NORTHEAST OHIO REGIONAL SEWER DISTRICT

2011 Rocky River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2011, the Northeast Ohio Regional Sewer District (NEORSD) and Cleveland Metroparks conducted a chemical, bacteriological, biological, and habitat assessment of the Rocky River and some of its tributaries. The area adjacent to the Rocky River Reservation is highly urbanized and may be a source of pollutants to the river, especially following rain events. In addition, there are also direct discharges to the river from wastewater treatment plants (WWTP) and combined sewer overflows (CSO). These point and nonpoint sources of pollution may be negatively impacting the biological communities and water chemistry within the Rocky River and its tributaries. One of the purposes of this study, therefore, was to determine the attainment status of the river and some of its tributaries in relation to point and nonpoint sources of pollution and measure the magnitude of some potential causes of impairment. Another purpose was to identify problem areas within the watershed that could be the focus of future restoration projects.

Water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys in the Rocky River were conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio Environmental Protection Agency (EPA) in Fish Community and Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD and Cleveland Metroparks joint study plan *2011 Rocky River Environmental Monitoring* approved by Ohio EPA on June 14, 2011. Habitat assessments and fish and benthic macroinvertebrate sampling on some of the tributaries to the Rocky River were conducted by Cleveland Metroparks Level 3 Qualified Data Collectors. The results from the sampling performed by the Cleveland Metroparks staff are expected to be detailed in a separate report prepared by them.

Figure 1 is a map of the sampling locations evaluated on the Rocky River during the study, and Table 1 indicates the sampling locations with respect to river mile (RM), latitude/longitude, description and surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance Division (WQIS).

