NORTHEAST OHIO REGIONAL SEWER DISTRICT

2008 Cuyahoga River Biological, Water Quality and Habitat Survey Results

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Introduction

During 2008, the Northeast Ohio Regional Sewer District[1] (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys on the Cuyahoga River between River Mile (RM) 16.20 and 7.00. The purpose of this study was to determine impacts from point and nonpoint sources of pollution in this segment of the river. In addition to sites immediately upstream (US) and downstream (DS) of Southerly Wastewater Treatment Center (WWTC), supplemental sites were sampled to determine any impacts from Big Creek, Mill Creek, and West Creek, all tributaries to the Cuyahoga River. RM 16.20, located upstream of Southerly WWTC, served as a reference site as it has been in known Warmwater Habitat (WWH) biological attainment according to the Ohio Environmental Protection Agency (EPA) since 2000 (Ohio EPA 2003). Figure 1 is a map of the sampling locations on the Cuyahoga River, and Table 1 indicates the sampling locations with respect to RM, latitude/longitude, description and surveys conducted. A digital photo catalog of the sampling locations is available upon request.

[1] Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan approved by Ohio EPA on April 10, 2008 (*2008 Cuyahoga River Electrofishing & Benthic Macroinvertebrate Surveys*). Data submitted to the Ohio EPA via the United Stated Postal Service on August 28, 2009.

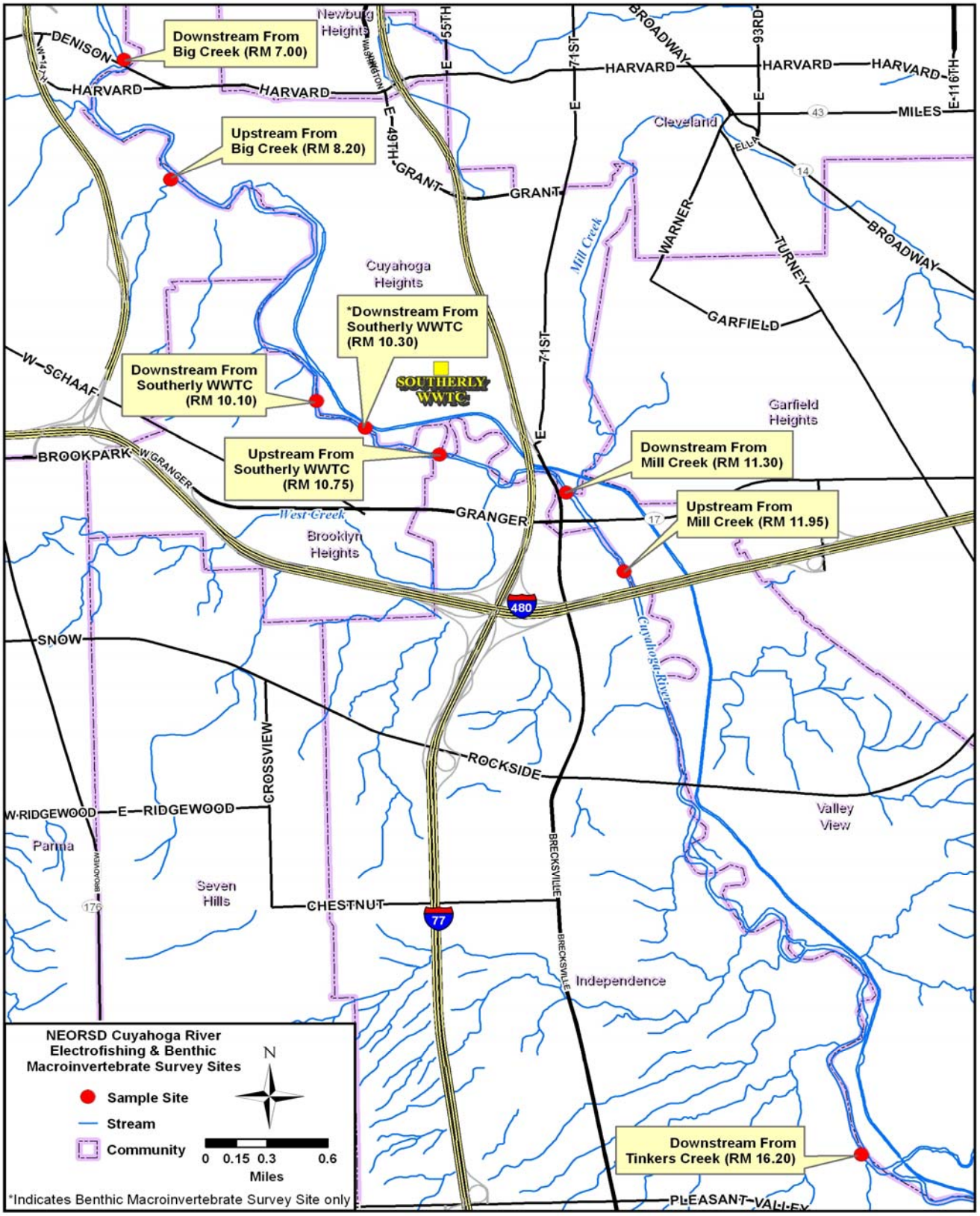


Figure 1. NEORSD Cuyahoga River Biological, Habitat and Water Chemistry Sites

Table 1. 2008 Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
Old Riverview Road	N41.3678°	W81.6139°	16.20	Downstream of the confluence with Tinkers Creek	Background data for fish, habitat and macroinvertebrates
Upstream of Mill Creek	N41.4123° N41.4123°	W81.6364° W81.6364°	12.10[2] 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 discharge on fish, habitat and macroinvertebrates
Downstream of Southerly WWTC	N41.4214° N41.4242°	W81.6590° W81.6638°	10.30[3] 10.10	Downstream Southerly WWTC effluent discharge	Evaluate Southerly WWTC discharge on fish, habitat and macroinvertebrates
Upstream of Big Creek	N41.4393° N41.4395°	W81.6713° W81.6754°	8.30[2] 8.20	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	Evaluate Big Creek discharge on fish, habitat and macroinvertebrates

Water Chemistry Sampling

Water chemistry samples were collected from all seven of the sample locations during fourteen sampling events, beginning June 25, 2008, and ending September 22, 2008. Bacteriological analysis for *Escherichia coli* was conducted on samples collected at RMs 10.75, 8.30 and 7.00 in support of an Ohio EPA study at the same sites on the

[2] HD and Water Chemistry Collection Site

[3] The site at RM 10.30 has historically been the downstream of Southerly WWTC sampling location. The site at RM 10.10 was added in 2006 because it is in an area more conducive to macroinvertebrate colonization due to the presence of a functional riffle and is also within the electrofishing zone. Both sites were sampled for macroinvertebrates in 2008.

river. The techniques that were used for the water chemistry sampling and chemical analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2006b). Field analyses included the use of a Marsh-McBirney FloMate Model 2000 Portable Flow Meter, which measures velocity in feet per second, and the YSI-556 MPS Multi-Parameter Water Quality Meter to measure dissolved oxygen, water temperature, specific conductivity and pH at the time of sampling. After the study it was determined that the pH was being calibrated once a week and not daily. Therefore, some of the samples have field pH measurements that did not follow the Ohio EPA Surveillance Methods, and those samples will not be used for comparison to Ohio water quality criteria.

On July 14, 2008, elevated concentrations of copper and iron were measured during a heavy rain event. The Cuyahoga River United States Geological Survey (USGS) flow gauge at Independence (ID: 04208000) daily mean flow was 1010 cubic feet per second (ft^3/sec). At RM 7.00, the Aquatic Life Use Criterion (Ohio EPA 2009) for the copper concentration exceeded the hardness based criterion of 0.0219 milligrams per liter (mg/L), with a result of 0.035 mg/L. That same day, iron concentrations exceeded the protection of Agricultural Use Criterion (Ohio EPA 2009) of 5.0 mg/L at RMs 12.10, 11.30, 10.75, and 8.30, with concentrations of 5.11, 6.14, 5.6, and 5.4 mg/L, respectively.

