**NORTHEAST OHIO REGIONAL SEWER DISTRICT**

# 2011 Big Creek Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results

**Bigmouth shiner (*Notropis dorsalis*)**

## Prepared by
## The Water Quality and Industrial Surveillance Division

## Introduction

During 2011, the Northeast Ohio Regional Sewer District (NEORSD) conducted electrofishing, benthic macroinvertebrate surveys, water chemistry sampling, and habitat assessments at two sites on Big Creek, a tributary to the Cuyahoga River. One study site, located at River Mile (RM) 0.15 on the Main Branch, was required under the District's Combined Sewer Overflow (CSO) permit, Ohio Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*FD. This site was downstream of all NEORSD-owned combined sewer overflows (CSOs) that discharge into Big Creek. According to the permit (1997), "discharges from combined sewer overflows shall not cause or significantly contribute to violations of water quality standards or impairment of designated uses." In support of the permit-required monitoring, studies at RM 4.40 on the Main Branch were conducted to determine the extent to which the downstream macroinvertebrate community at RM 0.15 was impacted by NEORSD CSO discharges and other environmental factors such as urban and stormwater runoff. Habitat Assessments and fish community surveys were also included as supplemental data.

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 *2011 Big Creek Environmental Monitoring*, approved by Ohio EPA on June 18, 2011. Data were submitted to the Ohio EPA within one year of the completion of sampling.

Figure 1 is a map of the sampling locations on Big Creek, and Table 1 lists the sampling locations and their respective RM, 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 Division.

