NORTHEAST OHIO REGIONAL SEWER DISTRICT

2010 Cuyahoga River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance's
Environmental Assessment Section

Introduction

In 2010, 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 or under direct supervision of 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 *2010 Cuyahoga River Environmental Monitoring* approved by Ohio EPA on June 18, 2010.

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 such as Southerly Wastewater Treatment Center (WWTC) and combined sewer overflows (CSO) on Mill Creek and Big Creek. 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. Recent monitoring by NEORSD and the Ohio EPA, however, has shown recovery in some reaches of the river. 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 some potential causes of impairment.

Another purpose of the study was to collect baseline data on chlorophyll *a* levels in the river, establish the factors controlling algal production, and determine any potential impacts from Southerly Wastewater Treatment Center, a point source for nutrients in the river. Data sondes were installed in the river as part of this sampling to provide a more comprehensive understanding of the relationship among algal production, nutrient levels, and dissolved oxygen diel swings in the river.

Finally, the fish community in the Cuyahoga River navigation channel was monitored in support of two grants related to habitat restoration as part of the Great Lakes Restoration Initiative. One of these projects is 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. This project entails installing artificial habitat for use by larval fish migrating to and from Lake Erie. The second project is being led by the Cuyahoga County Engineer's Office, which became the Cuyahoga County Department of Public Works in 2011, and is titled *Cuyahoga AOC Urban Riparian Habitat Restoration*. The purpose of this project is to restore native habitat within a section of the navigation channel.

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 Department (WQIS).

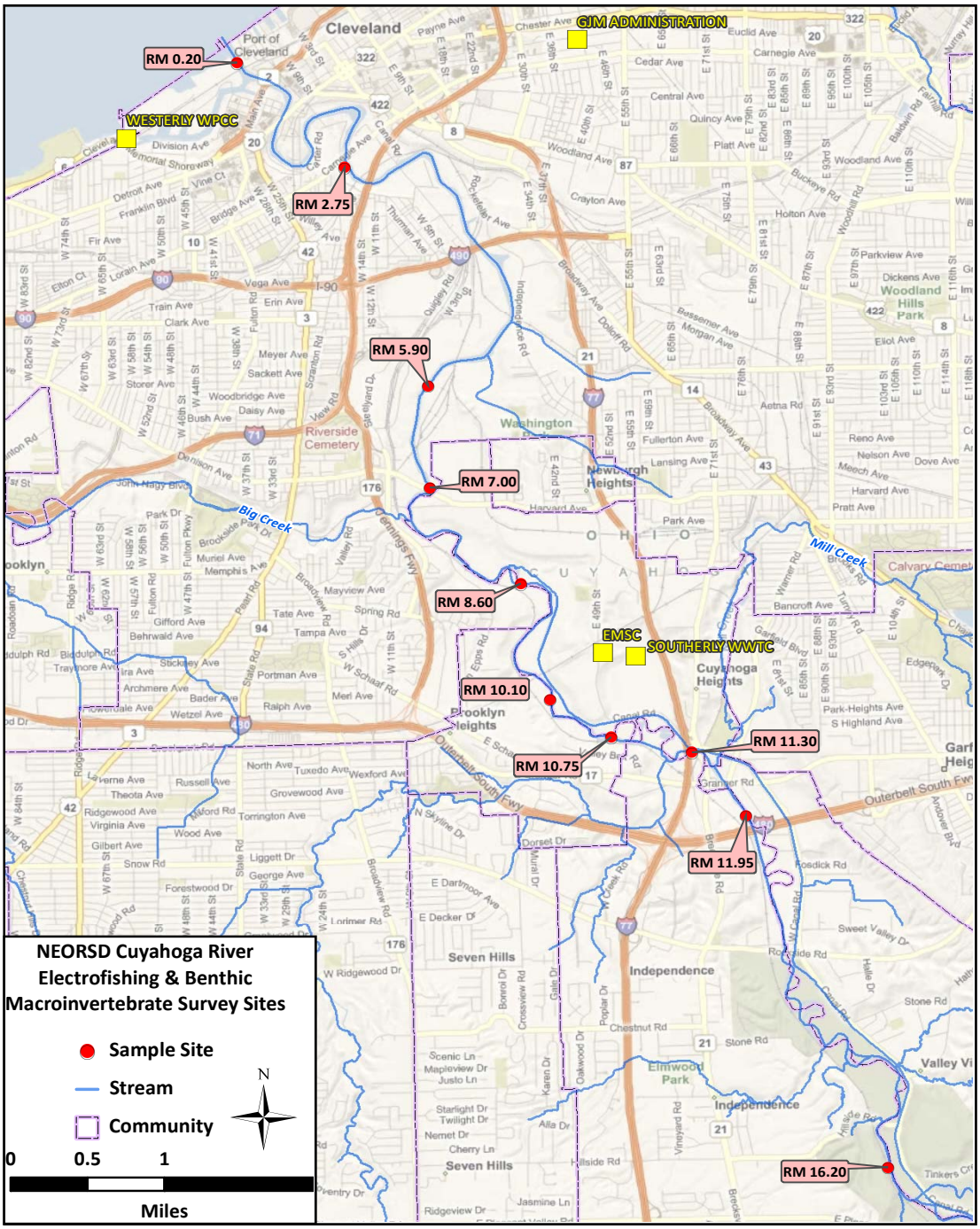


Figure 1. Sampling Locations

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

[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 five times between July 27th and August 24th at the sites between river miles 7.00 and 16.20. No sampling was conducted within the navigation channel because the purpose of including those sites in the study was only to determine what fish species were present. 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. Bacteriological samples were collected in a sterilized plastic bottle treated with sodium thiosulfate. 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 either a YSI-556 MPS Multi-Parameter Water Quality Meter or YSI 600XL sonde.

