aquatic vegetation quality. The L-QHEI also has a maximum score of 100. More information can be found in Ohio EPA's *Methods for Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)* (2010). L-QHEI field sheets are also available upon request from the NEORSD WQIS Division.

Results and Discussion

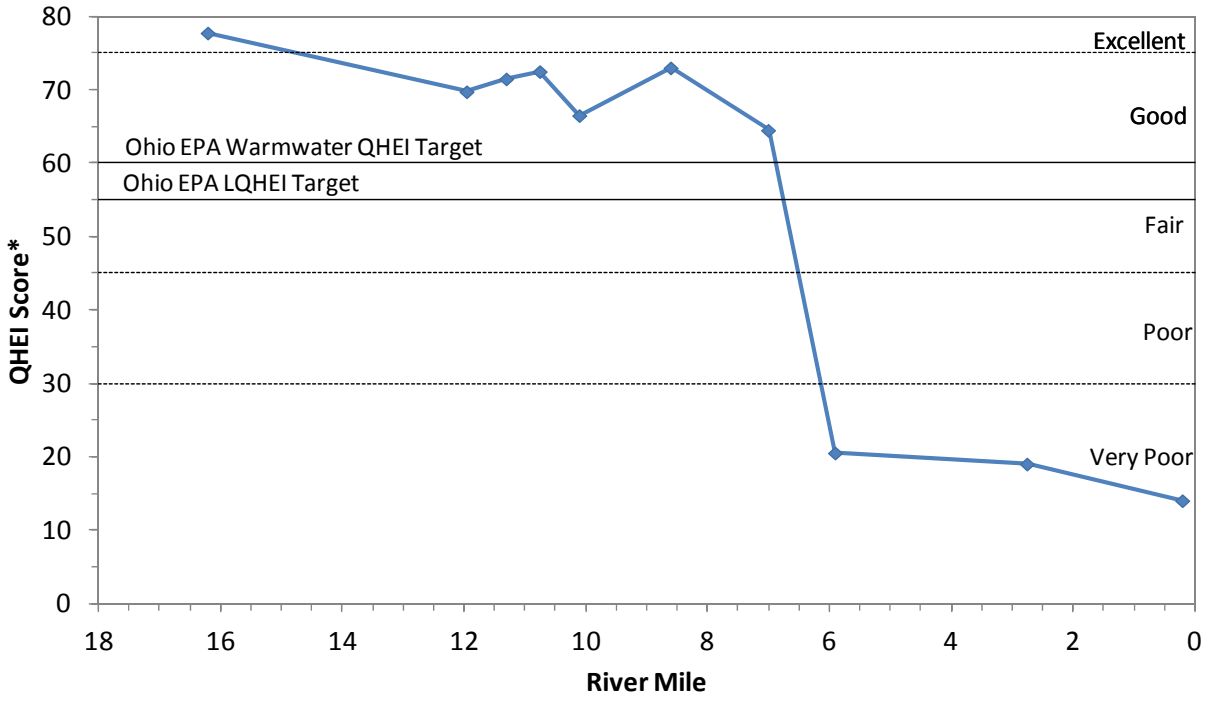
All of the sites upstream of the navigation channel had QHEI scores that met Ohio EPA's target of 60 and, therefore, should be capable of supporting warmwater habitat fish communities (Figure 2). The highest score was found at the site immediately downstream of Tinkers Creek, while the lowest one was at the site immediately downstream of Big Creek. No significant differences were found when comparing the 2013 scores to recent years.

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 five 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.

Figure 2. 2013 Cuyahoga River Qualitative Habitat Evaluation Index Scores



*Scores for sites at RMs 5.90, 2.75 and 0.20 were calculated using the Lacustuary Qualitative Habitat Evaulation Index (L-QHEI). Narrative ratings shown are for QHEI.

The sites in the navigation channel were evaluated using the L-QHEI and all failed to meet Ohio EPA's target score (Figure 2). The site characteristics that contributed heavily to the low scores included muck substrates, a general lack of instream cover, poor development, and a highly modified shoreline. Based on these attributes, it would not be expected that these sites would be able to support warmwater habitat fish communities. Some changes at RM 2.75 had occurred since the previous year due to the restoration project there. Although aquatic plants were introduced into a section of the electrofishing zone, they were not enough to significantly increase the score in their current amounts. This could possibly change in the future as more plants become established in the area.