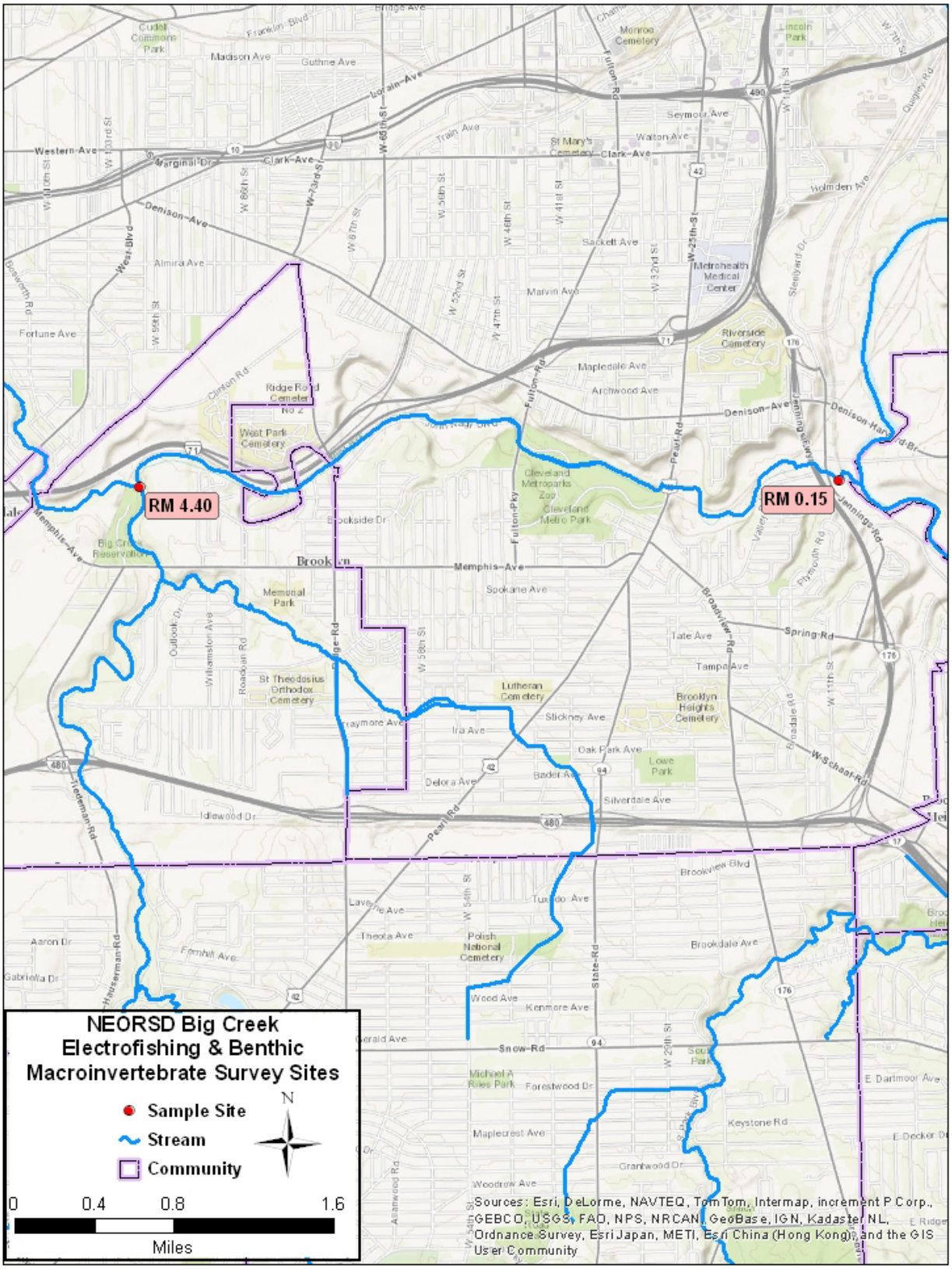



Figure 1. Map of sampling zones at RM 0.15 and 4.40 in Big Creek

Table 1. Sampling Locations

| Location | Latitude | Longitude | River Mile | Description | Quadrangle | Purpose |
|---|---|---|---|---|---|---|
| Big Creek – Main Branch | N41.4460° | W81.6865° | 0.15 | Downstream of Jennings Road | Cleveland South | Ohio EPA Permit No. 3PA00002*FD |
| Big Creek – Main Branch | N41.4460° | W81.7540° | 4.40 | Memphis MetroPark | Lakewood | Evaluate water chemistry, habitat, fish, and macroinvertebrates upstream of CSOs |

## Water Chemistry Sampling

### Methods

Water chemistry samples were collected from RMs 0.15 and 4.40 during seven sampling events, beginning June 28, 2011 and ending August 10, 2011; the samples at RM 0.15 were collected to fulfill requirements under Ohio EPA NPDES Permit No. 3PA00002*FD. Techniques for water chemistry sampling and subsequent chemical analysis followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (OEPA, 2009).

Samples were collected in two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-milliliter plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. The bacteriological samples were collected in sterile 250 mL plastic bottles. All samples were stored on ice in a cooler in the locked vehicle until they were relinquished to NEORSD's Analytical Services with a Chain of Custody (COC). A NEORSD Surface Water Condition Sampling Field Data Form detailing site observations was also completed for each sample. All Certificates of Analysis, COCs, and Surface Water Condition Sampling Field Data Forms are available upon request from the NEORSD Water Quality and Industrial Surveillance Division.

Instruments used for field analysis included a YSI-556 MPS Multi-parameter Water Quality Meter or a YSI 600XL Sonde for measuring dissolved oxygen, conductivity, pH, and water temperature. These meters were calibrated weekly for dissolved oxygen and specific conductance; pH was calibrated each day that sampling was conducted.

### Results and Discussion

During the seven sampling events, two sample duplicates and two field blanks were obtained for quality assurance and quality control (QA/QC) purposes.

Field blanks were obtained on August 3, 2011, and August 10, 2011, for QA/QC of the water samples. Sample duplicates were collected from RM 0.15 on August 3, 2011, and on August 10, 2011. The sample duplicate results were compared to the sample results using relative percent difference (RPD), given below in Formula 1.