Benthic and water column chlorophyll *a* sampling was also conducted two times at four locations on the Cuyahoga River in 2010. The four sites that were sampled were downstream of Tinkers Creek, upstream and downstream of Southerly WWTC, and downstream of Big Creek. For the benthic samples, five rocks were collected from three locations in the river for a total of fifteen. The algal mass from a portion of each rock was scraped off and composited to form a slurry. Water column samples consisted of grab samples collected from the river in the same vicinity as the benthic samples. Chemical and physical water quality parameters measured in conjunction with the chlorophyll *a* samples included total phosphorus, dissolved reactive phosphorus, nitrate+nitrite, alkalinity, turbidity and suspended solids. In addition, YSI data sondes were installed at these locations approximately one day prior to sampling and removed one or two days after sampling was completed. The sondes measured dissolved oxygen, temperature, conductivity, and pH in fifteen-minute increments.

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. Most of the applicable criteria for these sites were met for the samples collected. One of the exceptions to this was *E. coli*. At each site, the seasonal geometric mean exceeded the criterion of 126 colony-forming units per 100 mL (CFU/100mL). The percentage of samples exceeding 298 CFU/100mL was also greater than 10% for all of the 30-day periods starting on days samples were collected at each site. The highest *E. coli* densities occurred at the two most upstream sites. Two of the sample days were considered wet weather events[2], which could account for the highest densities occurring then. Since the densities at the sites immediately downstream of Mill Creek and Big Creek were generally lower than those immediately upstream, combined sewer overflows do not appear to be the major contributor to the problem.

Potentially, the human health nondrinking and wildlife outside mixing zone averages for mercury were also exceeded for all of these sites for at least some 30-day periods during sampling. All of the sites had either one or two samples with mercury concentrations greater than the minimum detection limit (MDL). However, because the MDL for mercury is greater than the criteria and some of the measured concentrations were estimates, it is unknown whether the criteria were actually exceeded.

As part of QA/QC measures, field blanks were collected three times during the sampling. The results from analysis of the field blanks showed that there were a few

[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 were considered wet weather samples.

instances in which the concentration of a parameter that was measured was higher than the detection limit. For some of these constituents, the results were similar to those obtained during an analysis of the bottles used during sample collection. One exception to this was for selenium in one of the samples. It is uncertain what cause the elevated selenium concentration in this sample because no other samples, either from the river or field blanks, were as high.

Duplicate samples were collected four times during the sampling. The results for 42 parameters measured from each of the duplicates were compared by calculation of relative percent differences. There were nine instances in which the relative percent difference between the duplicate samples was greater than 30%, the acceptable level for field duplicates. For all of the instances in which this occurred, the measured values were less than ten times the practical quantitation limit. Therefore, the low quantity being measured is considered to be the reason for the greater than acceptable differences, and not because of any sampling errors.

Chlorophyll *a* sampling was also conducted one time each in July and September under low-flow conditions at RMs 16.20, 10.75, 10.10, and 7.00. The Ohio EPA is currently in the process of developing nutrient criteria for streams. It is expected that these criteria may include chlorophyll *a* monitoring in order to determine if the nutrient criteria are being met. The purpose of this sampling, therefore, was to establish baseline levels upstream of Southerly WWTC and determine any impacts from nutrients in the effluent on algal production. Benthic chlorophyll *a* samples were collected to determine algal biomass that is attached to the stream substrate. Water column chlorophyll *a* samples were collected to determine algal biomass that has sloughed off from the substrate. Data sondes were installed in the river as part of this sampling to provide a more comprehensive understanding of the relationship among algal production, nutrient levels, and dissolved oxygen diel swings in the river.

When averaging the two sampling events, the sites immediately upstream and downstream of Southerly WWTC had the highest benthic chlorophyll *a* concentrations, with the site immediately upstream of Southerly WWTC also having the highest water column concentration (Table 2). As might be expected, dissolved oxygen measurements collected using the data sondes showed that the highest diel swings occurred where the chlorophyll *a* concentrations were the highest.

Canopy cover and suspended solids are two factors that may influence algal production, with an increase in either factor causing a decrease in chlorophyll *a* concentrations (Ohio EPA, 2003; Miltner, 2010). These factors may explain some of the results obtained in 2010. For example, the most upstream site had the least amount of canopy cover, and could therefore be expected to have the highest chlorophyll *a* concentrations. However, it also had a higher average amount of suspended solids and a higher turbidity, which may interfere with algal production. This was seen in the results,

as this site had a lower average benthic chlorophyll *a* concentration than the others. The sites immediately upstream and downstream of Southerly WWTC had similar canopy cover, suspended solids, and turbidity, and also had similar benthic chlorophyll *a* concentrations. Nutrients do not appear to be a major factor controlling algal production in this section of the river. The two sites downstream of Southerly WWTC, which had the highest nutrient levels, did not have higher chlorophyll *a* concentrations than the site immediately upstream of Southerly WWTC, which had the lowest amount of nutrients.

Table 2. Chlorophyll *a* Sampling Results

	RM 16.20		RM 10.75		RM 10.10		RM 7.00	
	7/7/2010	9/1/2010	7/7/2010	9/1/2010	7/7/2010	9/1/2010	7/7/2010	9/1/2010
Benthic Chlorophyll *a* (mg/m2)	118	354.4	173.7	387.5	153.4	470.7	187.2	281.0
Water Column Chlorophyll *a* (ug/L)	22.03	13.25	26.14	17.47	18.03	9.85	10.12	8.85
Alkalinity (mg/L CaCO3)	147.2	153.3	150.6	153.5	131.9	132.5	128.5	132.2
Total Suspended Solids (mg/L)	12.6	14.9	9.3	7.9	7.5	7.6	7	10.5
Turbidity (NTU)	4.48	8.49	5.06	4.65	3.53	4.72	2.87	8.16
Total Phosphorus (mg/L)	0.08	0.095	0.068	0.085	0.289	0.369	0.318	0.429
Soluble Reactive Phosphorus (mg/L)	0.038	0.051	0.023	0.041	0.245	0.311	0.279	0.357
Nitrate +Nitrite (mg/L)	3.858	4.965	3.799	5.188	7.412	8.5	7.547	8.828
Canopy Cover (Average Degrees Open)	149.7		121.4		118.3		110.0	
Average DO Swing (Max - Min)	---	2.89	5.95	4.41	4.20	3.21	---	2.96

These results differ some from what was measured in 2009, when the highest benthic chlorophyll *a* concentration was found downstream of Big Creek and the lowest was downstream of Southerly WWTC. These differences may be due to the limited amount of sampling that has been conducted to date. Most likely, there is a combination of interacting factors that control how much algal production is occurring in a stream and these relationships have not been fully determined, yet.