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	77.75	Excellent	x			x		x	x		x		5						0		x	x			x				x	x		5
11.95	69.75	Good	x					x	x		x		4			x			1		x	x		x					x	x		5
11.30	71.50	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	66.50	Good	x						x		x		3				x		1		x	x		x	x				x	x		6
8.60	73.00	Good	x			x		x	x		x		5						0		x	x			x				x	x		5
7.00	64.50	Good	x						x		x		3				x		1		x	x		x	x				x	x		6

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2013, except at RM 16.20 and RM 2.75. No surveys were conducted at RM 16.20 due to flow conditions in the river that prevented boat launching. The site at RM 2.75 could not be sampled due to the restoration activities that were taking place there. 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*)
7/31/13	5.90	679**
8/1/13	11.95, 11.30, 7.00	447
8/2/13	10.75, 10.10, 8.60	405
8/7/13	0.20	718**
9/5/13	5.90, 0.20	587**
9/10/13	11.95, 11.30	289
10/14/13	10.75, 10.10	369
10/15/13	8.60, 7.00	348

*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 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
Percent omnivores	Number of intolerant species

Table 8. Index of Biotic Integrity Metrics	
Boat	Lacustuary
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

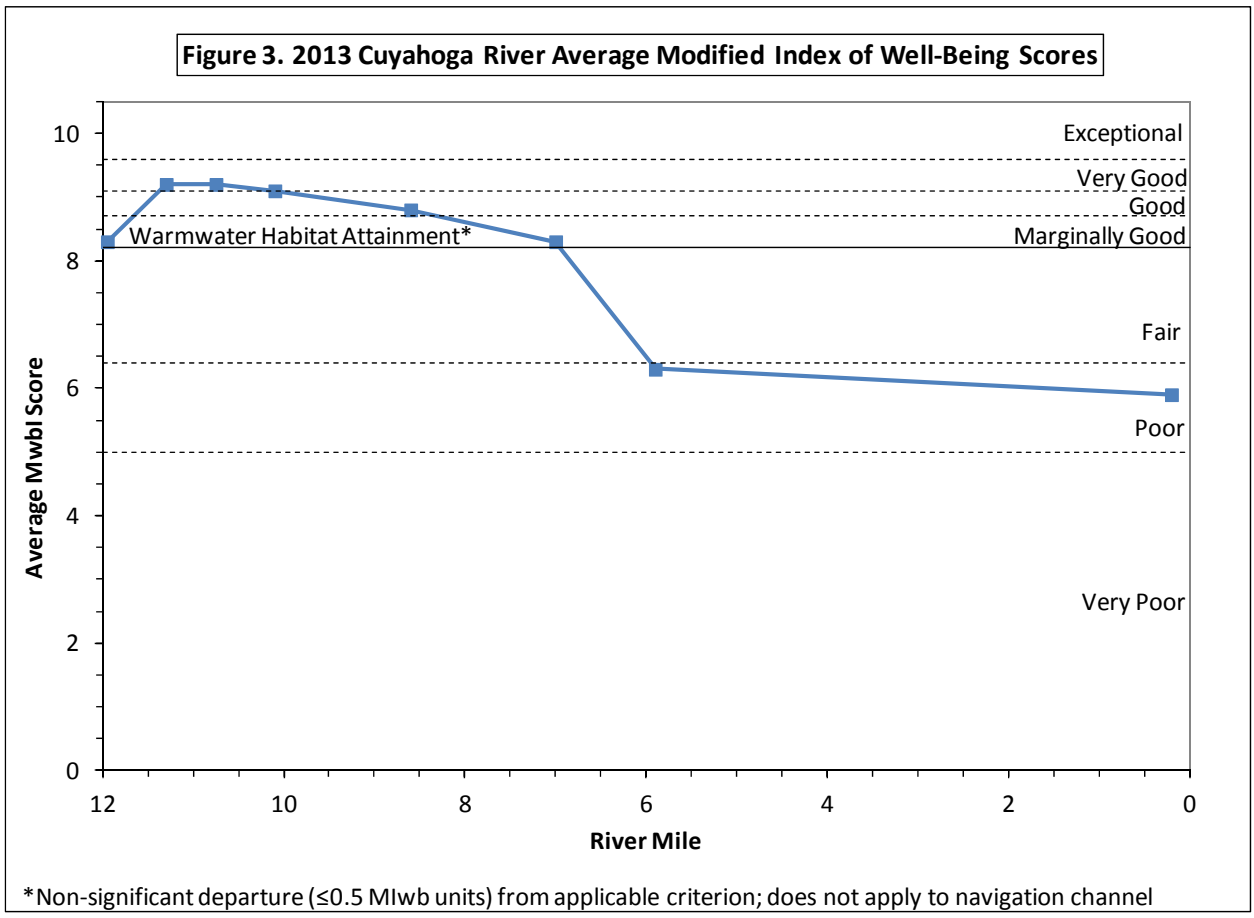
Lists of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