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

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

Each sample was analyzed for 45 chemical parameters, plus 4 field measurements. The sample and the sample duplicate were compared for 43 individual laboratory parameters reported on the Certificate of Analysis. After each RPD was calculated, any differences over 40% were investigated. Forty percent is allowable for field samples; those that are higher may indicate problems with sample collection and as a result the data may be considered estimated. Because the data does not fulfill the Ohio EPA requirements of level 3 credible data in these instances, it is downgraded to level 2 and used to determine trends only. An RPD greater than 60% results in rejection of the data. After evaluating the RPD values for the duplicate, there was one instance where the RPD for a set of parameters was greater than 40%. On August 10, 2011, the sample at RM 0.15 showed an RPD for TSS at 48.1%, this was between 40-60% and this data resulted in being considered estimated and downgraded to level 2. The concentrations of ammonia and copper in the field blanks collected on August 3 were high enough to qualify the samples to level 2. At this time, it is not known what caused the contamination on that day.

RM 0.15 and RM 4.40 on Big Creek are designated as warmwater habitat, agricultural water supply, industrial water supply, and Class B primary contact recreation waters. RM 4.40, which is located within the Cleveland Metroparks, is also designated as a State Resource Water. All of the samples collected for this study were in attainment of applicable Ohio Water Quality Standards (OAC 3745-1) with the exception of *Escherichia coli (E. coli)*. At both RM 0.15 and RM 4.40, the seasonal geometric mean of 161 colony-forming units per 100 milliliters (CFU/100 mL) was exceeded for *E. coli*. Also at RM 0.15 and RM 4.40, the percentage of samples exceeding 523 CFU/100mL was greater than 10% for all 30-day periods that included at least two samples. Elevated

*E. coli* results were collected during both dry and wet weather events[1]. Results are shown in Table 2.

The exceedences on Big Creek RM 0.15 on July 13, July 20, August 3 and August 10 were most likely due to wet weather bacterial contamination from Combined Sewer Overflows (CSOs) 045 and 059. Overflow volumes from CSO 045 and CSO 059 varied from 0.081 million gallons per day (mgd) to 36 mgd during the wet weather events in July and August. It is unclear what caused the elevated levels of *E. coli* on June 28, July 6 and July 27, 2011, however, residual effects from urban and stormwater runoff may have also contributed to the elevated bacteria densities.

For RM 4.40, the exceedences on July 2 and July 13 were most likely due to wet weather, but it is unclear what caused the elevated *E. coli* densities seen during dry weather. Although no sources have been identified, potential sources of bacteriological contamination to the Big Creek watershed include sanitary sewer overflows, improper sanitary connections, inflow and infiltration, storm sewer outfalls, and urban and stormwater runoff.

Mercury analysis for all of the samples was completed using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking water 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 contamination above those levels typically found in the creek. For the data that was collected in 2011, the sites at RMs 0.15 and 4.40 had mercury concentrations that resulted in 30-day averages that exceeded the Human Health Nondrinking water and Protection of Wildlife Outside Mixing Zone Averages (OMZA). It is expected that the use of EPA Method 1631E for all of the samples would have resulted in exceedances throughout the sampling.

**Table 2. Big Creek *E. coli* Densities**

| Sample Date | Downstream of Jennings Rd. RM 0.15<br>*E.coli*<br>*CFU/100mL* | Memphis Tiedeman Park RM 4.40<br>*E.coli*<br>*CFU/100mL* | Precipitation Within 3 days of sampling Rain Gauge at Big Creek (RJA)<br>Total inches |
|---|---|---|---|
| 6/28/2011 | 9600 | 3800 | 0 |
| 7/6/2011 | 1418 | 4800 | 0 |

[1] [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.

| Table 2. Big Creek *E. coli* Densities | | | |
|---|---|---|---|
| Sample Date | Downstream of Jennings Rd. RM 0.15<br>*E.coli*<br>*CFU/100mL* | Memphis Tiedeman Park RM 4.40<br>*E.coli*<br>*CFU/100mL* | Precipitation Within 3 days of sampling Rain Gauge at Big Creek (RJA)<br>Total inches |
| 7/13/2011 | 600 | 424 | 0.21 |
| 7/20/2011 | 9400 | 7500 | 3.11 |
| 7/27/2011 | 460 | 443 | 0 |
| 8/3/2011 | 18,000 | - | 0.02 |
| 8/10/2011 | 13,200 | - | 0.54 |