Habitat Assessment

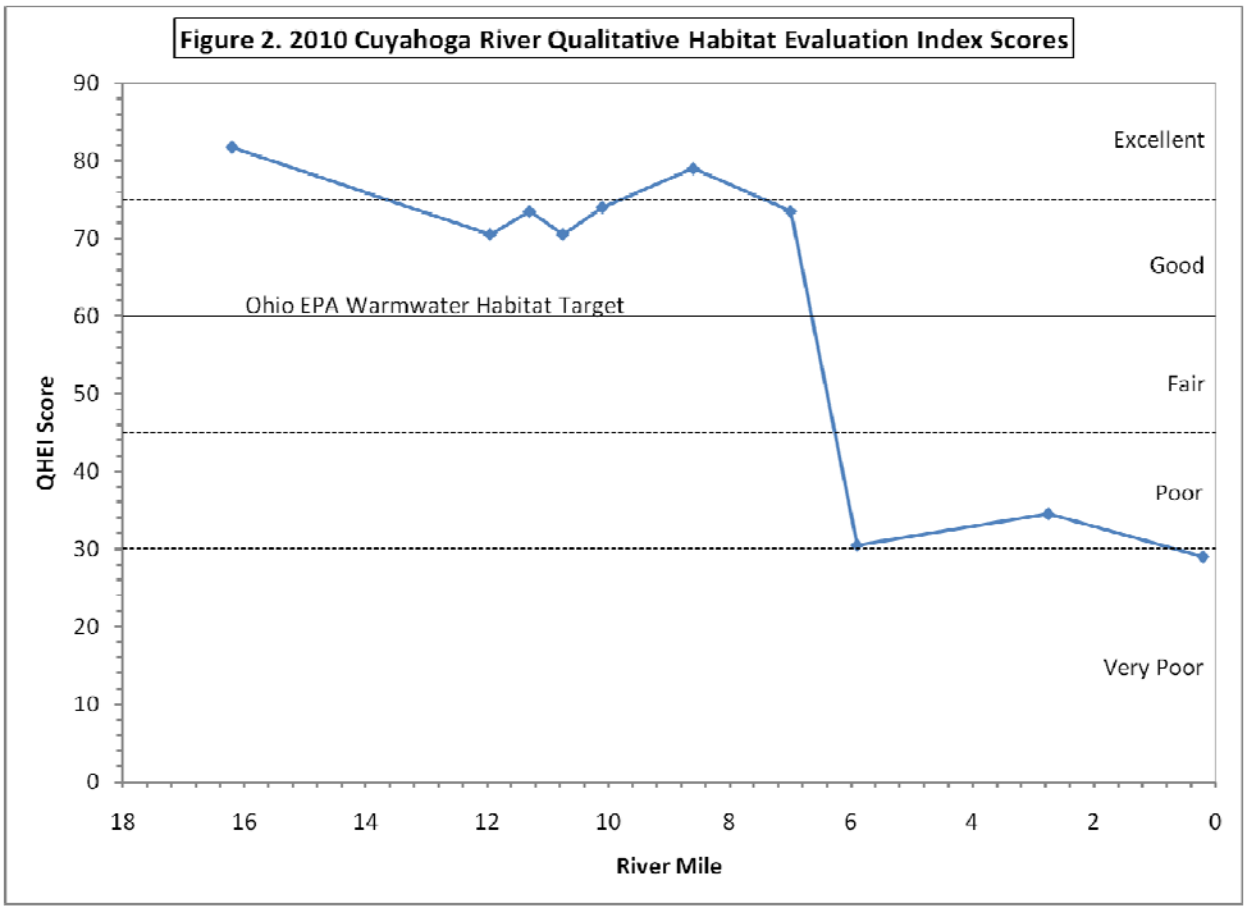
Methods

Habitat assessments were conducted one time at each site in 2010 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). Sites meeting this goal are expected to attain the warmwater habitat designated use. Two of the sites also exceeded a score of 75, which indicates that they have the ability to support exceptional warmwater habitat fish communities.



In addition to examining overall QHEI scores, individual components of the index can also be used to evaluate whether a site is capable of attaining the warmwater habitat

designated use. This is done by categorizing specific attributes as indicative of either a warmwater habitat or modified warmwater habitat (Rankin, 1995). Attributes that are considered characteristic of modified warmwater habitats 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 warmwater habitat attainment even if it had an overall QHEI score of at least 60 (Ohio EPA, 1999).

For the sites upstream of the navigation channel, the only site that had less than one high and four moderate attributes was the one downstream of Tinkers Creek (Table 3). All of the others did not meet this target; although the site upstream of Big Creek had no high-influence attributes and only four moderate ones. All of the other sites exhibited a lack of adequate instream cover, a high influence attribute, and five or six moderate attributes. Typically, the problems at these sites were related to silt, sand substrate, moderate embeddedness, and low sinuosity.

The sites within the navigation channel scored in either the *Poor* or *Very Poor* categories. These sites had a large number of both high and moderate influence modified warmwater habitat attributes, and therefore, are not expected to support warmwater habitat communities. This is consistent with their designation as limited resource waters. The restoration project at RM 2.75, the site that was formerly Scaravelli's Marina, will help to address some of the habitat issues there. For example, this site has a minimal riparian zone. One of the goals of the restoration project is to create a functional riparian habitat along a ½ mile stretch of the river that will provide food, shelter and dissolved oxygen for fish.