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 lower than in 2012 (Table 10), mainly due to a lower number of fish that were collected. Flows when the surveys were conducted in 2013 were generally higher than the previous year, which, because the fish were spread out over a greater depth of water, could account for the differences.

Table 9. 2013 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	**40**	*8.6*	**42**	8.0	**41**	*8.3*
Downstream from Mill Creek	11.30	**44**	**9.3**	**40**	**9.0**	**42**	**9.2**
Upstream from Southerly WWTC	10.75	*38*	**9.1**	34	**9.2**	*36*	**9.2**
Downstream from Southerly WWTC	10.10	*36*	*8.6*	30	**9.5**	33	**9.1**
Upstream from Big Creek	8.60	**42**	**9.1**	**40**	*8.5*	**41**	**8.8**
Downstream from Big Creek	7.00	34	*8.4*	34	8.1	34	*8.3*
US of Newburgh SS RR Bridge*	5.90	21	6.5	29	6.1	25	6.3
Upstream of Confluence w/ Lake Erie*	0.20	27	5.8	26	6.0	27	5.9

Bold = meets WWH criterion [IBI ≥40; MIwb ≥8.7]
Italics = non-significant departure from WWH criterion [IBI ≥36; MIwb ≥8.2]
* WWH criteria do not apply; LIBI used instead of IBI.



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. The scores at these sites were also lower than in 2012. Contrary to the other sites, though, a greater number of fish were collected in 2013 in the navigation channel. The decrease in MIwb scores was due to a lower diversity in terms of both numbers and weight of fish collected.

Table 10. Cuyahoga River Historic MIwb Scores (1990-2013)

	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	-	-	-
2003	-	-	-	7.6	7.8	-	7.0	-	-	-

Table 10. Cuyahoga River Historic MIwb Scores (1990-2013)										
	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*
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
2013	-	*8.3*	**9.2**	**9.2**	**9.1**	**8.8**	*8.3*	6.3	-	5.9

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

Four of the sites upstream of the navigation channel had average IBI scores that met the warmwater habitat criterion or were within non-significant departure from it (Table 9 and Figure 4). The two sites that failed to meet it were the ones immediately downstream of Southerly WWTC and immediately downstream of Big Creek. These sites had the lowest number of warmwater habitat characteristics and one-high influence modified-warmwater habitat characteristic, sparse instream cover, that could have resulted in the lower scores there.

Compared to the previous year, the scores in 2013 were higher at the sites immediately upstream and downstream of Mill Creek and Big Creek, while the scores at the sites immediately upstream and downstream of Southerly WWTC were slightly lower (Table 11). During the summer of 2013, a significant stream restoration project started near the West Creek Confluence, which is located just upstream of Southerly WWTC. Potentially, activities related to this project may have negatively impacted the two sites on the Cuyahoga River immediately downstream of it, resulting in the lower scores obtained. The improvements in the scores at the other sites may have been due to the differences in flow in the river between the two years; the generally drier conditions in 2012 and resultant lower river levels could have affected which fish were present in the river at the times that surveys were completed.

An examination of the individual IBI metrics showed that generally, the proportion of round-bodied suckers scored poorly (metric score of 1) at most of the sites in 2013; the exception to this was the site at RM 8.60. Because those types of suckers are also simple lithophils, that metric also scored poorly at many of the sites. For the sites

that did not score well, habitat may be the main contributing factor. The site at RM 8.60 has an extended riffle/run sequence where the majority of the round-bodied suckers were collected. While the other sites also had riffles, the quality of the riffles was not as high and could have resulted in the lower number of round-bodied suckers collected there.