On September 9, 2008, the iron concentration at RM 16.20 also exceeded the Agricultural Use Criterion with a result of 6.59 mg/L. All exceedances occurred on wet weather sampling days[4]. The Human Health Criterion (Ohio EPA 2009) for soluble iron concentration is 0.30 mg/L; however, NEORSD did not measure for soluble iron and can not determine any exceedances for the soluble criterion. No other exceedances of Aquatic Life or Human Health criteria occurred during sampling. Certificate of Analysis reports are available upon request.

The Primary Contact Recreation Use Criterion for *E. coli* "… is a geometric mean based on not less than five samples within a thirty-day period, which shall not exceed 126 per 100 mL and *E. coli* content shall not exceed 298 per 100 mL in more than ten percent of the samples taken during any thirty-day period," (Ohio EPA 2009). Table 2 lists the *E. coli* sample results for the sites sampled from June 25, 2008 to September 22, 2008.

The thirty-day geometric mean for *E. coli* was exceeded at all the sites during the sampling period. Samples collected between June 25, 2008, and September 15, 2008, from River Miles 10.75 and 8.30 resulted in *E. coli* densities exceeding the criteria level not to be exceeded in more than 10% of the samples taken during any thirty day period. All the samples collected at River Mile 7.00 exceeded the criteria level not to be

[4] 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.

exceeded in more than 10% of the samples taken during any thirty day period. The Primary Contact Recreation Use Criterion for *E. coli* was not met during the sampling period.

For the sites at RMs 10.75 and 8.30, one of the reasons *E. coli* did not meet the criterion may be due to wet weather events that occurred during the sampling period. Wet weather events may cause Combined Sewer Overflows (CSOs) and storm sewer runoff from non-point sources to enter the river that may contain flows with elevated bacteria levels. During the sampling period, one CSO overflowed five times on Spring Creek and two CSOs overflowed on Mill Creek, one three times and one once. Mill Creek is tributary to the Cuyahoga River upstream from River Mile 10.75. Spring Creek is tributary to the Cuyahoga River downstream of RM 8.30.

For RM 10.75, only one sample collected during dry weather resulted in exceedances in the 30-day periods in which it was included. This sample was only slightly higher than the 298 CFU/100 mL value that 10% of the samples cannot be greater than. At RM 8.30, there were no exceedances for samples collected during dry weather. For the site at RM 7.00, there were some elevated *E. coli* densities even during dry weather sampling. It is uncertain what the causes for the high bacteria levels were, but it may have been due to the influence of Big Creek at this site.

Table 2.
Cuyahoga River *E. coli* Densities

Sample Date	RM 10.75	RM 8.30	RM 7.00	USGS Flow Gauge	Precipitation within 3 days of sampling[5]
	E. coli (CFU/100mL)			(ft^3/sec)	(Total Inches)
06/25/2008	560	380	370	472	1.16
07/02/2008	290	225	310	417	0.39
07/07/2008	200	220	220	446	0.00
07/14/2008	3900	6300	7400	1100	1.20
07/21/2008	74	143	146	364	0.04
07/28/2008	144	138	175	371	0.00
08/04/2008	245	148	640	290	0.00
08/11/2008	660	700	1910	514	0.88
08/18/2008	335	295	372	378	0.00
08/25/2008	275	305	560	318	0.11
09/03/2008	40	37	308	247	0.00
09/09/2008	5600	4200	16000	562	0.48
09/15/2008	1050	1200	1100	960	1.51
09/22/2008	124	123	368	272	0.00

[5] As measured at Southerly WWTC.

Habitat Assessment

A Qualitative Habitat Evaluation Index (QHEI) score was determined for each of the seven electrofishing zones on the Cuyahoga River. QHEI sheets for each site evaluated are available upon request. The QHEI, developed by Ohio EPA, 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 describe the physical attributes of a stream and may be important in explaining why fish species are present or absent. A more detailed description of the QHEI can be found in Ohio EPA's (2006), *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*.

Ohio EPA has set a target score of 60 for the QHEI (Ohio EPA 2003). WWH sites that meet this target are expected to be capable of meeting applicable biological criteria. All of the sites that were evaluated in 2008 met this target (Table 3). In addition, all but two of the sites received scores that were considered "Excellent," (score ≥ 75). For the two that did not, RM 11.95 and RM 8.20, neither site scored as well as the other sites for instream cover and channel morphology. The site at RM 8.20 also had a lower score for the substrate metric. Specific habitat characteristics that may have affected the biological community are discussed in the electrofishing and macroinvertebrate sections.

Table 3. 2008 Cuyahoga River Qualitative Habitat Evaluation Index Scores

Site Location	2008
DS Tinkers Creek RM 16.20	82 (E)
US Mill Creek RM 11.95	68 (G)
DS Mill Creek RM 11.30	78 (E)
US Southerly WWTC RM 10.75	78 (E)
DS Southerly WWTC RM 10.10	76 (E)
US Big Creek RM 8.20	66 (G)
DS Big Creek RM 7.00	77 (E)
(E)- Excellent (G)- Good	

Electrofishing

Methods

Electrofishing was accomplished by utilizing the NEORSD's 17-foot Coffelt aluminum electrofishing boat. Boat electrofishing consists of shocking all habitat types within a sampling zone that is 0.5 kilometers in length, while moving from upstream to downstream. Electrofishing was completed on the river under relatively low flow conditions. The average daily flows recorded by the USGS gage station in Independence for each of the sampling dates are shown in Table 4.

Table 4. Cuyahoga River Average Daily Mean Flows

Date	Flow (ft^3/s)
7/18/2008	448
7/21/2008	364
7/22/2008	349
8/14/2008	328
8/20/2008	362
9/4/2008	234
9/23/2008	290
9/24/2008	320
10/7/2008	286*
10/15/2008	221*

*Provisional data subject to revision by USGS

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. A detailed description of the sampling methods utilized in the fish surveys can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b).

Three electrofishing passes were conducted at all the sites except for RM 16.20 (two passes) and RM 11.95 (one pass). These two sites were not sampled three times because they were inaccessible due to blockage of the river by a fallen tree. For the sites at RMs 10.75, 8.20, and 7.00, the second pass was conducted by Ohio EPA personnel. This sampling was done in support of the Ohio EPA's project study plan entitled "2008 Biological and Water Quality Survey of the Lower Cuyahoga River." The methods used for these surveys were considered identical to those used by NEORSD.

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*.

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. Unlike the IBI score, 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.

In 2008, the site located downstream of Tinkers Creek met the WWH IBI criterion and was in nonsignificant departure (≤4 IBI units) from the exceptional warmwater habitat (EWH) criterion (Table 5). It also met the EWH criterion for the MIwb. The sites downstream of Mill Creek and upstream and downstream of Southerly WWTC were within nonsignificant departure of WWH criterion, effectively meeting the criterion.

These three sites also were in attainment of either the WWH or EWH criteria for the MIwb. The sites immediately upstream and downstream of Big Creek were in partial attainment, as they were in nonsignificant departure for the MIwb, but were just below the IBI criterion. For the site downstream of Big Creek, the scores in 2008 were the highest ever recorded at that location. A comparison could not be made for the survey site at RM 8.20 because this was the first year that it was sampled. This site was used instead of the previous site located at RM 7.55 due to better habitat and the presence of a functional riffle. Based on the one pass that was conducted, the site immediately upstream of Mill Creek had scores that would have been in partial attainment. However, since Ohio EPA methods require two or three electrofishing passes to be conducted at each site, the results from this site cannot be used to determine attainment status and are presented for comparison purposes only.

Table 5. 2008 Cuyahoga River IBI and MIwb Scores (Includes Gizzard Shad)

		IBI Scores				MIwb Scores			
Site	RM	Pass 1	Pass 2	Pass 3	Average	Pass 1	Pass 2	Pass 3	Average
DS Tinkers Creek	16.20	**40**	**48**	--	*44*	**9.7**	**10.0**	--	**9.9**
US Mill Creek**	11.95	34	--	--	34	*8.2*	--	--	*8.2*
DS Mill Creek	11.30	**42**	34	*38*	*38*	*9.2*	**8.8**	*9.2*	*9.1*
US SWWTC	10.75	*38*	*44**	30	*37*	**9.0**	*8.4**	*9.3*	**8.9**
DS SWWTC	10.10	*44*	34	30	*36*	**8.7**	**9.9**	*9.5*	*9.4*
US Big Creek	8.20	34	32*	30	32	7.5	**8.9***	**9.0**	*8.5*
DS Big Creek	7.00	**42**	32*	28	34	*8.6*	*9.1**	7.8	*8.5*

bold underline = meets EWH criterion [IBI ≥48; MIwb ≥9.6]
italics underline = nonsignificant departure from EWH criterion [IBI ≥44; MIwb ≥9.1]
bold = meets WWH criterion [IBI ≥40; MIwb ≥8.7]
italics = nonsignificant departure from WWH criterion [IBI ≥36; MIwb ≥8.2]
*Sampling conducted by Ohio EPA
**Sampling not conducted in accordance with Ohio EPA methods and is presented for comparison purposes only.