Table 3. Qualitative Habitat Evaluation Index scores and physical attributes

			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence												
River Mile	QHEI Score	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	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	81.75	Excellent	x					x	x		x	x	5						0			x			x				x			3
11.95	70.50	Good	x						x		x		3			x	x		2		x	x		x					x	x		5
11.30	73.50	Good	x						x		x		3				x		1		x	x		x	x				x	x		6
10.75	70.50	Good	x						x		x		3				x		1		x	x		x	x				x	x		6
10.10	74.00	Good	x						x		x	x	4				x		1		x	x		x	x				x			5
8.60	79.00	Excellent	x					x	x		x		4						0			x			x				x	x		4
7.00	73.50	Good	x						x		x		3				x		1		x	x			x				x	x		5
5.90	30.50	Poor									x		1	x	x	x	x		4		x			x				x	x		x	5
2.75	34.50	Poor									x		1	x	x		x		3		x			x	x			x	x		x	6
0.20	29.00	Very Poor									x		1	x	x	x	x		4		x			x				x	x		x	5

Fish Community Assessment

Methods

Three quantitative electrofishing passes were conducted at each site in 2010. Qualitative sampling was also conducted at RM 7.00 three times during the spring to determine what species may be spawning in the river. A list of the dates surveys were completed, along with flow as measured at the United States Geological Survey gage station in Independence, is given in Table 4. 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 4. Sampling Dates and River Flows

Date	Sites sampled (RMs)	Daily Mean Flow (CFS*)
4/9/10	7.00	649
4/23/10	7.00	321
5/28/10	7.00	649
7/15/2010	16.20, 11.95, 10.75	268
7/16/2010	10.75, 10.10, 8.60, 7.00	299
7/21/2010	5.90, 2.75, 0.20	267
8/11/2010	10.75, 10.10, 8.60, 7.00	255
8/19/2010	5.90, 2.75, 0.20	264
8/20/2010	16.20, 11.95, 11.30	243
9/14/2010	16.20, 11.95, 11.30	212
9/15/2010	10.75, 10.10, 8.60, 7.00	204
9/23/2010	5.90, 2.75, 0.20	366

*Provisional data

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 two 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 both IBIs are shown in Table 5.

Table 5. 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 were in attainment of the warmwater habitat criterion (Table 6, Figure 3). In addition, these sites, with the exception of RM 11.95, also met or were within non-significant departure (≤0.5 MIwb units) from the criterion for exceptional warmwater habitat. The scores for all of the sites except for RM 16.20 were higher than in 2009. This continued a general upward trend in MIwb scores that has been occurring over the last 20 years (Table 7).

Table 6. 2010 Cuyahoga River IBI and MIwb scores									
		1st Pass		2nd Pass		3rd Pass		Average	
Location	River Mile	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb
Downstream from Tinkers Creek	16.20	**40**	*8.6*	**46**	**10.1**	**44**	**9.9**	**43**	**9.5**
Upstream from Mill Creek	11.95	30	7.4	**46**	**9.6**	**40**	**10.1**	*39*	**9.0**
Downstream from Mill Creek	11.30	**40**	**9.7**	**42**	**9.3**	*36*	**10.0**	*39*	**9.7**
Upstream from Southerly WWTC	10.75	32	**9.0**	34	**9.5**	34	**10.6**	33	**9.7**
Downstream from Southerly WWTC	10.10	*38*	**8.8**	34	**9.1**	*38*	**10.5**	*37*	**9.5**
Upstream from Big Creek	8.60	**42**	*8.6*	**44**	**8.7**	*36*	**10.3**	**41**	**9.2**
Downstream from Big Creek	7.00	30	*8.4*	32	*8.6*	32	**9.3**	31	**8.8**
Upstream of Newburgh SS RR Bridge	5.90	22	6.4	20	5.7	28	6.5	23	6.2
Scaravelli's Marina	2.75	22 (26)	7.9	24 (23)	6.9	28 (36)	6.9	25 (28)	7.2
Upstream of confluence w/ Lake Erie	0.20	28 (29)	6.5	26 (34)	6.3	26 (28)	6.2	27 (30)	6.3