As in the past, the metric for number of pollution intolerant fish scored poorly at all of the sites; no fish considered to be intolerant were collected in 2013. Water quality conditions could be one reason for why these fish are absent. Exceedances of the bacteriological criteria indicate that there may be some sanitary sewage present in the river. The stress to fish associated with such pollutants could therefore be a hindrance to the establishment of those species.

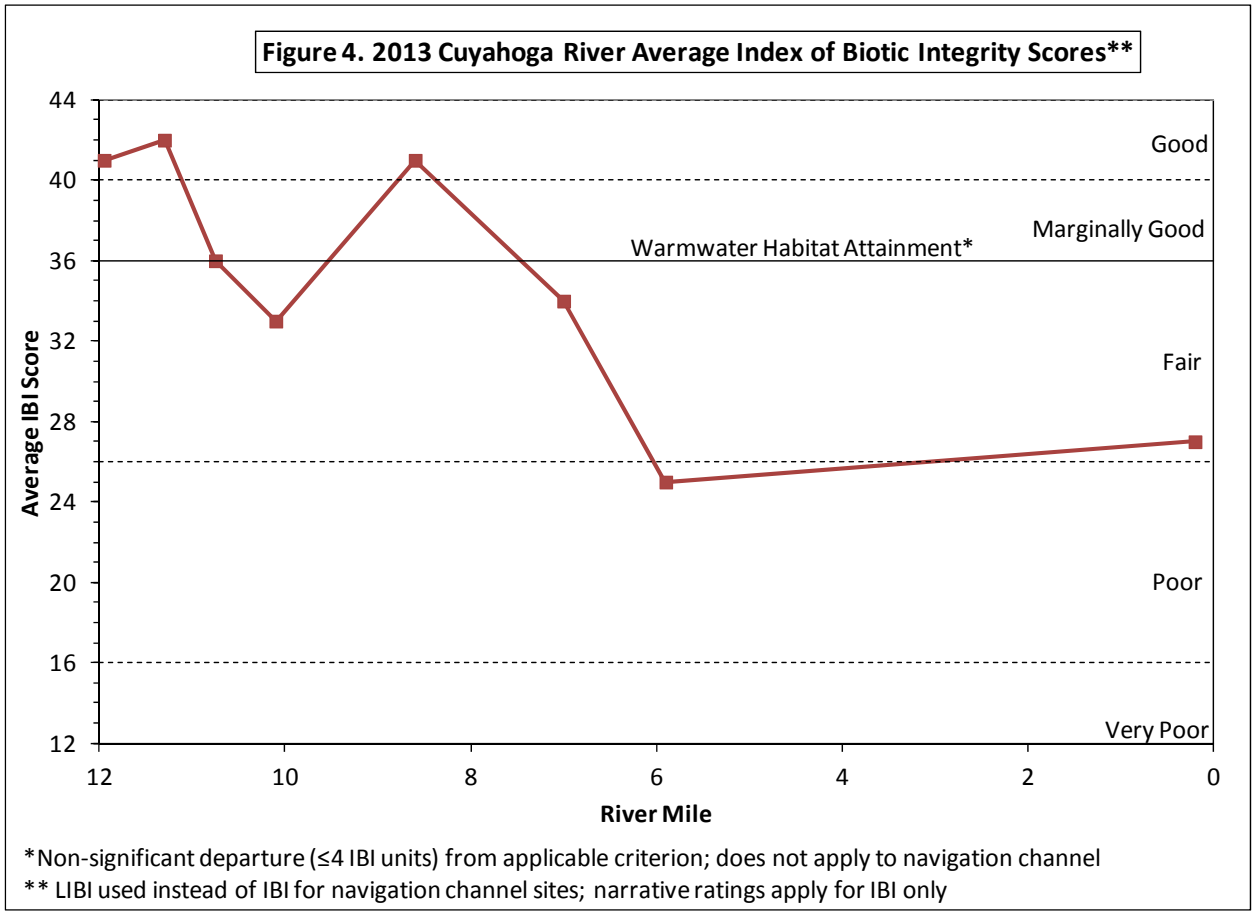


Table 11. Cuyahoga River Historic IBI Scores (1990-2013)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90*	RM 2.75*	RM 0.20*
1990	-	-	-	15	15	-	-	-	-	-
1991	-	-	-	17	16	-	18	-	-	-
1992	-	-	-	20	19	-	21	-	-	-
1997	-	-	-	25	17	-	18	-	-	-
1998	-	-	-	26	27	-	21	-	-	-
1999	-	-	-	31	31	-	24	-	-	-
2001	-	-	-	30	29	-	22	-	-	-
2003	-	-	-	34	28	-	23	-	-	-
2004	-	-	-	35	35	-	-	-	-	-
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	19	29	30
2011	**47**	*39*	35	**44**	*36*	**40**	32	30	25	32
2012	-	*36*	35	*38*	34	*38*	29	26	21	32
2013		**41**	**42**	*36*	33	**41**	34	25	-	27

Bold = meets WWH criterion [≥40]
Italics = non-significant departure from WWH criterion [≥36]
* WWH criterion does not apply; LIBI used instead of IBI

The sites within the navigation channel were evaluated using the lacustuary IBI (LIBI). Using this index and Ohio EPA's scoring criteria, both sites rated *Poor*. For the site at RM 5.90, this was the same rating that was received in past years; the score at RM 0.20 was lower than the *Fair* received in 2012. Most of the LIBI metrics scored poorly (0 or 1) for at least one electrofishing pass at both of these sites. The metrics with better scores (3 or 5) for both passes included the proportions of omnivores and non-indigenous individuals at both sites, proportion of top carnivores at RM 5.90, and proportion of tolerant individuals and those with DELTs at RM 0.20. A lack of suitable habitat, specifically due to the highly modified nature of the navigation channel, was mostly likely the main cause for the generally poor fish community at these locations.

