NORTHEAST OHIO REGIONAL SEWER DISTRICT

2011 Cuyahoga River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2011, 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 *2011 Cuyahoga River Environmental Monitoring* approved by Ohio EPA on June 14, 2011.

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 second year of baseline data collection for these grants.

Figure 1 is a map of the sampling locations evaluated during the study, 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 Division (WQIS).

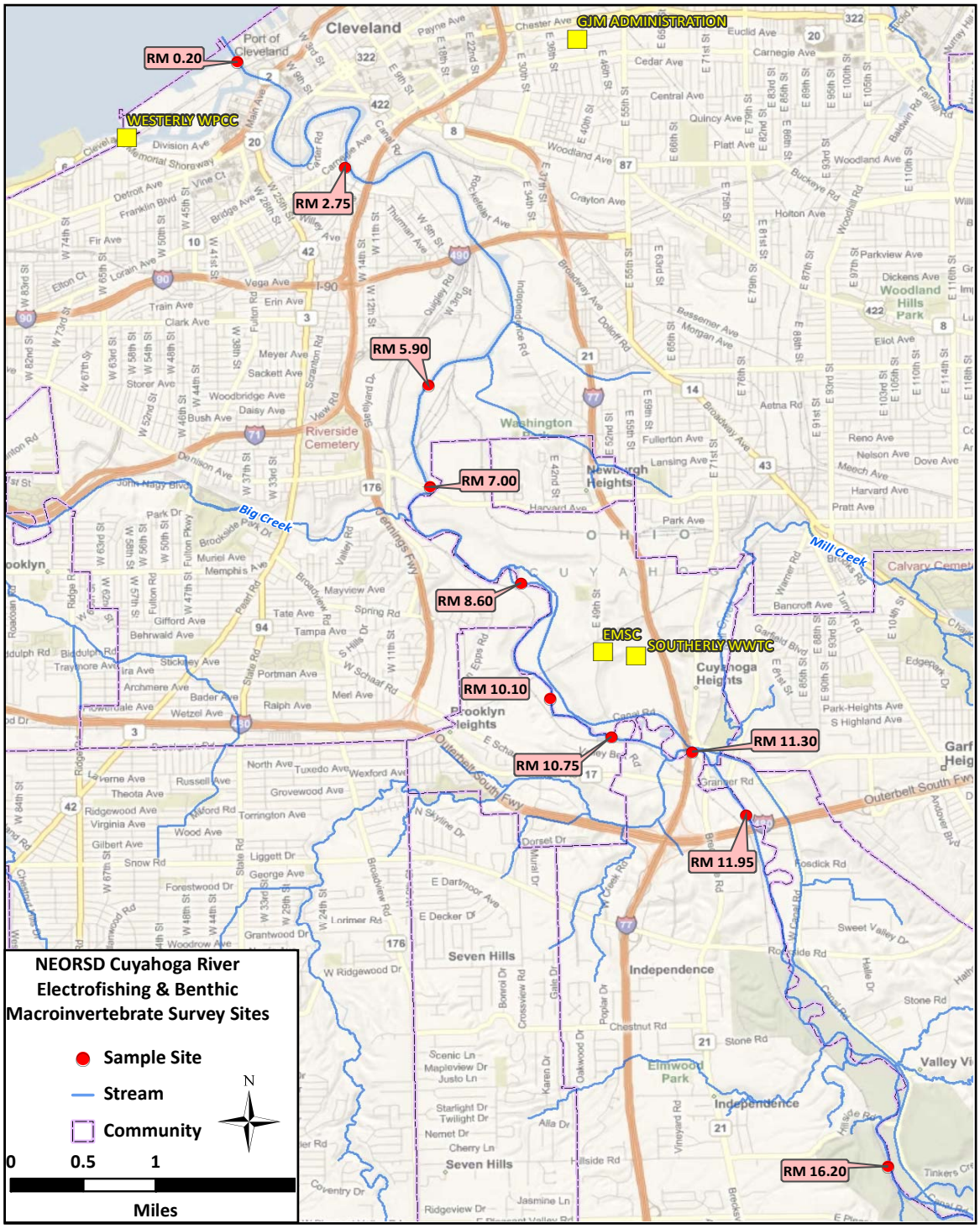


Figure 1. Sampling Locations

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 navigation channel on fish.

[1] HD and Water Chemistry Collection Site

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
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 22nd and September 7th at the sites between RMs 7.00 and 16.20 and five times at the sites in the navigation channel. Techniques used for sampling and analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009a). 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.

Bacteriological samples were collected in sterilized plastic bottles. All water quality samples were collected as grab samples. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% of the total samples collected. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Clean sampling techniques were used for the collection of mercury samples on June 22nd to allow for use of EPA Method 1631, a low-level mercury analysis method.

Results and Discussion

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 and fish passage from June through January, 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. The two exceptions to this were *Escherichia coli* (*E. coli*) and mercury. 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. For those streams designated Class A primary contact recreation, these criteria are 126 colony-forming units (CFU)/100mL and 298 CFU/100mL, respectively. Both of these criteria were exceeded at all of the sites throughout the sampling. The lowest densities occurred at the site near the mouth of the river, while the highest was at the site immediately downstream of Big Creek (Table 2). Wet weather[2], as measured at the NEORSD rain gage near Southerly Wastewater Treatment Center (WWTC) could explain the elevated densities observed during most of the sampling. The *E. coli* densities during the one dry-weather sampling event, while generally above 126 CFU/100mL, were all below 298 CFU/100mL. Wet weather sources of bacteria to the river could include runoff, CSOs, and bypasses at Southerly WWTC.