These scores were calculated including all gizzard shad collected during the sampling effort. In some instances, it may be appropriate to exclude this species from sample results. As the season progresses, more gizzard shad migrate into the river from Lake Erie due to its warmer temperatures. This influx may skew results because of the large number of these fish that come into the river that do not actually reside there. When the IBI and MIwb scores are recalculated without gizzard shad, all of the sites except for the one immediately upstream from Mill Creek (RM 11.95) are in full attainment of the fish criteria (Table 6). The scores for RM 11.95 did not change because no gizzard shad were collected during the one electrofishing pass that was completed.

Table 6. 2008 Cuyahoga River IBI and MIwb Scores (Excludes Gizzard Shad)

		IBI Scores				MIwb Scores			
Site	RM	Pass 1	Pass 2	Pass 3	Average	Pass 1	Pass 2	Pass 3	Average
DS Tinkers Creek	16.20	**40**	**50**	--	*45*	**9.5**	**9.8**	--	**9.7**
US Mill Creek**	11.95	34	--	--	34	*8.2*	--	--	*8.2*
DS Mill Creek	11.30	**42**	40	*42*	*41*	*9.0*	**8.6**	*9.0*	*8.9*
US SWWTC	10.75	*38*	*44**	32	*38*	**9.0**	*8.4**	*8.9*	**8.8**
DS SWWTC	10.10	*42*	42	32	*39*	**8.6**	**9.7**	*9.2*	*9.2*
US Big Creek	8.20	34	38*	40	37	7.4	**8.6***	**8.7**	*8.2*
DS Big Creek	7.00	**44**	44*	38	42	*8.1*	*9.0**	7.8	*8.3*

bold underline = meets EWH criterion [IBI ≥48; MIwb ≥9.6]
italics underline = nonsignificant departure from EWH criterion [IBI ≥44; MIwb ≥9.1]
bold = meets WWH criterion [IBI ≥40; MIwb ≥8.7]
italics = nonsignificant departure from WWH criterion [IBI ≥36; MIwb ≥8.2]
*Sampling conducted by Ohio EPA
**Sampling not conducted in accordance with Ohio EPA methods and is presented for comparison purposes only.

Individual IBI metric scores were examined to determine which metrics were not indicative of a healthy fish population in the river. All of the sites scored poorly (metric score of "1") for the number of intolerant species. The only species designated as a "common intolerant" that was collected at any site in 2008 was a mimic shiner. It was collected during the second pass at the site immediately downstream of Southerly WWTC. For RM 16.20, this metric was the only one that did not receive either a "3" or "5" on all completed passes. This is not unexpected since this site was in nonsignificant departure from exceptional warmwater habitat.

At RM 11.95, the proportion of top carnivores scored poorly for the one electrofishing pass that was conducted. Reasons why this metric did not score better may be due to the general habitat limitations of the site, which include no channel sinuosity, poor development, and sparse instream cover.

At RM 8.20, the metric for the proportion of round-bodied suckers scored poorly on all three passes. This may be due to the quality of the riffle in the electrofishing zone. The riffle substrate at this site was generally unstable, with moderate embeddedness and moderate to heavy silt, all characteristics that may hinder successful establishment of a round-bodied sucker population.

For the other locations, there was no one metric that always scored poorly. Differences in metric scores over the three passes show the inherent variability in this type of sampling. Since the fish population in the river is constantly moving around and sampling does not result in the collection of every fish in the area, individual passes only

show a snapshot of what is occurring at one time. Multiple passes allow for a more accurate representation of the actual health of the fish community.

An evaluation of the changes in IBI and MIwb scores in the river generally shows a continued increase over the time frame that NEORSD has conducted sampling (Table 7). This has been true for the sites upstream and downstream of Southerly WWTC (Figures 2 and 3) and upstream and downstream of Big Creek. Although there were some instances in which the scores declined from one year to the next, this was most likely the result of sampling variability and not necessarily because of a decline in the water quality of the river.

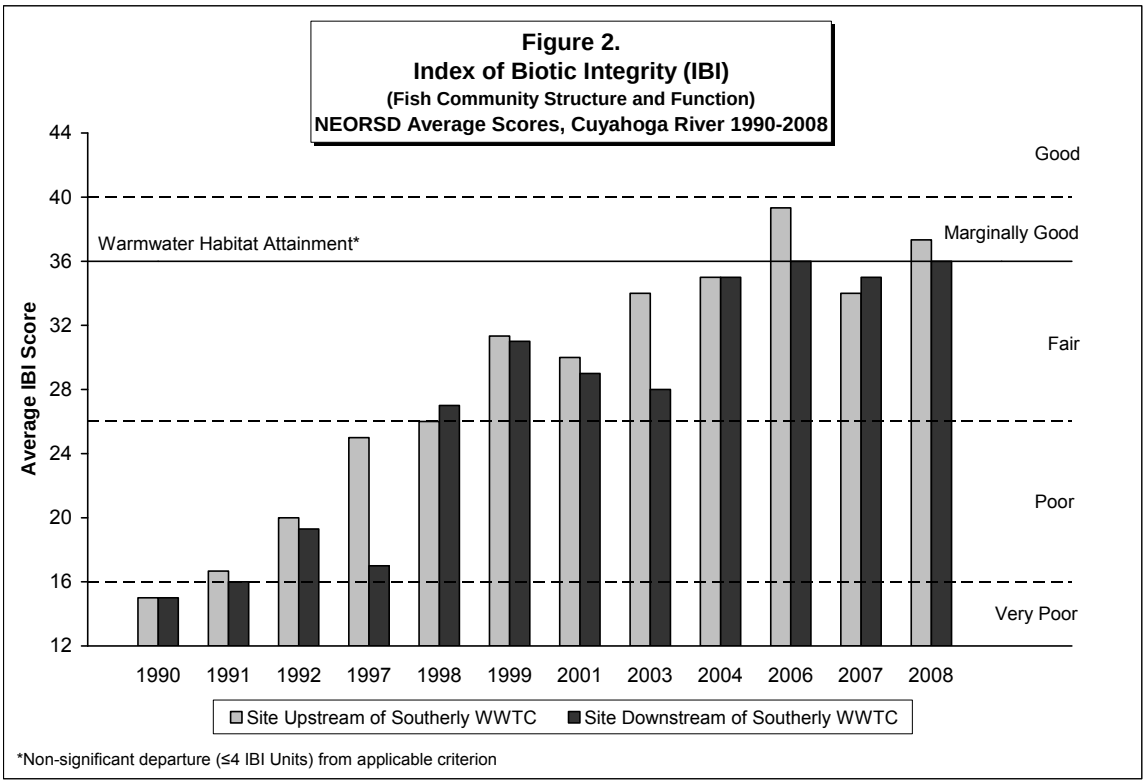
Table 7.
Cuyahoga River, 1990-2008
Average Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb) Scores

	DS Tinkers Creek RM 16.20		US Mill Creek RM 11.95		DS Mill Creek RM 11.30		US SWWTC RM 10.75		DS SWWTC RM 10.10		US Big Creek RM 7.55/8.20*		DS Big Creek RM 7.00	
Year	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb	IBI	MIwb
1990	-	-	-	-	-	-	15	4.5	15	4.6	-	-	-	-
1991	-	-	-	-	-	-	17	5.5	16	5.6	-	-	18	6.1
1992	-	-	-	-	-	-	20	5.6	19	6.6	-	-	21	5.9
1997	-	-	-	-	-	-	25	7.5	20	6.1	-	-	18	6.2
1998	-	-	-	-	-	-	26	7.8	27	7.7	-	-	23	5.5
1999	-	-	-	-	-	-	31	*8.2*	32	*8.6*	-	-	24	7.0
2001	-	-	-	-	-	-	30	7.4	29	*8.2*	18	5.6	22	6.1
2003	-	-	-	-	-	-	34	7.6	28	7.8	27	6.8	23	7.0
2004	-	-	-	-	-	-	35	8.0	35	*8.4*	-	-	-	-
2006	-	-	-	-	-	-	*39*	**8.8**	*36*	*8.5*	30	7.0	31	7.8
2007	*39*	*8.6*	30	*8.5*	*38*	*8.3*	34	*9.4*	35	**9.7**	24	7.6	33	*8.3*
2008	*44*	**9.9**	34	*8.2*	*38*	*9.1*	*37*	**8.9**	*36*	*9.4*	32	*8.5*	34	*8.5*