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 Third Rock Consulting of Lexington, Kentucky, 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

In 2013, the ICI scores at all of the sites upstream of the navigation were in attainment of the warmwater habitat criterion of 34 (Table 13 and Figure 5). The highest score was at the site immediately upstream of Southerly WWTC and also met the exceptional warmwater habitat criterion. This score was a significant increase over the score obtained in 2012 (Table 14). The other site that showed a significant increase was the one immediately downstream of Big Creek. For the other sites, the change in scores between years was ≤4 ICI units, a difference that the Ohio EPA does not consider to be significant.

Most of these sites had a relative low percentage of macroinvertebrates considered to be pollution tolerant (Table 13). The highest percentage occurred at the site immediately upstream of Mill Creek. This differed from 2012, in which the highest percentages of pollution-tolerant organisms were found immediately downstream of Mill Creek and Southerly WWTC. The reason for the increase at RM 12.10, remains unclear, as there were no obvious causes for it.

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	**36**	---	1561	46	10	0.23	Good
Upstream of Mill Creek	12.10	**40**	---	4368	51	12	2.93	Good
Downstream of Mill Creek	11.30	**34**	---	3125	38	9	0.42	Good
Upstream of Southerly WWTC	10.75	**46**	---	1757	56	12	0.47	Exceptional
Downstream of Southerly WWTC	10.10	**34**	---	1874	49	11	0.34	Good
Upstream of Big Creek	8.60	**42**	---	2006	42	9	0.16	Very Good
Downstream of Big Creek	7.00	**38**	---	1443	49	9	0.33	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
Head of Navigation Channel	5.90	---	36	1089	45	2	27.92	Fair
Cuyahoga River Mouth	0.20	---	---	---	4	0	---	Very Poor*

Bold indicates attainment of WWH criterion
Italics indicates non-significant departure (≤4 ICI units) from criterion
* Based on best professional judgment