Table 2. 2011 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
6/22/2011*	2250	3550	4568	5273	6318	11,500	10,750	---	---	---
8/10/2011*	3700	10,800	8400	9600	7400	6800	10,100	5100	2800	5800
8/17/2011*	640	570	710	580	620	780	740	526	644	112.5
8/23/2011*	205	172	172	200	112	190	146	260	300	220
8/31/2011	188	183.5	150	167	143	153	170	155	44	42
9/7/2011*	1312.5	3000	2500	3800	3360	3000	11,600	12,000	600	400
Seasonal Geomean	804	1129	1099	1245	1077	1321	1688	1053	428	300

* Wet weather event;
--- no samples collected

[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.

Mercury analysis for all of the sampling events except for one 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. For the data that was collected in 2011, all three of the sites within the navigation channel had mercury concentrations that resulted in at least some 30-day averages that exceeded the criteria. These concentrations were just above the detection limit, and samples collected later in the season had dropped again to below it; therefore, it does not appear that there is a significant mercury source in that section of the river.

Use of the low-level EPA Method 1631E for the samples collected on June 22nd resulted in mercury concentrations just below the detection limit for EPA Method 245.1, but above the Human Health Nondrinking and Protection of Wildlife OMZA criteria. Based on this, it is expected that the use of EPA Method 1631E for all of the samples would have resulted in exceedances of both of those criteria throughout the sampling period at all of the sites.

There are no water quality standards for nutrients; Ohio EPA is currently in the process of developing them. Nutrient levels increased downstream of Southerly WWTC, but did not appear to be directly impacted by any of the tributaries that discharge to the river within the section of the river that was sampled (Table 3). The effects of too much algae are typically the greatest when flow in the river is low. Because there were no extended periods of low flow in the river in 2011, no chlorophyll *a* sampling was conducted. Therefore, the degree to which nutrient levels were affecting algal production could not be determined. Results from 2010 indicated that nutrients were not the most important factor influencing algal growth in the river. Sampling in 2012 may further aid in determining the overall impact of nutrients on the Cuyahoga River.

As part of QA/QC measures, five field blanks were collected over the course of the sampling. There were instances in which the concentration of copper and COD in the field blank was high enough that some of the results associated with those samples needed to be qualified or rejected. This occurred with all five field blanks for copper and with one field blank for COD. Because there were no exceedances associated with these parameters, qualification or rejection of these results did not significantly change the overall water chemistry assessment of the river. It is not clear at this time where this contamination is coming from. Further investigations in 2012 may help to determine potential sources and how to eliminate them.

Table 3. 2011 Cuyahoga River Nutrient Concentrations (mg/L)				
	TP	SRP	$NO_3 + NO_2$	NH_3
RM 16.20	0.15	0.08	2.29	0.05
RM 12.10	0.17	0.08	2.44	0.06
RM 11.30	0.17	0.08	2.40	0.06
RM 10.75	0.17	0.07	2.27	0.07
RM 10.10	0.26	0.16	4.10	0.13
RM 8.60	0.26	0.16	3.99	0.12
RM 7.00	0.26	0.15	3.97	0.14
RM 5.90	0.22	0.16	4.24	0.12
RM 2.75	0.19	0.12	3.93	0.20
RM 0.20	0.13	0.08	2.87	0.22

TP = total phosphorus
SRP = soluble reactive phosphorus
$NO_3 + NO_2$ = nitrate + nitrite
NH_3 = ammonia

Duplicate samples were also collected six times as part of this study to quantify the variability and error that could occur during sampling. Relative percent difference (RPD) was used to determine the degree of discrepancy between the two samples. Generally, an RPD of 40% is allowable for field samples; those that are higher may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards. There were four instances in which the RPD for a set of parameters was greater than 40%; once each for ammonia, arsenic, total suspended solids (TSS), and zinc. The samples for arsenic and TSS were collected as part of wet weather events. 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 set of samples in which the RPDs for ammonia and zinc were greater than acceptable were collected during a dry weather event. It is uncertain what caused the discrepancies between the samples in this instance

Habitat Assessment

Methods

Habitat assessments were conducted one time at each site in 2011 using Ohio EPA's Qualitative Habitat Evaluation Index (QHEI). The QHEI is used to assess the