Bold Underline = meets EWH criterion [IBI ≥48; MIwb ≥9.6]
Italics Underline = nonsignificant departure from EWH criterion [IBI ≥44; MIwb ≥9.1]
Bold = meets Warmwater Habitat (WWH) criteria [IBI ≥40; MIwb ≥8.7]
Italics = non-significant departure from WWH criteria [IBI ≥36; MIwb ≥8.2]
- = Electrofishing survey not conducted
*Site was switched from RM 7.55 to RM 8.20 in 2008

In 2008, the proportion of pollution-sensitive fish collected at the five sites upstream of Southerly WWTC was between 35% and 45% (Figure 4). The sites downstream of Southerly WWTC had lower proportions of these fish. These generally high percentages of pollution-sensitive fish are another indication of the improvement in

water quality conditions in the Cuyahoga River since NEORSD started sampling. When sampling first began in 1990, most of the species that were collected were pollution tolerant. Since that time, the number of native species and the proportion of pollution-sensitive fish, as seen at the sites immediately upstream and downstream of Southerly WWTC, have increased as water quality in the river improved (Figures 5 and 6). In recent years, both of these have leveled off, which may be an indication that the fish community is stabilizing to the conditions that are present. Since 2006, additional species of fish have been collected that have not been collected in the Cuyahoga River in past years. Once these species become established on the Cuyahoga River, fish index scores should improve further. However, it is expected that both of these measures will continue to increase in the future as the health of the river improves even further.



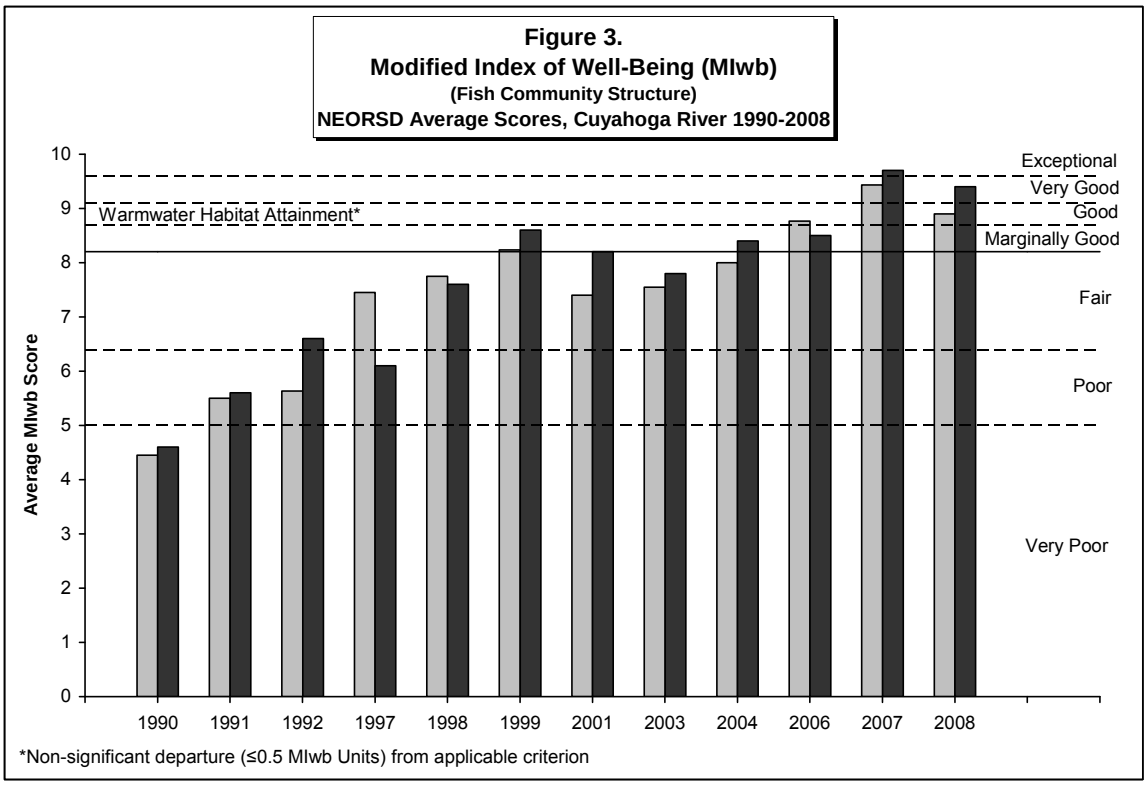


Figure 3.
Modified Index of Well-Being (MIwb)
(Fish Community Structure)
NEORSD Average Scores, Cuyahoga River 1990-2008
Average MIwb Score
Warmwater Habitat Attainment*
Exceptional
Very Good
Good
Marginally Good
Fair
Poor
Very Poor
1990
1991
1992
1997
1998
1999
2001
2003
2004
2006
2007
2008
*Non-significant departure (≤0.5 MIwb Units) from applicable criterion

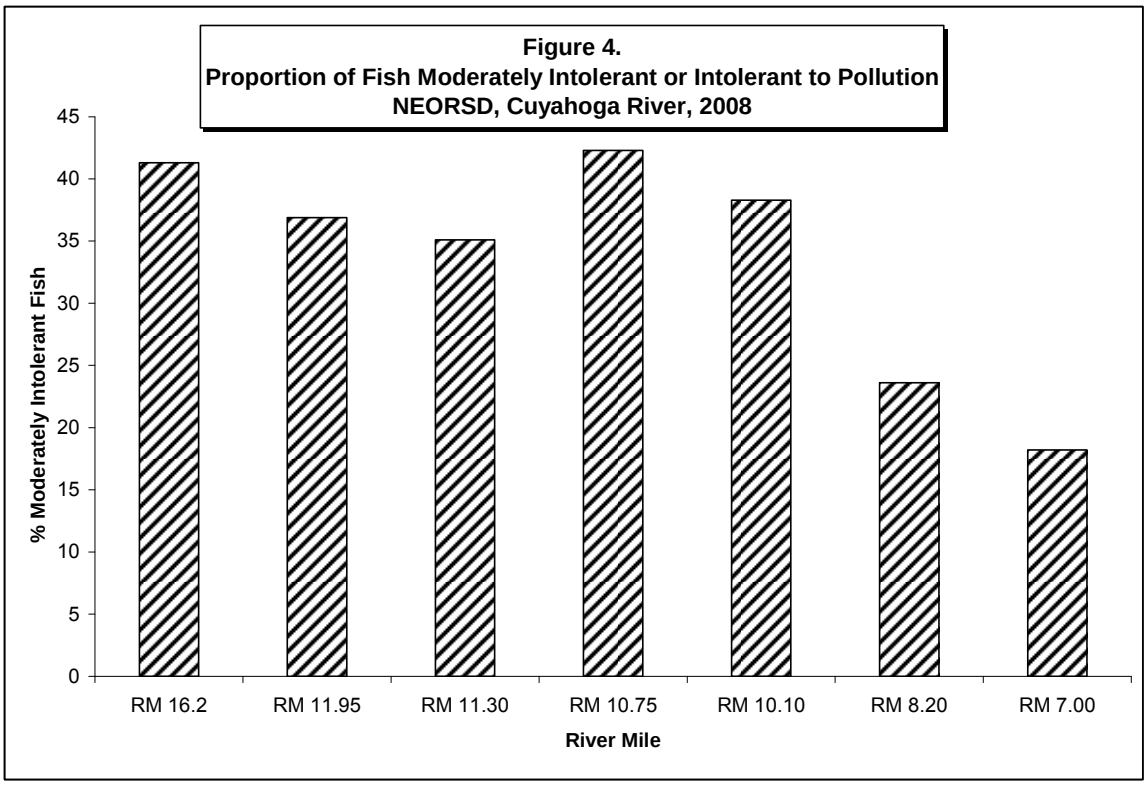


Figure 4.
Proportion of Fish Moderately Intolerant or Intolerant to Pollution
NEORSD, Cuyahoga River, 2008
% Moderately Intolerant Fish
RM 16.2
RM 11.95
RM 11.30
RM 10.75
RM 10.10
RM 8.20
RM 7.00
River Mile