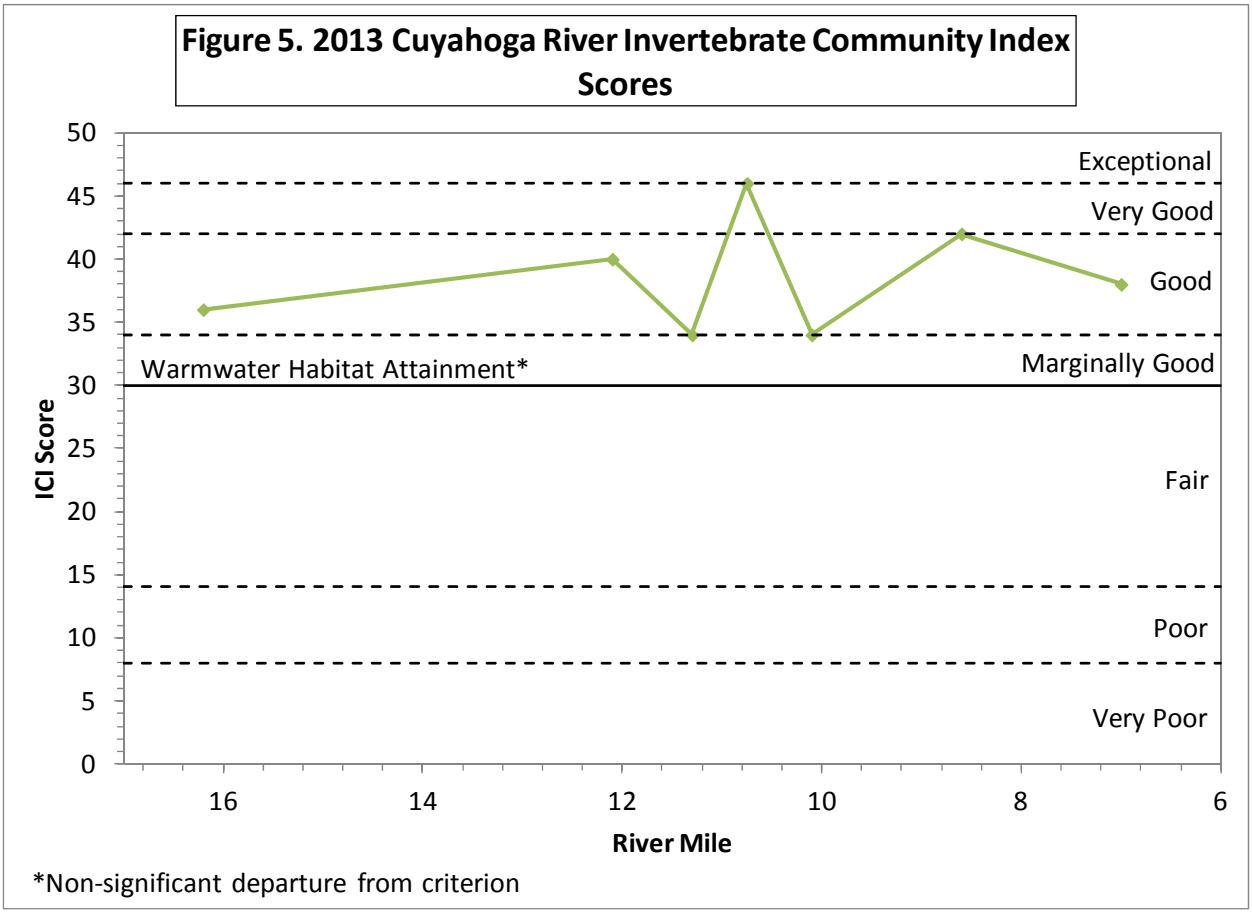
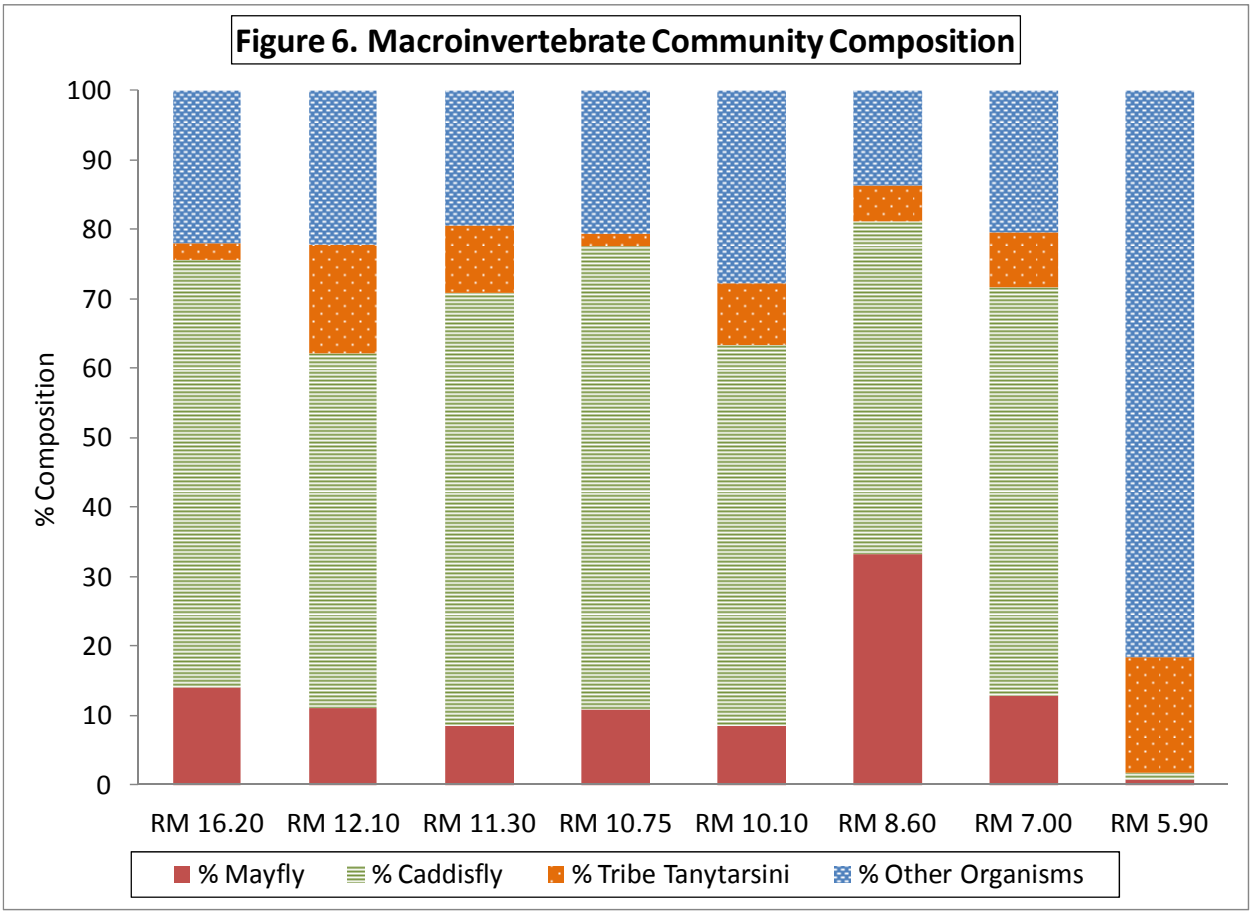