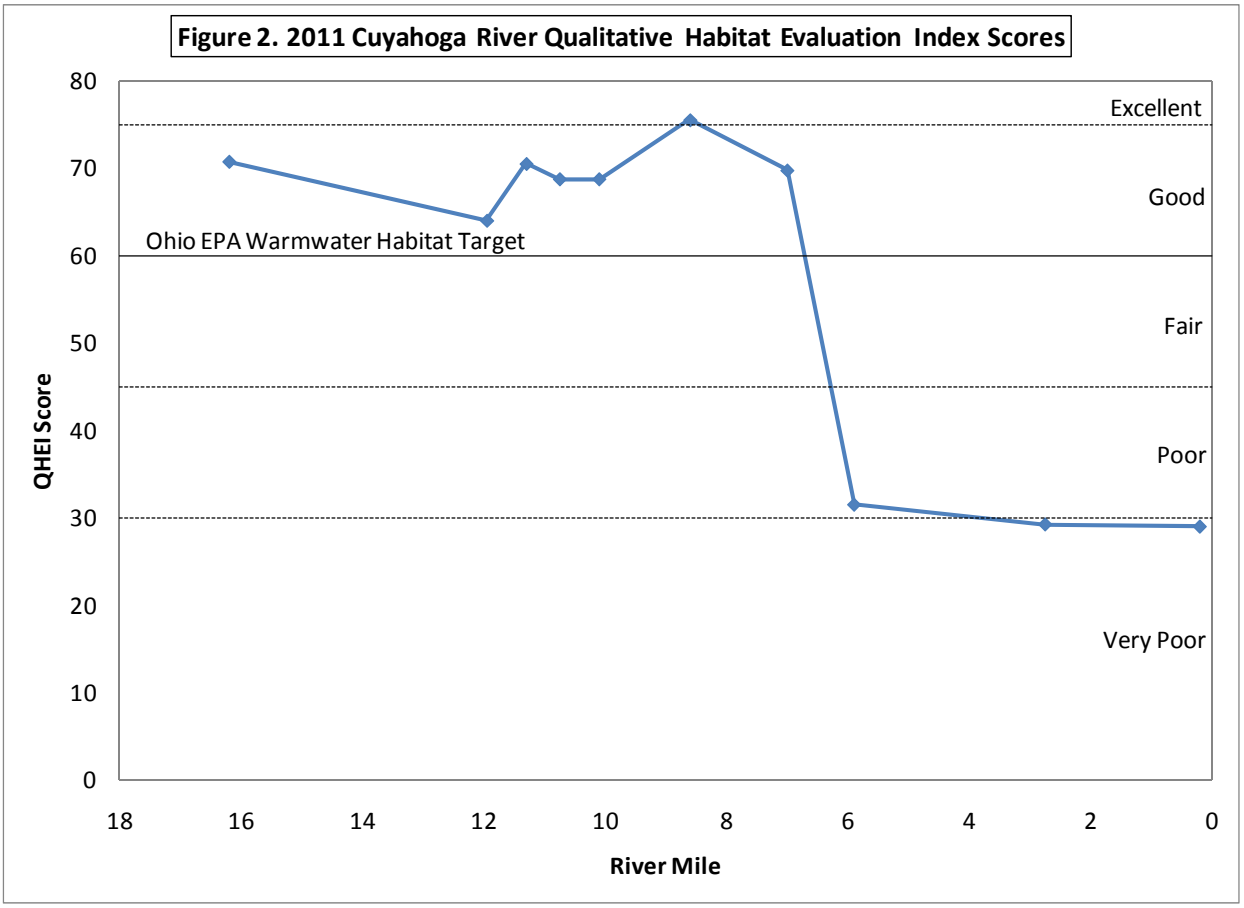
aquatic habitat conditions at each sample location by providing an evaluation of the physical components of a stream. The index is based on six metrics: stream substrate, instream cover, stream channel morphology, riparian and bank condition, pool and riffle quality, and stream gradient. These metrics may be important in explaining why fish species are present or absent at a site. A more detailed description of the QHEI can be found in Ohio EPA's (2006a), *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*. QHEI sheets for each site evaluated are available upon request from WQIS.

Results and Discussion

All of the sites upstream of the navigation channel were rated either *Good* or *Excellent* and met the target goal of 60 set by the Ohio EPA (Figure 2) (Ohio EPA, 2003). Sites meeting this goal are expected to attain the warmwater habitat (WWH) designated use. The site immediately upstream of Big Creek also exceeded a score of 75, which indicates that it has the ability to support exceptional warmwater habitat (EWH) fish communities.

Individual components of the QHEI can also be used to evaluate whether a site is capable of attaining 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).

The WWH attributes shared by all or most of the sites upstream of the navigation channel included fast currents and eddies, maximum depths greater than 40cm, and no channelization. All of these sites had at least one high-influence MWH attribute: sparse instream cover; the sites immediately upstream of Mill Creek and Southerly WWTC also had no sinuosity (Table 4). All of the sites also had between two and six moderate-influence MWH attributes, which as indicated previously, may make it less likely that the WWH fish criteria will be obtained. The characteristic shared by these sites was sand as one of the dominant substrate types. Many of the sites also had moderate to high embeddedness and fair development.



The sites within the navigation channel scored in either the *Poor* or *Very Poor* categories and had a large number of both high and moderate influence MWH attributes (Table 4). The only WWH attribute that these sites had was a maximum depth greater than 40cm. The MWH characteristics shared by these sites included channelization, muck substrates, sparse instream cover, heavy silt cover, poor development, only slow current velocities, high embeddedness, and a lack of riffles. All of these characteristics are consistent with these sites being designated limited resource waters and make it highly unlikely that a healthy fish community would be present.

