NORTHEAST OHIO REGIONAL SEWER DISTRICT

2012 Big Creek Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results

Prepared by
The Water Quality and Industrial Surveillance Division

Introduction

In 2012, the Northeast Ohio Regional Sewer District (NEORSD) conducted stream monitoring activities at River Mile (RM) 0.15 on Big Creek, an urbanized tributary to the Cuyahoga River. RM 0.15 is located downstream of Jennings Road on the Big Creek Main Branch and is downstream of NEORSD-owned combined sewer overflows (CSOs). NEORSD assessed stream habitat, water chemistry, and fish and benthic macroinvertebrate community health to evaluate the impact of CSOs and other environmental factors on the creek. Macroinvertebrate and water chemistry sampling at RM 0.15 was required by Ohio Environmental Protection Agency (Ohio EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*FD.

Stream monitoring activities were conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the NEORSD Study Plan *2012 Big Creek Environmental Monitoring*, approved by Ohio EPA on May 15, 2012. The results obtained from these assessments were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI). Water chemistry data was compared to the Ohio Water Quality Standards (Ohio EPA, 2009a) to determine attainment of designated uses. An examination of the individual metrics that comprise the IBI and ICI was used in conjunction with the water quality data, NEORSD Macroinvertebrate Field Sheet, and QHEI results to identify impacts to the fish and benthic macroinvertebrate communities. Results were also compared to historic data to show temporal trends.

Figure 1 is a map of the sampling location on Big Creek, and Table 1 lists the sampling location and its respective river mile, latitude/longitude, site description, and surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD Water Quality and Industrial Surveillance (WQIS) Division.