Wet Weather Event

## Habitat Assessment

### Methods

Qualitative Habitat Evaluation Index (QHEI) scores were determined for RM 0.15 and RM 4.40 on Big Creek. 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, stream channel morphology, riparian and bank condition, pool and riffle quality, and stream gradient. 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). A QHEI score of 60 or more suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2003). In 2011, both sites met the target score of 60 (Table 3). QHEI field sheets for each site are available upon request from the NEORSD Water Quality and Industrial Surveillance Division. QHEI scores in 2010 were similar, in the *Good* narrative rating.

| Table 3. 2010 & 2011 Big Creek Qualitative Habitat Evaluation Scores | | | |
|---|---|---|---|
| Site Location | 2010 Score | 2011 Score | Narrative Score |
| River Mile 0.15 | 70.5 | 69.5 | *Good* |
| River Mile 4.40 | 60.5 | 63.0 | *Good* |

**Results and Discussion**

The RM 0.15 site on the Main Branch of Big Creek 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 creek has a predominantly gravel and sand substrate and features a large riffle, several runs, and deep pools. Moderate to sparse instream cover, undercut banks, deep pools, overhanging vegetation, slow shallows, boulders, and logs or woody debris were present at this site. The creek has a very narrow riparian zone on both banks surrounded by urban and industrial land use, and the bank on river right has heavy to severe erosion. The habitat changed after the QHEI was completed on July 14, 2011, as a result of the wet weather event on July 20, 2011. Severe erosion was more evident on river right and a less developed riffle was obvious in the electrofishing zone downstream of CSO 045.

The RM 4.40 site on the Main Branch of Big Creek is located within the Cleveland Metroparks Memphis Picnic Area, approximately 100 feet upstream of the confluence with the Ford Branch. The predominant substrates are boulders and bedrock surrounded by cobble, gravel, and sand, creating a series of riffles and runs. The site has no sinuosity, and channel walls still exist at the upstream end. Instream cover consists of slow shallows and high quality boulders. The banks have little to no erosion, and the bank on river left has a very narrow riparian zone compared with a moderate riparian zone on river right. The surrounding land use is primarily residential/park on river left and urban/industrial on river right.

## Electrofishing

**Methods**

Longline electrofishing was conducted twice at each site on Big Creek. RM 0.15 was sampled on June 16 and August 1, 2011. RM 4.40 was sampled on June 16 and August 5, 2011. Sampling consisted of shocking all habitat types within the sampling zone while moving from downstream to upstream. The methods followed those described in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish were identified to species level, counted, and examined for the presence of external anomalies including deformities, erosions, lesions, and tumors (DELTs). Fish at RM 0.15 were also weighed for the purpose of calculating the Modified Index of Well-being (MIwb). Fish were then returned to the waters from which they were collected with the exception of those collected as voucher specimens. Lists of the species, numbers, pollution tolerances and incidence of DELT anomalies are available upon request from the NEORSD Water Quality and Industrial Surveillance Division.

The electrofishing results for each pass were utilized to calculate the Index of Biotic Integrity (IBI) for RM 4.40 (headwater site), and RM 0.15 (wading site). The IBI was developed by the Ohio EPA to evaluate fish community health by incorporating 12 metrics based upon structural and functional attributes of the fish community (Ohio EPA, 1987a). The structural attributes are based upon fish numbers and diversity, while the functional attributes reflect environmental tolerances, feeding strategies, reproductive requirements, and incidence of disease. The twelve metrics are listed below, with headwater metrics listed first and wading metrics next.