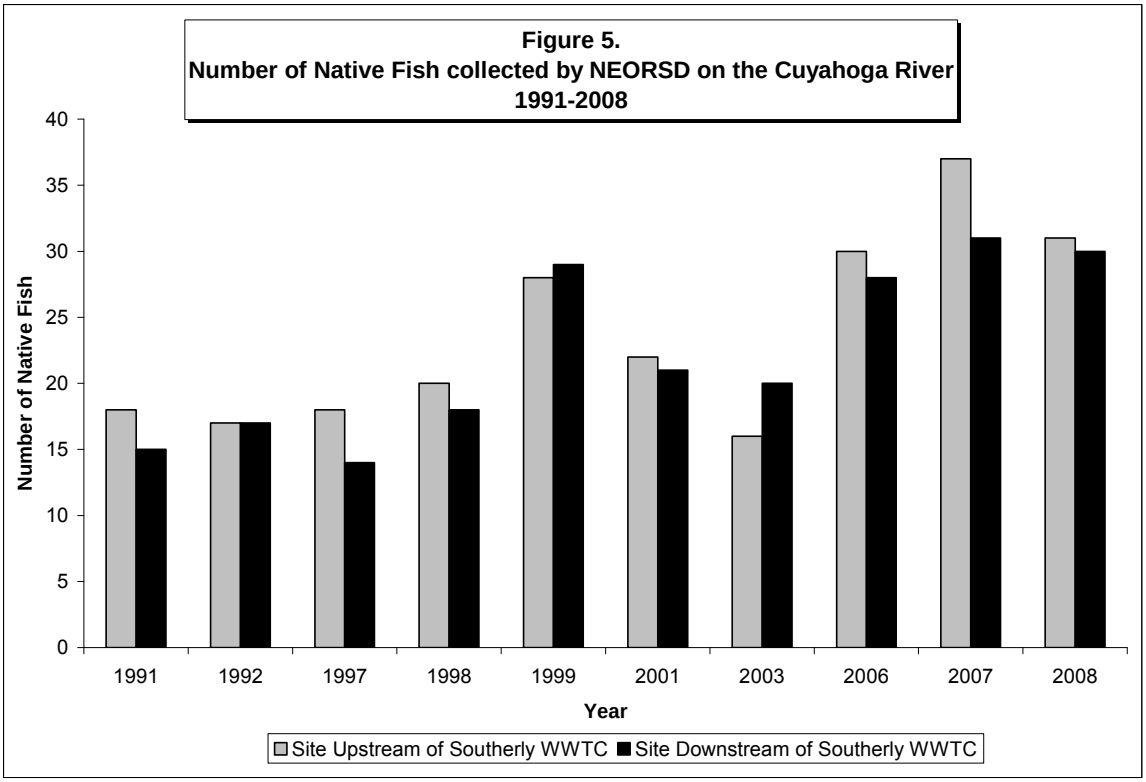


Figure 5.
Number of Native Fish collected by NEORSD on the Cuyahoga River
1991-2008
Number of Native Fish
0
5
10
15
20
25
30
35
40
1991
1992
1997
1998
1999
2001
2003
2006
2007
2008
Year
Site Upstream of Southerly WWTC
Site Downstream of Southerly WWTC

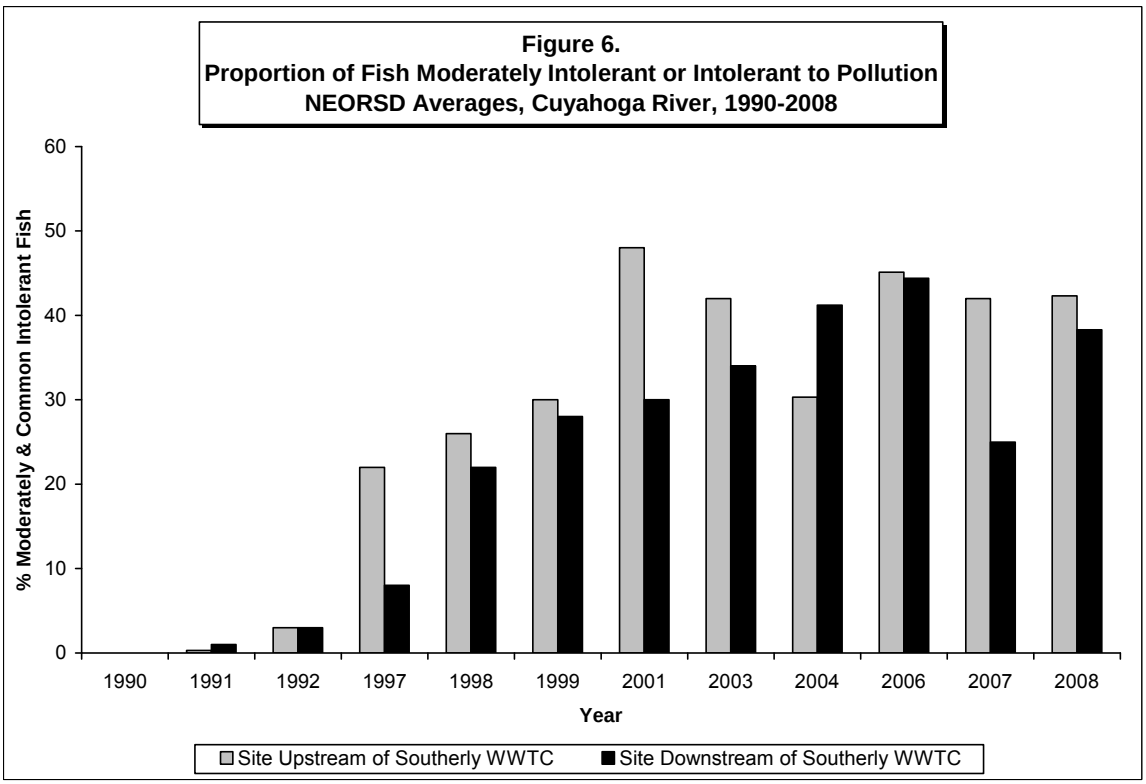


Figure 6.
Proportion of Fish Moderately Intolerant or Intolerant to Pollution
NEORSD Averages, Cuyahoga River, 1990-2008
% Moderately & Common Intolerant Fish
0
10
20
30
40
50
60
1990
1991
1992
1997
1998
1999
2001
2003
2004
2006
2007
2008
Year
Site Upstream of Southerly WWTC
Site Downstream of Southerly WWTC

Macroinvertebrate Sampling

Methods

Macroinvertebrates in the Cuyahoga River were sampled quantitatively for a six-week period in 2008 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. Methods for sampling followed an approved modification of the Ohio EPA's (1987b) *Biological Criteria for the Protection of Aquatic Life, Volume III.* The modification included dismantling the HDs in the field within a number 30 sieve (opening size 0.0234 inches) bucket.

The quantitative and qualitative macroinvertebrate samples were shipped to EA Engineering, Science and Technology (Deerfield, IL) for identification and enumeration. Specimens were identified to the lowest practical taxonomic level, as long as the maturity and condition of specimen allowed. The lowest practical level of taxonomy is defined by the Ohio EPA (1987b).

The overall aquatic macroinvertebrate community in the river 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 & Discussion

In almost every field season since 1984, either the Ohio EPA or NEORSD or both have conducted sampling at various locations to determine impacts from potential point and nonpoint sources of pollution on the macroinvertebrate community in the Cuyahoga River (OEPA 1990). Refer to Figure 1 for the study area. Figure 7 demonstrates the improvement of the macroinvertebrate community in the Cuyahoga River over the last few decades. Scores were averaged by decade and, since exact river miles changed from year to year, the locations listed are ordered according to the input of interest. In the most recent decade, the average ICI score has been within non-significant departure (≤4 ICI units) of the WWH criterion of 34.