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

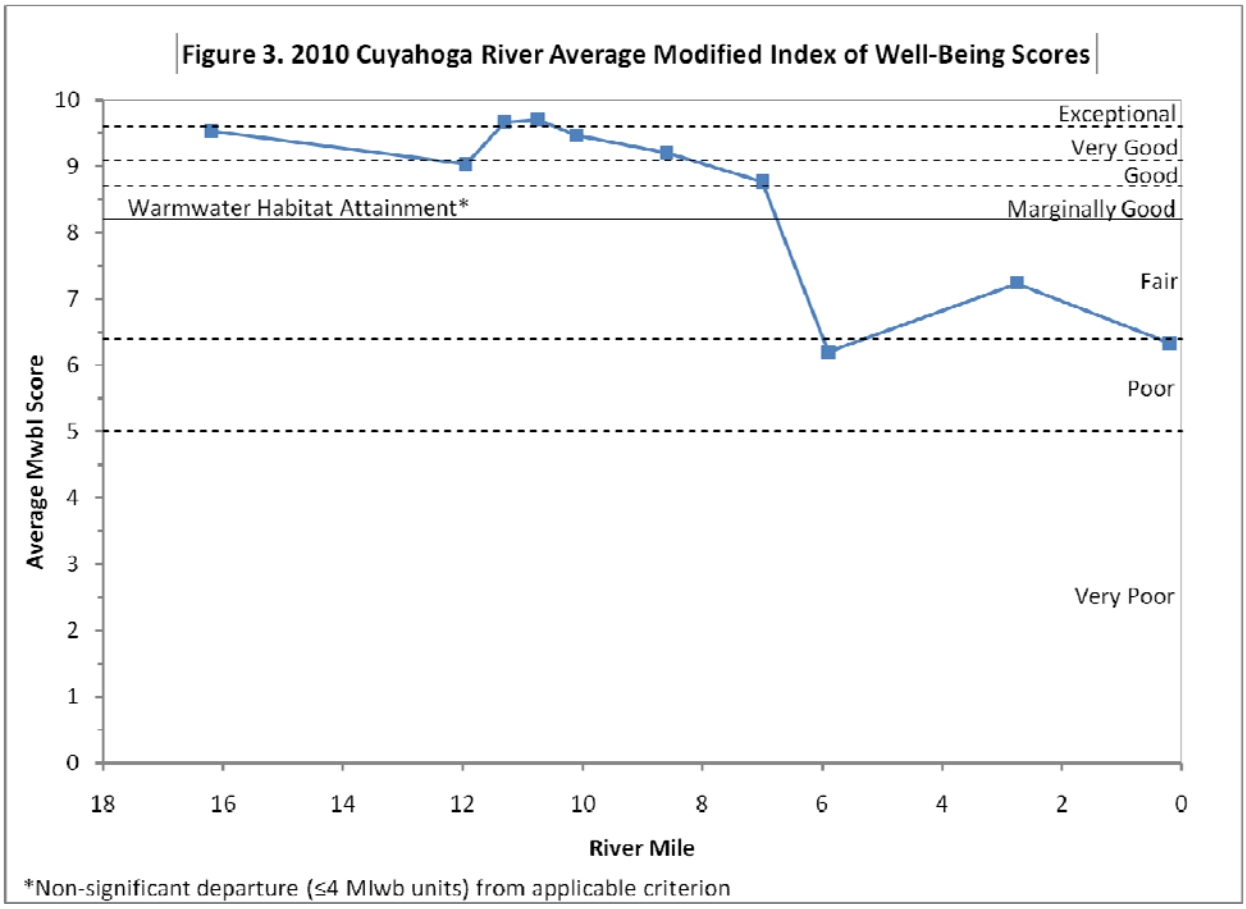
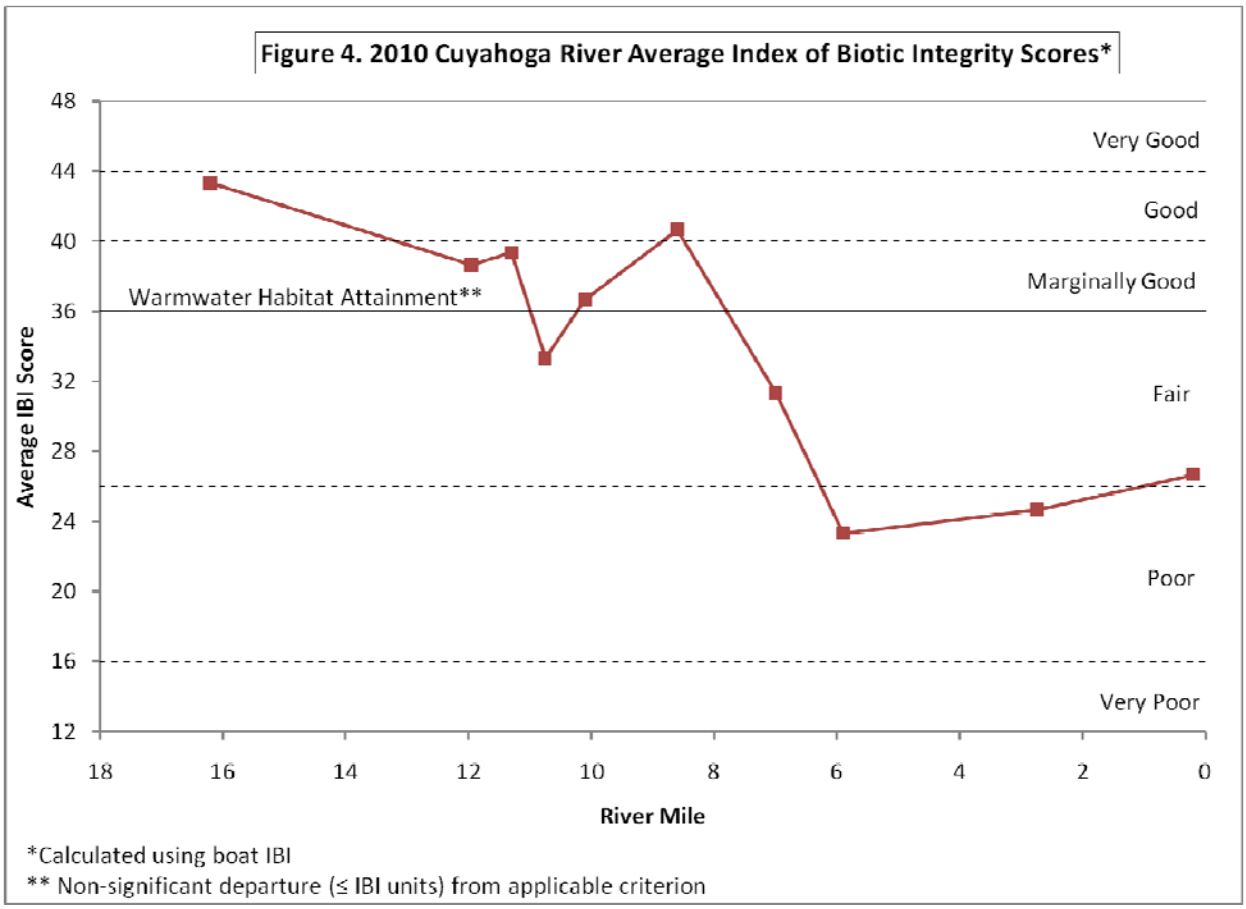


Table 7. Cuyahoga River historic MIwb scores from NEORSD sampling (1990-2010)							
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00
1990	-	-	-	4.5	4.6	-	-
1991	-	-	-	5.5	5.6	-	6.1
1992	-	-	-	5.6	6.6	-	5.8
1997	-	-	-	7.5	6.1	-	6.1
1998	-	-	-	7.8	7.6	-	5.5
1999	-	-	-	8.2	*8.6*	-	7.0
2001	-	-	-	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*
2010	**9.5**	**9.0**	**9.7**	**9.7**	**9.5**	**9.2**	**8.8**