1. Number of native species
2. Number of darter species
3. Number of headwater species / sunfish species
4. Number of minnow species / sucker species
5. Number of sensitive species / intolerant species
6. Proportion of Tolerant species
7. Proportion of omnivores
8. Proportion of insectivores
9. Proportion of pioneering species / top carnivores
10. Number of individuals
11. Number of simple lithophils
12. Proportion with DELT anomalies

Individual metric scores in each respective index are determined by comparing the fish data collected at RMs 0.15 and 4.40 with values expected at reference sites in a similar geographical region. The individual metric scores were added together to produce an overall IBI score for each site. The maximum possible score is 60 and the minimum is 12. The IBI score corresponds to narrative ratings of *Exceptional, Good, Marginally Good, Fair, Poor,* or *Very Poor*.

The second index utilized by the Ohio EPA is the MIwb. The MIwb, given in Formula 2, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (Formula 3) based on numbers and weight of fish. The result of the mathematical calculation is the MIwb score, which also corresponds to a narrative rating based upon the geographical region.

Formula 2: $$MIwb = 0.5\ lnN + 0.5\ lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

$N$ = 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

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

Formula 3:

$n_i$ = Relative numbers or weight of species

$N$ = Total number or weight of the sample

Since the drainage area at RM 4.40 was less than 20 square miles, Ohio EPA's Modified Index of Well-Being (MIwb) was not calculated for that site.

**Results and Discussion**

The Warmwater Habitat (WWH) IBI criterion in the Erie-Ontario Lake Plain (EOLP) ecoregion is 38 for wading sites and 40 for headwater 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 4 shows the individual scores for each pass conducted in 2011, and Table 5 lists the average IBI and MIwb scores for each site from 2008 – 2011.

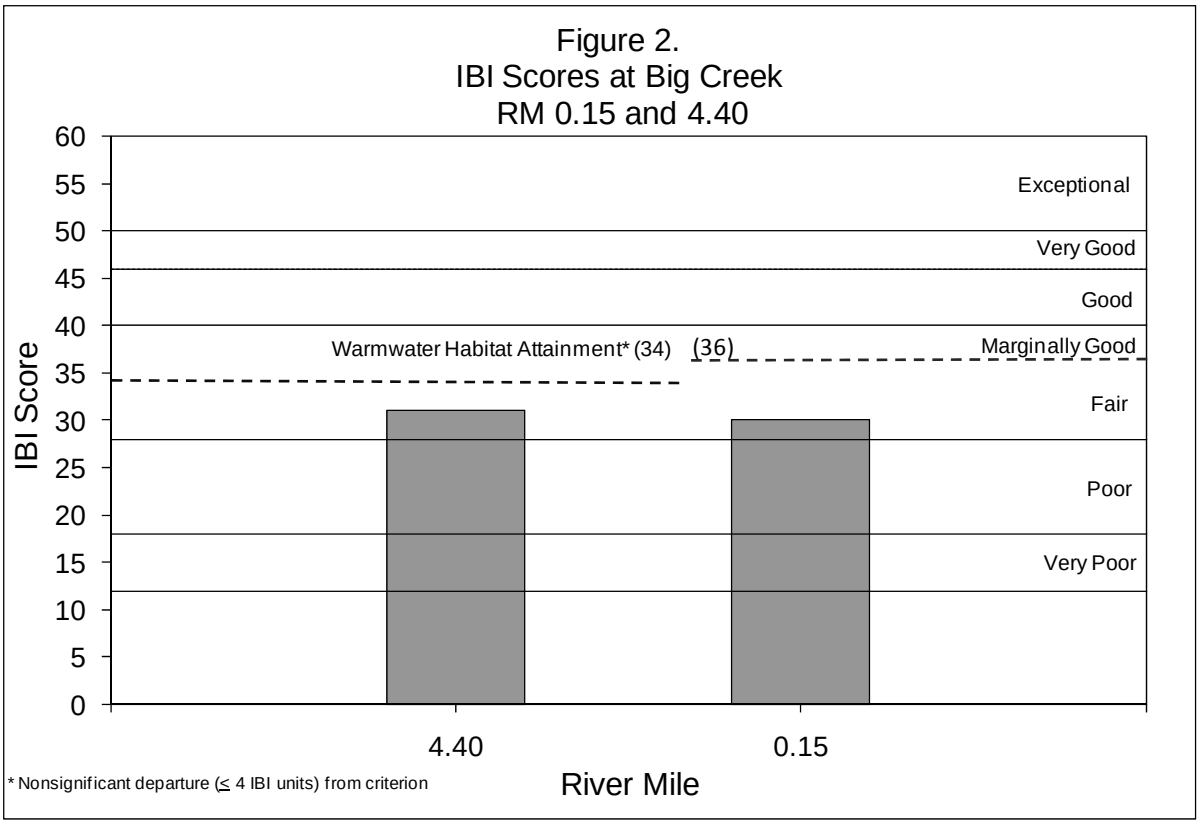
In 2011, Big Creek at RM 0.15 received an average IBI score in the *Fair* range (30) (Figure 2). At RM 0.15, the northern bluegill sunfish comprised 32% of the total fish collected. White suckers and round gobies dominated the total catch in 2010 (52%) and in 2009 (61%). In 2008, round gobies and largemouth bass comprised 23% of the catch. Average IBI scores of 29 (*Fair*), 26 (*Poor*) and 32 (*Fair*) were obtained in 2010, 2009, and 2008, respectively. Twelve species of fish were caught in the two passes at this site and 39% of the total catch consisted of highly pollution-tolerant fish. A high proportion of insectivores increased the IBI metric scoring.