Evaluation of the 2008 ICI results indicates a community narrative rating of *Good* at all locations. This is the first time that the ICI scores exceeded the WWH criterion at all sample locations during the same year (Table 8). The identification and enumeration of the collections are available upon request.

Historically, the area at RM 10.30 has failed to meet the WWH criterion because it is not ideal for macroinvertebrate sampling. The site is located on the edge of a cliff and the entire area sampled is only about two feet wide by fifteen feet long due to the presence of a large pool that makes it impossible to sample the reminder of the area. Although in some years a small margin area just downstream can be sampled, generally, this site is not favorable for assessment of the macroinvertebrate community. This could explain its highly volatile densities and scoring. Figure 8 demonstrates the dynamics of the changes in the number of organisms found on the HD during the past several years. In spite of the difficulties found in sampling this site, the 2008 results demonstrate that it can achieve ICI scores that meet the criterion.

Compared to 2007, most of the ICI scores were higher in 2008. One reason for the improvement in scores from one year to the next may be due to flow conditions during sampling. In 2007, there was one significant rain event during the colonization period (Figure 9). This event most likely scoured the macroinvertebrate community, which failed to recover before the HDs were removed from the river. Although there were a greater number of relatively high flow periods during 2008, those may not have been severe enough to cause the same negative impact as the one in 2007.

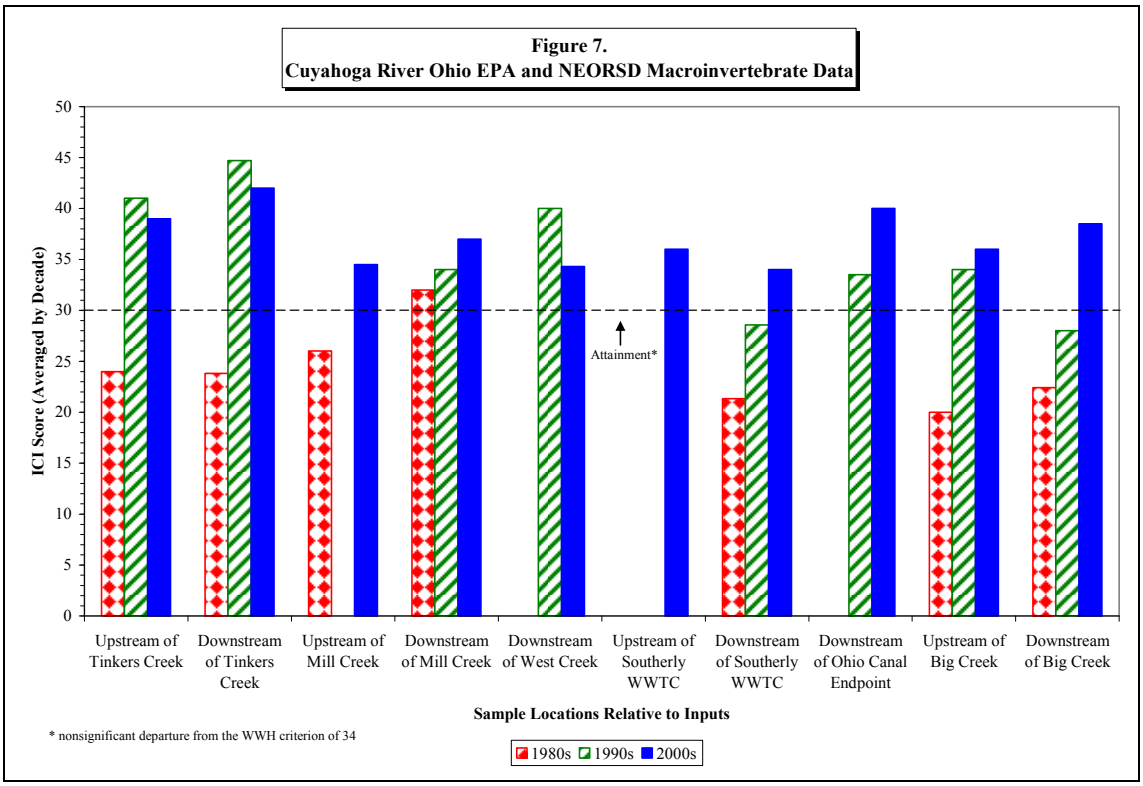
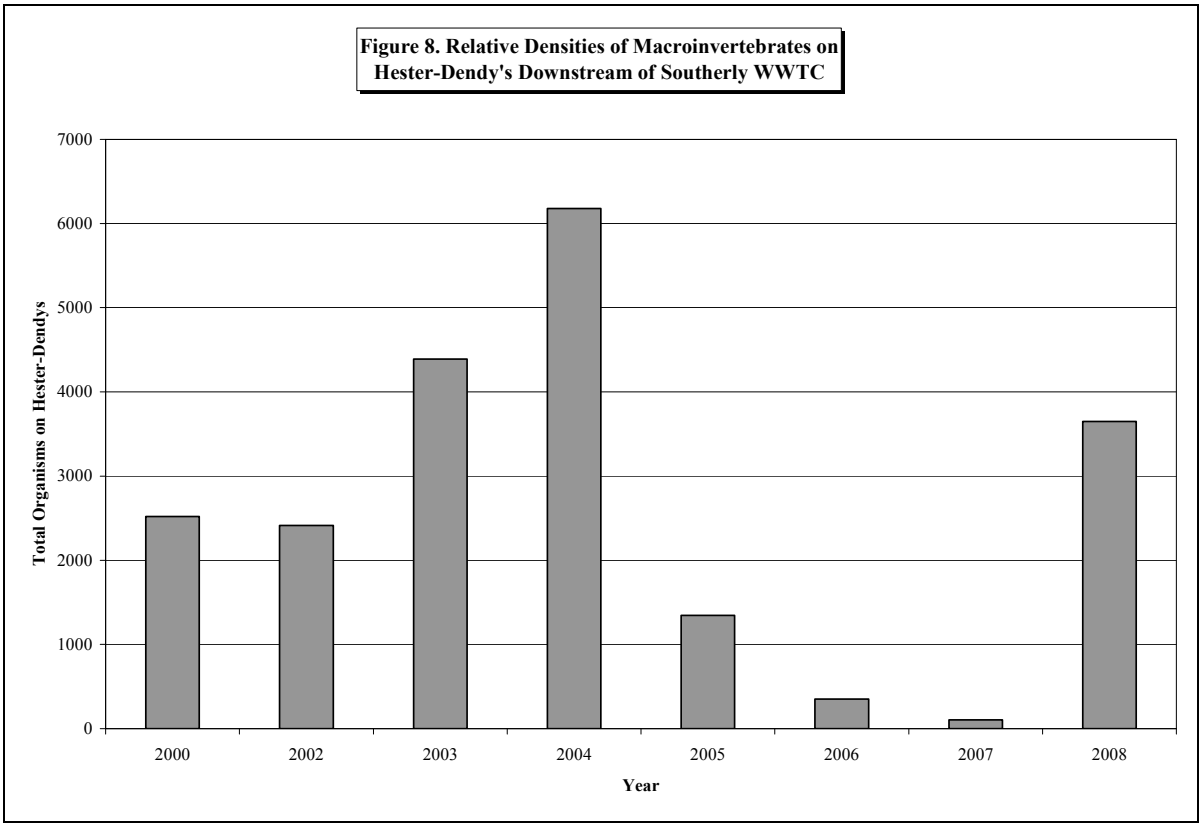
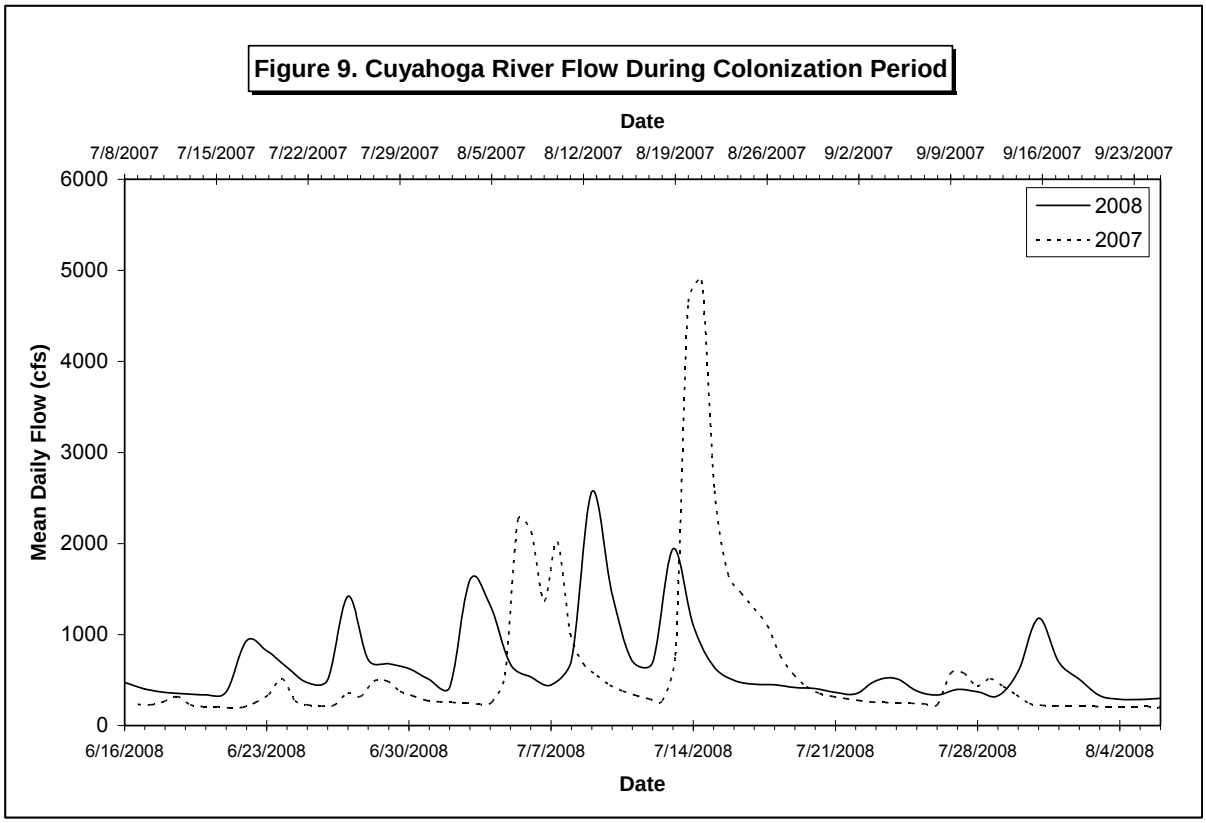
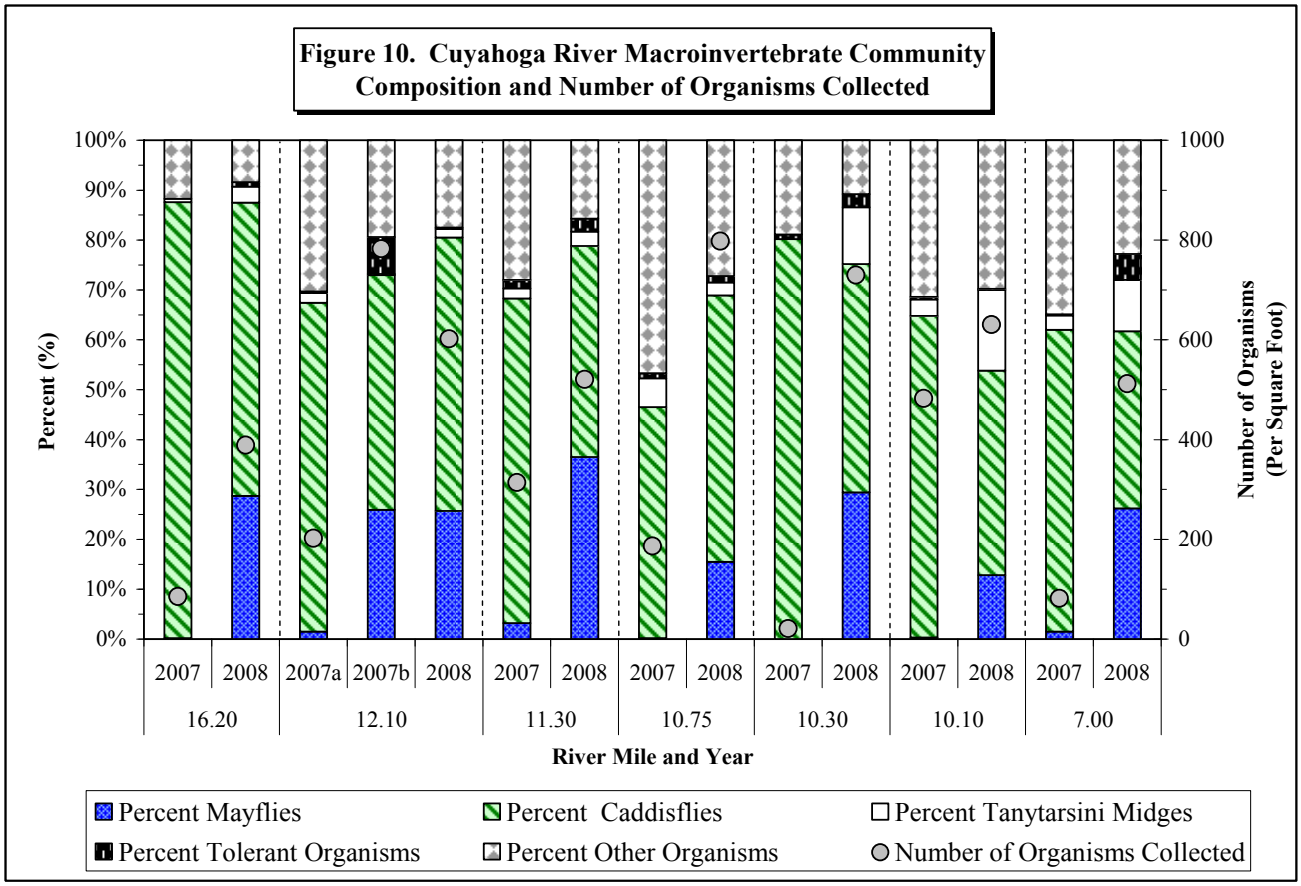