Table 4. 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	70.75	Good						x	x		x		3				x		1	x		x		x	x				x	x		6
12.10	64.00	Good	x						x	x	x	x	5			x	x		2			x		x								2
11.30	70.50	Good	x						x		x		3				x		1		x	x		x	x				x	x		6
10.75	68.75	Good	x						x		x	x	4			x	x		2		x	x		x					x			4
10.10	68.75	Good	x						x	x	x		4				x		1			x		x	x					x		4
8.60	75.50	Excellent	x			x			x		x		4				x		1		x	x			x				x	x		5
7.00	69.75	Good	x					x	x		x		4				x		1		x	x		x	x				x	x		6
5.90	31.50	Poor									x		1	x	x		x		3		x			x	x			x	x		x	6
2.75	29.25	Very Poor									x		1	x	x		x		3		x			x	x	x		x	x		x	7
0.20	29.00	Very Poor									x		1	x	x	x	x		4		x			x		x		x	x		x	6

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2011. A list of the dates when 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 5. Sampling was conducted using either a 14-foot Alweld commercial boat or 17-foot Coffelt electrofishing boat, both equipped with a Smith-Root 5.0 GPP Electrofisher. Electrofishing consisted of shocking all habitat types within a sampling zone while moving from upstream to downstream. The sampling zone was 500 meters long at 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 DELT anomalies (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 5. Sampling Dates and River Flows

Date	Sites sampled (RMs)	Daily Mean Flow (CFS*)
7/6/11	5.90, 2.75	549**
7/7/11	16.20, 11.95, 11.30	316
7/8/11	0.20	541**
7/15/11	10.75, 10.10, 8.60, 7.00	254
8/22/11	5.90, 2.75	757**
8/24/11	0.20	926**
8/29/11	10.75, 10.10	270
8/30/11	16.20, 11.95, 11.30, 8.60, 7.00	272

*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*. All of the sites were evaluated using the boat IBI, which is calibrated for sites that are sampled using boat electrofishing methods. The three furthest downstream sites were also evaluated using the lacustuary IBI (Ohio EPA, undated). The lacustuary IBI is intended to be used in those areas near the mouths of rivers that may be influenced by lake levels. Although use of the lacustuary IBI has not been codified in the State of Ohio Water Quality Standards, it may be more appropriate to use in these areas than the boat IBI. The metrics used in each of the IBIs are shown in Table 6.

Table 6. 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
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

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

Results and Discussion

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 WQIS.

All of the sites upstream of the navigation channel had average MIwb scores that met the WWH criterion or were within non-significant departure (≤0.5 MIwb units) from it (Table 7, Figure 3). Three of the sites, downstream of Tinkers Creek and immediately upstream and downstream of Southerly WWTC, also had scores that met or were within non-significant departure from the EWH criterion. Generally, the scores in 2011 were slightly lower than in 2010 (Table 8). The greatest decrease was at the site immediately downstream of Mill Creek. Because the sites within the navigation channel are designated Limited Resource Water-Navigation Maintenance and Fish Passage, the biological criteria do not apply to them. The MIwb was still calculated for these sites to get a general indication of how healthy they were. All three sites had average MIwb scores that rated *Fair* and were higher than in 2010.

Table 7. 2011 Cuyahoga River IBI and MIwb Results

		1st Pass		2nd Pass		Average	
Location	River Mile	IBI	MIwb	IBI	MIwb	IBI	MIwb
Downstream from Tinkers Creek	16.20	**46**	**9.6**	**48**	**9.5**	**47**	**9.6**
Upstream from Mill Creek	11.95	**40**	*8.6*	*38*	**8.8**	*39*	**8.7**
Downstream from Mill Creek	11.30	34	*8.5*	*36*	**9.2**	35	**8.9**
Upstream from Southerly WWTC	10.75	**46**	**9.5**	**42**	**9.5**	**44**	**9.5**
Downstream from Southerly WWTC	10.10	**42**	**9.1**	30	**9.0**	*36*	**9.1**
Upstream from Big Creek	8.60	**42**	**8.7**	*38*	**8.8**	**40**	**8.8**
Downstream from Big Creek	7.00	34	**9.4**	30	7.4	32	*8.4*
US of Newburgh SS RR Bridge	5.90	*36* (34)	*8.2*	26 (24)	6.3	31 (29)	7.3
Scaravellei's Marina	2.75	28 (26)	7.9	30 (24)	*8.3*	29 (25)	8.1
Upstream of confluence w/ Lake Erie	0.20	34 (31)	6.6	26 (27)	7.0	30 (29)	6.8