In 2011, Big Creek at RM 4.40 received an average IBI score of 31, also in the (*Fair)* range (Table 5). A total of 412 central stoneroller minnow species comprised 54% of the catch on the two passes at RM 4.40. In 2010, central stoneroller minnow also dominated the total catch; however, the blacknose dace was also abundant at this site and these two species accounted for 82% of the total fish collected on two passes. Nine species of fish were caught in 2011 in the two passes at this site and 45% of the total catch consisted of highly pollution-tolerant fish. One moderately intolerant species, the sand shiner, was collected at RM 4.40. A low proportion of omnivores and pioneering species and zero DELT anomalies increased the IBI metric scoring at this site. Bigmouth shiners, which have been known to inhabit this site, and were first discovered at RM 4.40 in 2008, were not collected at this site in 2011. Average IBI scores of 35 (*Fair*), 36 (*Marginally Good*) and 32 (*Fair*) were obtained in 2010, 2009 and 2008 (Table 5), respectively.

| Table 4. 2011 Big Creek IBI & MIwb Scores | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1st Pass | | 2nd Pass | | Average | |
| Location | River Mile | IBI | MIwb | IBI | MIwb | IBI | MIwb |
| River Mile 0.15 | 0.15 | 30 | 7.0 | 30 | 5.2 | 30 | 6.1 |
| River Mile 4.40 | 4.40 | 32 | --- | 30 | --- | 31 | --- |

| Table 5. 2008 – 2011 Average Big Creek IBI & MIwb Scores | | | | | | |
|---|---|---|---|---|---|---|
| | | | IBI | | MIwb | |
| River Mile | Type | Year | Score | Narrative Rating | Score | Narrative Rating |
| 0.15 | Wading | 2011 | 30 | Fair | 6.1 | Fair |
| | | 2010 | 29 | Fair | 6.1 | Fair |
| | | 2009 | 26 | Poor | 5.6 | Poor |
| | | 2008 | 32 | Fair | 6.6 | Fair |
| 4.40 | Headwater | 2011 | 31 | Fair | --- | --- |
| | | 2010 | 35 | Fair | --- | --- |
| | | 2009 | *36*[b] | Marginally Good | --- | --- |
| | | 2008 | 32 | Fair | --- | --- |

[b]*Non-significant departure from WWH criterion (≤4 IBI units)*



## Macroinvertebrate Sampling

### Methods

Quantitative macroinvertebrate sampling was conducted at RMs 0.15 and 4.40 using a modified multi-plate Hester-Dendy (HD) artificial substrate sampler. Five identical HD sampler replicates were tied to a cinder block and initially installed at each site on June 28, 2011, for a six-week period. The HD at RM 0.15 was installed three times at the site and after each installation, the HD turned up missing. HD installation dates were on June 28, July 6, and August 18, 2011. The HD at RM 4.40 was reinstalled on August 8, 2011, but also turned up missing. The HDs may have been washed out due to storm events during the sampling time.