Table 14. Cuyahoga River Historic ICI Scores (2006-2013)									
Year	16.20	12.10	11.30	10.75	10.10	8.60	7.00	5.90*	0.20*
2006	30	---	---	**38**	**34**	---	---	---	---
2007	**34**	**35**	**34**	*32*	**36**	---	**38**	---	---
2008	**40**	**40**	**40**	**40**	**40**	---	**38**	---	---
2009	**36**	**38**	**36**	**42**	**38**	**36**	**42**	---	---
2010	**36**	**40**	**40**	**36**	32	**44**	**34**	---	---
2011	**40**	**36**	**36**	*30*	---	---	26	46	36
2012	**40**	**44**	**38**	**40**	**34**	**40**	*30*	28	16
2013	**36**	**40**	**34**	**46**	**34**	**42**	**38**	36	---

Bold indicates attainment of WWH criterion
Italics indicates non-significant departure (≤4 ICI units) from criterion
**LICI instead of ICI*

Organisms belonging to the pollution-sensitive taxa groups (mayflies, caddisflies, and tribe Tanytarsini midges, also known as EPT taxa) comprised the majority of the macroinvertebrate communities at the locations upstream of the navigation channel (Figure 6). Differences among the sites, such as the greater percentage of mayflies at RM 8.60, could be attributed to habitat characteristics that may make each site more suitable to one taxa group over another. Because the overall totals of these three groups were similar at the sites, it does not appear that there were significant water quality differences among them.

The macroinvertebrates collected from RM 5.90 were analyzed using the LICI and received a score of 36. This score was higher than 2012, but lower than 2011. A larger percentage of the macroinvertebrate population at this site was considered to be pollution-tolerant compared to the upstream sites; a relatively small percentage belonged to the EPT taxa. No HD was collected from the site at RM 0.20, so an assessment was based on only the qualitative sample. This sample contained only four taxa, none of which were EPT. Because of this and the conditions noted in the field, this site was assigned a narrative rating of *Poor*.