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

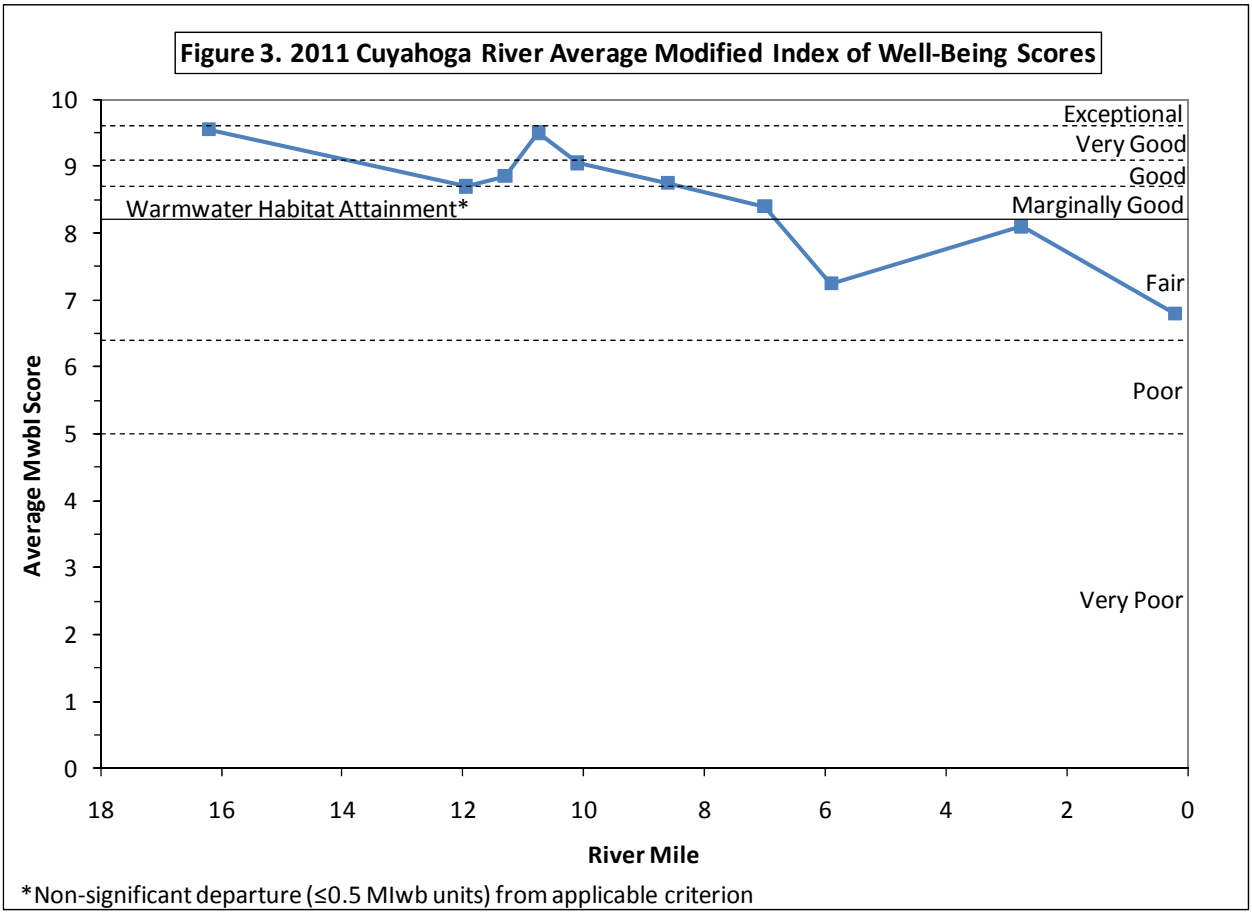


Table 8. Cuyahoga River Historic MIwb Scores (1990-2011)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90	RM 2.75	RM 0.20
1990	-	-	-	4.5	4.6	-	-	-	-	-
1991	-	-	-	5.5	5.6	-	6.1	-	-	-
1992	-	-	-	5.6	6.6	-	5.8	-	-	-
1997	-	-	-	7.5	6.1	-	6.1	-	-	-
1998	-	-	-	7.8	7.6	-	5.5	-	-	-
1999	-	-	-	8.2	*8.6*	-	7.0	-	-	-
2001	-	-	-	7.4	*8.2*	-	6.1	-	-	-
2003	-	-	-	7.6	7.8	-	7.0	-	-	-
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*	-	-	-

Table 8. Cuyahoga River Historic MIwb Scores (1990-2011)										
	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
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

Bold = meets WWH criterion [≥8.7]
Italics = non-significant departure from WWH criterion [≥8.2]

Most of the IBI scores for the sites upstream of the navigation channel also met the WWH criterion or were within non-significant departure (≤4 IBI units) from it (Table 7, Figure 4). The sites downstream of Tinkers Creek and immediately upstream of Southerly WWTC were also within non-significant departure from the EWH criterion. The sites that were not in attainment of the IBI criterion were those immediately downstream of Mill Creek and Big Creek. This is the first year since sampling first began at the site immediately downstream of Mill Creek that it was not in attainment of the criterion (Table 9). The results for these two sites indicate that Mill Creek and Big Creek may be having a negative impact on the river because the sites immediately upstream of them scored higher. However, the site near the mouth of Mill Creek was in attainment of its applicable IBI criterion. It is therefore uncertain if Mill Creek was actually impacting the river or if the lower fish scores at the site immediately downstream of Mill Creek were due to some other factor. Possibly, completion of a third electrofishing pass at that site would have resulted in it being in full attainment of the criteria.