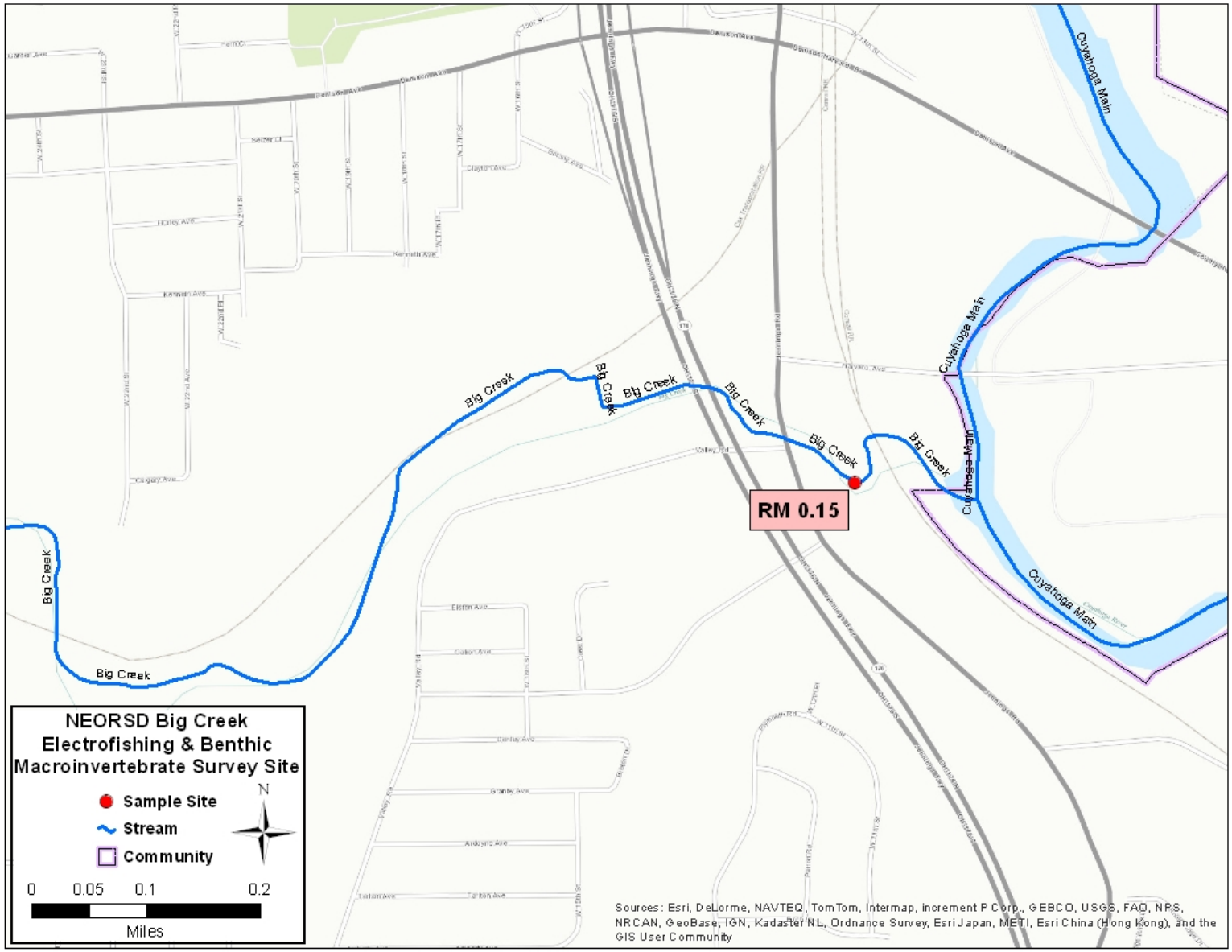


Figure 1. Sampling Location

Table 1. 2012 Big Creek Sampling Location						
Water Body	Latitude	Longitude	River Mile	Location Information	USGS HUC 8 Number - Name	Purpose
Big Creek	41.4460	-81.6865	0.15	Downstream of Jennings Road	04110002 Cuyahoga	Evaluate water chemistry and macroinvertebrates as required by Ohio EPA Permit #3PA00002*FD, and evaluate the fish community and instream habitat as supplemental data

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted six times between June 19 and July 24, 2012, on Big Creek at RM 0.12. Techniques used for sampling and analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2012) and the Ohio EPA *Surface Water Field Sampling Manual* (2013). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

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

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

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

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

X = sample/detection limit ratio

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

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

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

Results and Discussion

One field blank was collected during the study. In this blank sample, the turbidity was at a level that required the result for the associated sample collected from Big Creek to be downgraded to level 2 data. The turbidity observed in the blank compared to that in the sample did not meet Ohio EPA requirements for level 3 data. The intended use for level 2 data is for determining trends only. Based on the qualification of this data, it appears that at some unknown point during sampling or analysis, a contaminant was introduced into the sample container or the glass vial used during analysis in the turbidimeter. It is also possible that the surface of the sample vial was scratched, leading to an erroneous measurement. The only other parameter for which the field blank showed possible contamination was ammonia. The concentration of ammonia in the blank was at a level that required the associated sample from Big Creek to be listed as estimated. It is unclear how the field blank became contaminated. This contamination may be due to inappropriate sample collection, handling, contaminated blank water and/or interference during analysis.

For the one duplicate sample that was collected during the study, the RPD for the two iron results was greater than acceptable and resulted in rejection of the data. Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, heterogeneity of the water being sampled and/or improper handling of samples. Because all other parameters had acceptable RPDs between the two samples, it is uncertain what the actual cause for the variation of iron results was.

The final QA/QC check for the samples was a comparison of paired parameters. This comparison showed that all of the chromium and hexavalent chromium results, except for those from one sample, needed to be either listed as estimated or rejected entirely. The reasons these parameters did not meet Ohio EPA's requirements may include differences in sampling and/or analysis methods, especially interferences from other metals or turbidity in the determination of hexavalent chromium (Eaton, Clesceri, & Greenberg, 1995).

RM 0.15 on Big Creek is designated as warmwater habitat (WWH), agricultural water supply, industrial water supply, and Class B primary contact recreation water. Exceedances of the water quality standards associated with these uses occurred for only bacteria 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 (single sample maximum). For those streams designated Class B primary contact recreation, these criteria are 161 colony-forming units (CFU)/100mL and 523 CFU/100mL, respectively. The seasonal geomean criterion was exceeded at RM 0.15 in 2012 (Table 2). The single sample maximum criterion was also exceeded in each 30-day period with two or more samples.

Table 2. 2012 Big Creek *E. coli* Densities (colony-forming units/100mL)

Date	RM 0.15
6/19/2012*	1683
6/26/2012	1367
7/2/2012*	24,800
7/10/2012	395
7/17/2012	370
7/24/2012	867
Seasonal Geomean	1391

*Wet weather event
Exceeds single sample maximum criterion for 30-day period starting on that date

Two of the samples were collected during what has been defined as a wet weather event[1]. In total, 22 recorded combined sewer overflows to Big Creek or its tributaries

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

occurred from June 17 to July 24, 2012, for those CSOs with monitoring capabilities (Table 3); all but one were during wet weather. These overflows contained a mixture of rainwater, urban and stormwater runoff, and raw sewage and were likely sources of elevated *E. coli* densities in the creek. Illicit discharges located upstream of the sampling location may also be a source of bacterial pollution.