Bold = meets WWH criterion [≥8.7]

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

For the IBI, most of the sites upstream of the navigation channel had average scores that met or were within non-significant departure (≤4 IBI units) from the warmwater habitat criterion (Figure 4). The two sites that scored the highest, RMs 16.20 and 8.60, also had the highest QHEI scores. The sites that did not meet the IBI criteria were the ones at RMs 10.75 and 7.00. For the site at RM 10.75, the score was a decrease from 2009, when the site was in attainment (Table 8). The reason for the decrease is unknown. Results from the July whole effluent toxicity test at Southerly WWTC, which was conducted around the same time as the first electrofishing pass, indicated some potential toxicity to larval fathead minnows in samples collected from this site. Based on this, an unknown toxicant could have been negatively impacting the fish community at this location. However, the results from this toxicity tested were not considered to be valid ("AE" code), therefore it is not certain if any toxicity actually occurred. It is also possible that restoration work on West Creek may have increased the sediment load to the river at this site, thereby impairing the fish community. The average IBI score at RM 7.00 was the lowest of these sites; however, it was similar to what has been received at that site for the last few years. This site scored lower than the other sites for the instream cover metric in the QHEI. It is also downstream of Big Creek, which may be a source of pollutants.



An examination of scores for each metric of the IBI was also done to provide a more in depth characterization of the fish community. For most of the metrics at these sites, at least one electrofishing pass resulted in a score of either a "3" or "5", indicating a generally healthy fish population. Fluctuations within these scores from one pass to another could be due to variability in the fish community or the surveys themselves and not necessarily a result of water quality issues.

Table 8. Cuyahoga River historic IBI scores from NEORSD sampling (1990-2010)							
	RM 16.20	RM 11.95	RM 11.30	RM 10.75	RM 10.10	RM 8.60	RM 7.00
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

Bold = meets WWH criterion [≥40]

Italics = non-significant departure from WWH criterion [≥36]

Metrics that are consistently poor (score of "1") may be a sign that water quality or habitat limitations are negatively impacting the fish population at a location. For the sampling that was conducted in 2010, there were some instances in which a metric scored a "1" for all three passes. The site at RM 8.60 scored poorly on the metric looking at the proportion of top carnivores, which it also did in 2009. A lesser amount of appropriate habitat structures, deeper pools and steep drop offs, which are preferred by smallmouth bass and rock bass, may explain the lower numbers of these carnivores at this location (Trautman, 1981). The site at RM 7.00 scored poorly for the number of sunfish species and the proportion of omnivores. Bluegill were the only sunfish collected at this location. While most sunfish species prefer aquatic vegetation, which this site lacked, the habitat present should have been suitable for green sunfish. The poor score received for the omnivore metric was mostly due to the relatively high number of gizzard shad that were collected.

All of the sites received a score of "1" for all three passes for the number of intolerant species. Only one intolerant fish was collected throughout all of the sampling conducted on the Cuyahoga River in 2010. The intolerant fish that was collected was a rosyface shiner (*Notropis rubellus*) at RM 11.95. This species has never been collected on the Cuyahoga River through NEORSD sampling.

Three other new species were collected at these sites in 2010 and included one saugeye each at RMs 16.20 and 10.10, a walleye (*Sander vitreus*) at RM 10.10, and an orangespotted sunfish (*Lepomis humilis*) at RM 16.20. These fish all have an intermediate tolerance to pollution.

Qualitative sampling was conducted at RM 7.00 during April and May to determine which species are spawning at that location. The riffle located here is the first one upstream of the navigation channel. This sampling was done as part of *Cuyahoga River Larval Fish Study*. These surveys showed that there are numerous species inhabiting the river at this time of year, some of which may be staging to spawn. Larval fish from the species that are spawning at this location may be positively impacted if the installation of the artificial habitat improves their ability to survive migration to Lake Erie.

All three of the sites within the navigation channel are designated limited resource water from June through January and, therefore, the biological criteria do not apply to them. The purpose of sampling these sites was to establish a baseline of what species are present. A comparison will then be made once restoration projects and the installation of artificial habitats are completed. Although the criteria do not apply to these sites, they had boat IBI and MIwb scores that would have fallen within the *Fair* or *Poor* categories (Figures 3 and 4). Using the metrics for the lacustuary IBI, the average scores at RM 2.75 and 0.20 were higher than those using the boat IBI, but because the narrative ratings are somewhat different, still fell within the *Poor* category.

Generally, these sites had a lower number of native species and overall individuals present than those upstream of the navigation channel. There was also a lower percentage of fish considered to be pollution-sensitive. Two species of note that were collected included a bowfin (*Amia calva*) at RM 5.90 and a northern pike (*Esox lucius*) at RM 2.75. This is the first time that a bowfin has been collected on the Cuyahoga River through NEORSD sampling; northern pike have only occasionally been collected. The collection of the bowfin brings the total number of species collected to date on the Cuyahoga River through NEORSD sampling to 69.

Overall, the results from the fish surveys conducted in 2010 upstream of the navigation channel indicate that this section of the river has a generally healthy fish community. Most of the sites that were surveyed were in full attainment of the applicable fish criteria, with many scores for at least the MIwb improving over past years. The results from the sites in the navigation channel, however, highlight the need for better habitat there. Completion of the *Cuyahoga River Larval Fish Study* and *Cuyahoga AOC Urban Riparian Habitat Restoration* may increase the number of fish able to survive within the navigation channel and lead to an improvement in the fish community.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively for a six-week period 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 upstream of the navigation channel. Methods for sampling followed the Ohio EPA's Biological Criteria for the Protection of Aquatic Life, Volume III (1987b).

The quantitative and qualitative macroinvertebrate samples were sent to Aquatic Macroinvertebrate Taxonomy (AMT) (Ravenna, 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.