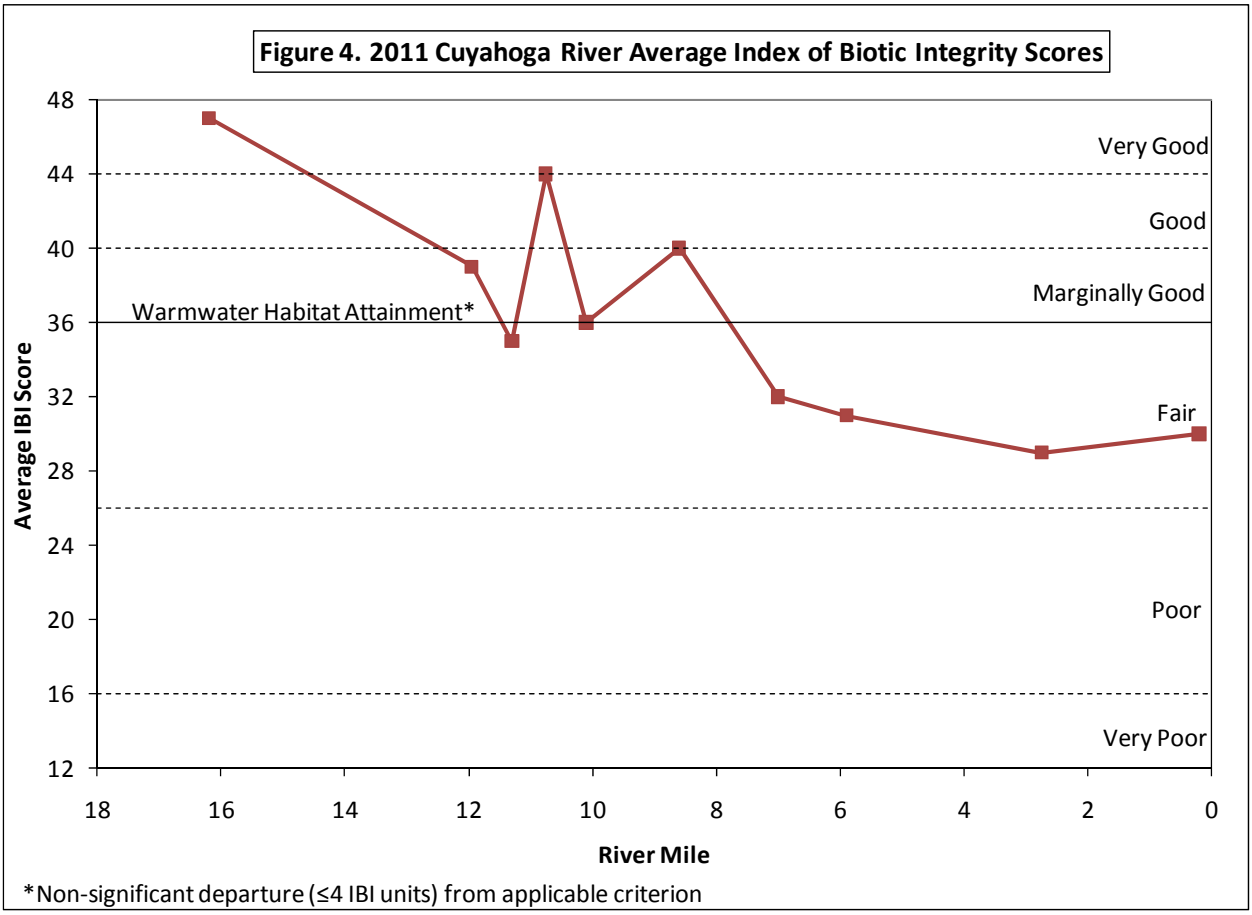


Table 9. Cuyahoga River Historic IBI Scores (1990-2011)										
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00	RM 5.90	RM 2.75	RM 0.20
1990	-	-	-	15	15	-	-	-	-	-
1991	-	-	-	17	16	-	18	-	-	-
1992	-	-	-	20	19	-	21	-	-	-
1997	-	-	-	25	17	-	18	-	-	-
1998	-	-	-	26	27	-	21	-	-	-
1999	-	-	-	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	-	-	-

Table 9. Cuyahoga River Historic IBI Scores (1990-2011)										
	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
2010	**43**	*39*	*39*	33	*37*	**41**	31	23 (19)	25 (28)	27 (30)
2011	**47**	*39*	35	**44**	*36*	**40**	32	31 (29)	29 (25)	30 (29)

Bold = meets WWH criterion [≥40]
Italics = non-significant departure from WWH criterion [≥36]
Scores in parentheses are those calculated using the lacustuary IBI

The lack of pollution-intolerant species continues to be a limiting factor to higher IBI scores at all of these sites. The only intolerant fish that were collected at any of the sites in 2011 included a stonecat madtom (*Noturus flavus*) at the site immediately downstream of Tinkers Creek and a mimic shiner (*Notropis volucellus*) at the site immediately upstream of Southerly WWTC. Elevated bacterial densities, such as were found for most of the water quality sampling, are an indication of the presence of sanitary or combined sewage within the river that may be preventing the establishment of more pollution-intolerant fish species at these locations.

One of the other metrics that did poorly during the sampling (a score of "1" for both surveys) included the proportion of top carnivores at the site immediately upstream of Big Creek. This also occurred in previous years. Smallmouth bass and rock bass, the two dominant carnivore species found in the Cuyahoga River, prefer deeper pools and steep drops offs (Trautman, 1981). A lesser amount of these habitat structures may explain the lower numbers of these carnivores at this site.

There were two other instances in which a score of "1" was received at the same site during both passes: the proportion of round-bodied suckers at the site immediately downstream of Mill Creek and the number of individuals at the site immediately downstream of Big Creek. Combined sewage overflows from the Mill Creek Tunnel and other CSO outfalls during wet weather may have resulted in a lower number of round-bodied suckers, which are pollution sensitive, in that section of the river. Likewise, inputs from CSOs in Big Creek, along with sparse instream cover, may be the reasons for the lower number of individuals at the downstream site compared to the other sites that were surveyed.

The average scores within the navigation channel using the boat IBI metrics rated *Fair* and were higher than those received in 2010. Generally, these sites lack adequate habitat to allow for a better fish community. This is supported by looking at the individual metrics that make up the boat IBI. In addition to the absence of any pollution-intolerant species, all three sites also scored a "1" during both passes for proportion of

round-bodied suckers, number of sucker species, and proportion of simple lithophils, those fish that require clean gravel and cobble substrates for spawning. Round-bodied suckers, which include northern hogsuckers and redhorses, are all simple lithophils. Therefore, their limited numbers at the head of the navigation channel and absence at the lower two sites during both surveys resulted in the low scores for these metrics and was most likely due to the presence of only muck substrates and lack of functional riffles.