Conclusions

Biological sampling that was conducted in the Cuyahoga River in 2013 showed that four out of the six sites upstream of the navigation channel were in full attainment of the warmwater habitat criteria for fish and macroinvertebrates (Table 15). The site at RM 16.20 met the criterion for the ICI; it is expected that it would have met the fish criteria as well if sampling could have been conducted there. The other two sites, the ones immediately downstream of Southerly WWTC and Big Creek, were in partial attainment of the criteria. They met the ICI and MIwb criteria, but failed to meet the one for the IBI. Habitat conditions could be a significant factor causing these sites to not be in full attainment as both sites had sparse instream cover, an attribute that can have a high influence on the fish community. In the past, these sites have also generally not scored as well as the other ones above the navigation channel.

Table 15. 2013 Cuyahoga River Survey Results						
River Mile	Aquatic Life Use Attainment Status	IBI Score (Narrative Rating)	MIwb Score (Narrative Rating)	ICI Score (Narrative Rating)	QHEI Score (Narrative Rating)	Water Quality Exceedances
16.20	(FULL**)			36 *(Good)*	77.75 *(Excellent)*	*E. coli,* Mercury
11.95	FULL	41 *(Very Good)*	8.3 *(Marginally Good)*	40 *(Good)*	69.75 *(Good)*	*E. coli,* Mercury
11.30	FULL	42 *(Very Good)*	9.2 *(Very Good)*	34 *(Good)*	71.50 *(Good)*	*E. coli,* Mercury
10.75	FULL	36 *(Marginally Good)*	9.2 *(Very Good)*	46 *(Exceptional)*	72.50 *(Good)*	*E. coli,* Mercury
10.10	PARTIAL	33 *(Fair)*	9.1 *(Very Good)*	34 *(Good)*	66.50 *(Good)*	*E. coli,* Mercury
8.60	FULL	41 *(Very Good)*	8.8 *(Good)*	42 *(Very Good)*	73.00 *(Good)*	*E. coli,* Mercury
7.00	PARTIAL	34 *(Fair)*	8.3 *(Marginally Good)*	38 *(Good)*	64.50 *(Good)*	*E. coli,* Mercury
5.90*	N/A	34 *(Fair)*	6.3 *(Fair)*	36 *(Fair)*	20.50 *(Very Poor)*	*E. coli,* Mercury
2.75	N/A				19.00 *(Very Poor)*	*E. coli*
0.20*	N/A	27 *(Poor)*	5.9 *(Fair)*	-- *(Very Poor***)*	14.00 *(Very Poor)*	*E. coli,* Mercury

WWH biocriterion attainment: IBI score of 40; MIwb score of 8.2; ICI score of 34
Non-significant departure: ≤4 IBI units; ≤0.5 MIwb units; ≤4 ICI units
--HD not collected; qualitative assessment only
*Lacustuary scoring
**Based in ICI score and best professional judgment
***Narrative rating based on best professional judgment and habitat evaluation

For all of the sites, some water quality impairments may be preventing establishment of healthier biological communities; no pollution-intolerant fish were collected in 2013. As in the past, exceedances of the water quality standards occurred for *E. coli*, indicating the presence of some sanitary sewage in the river and mercury. Potential sources of pollution include illicit discharges, CSOs, stormwater runoff, flow from upstream tributaries, and for mercury, atmospheric deposition. As has been found in recent years, effluent from Southerly WWTC did not appear to significantly contribute to these exceedances.

Within the navigation channel, the fish community was highly impacted due to the human modifications present there. The macroinvertebrate community near the mouth of the river was also highly impacted, with only a few taxa collected. The macroinvertebrate community at the head of the navigation channel was rated *Fair*, but still consisted of a smaller proportion of pollution-sensitive taxa when compared with the sites upstream. Because restoration of the site at RM 2.75 was completed in 2013, no biological assessment could be conducted. The restoration included introduction of aquatic vegetation in the area. Once this vegetation becomes established, the biological communities may possibly respond in a positive manner. Post-construction monitoring in 2014 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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