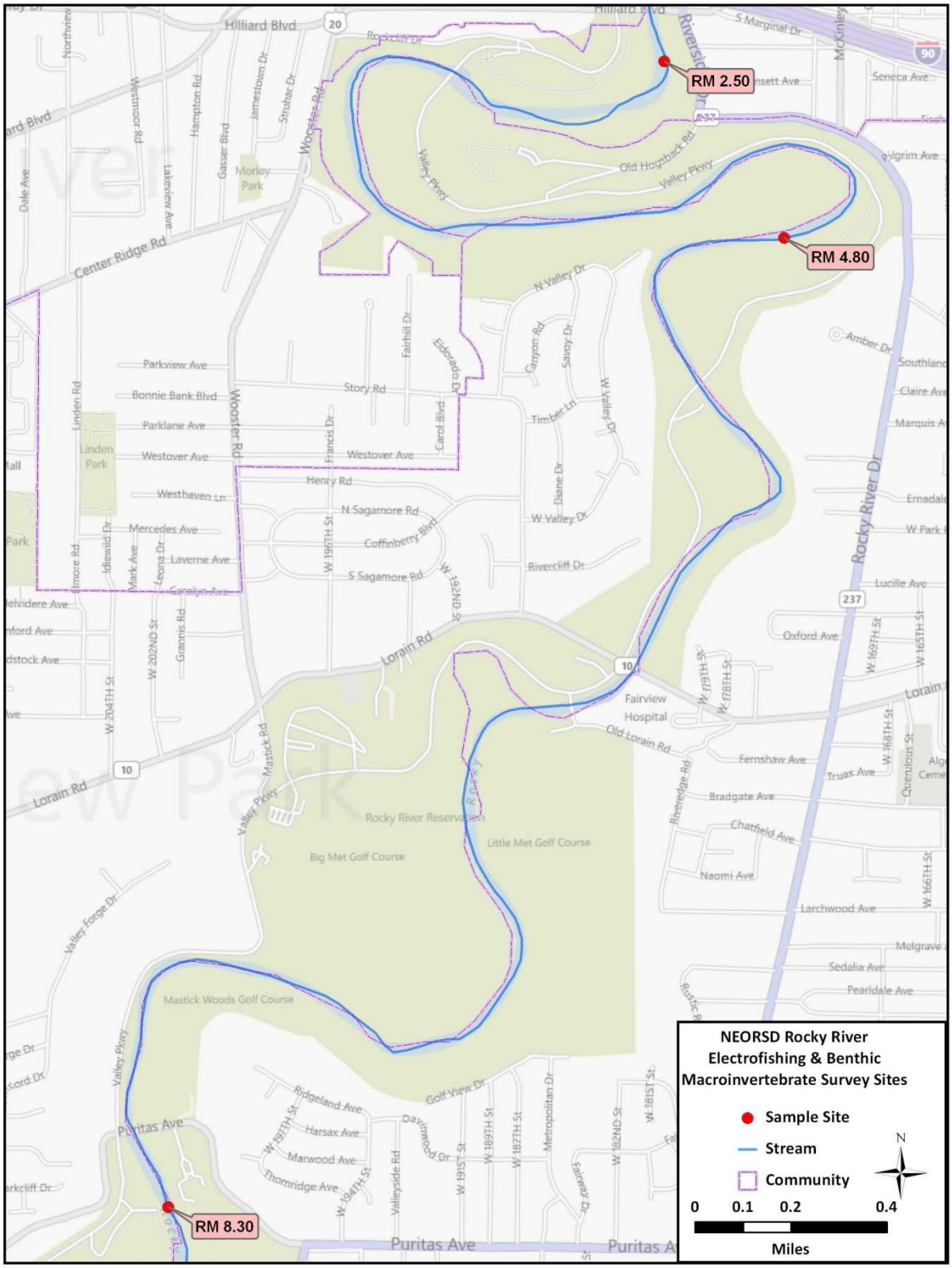


Figure 1. Sampling Locations

Table 1. Sample Locations					
Location	Latitude	Longitude	River Mile	Description	Purpose
Upstream of Mastick Road	41.435408°N	-81.843580°W	8.30	Rocky River US of NEORSD CSOs	Evaluate water chemistry, fish, macroinvertebrates and habitat upstream of CSOs
Near Tyler Barn	41.464507°N	-81.818570°W	4.80	Rocky River US of CSO 068	Evaluate water chemistry, fish, macroinvertebrates and habitat upstream of CSO 068
Upstream of Hilliard Boulevard	41.469855°N	-81.823322°W	2.50	Rocky River DS of NEORSD CSOs	Evaluate water chemistry, fish, macroinvertebrates and habitat downstream of CSOs

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between August 11th and September 8th at all three sites. Techniques used for sampling and analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009a). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. Bacteriological samples were collected in sterilized plastic bottles. All water quality samples were collected as grab samples. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% of the total samples collected. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde.

Results and Discussion

These sites are all designated warmwater habitat, agricultural water supply, industrial water supply, and Class A primary contact recreation. The lower two sites are also designated seasonal salmonid habitat, but this use is only in effect from October to May. 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) (Table 2). The percentage of samples exceeding 298 CFU/100mL was also greater than 10% for all of the 30-day periods that included at least two samples. The highest densities generally occurred at the two upstream sites. Two of the samples were collected following wet weather events[1], as measured at the NEORSD John Marshall High School rain gage, which could explain the elevated densities measured at those times. However, there was also a relatively high density for the most upstream site during one of the dry weather events. These elevated densities could indicate the presence of sanitary or combined sewage within the river. Because the two lower sites had lower overall *E. coli* densities than the upstream site, it appears that other sources of bacterial contamination may be having more of an impact on the Rocky River than CSOs. Other potential sources could include stormwater runoff, effluent from upstream wastewater treatment plants, and wildlife.

Table 2. 2011 Rocky River *E. coli* Densities (colony-forming units/100mL)

Date	RM 8.30	RM 4.80	RM 2.50
8/11/2011	205	320	265
8/18/2011	395	390	392
8/25/2011*	5800	3100	1582
9/1/2011	2700	340	158
9/8/2011*	1200	1800	700
Seasonal Geomean	1088	750	449

*Wet Weather Event

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

[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.

contamination was present above those levels typically found in the river. For the data that was collected in 2011, the sites at RMs 8.30 and 2.50 had mercury concentrations that resulted in one 30-day average each that exceeded the Protection of Wildlife OMZA. These concentrations were just above the detection limit, and samples collected the following week had dropped again to below it; therefore, it does not appear that there is a significant mercury source in that section of the river. The use of the low-level EPA Method 1631E for analysis, though, would have been expected to have resulted in exceedances of the Human Health Nondrinking and Protection of Wildlife criteria throughout the sampling period at all of the sites.

Nutrient concentrations were similar at all three sites and did not appear to be influenced by CSOs or by any other point or nonpoint sources within the study area (Table 3). Ohio EPA is in the process of developing nutrient criteria for streams. Because there are currently no nutrient criteria, total phosphorus and total inorganic nitrogen (TIN: $NO_3 + NO_2 + NH_3$) concentrations were compared to recommended management values to help prevent eutrophication in streams presented in *A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio* (Miltner, 2010). The average concentration for total phosphorus was below the management value of 0.1mg/L, but the average TIN concentration was above the management value of 1.1mg/L. Elevated nutrient concentrations can result in increased algal production in a stream. Because chlorophyll *a* sampling was not conducted, it is unknown whether this is actually occurring in the Rocky River. Collection of chlorophyll *a* samples in the future will help to determine if it is.

Table 3. 2011 Average Rocky River Nutrient Concentrations (mg/L)

	TP	SRP	$NO_3 + NO_2$	NH_3	TIN
RM 8.30	0.08	0.03	1.98	0.04	2.02
RM 4.80	0.07	0.02	1.78	0.04	1.82
RM 2.50	0.06	0.02	1.74	0.04	1.78

TIN = total inorganic nitrogen = $NO_3 + NO_2 + NH_3$

As part of QA/QC measures, two field blanks were collected over the course of the sampling. There were instances in which the concentrations of a few parameters in the field blank were high enough that some of the results associated with those samples needed to be qualified or rejected based on guidelines established by Ohio EPA. This occurred with one field blank for ammonia and both field blanks for copper and total phosphorus. Because there were no exceedances associated with these parameters, qualification or rejection of these results did not significantly change the overall water

chemistry assessment of the river. Where this contamination is coming from is not clear at this time. Further investigations in 2012 may help to determine potential sources and how to eliminate them.