Table 8. 2008 Cuyahoga River ICI Metric and Index Scores								
	RM 16.20	RM 12.10	RM 11.30	RM 10.75	RM 10.30	RM 10.10	RM 8.30	RM 7.00
Index/Metric	Value (Score)	Value (Score)	Value (Score)	Value (Score)	Value (Score)	Value (Score)	Value (Score)	Value (Score)
Total Organisms	1,944	3,011	2,603	3,988	3,649	3,152	4,128	2,560
Total Taxa	22(2)	27(4)	27(4)	25(4)	26(4)	33(4)	25(4)	39(6)
Mayfly Taxa	2(0)	2(0)	3(2)	3(2)	4(2)	3(2)	3(2)	3(2)
Caddisfly Taxa	7(6)	4(4)	5(4)	5(4)	4(4)	4(4)	3(4)	5(4)
Dipteran Taxa	10(4)	14(6)	12(4)	12(4)	12(4)	17(6)	12(4)	18(6)
% Mayfly Composition	28.7(6)	25.7(4)	36.5(6)	15.5(4)	29.4(6)	12.8(2)	10.2(2)	26.2(6)
% Caddisfly Composition	58.8(6)	54.8(6)	42.3(6)	53.4(6)	45.8(6)	41.0(6)	77.2(6)	35.5(6)
% Tanytarsini Composition	3.2(2)	1.7(2)	2.9(2)	2.6(2)	11.4(2)	16.2(4)	5.7(2)	10.3(2)
% Other Dipteran Composition	8.9(6)	15.2(6)	16.4(6)	21.7(4)	12.3(6)	28.6(4)	5.2(6)	24.8(4)
% Tolerant Organisms	0.9(6)	0.3(6)	2.6(4)	1.3(6)	2.6(4)	0.2(6)	1.1(6)	5.2(0)
Qualitative EPT Taxa	10(2)	9(2)	9(2)	12(4)	10(2)	11(2)	7(2)	8(2)
Total ICI Scoring	**40**	**40**	**40**	**40**	**40**	**40**	**38**	**38**
Bold = meets Warmwater Habitat (WWH) criteria [ICI ≥34]								