Of note are the IBI and MIwb scores received at the site at the head of the navigation channel in July that were in non-significant departure of the WWH criteria. Although the criteria do not apply at this location, these scores indicate that it may be possible for this site to have a healthy fish population, especially if habitat improvements occur downstream of it. The results from the second pass and both passes at the other sites, though, indicate that these sites are generally incapable of supporting such fish communities under current conditions.

For the lower three sites, the IBI was also calculated using the lacustuary metrics; all three sites rated *Poor*. Inadequate habitat may explain the generally low metric scores received for number of sunfish and cyprinid species, the proportion of phytophilic and top carnivore species, and the number of individuals. Sedimentation and low dissolved oxygen concentrations could account for the low number of benthic and pollution intolerant species (Ohio EPA, undated).

Overall, the results from the fish surveys conducted in 2011 indicate a generally healthy fish community upstream of the navigation channel, with some potential localized impacts downstream of tributary streams that have CSOs discharging to them. Most of the sites that were surveyed were in full attainment of the applicable fish criteria; two of the sites were high enough that they also would have met attainment of EWH criteria. Results from within the navigation channel, however, continue to show the inability of those sites to support a warmwater fish community under current habitat and water quality conditions.

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 Table 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. Due to the high frequency of wet weather in 2011, however, the HDs in the navigation channel were installed for approximately nine weeks, while those upstream of the navigation channel were installed for approximately ten weeks. Also, the HDs were retrieved in October, which was past the recommended end date of September 30th.

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 Cuyahoga River was evaluated using Ohio EPA's Invertebrate Community Index (ICI) and Lacustuary ICI (LICI) (OEPA 1987a, Ohio EPA undated). The ICI and LICI both consist of ten community metrics (Table 10), 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 10. 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

It is uncertain if the extended colonization period had any impact on the composition and abundance of macroinvertebrates on the HDs. Based on the results that were obtained, though, the four most upstream sites that were assessed in the river were

in attainment or non-significant departure (≤4 ICI units) of the criterion (Table 11). This is the fifth year in a row that these sites have been so (Figure 5). Generally, all four of these sites had relatively low numbers of mayflies and tribe Tanytarsini midges, but were high in caddisflies.

Table 11. Macroinvertebrate Results

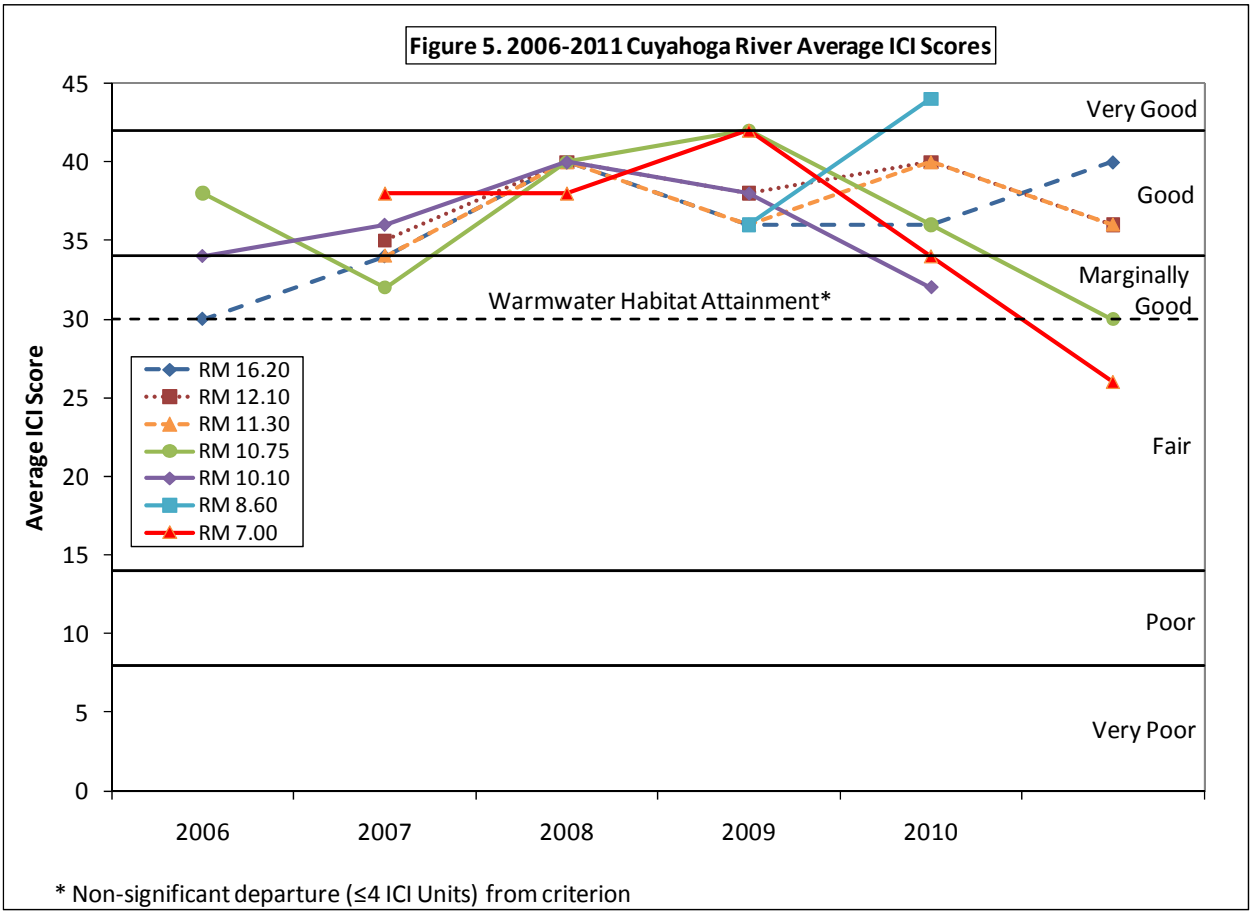
Location	River Mile	ICI Score	LICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant (as defined)	Narrative Rating
Downstream of Tinkers Creek	16.20	**40**	---	915	47	8	0.7	Good
Upstream of Mill Creek	12.10	**36**	---	325	49	8	1.2	Good
Downstream of Mill Creek	11.30	**36**	---	569	45	8	3.0	Good
Upstream of Southerly WWTC	10.75	*30*	---	428	47	9	10.5	Marginally Good
Downstream of Southerly WWTC	10.10	NA	---	NA	NA	10	NA	NA
Upstream of Big Creek	8.60	14*	---	11	30	9	39.6	Fair*
Downstream of Big Creek	7.00	26	---	592	52	10	65.7	Fair
Head of Navigation Channel	5.90	---	48**	238	39	5	40.6	Good
Abandoned Marina (formerly Scaravelli's)	2.75	---	NA	NA	NA	2	NA	NA
Cuyahoga River Mouth	0.20	---	38	259	27	1	8.0	Fair