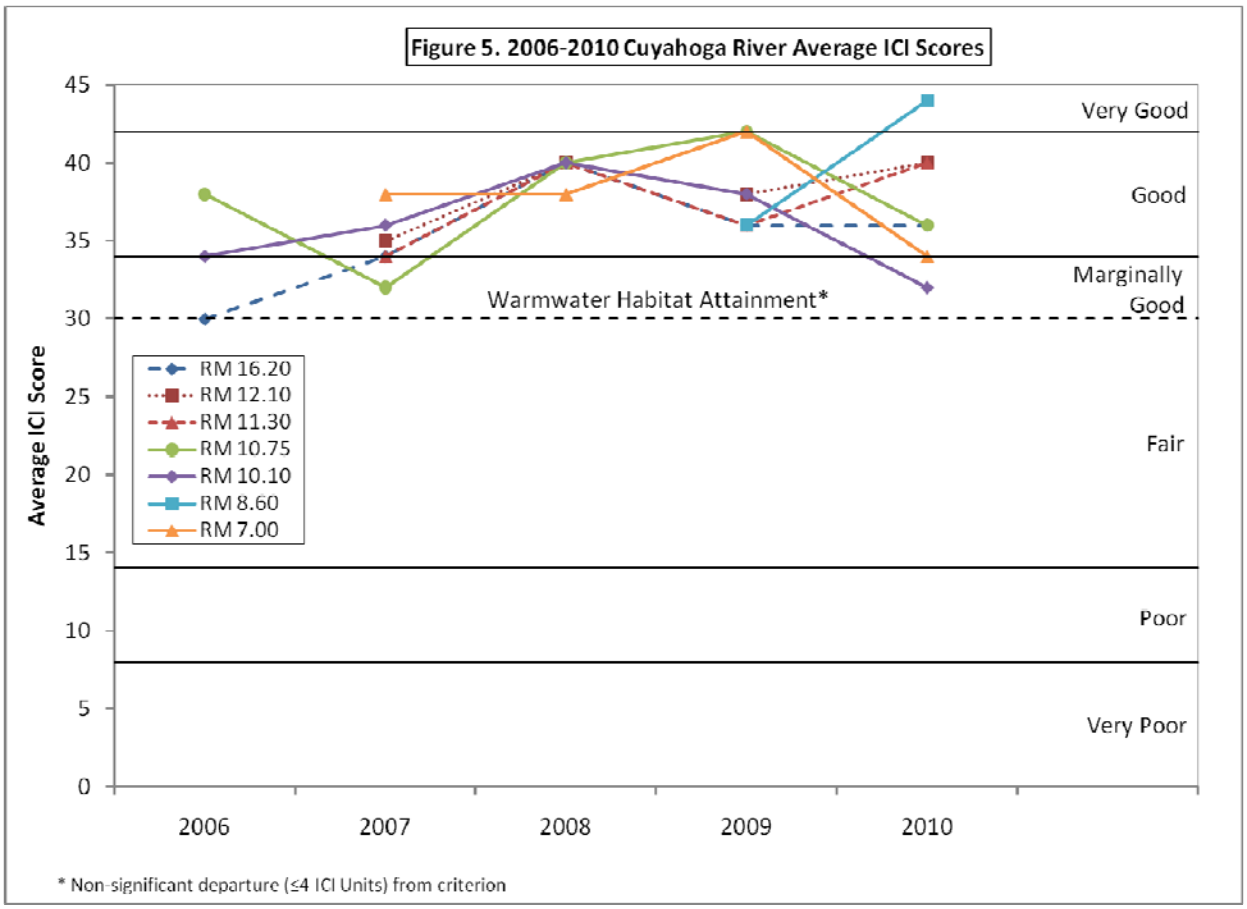
The overall aquatic macroinvertebrate community in the streams was evaluated using Ohio EPA's Invertebrate Community Index (ICI), (OEPA 1987a). The ICI consists of ten community metrics, each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the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

Results and Discussion

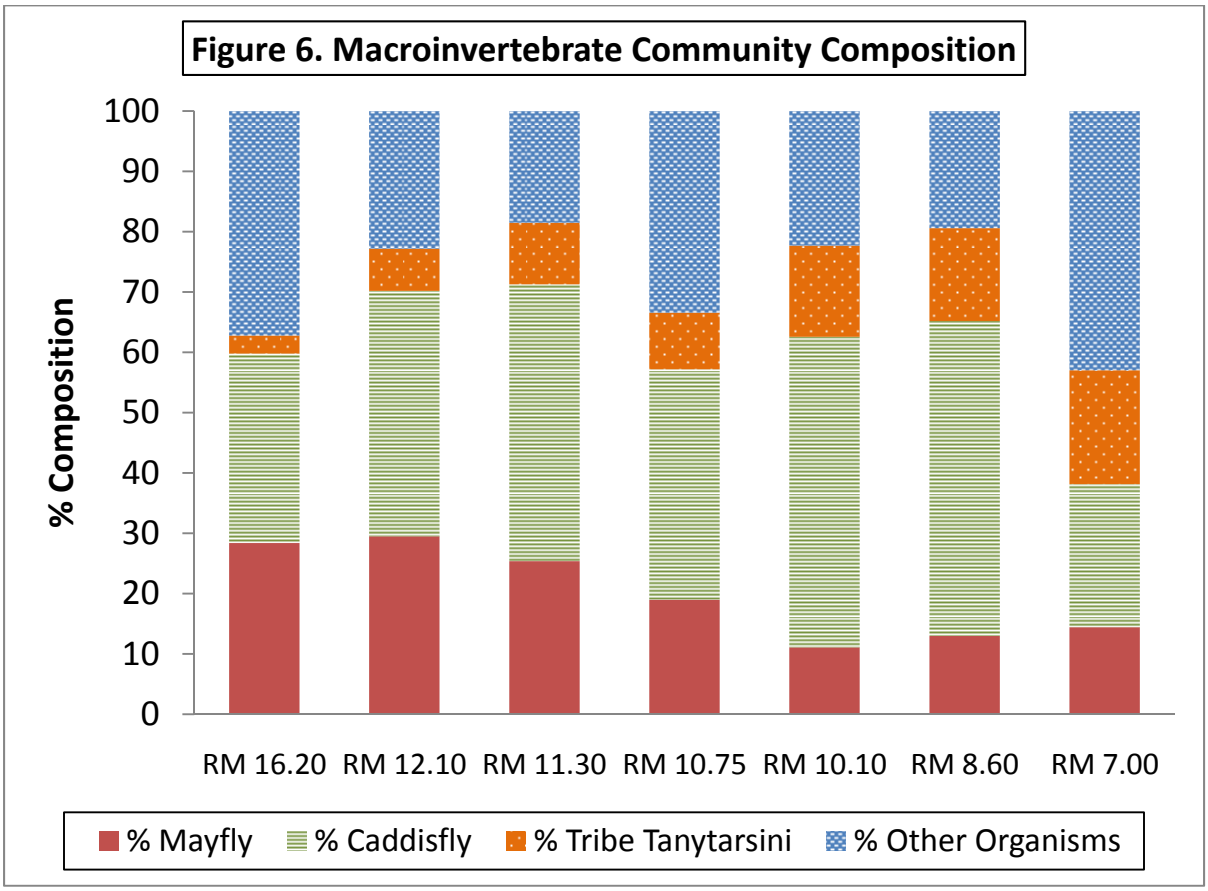
All of the sites were in attainment or non-significant departure (≤4 ICI Units) of the ICI biocriterion (Table 9), as they have been for each of the years since 2006 in which they were sampled (Figure 5). The highest score was at the site immediately upstream of Big Creek, while the lowest was at the site immediately downstream of Southerly WWTC. These results generally indicate that there are no significant water quality problems within the river at these locations.