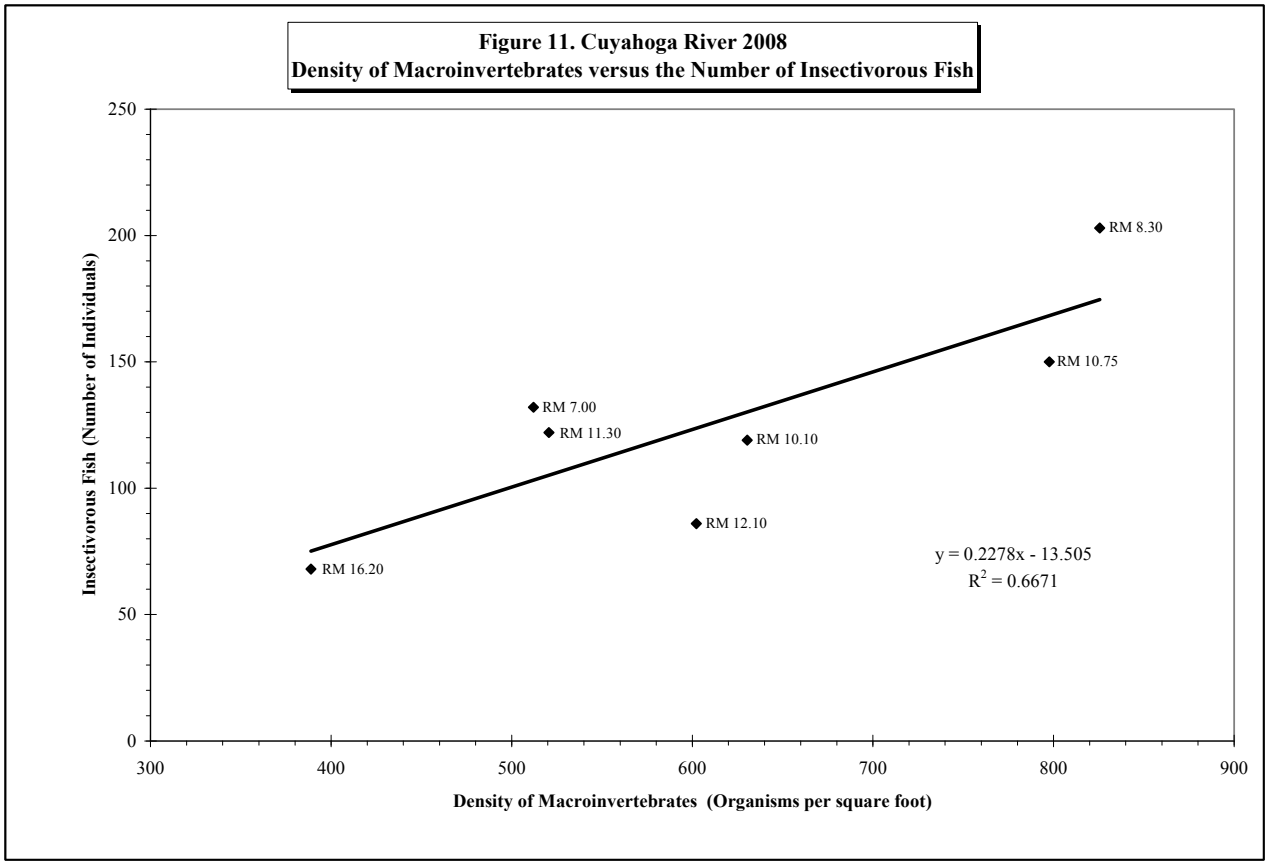




Represented in Figure 10 are the community compositions and the density of macroinvertebrates for samples collected in both 2007 and 2008. Most of the 2008 samples had greater densities than the samples collected in 2007. In 2008, mayflies were also significantly represented at each site. This might be explained by the clinging nature of the mayflies. The heavy rain in 2007 may have been too great for the mayflies to hold on to the HD and therefore, they were swept off. The two week period following the rain was not enough time for the mayflies to re-colonize the HD. A second HD (noted as "2007b" in Figure 10) was installed at RM 12.10 just before the rain event, since the first one (noted as "2007a" in Figure 10) was partially buried. The second HD for RM 12.10 had a higher density of organisms, specifically mayflies, than any other HD collected in 2007 on the Cuyahoga River. The second HD at 12.10 also had the greatest percentage of tolerant organisms of both years. For the remainder of the sites, the increase in density between the years 2007 and 2008 helps explain the negative impact the rain event appeared to have on the 2007 scores. The increase in densities, of organisms per square foot, between 2007 and 2008 can also be seen in Figure 10. In some cases, the density increase is more than double than the previous sampling year. This could be more evidence that the rain had a greater effect on the samples during the 2007 field season.



In addition to demonstrating the effect of flow, the density of macroinvertebrates is also important in that it may be a factor in the health of the fish community. The 2008 data shows a correlation between the density of macroinvertebrates and the number of insectivorous fish, those that feed mostly on macroinvertebrates. The linear relationship between the two parameters suggests that the greater the density of macroinvertebrates found at a site, the greater the number of insectivorous fish (Figure 11). Because of this, it is possible that increases in the number of macroinvertebrates could result in increased IBI scores.



Conclusions

The health of the fish and macroinvertebrate communities in the Cuyahoga River has improved substantially over the past several decades. Four out of the seven sites sampled in 2008 for both fish and macroinvertebrates were in full attainment of Ohio EPA's biocriteria (Table 9), with the others being in partial attainment. This is an indicator of both the recovery of the river and the success of pollution reduction projects completed by NEORSD and other agencies and communities.

Table 9. Attainment Status of the Cuyahoga River Sites in 2008.

River Mile	Attainment Status	Average IBI Score	Average MIwb Score	ICI Score	Relative Location	Sampling Reason
16.20	FULL	44	9.9	40	Downstream Tinkers Creek	Reference Site
11.95[2] / 12.10	PARTIAL	34	8.2	40	Upstream Mill Creek	Trend Assessment
11.30	FULL	38	9.1	40	Downstream Mill Creek	Trend Assessment
10.75[1]	FULL	37	8.9	40	Upstream Southerly WWTC	Trend Assessment
10.30	*	-	-	40	Historical Downstream of Southerly WWTC	Trend Assessment
10.10	FULL	36	9.4	40	Downstream Southerly WWTC	Trend Assessment
8.20[1] / 8.30	PARTIAL	32	8.5	38	Upstream Big Creek	Trend Assessment
7.00[1]	PARTIAL	34	8.5	38	Downstream Big Creek	Trend Assessment
Warmwater Habitat Criterion		≥40	≥8.7	≥34		
Nonsignificant Departure from Criterion		≤4	≤0.5	≤4		

[1]The IBI and MIwb averages included one pass conducted by Ohio EPA.
[2] The IBI and MIwb result is not an average since only one pass was completed.
* Site in attainment of ICI criterion. Fish community not assessed at this location.

Specific NEORSD projects that have reduced pollution to the river include the following:

1. NEORSD has had a pretreatment program since the 1970's, and became the Pretreatment Control Authority in 1985. This has reduced loadings of metals to Southerly WWTC and thus improved effluent quality.

2. Upgrades to Southerly WWTC, including treatment processes for nitrification and dechlorination, have also resulted in improved effluent quality.

3. Increased collection of wet weather flows (Mill Creek Stormwater Tunnel) for treatment has resulted in less pollution from sewage overflows reaching the river.

4. Decommissioning of smaller wastewater treatment plants, whose flows are now conveyed to Southerly WWTC via the NEORSD Cuyahoga Valley Interceptor, has also reduced the amount of pollution entering the river.

5. The capture for treatment of previously untreated dry weather sewage overflows identified via the NEORSD Environmental Assessment program and other efforts has reduced the pollutant loading to the river.

It is expected that the biological community in the Cuyahoga River will continue to improve as pollution impacts to the river are reduced or eliminated. Monitoring of fish and macroinvertebrates in upcoming years will help to determine if the Cuyahoga River is achieving WWH criteria.

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