Table 3. Overflows to Big Creek from June 17 to July 24, 2012

Outfall Name	Location	Receiving Water	Number of Overflows	Million Gallons (MG)
CSO 061	W. 38th/Muriel	Big Creek	4	Unknown
CSO 055	Bellaire/Kensington Dam	Big Creek	2	Unknown
CSO 056	Bellaire/Kensington Gate	Big Creek	3	1.179
CSO 058	W. 145th/Puritas	Big Creek	3	3.917
CSO 059	Spring/Jennings	Spring Creek*	9	4.412
CSO 085	W. 56th, south of Denison	Big Creek	1	<0.001

* Tributary to Big Creek

The human health nondrinking water and wildlife outside mixing zone average (OMZA) criteria for mercury, 0.0031 ug/L and 0.0013 ug/L, respectively, were also exceeded in 2012 (Table 4). The concentrations that were measured, however, did not indicate any contamination above normal levels. As with all areas within the NEORSD service area, atmospheric deposition may be a source of mercury in the Big Creek watershed.

Table 4. 2012 Big Creek Mercury Concentrations (µg/L)

6/19/2012	<0.005
6/26/2012	<0.005
7/2/2012	<0.005
7/10/2012	0.015
7/17/2012	0.007
7/24/2012	<0.005

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

Habitat Assessment

Methods

An instream habitat assessment was conducted once at RM 0.15 in 2012 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score of 60 or more suggests that sufficient habitat exists to support a fish community that meets the warmwater habitat criterion (Ohio EPA, 2003). A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

The QHEI score was 71.5 for RM 0.15 in 2012. This site met the target QHEI score of 60, as it has the past two years (See Table 5). The RM 0.15 site is located on the Main Branch of Big Creek, and begins downstream of the Jennings Road Pump Station and CSO 045 and extends to approximately 300 feet upstream of the confluence with the Cuyahoga River. The site has a predominantly gravel and sand substrate and features a large riffle, runs, and deep pools. Instream cover is moderate and consists of undercut banks, overhanging vegetation, slow shallows, boulders, rootmats, and logs or woody debris. The creek has a very narrow riparian zone to buffer the surrounding urban and industrial land use, and the bank on river right has heavy to severe erosion. The sediments at this site appear to be prone to shifting, presumably during wet weather events and high flows.

Table 5. 2012 Big Creek QHEI Results

River Mile	Year	QHEI Score	Narrative
0.15	2012	71.5	*Good*
	2011	69.5	*Good*
	2010	70.5	*Good*

Electrofishing

Methods

Two quantitative electrofishing pass was conducted at Big Creek RM 0.15 in 2012, on June 19th and July 23rd. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.20 kilometers. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

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 12 metrics utilized for wading sites are listed in Table 6.

Table 6. IBI Metrics (Wading)
Total number of Native Species
Number of Darter species
Number of Sunfish Species
Number of Sucker Species
Number of Intolerant Species
Percent Tolerant Species
Percent Omnivores
Percent Insectivores
Percent Top Carnivores

Table 6. IBI Metrics (Wading)
Percent Simple Lithophils
Percent DELT Anomalies
Number of Fish