Table 9. Macroinvertebrate Results							
Location	River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant	Narrative Rating
Downstream of Tinkers Creek	16.20	36	1323	47	10	2.4	Good
Upstream of Mill Creek	12.10	40	1889	50	8	2.2	Good
Downstream of Mill Creek	11.30	40	1376	47	7	2.8	Good
Upstream of Southerly WWTC	10.75	36	1367	47	10	5.1	Good
Downstream of Southerly WWTC	10.10	32	1492	49	10	10.3	Marginally Good
Upstream of Big Creek	8.60	44	1266	50	10	2.9	Very Good
Downstream of Big Creek	7.00	34	941	53	10	11.7	Marginally Good

It should be noted that when the HDs were retrieved, not all of them were completely submerged in the water due to low-flow conditions. Although this is not expected to have affected the composition of the macroinvertebrate communities, it did influence their densities. As a result, best professional judgment was used to estimate what percentage of the HDs was still under water. These estimates were then used to determine overall organism densities. Based on this, most of the sites ended up having similar densities. The exceptions to this were the site immediately upstream of Mill Creek, which had an overall density approximately 400 organisms higher than the next highest site, and the site immediately downstream of Big Creek, which was the lowest by 325 organisms.



The percentage of tolerant organisms was also generally similar at each of the sites; the two sites with the lowest ICI scores, immediately downstream of Southerly WWTC and Big Creek, had the greatest percentages. In terms of overall community composition, there was a general decrease in the percentage of mayflies and increase in the percentage of tribe tanytarsini midges in the downstream sites compared to the upstream ones (Figure 6). However, the overall total of mayflies, caddisflies, and tribe Tanytarsini midges, which are considered to be pollution sensitive groups, were generally similar among all the sites. Therefore, the differences among the individual groups may just be due to HD placement in the river and not because of water quality issues.



As in 2009, living freshwater mussels were once again found in the river. In 2010, WQIS Investigators found two species of freshwater mussels during the qualitative sampling on the river, which included one new species that was not found in 2009. Returning to the site, it was discovered that an additional two new species were discovered. WQIS Investigators then assisted Dr. Robert Krebs from Cleveland State University in surveying mussels in the river in September 2010. From this assessment, a total of four species of mussels were identified at the sites immediately upstream of Mill Creek and Southerly WWTC. In total, live specimens of four of these species were found upstream of Mill Creek. For the other two species, only relics were found. The presence of these organisms, which are sensitive to pollution, is another indication of the good water quality in the river.

Conclusions

Sampling in the Cuyahoga River in 2010 was done to determine impacts from point and nonpoint sources of pollution, such as Southerly WWTC and CSOs discharging to Big and Mill Creek, and in support of projects that will restore habitat within the

river's navigation channel. From this sampling, all of the locations upstream of the navigation channel were found to be in either full or partial attainment of the biological criteria. The two sites that were in partial attainment, being below the criterion for the IBI, were the ones immediately upstream of Southerly WWTC and downstream of Big Creek. The reason for these sites not being in full attainment is not entirely known, but it may be because they were receiving a generally higher sediment and pollutant load from West Creek and Big Creek, respectively.

Overall, though, the sampling that was conducted indicated good water quality at the sites upstream of the navigation channel. The exception to this was relatively high bacteria densities at all of the locations; all of the applicable recreation criteria were exceeded throughout the sampling, during both dry and wet weather. NEORSD combined sewer overflows did not appear to be entirely responsible for these exceedances, as high bacteria was also found upstream of them. No other water quality exceedances occurred during the sampling. Finally, monitoring of chlorophyll *a* levels at locations upstream and downstream of Southerly WWTC indicated that nutrients were not the most important factor influencing algal growth in the river; canopy cover and suspended solids may be more important. Additional data is needed, however, to fully determine all the controlling factors.

Within the navigation channel, only fish and habitat were assessed. Although no biological criteria apply in this section of the river, surveys indicated a generally poor fish community. This was expected and is most likely due to a lack of suitable habitat, a problem which may be corrected to some extent by restoration projects currently underway. Because no macroinvertebrate sampling was conducted within the navigation channel, a complete assessment of the health of the biological community in that section of the river could not be determined. The addition of such sampling in 2011, along with water chemistry monitoring, may help to do so.

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