Qualitative sampling was conducted using a D- frame dip net to sample all available habitats. Methods for sampling followed the Ohio EPA manual *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b). The NEORSD Macroinvertebrate Field Sheet was completed for each site. The macroinvertebrate samples were sent to Midwest Biodiversity Institute (Columbus, OH), for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as described in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b). Field sheets and taxa lists and enumerations are available upon request from the NEORSD Water Quality and Industrial Surveillance Division.

### Results and Discussion

Because the HDs were washed away at the two Big Creek sites, only qualitative sampling was completed. Twenty-five total taxa were collected at RM 0.15 on Big Creek (Table 6). The dominant taxa were Baetidae mayflies and midges. The only moderately intolerant species collected was *Hydropsyche bronta* group. Seven Ephemeroptera, Plecoptera, and Trichoptera, or EPT taxa, were found in the qualitative sample. This was greater than the three EPT taxa collected in 2010. EPT Taxa collected at this site in 2011 were *Baetis flavistriga*, *Baetis intercalaris*, *Cheumatopsyche* sp, *Hydropsyche bronta* group, *Hydropsyche sparna*, *Hydropsyche depravata* group, and *Hydroptila* sp. Based on the characteristics of the qualitative sample and best professional judgment, a narrative rating of *Poor/Fair* was assigned to this site.

Table 6.
2011 Qualitative Macroinvertebrate Sampling Results

| River Mile | Narrative Rating | Taxa | EPT Taxa |
|---|---|---|---|
| 0.15 | Fair/Poor | 25 | 7 |
| 4.40 | Fair | 30 | 6 |

Thirty total taxa were collected at RM 4.40 on Big Creek in 2011; Baetidae mayflies and isopods were the dominant taxa. The only moderately intolerant species collected was *Hydropsyche bronta* group. The qualitative sampling for macroinvertebrates yielded six EPT taxa and included *Baetis flavistriga*, *Baetis intercalaris*, *Cheumatopsyche* sp, *Hydropsyche bronta* group, *Hydropsyche sparna*, and *Hydropsyche depravata* group. This was the same number of EPT taxa that was collected in 2010. A narrative rating of *Fair* was assigned to the macroinvertebrate community at this site.

## Conclusions

At RM 0.15 and RM 4.40, QHEI scores of 69.5 (*Good*) and 63.0 (*Good*) were obtained, respectively. This shows that the habitat is capable of supporting WWH fish species. Fish Index scores have consistently achieved narrative ratings of *Poor* to *Fair* since 2008 at RM 0.15. Poor water quality, as indicated by bacterial contamination, may be an issue and may explain why a more diverse fish community was not present. Fish index scores at RM 4.40 achieved a narrative rating of *Fair* in 2008, 2010 and 2011. In 2009, however, a narrative rating of *Marginally Good* was achieved, indicating the potential for this site to be in attainment of the WWH criteria.

Narrative ratings of *Poor/Fair* and *Fair* were assigned to the macroinvertebrate communities at RMs 0.15 and 4.40, respectively, based on qualitative sampling and best professional judgment. The primary limiting factor for the macroinvertebrate communities at these two sites, particularly at RM 0.15, may be habitat characteristics such as spates, the increased flow velocities during heavy rain storm events causing flooding of streams. Additionally, environmental stressors such as CSO discharges, improper connections, and urban runoff may be negatively impacting the macroinvertebrate community at RM 0.15. Efforts to reduce CSOs, SSOs, stormwater and urban runoff, and other potential sources of pollutants may contribute to future results of healthier biological index scores on Big Creek.

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