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

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

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

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

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

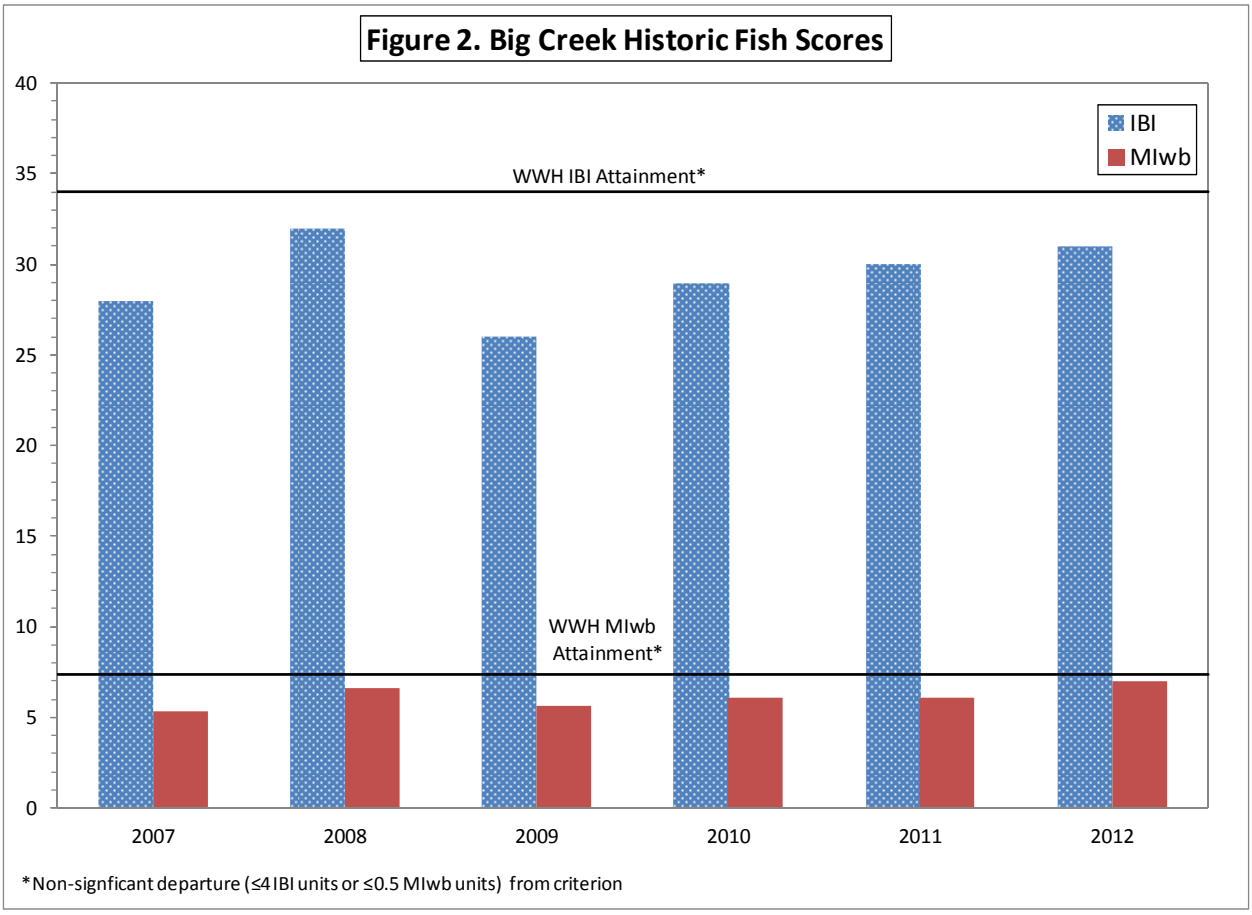
Lists of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

The Warmwater Habitat (WWH) IBI criterion in the Erie-Ontario Lake Plain (EOLP) ecoregion is 38 for wading sites. A site is considered in non-significant departure if it is within 4 IBI units of its applicable criterion. The MIwb criterion for wading sites is 7.9; non-significant departure is within 0.5 units. Table 7 lists the average IBI and MIwb scores from 2007 – 2012. Figure 2 illustrates temporal trends in IBI and MIwb scores from 2007-2012.

Table 7. 2007 – 2012 Average Big Creek IBI & MIwb Scores					
		IBI		MIwb	
River Mile	Year	Score	Narrative Rating	Score	Narrative Rating
0.15	2007	28[a]	Fair	5.3[a]	Poor
	2008	32[a]	Fair	6.6[a]	Fair
	2009	26	Poor	5.6	Poor
	2010	29[a]	Fair	6.1[a]	Fair
	2011	30[a]	Fair	6.1[a]	Fair
	2012	31[a]	Fair	7.0[a]	Fair
[a]Average score					

In 2012, the fish community at RM 0.15 had an average IBI score of 31(*Fair)* and an average MIwb score of 7.0 (*Fair)*, failing to meet the WWH biocriteria. The 2012 average score remains consistent with previous years' IBI and MIwb scores for this site. Fifteen species of fish were collected in the two electrofishing passes, and about 63% of the total catch consisted of pollution-tolerant individuals such as common white sucker (*Catostomus commersonii*), yellow bullhead (*Ictalurus natalis*), and green sunfish (*Lepomis cyanellus*). A total of 22 CSO overflow events from June 17, 2012 to July 24, 2012, contributed more than 9.5 million gallons of combined sewage to Big Creek, which may account, at least in part, for the abundance of pollution-tolerant species found during the two electrofishing passes. Improvements to the fish community would likely occur with a reduction of overflow events and illicit discharges, as the habitat should be capable of supporting a more diverse and functional population.