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



No HD was retrieved at RM 10.10, possibly because it was washed away due to high flows during the colonization period. Although an HD was retrieved at RM 8.60, colonization appeared to be negatively impacted by elevated flows in the river from a storm event that occurred ten days earlier. The total number of organisms found on this HD was only 53, which was much lower than the other sites and the same site when compared to past years. The location of the HD in the current at this site was such that it may have been affected more by the higher flows than the HDs at the other sites. Therefore, the ICI score obtained for this site is not considered to be an accurate representation of site conditions. For both of these sites, the number of mayfly and caddisfly taxa obtained in the qualitative sample was similar to the other upstream sites and indicates that they may have been in attainment of the ICI criterion if the HDs had not been impacted by the elevated flows and extended colonization periods.

At RM 7.00, the ICI score failed to meet the WWH criterion, which was the first time that this has happened within the last five years. Although the density of organisms was higher than at the other sites, the proportion of those organisms that were considered

to be pollution tolerant was much greater. In addition, there was also a much lower percentage of caddisflies.

The macroinvertebrate communities within the navigation channel were evaluated using the LICI to get provide a general assessment of conditions there even though the biocriteria do not apply. The LICI has not yet been officially approved as an evaluation method, but can still be used as an assessment tool for those locations that may be influenced by lake levels. The scoring categories for the LICI differs from the ICI, with a score of 42 considered to be the goal for Lake Erie lacustuaries.

HDs were successfully retrieved at RMs 5.90 and 0.20, while those at RM 2.75 were lost at some point during the colonization period. The score for RM 5.90 exceeded the goal score of 42, but the score for RM 0.20 did not (Table 12). The major differences between these two sites were a lower percentage of taxa considered to be pollution sensitive and a lower number of EPT taxa in the qualitative sample at RM 0.20. The qualitative sample collected at RM 2.75 contained a total of fifteen taxa, with two of those being EPT. These numbers were higher than the site at RM 0.20, but lower than the site at RM 5.90. Of the species that were collected, only one was considered to be pollution sensitive, with over half being either moderately or very tolerant to pollution. Because of this and the low number of EPT, it is not expected that this site would have been in attainment of the goal LICI score if the HD would have been successfully retrieved.

Conclusions

In 2011, water chemistry sampling and habitat and biological assessments were conducted within the Cuyahoga River to evaluate the impact of District facilities (Southerly WWTC and CSOs) and other sources on water chemistry and the biological community. In general, the biological community upstream of the navigation channel was healthy, meeting Ohio EPA's goals for WWH at most of the sites. There were a few instances in which impacts were found at sites for fish; the sites immediately downstream of Mill Creek and Big Creek failed to meet the criterion for the IBI. Based on the high frequency of wet weather during the sampling period and the elevated *E. coli* densities that were found, it appears that CSOs discharging to Mill Creek and Big Creek may be negatively affecting the biological community in the Cuyahoga River downstream of them. Habitat did not appear to be a significant contributor to these sites not being in full attainment of the biological criteria, as all sites upstream of the navigation channel met Ohio EPA's habitat goal for WWH.

The three sites within the navigation channel were also evaluated in support of three restoration projects currently being conducted within that section of the river.

These sites are all designated limited resource waters, and therefore, the biological criteria do not apply to them. Assessments using the IBI and MIwb indicated an impaired fish community, which is likely due to the limited habitat at those sites. As with the sites upstream of the navigation channel, the only water quality exceedances were for *E. coli* and mercury. The macroinvertebrate community at the head of the navigation channel, RM 5.90, as measured using the LICI, met Ohio EPA's goal for WWH, but the other two sites indicated some impairment. Continued monitoring of these sites as the restoration projects in the navigation are completed will help to determine their effectiveness in creating the habitat necessary to support a healthy fish community.

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