Macroinvertebrate Sampling

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. Methods for sampling followed the Ohio EPA's Biological Criteria for the Protection of Aquatic Life, Volume III (1987b). The recommended period for HDs to be installed is six weeks.

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

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (OEPA 1987a, Ohio EPA undated). The ICI consists of ten community metrics (Table 9), 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 9. ICI Metrics
Total number of taxa
Number of mayfly taxa
Number of caddisfly taxa
Number of dipteran taxa
Percent mayflies
Percent caddisflies
Percent Tanytarsini midges
Percent other diptera and non-insects
Percent tolerant organisms (as defined)
Number of qualitative EPT taxa

Results and Discussion

The WWH ICI criterion for the EOLP ecoregion is 34, which applies to RM 0.15. Table 10 summarizes the sampling results and Figure 5 shows historical ICI scores.

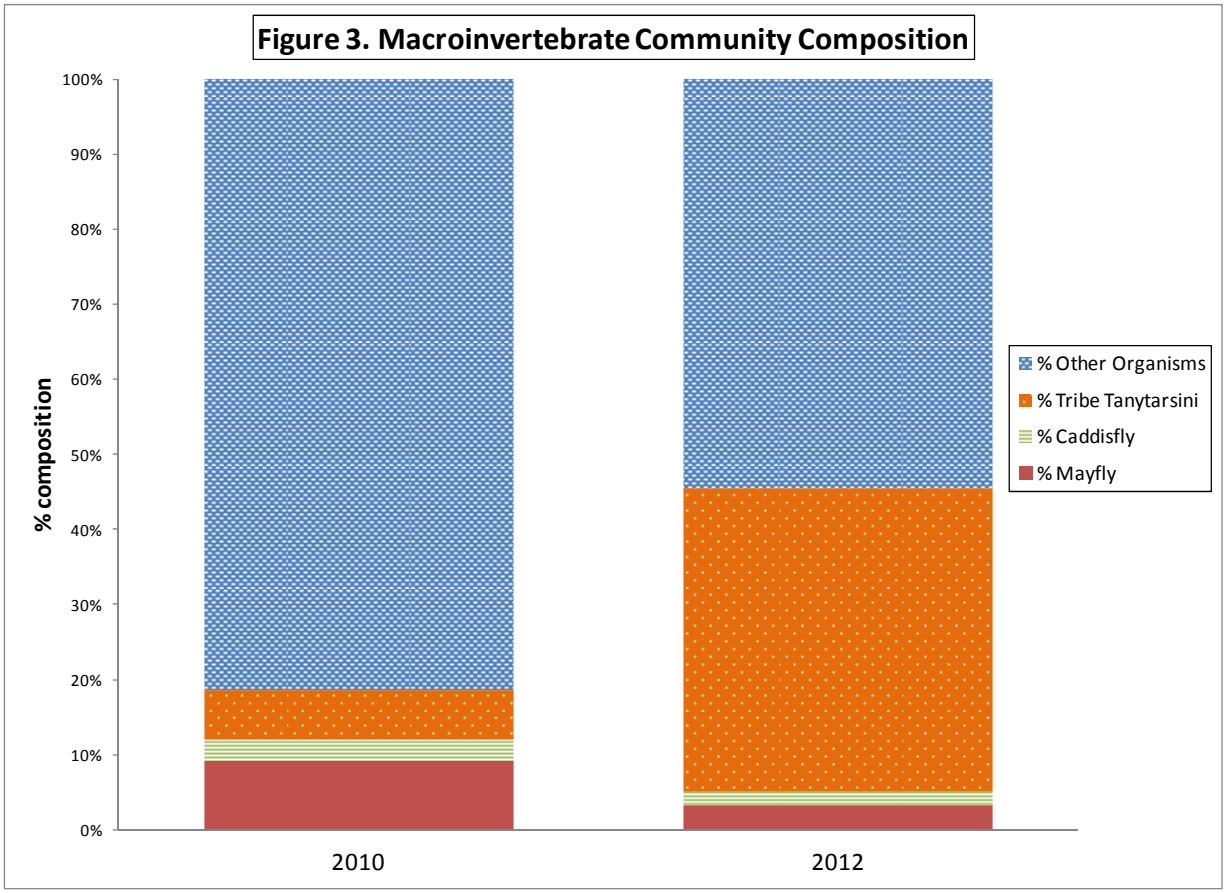
Table 10. 2012 Big Creek Invertebrate Community Index (ICI) Results						
River Mile	ICI Score	Narrative Rating	Quantitative Taxa	Qualitative Taxa	Qualitative EPT Taxa	% Tolerant (as defined)
0.15	*32*	*Marginally Good*	31	25	6	18.2
Bold = attainment of WWH criterion (ICI ≥ 34 units) *Italics indicates non-significant departure from WWH biocriterion [ICI ≥30]*						

HD samplers had to be reinstalled several times on Big Creek at RM 0.15 due to low flow, missing samplers or the blocks being buried. After the fourth colonization period, the HD was collected and the site received an ICI score of 32, the highest since sampling began in 1995, and in attainment of the criterion. The majority of the HD was comprised of Tribe Tanytarsini midges (40.4%) and other diptera and non-insects (54.5%). Two moderately intolerant taxa, *Urnatella gracilis* and *Ceratopsyche morosa*

group, were collected on the HD. An increase in the proportion of pollution-sensitive taxa on the HD improved the score from past sampling years.

In 2011, an HD was not collected, therefore, only a qualitative kick sample was performed. In the qualitative sample, seven EPT were collected, one taxa being moderately intolerant. The majority of the sample was composed of mayflies and midges. Based on characteristics of the qualitative sample and best professional judgment, the site at RM 0.15 in 2011 was given a narrative rating of *Poor/Fair*.

In 2010, Big Creek RM 0.15 obtained an ICI score of 20. Dipterans and non-insects dominated the macroinvertebrate community (82%) and only three EPT taxa were found in the qualitative sample. Compared to 2012, the HD collected in 2010 had a higher percentage of diptera and non-insects, resulting in the lowest metric score of 0 and a significantly lower percentage of Tribe Tanytarsini midges, resulting in a metric score of 2. This difference in community composition is the reason the score was lower in 2010 than 2012 (Figure 3).



As a result of NEORSD's Sewer System Maintenance and Operation (SSMO) Division's routine inspections of combined sewer regulators, a total of three

blockages/restrictions were discovered within the combined sewer system tributary to Big Creek during the HD colonization periods. Two overflows occurred at CSO-085 (07/05/12 and 07/31/12) during dry weather and one overflow occurred at CSO-058 (08/14/12) during wet weather. Figure 4 displays the locations of those CSOs in relation to the sampling site. Once SSMO discovered the blockage(s)/restriction(s) within the combined sewer system, immediate action was taken to remediate the overflow.

Figure 4. Big Creek CSOs that discharged during 2012 sampling

Conclusions

Sampling on Big Creek in 2012 was conducted to determine the impacts from CSOs discharging to the creek. From the water chemistry portion of this sampling, it was found that exceedances of the applicable water quality standards occurred for bacteria and mercury. Combined sewer overflow events due to wet weather, but also during periods of dry weather, were most likely responsible for the elevated *E. coli* densities that were found. Although the mercury criteria were exceeded, the concentrations were not above those typically found in the creek.

Assessment of the fish community in Big Creek indicated some impairment, as the WWH criteria for the IBI and MIwb were not met. The majority of the population consisted of pollution-tolerant fish, which may have been due to the presence of combined and sanitary sewage in the creek. The macroinvertebrate community showed less impairment than the fish; the ICI score for the site was in non-significant departure from the criterion. Some improvement to the macroinvertebrates has occurred during the last couple of years as the proportion of pollution-sensitive taxa groups increased substantially from 2010 to 2012. This may have been due to a reduction in dry-weather flow from an improper connection that was remediated following the assessments conducted in 2010. Improvements to both the fish and macroinvertebrate communities are expected to occur with a further decrease in wet and dry-weather overflows to Big Creek.

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