Also as part of QA/QC measures, two duplicate samples were collected during the study as a means of quantifying the variability and error that could occur during sampling. Relative percent difference (RPD) was used to determine the degree of discrepancy between the two samples. Generally, an RPD of 40% is allowable for field samples; those that are higher may indicate potential problems with sample collection. From the duplicate samples that were collected during this study, there were no instances when both of the results were above the practical quantitation limit in which the RPD between the two samples was greater than 40%.

Habitat Assessment

Methods

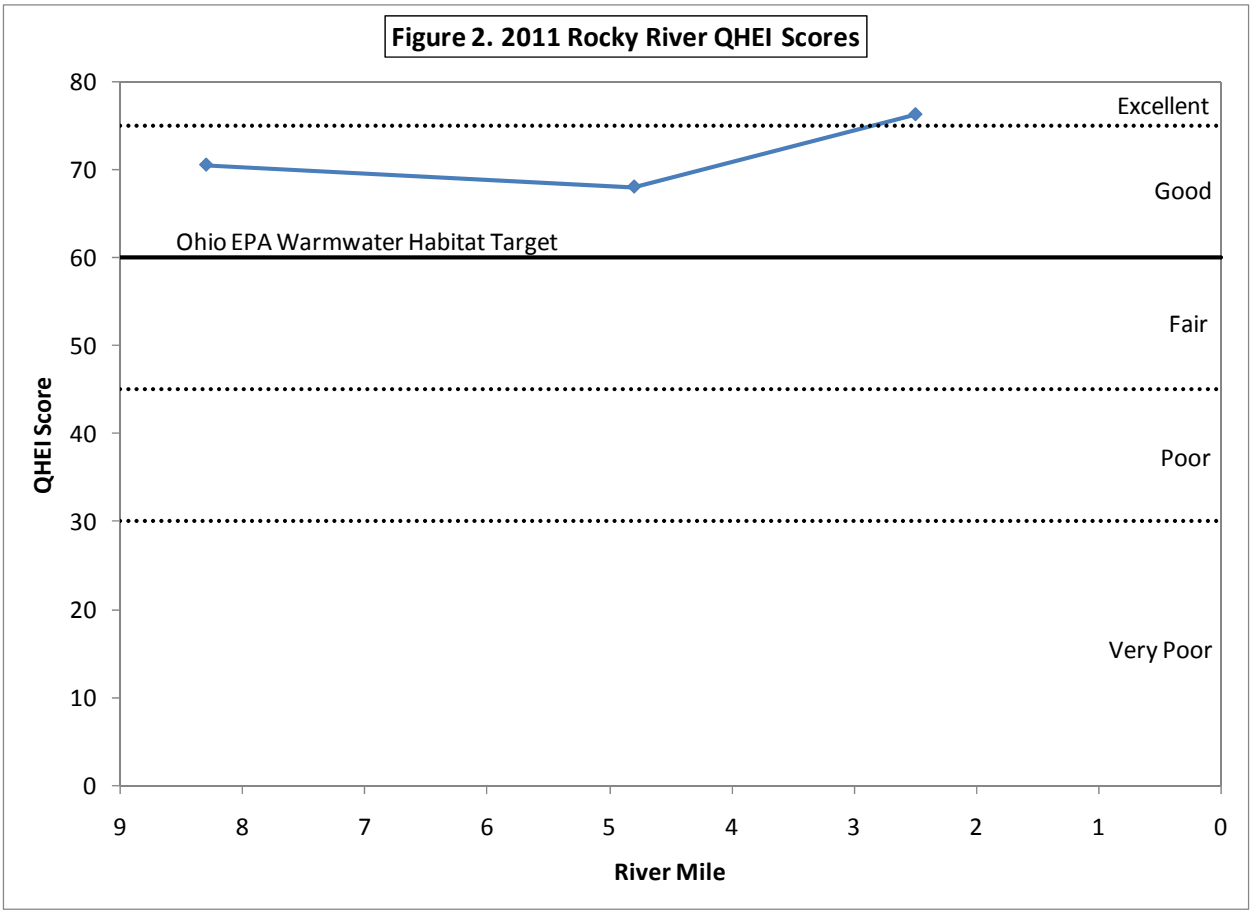
Habitat assessments were conducted one time at each site in 2011 using Ohio EPA's Qualitative Habitat Evaluation Index (QHEI). The QHEI is used to assess the aquatic habitat conditions at each sample location by providing an evaluation of the physical components of a stream. The index is based on six metrics: stream substrate, instream cover, stream channel morphology, riparian and bank condition, pool and riffle quality, and stream gradient. These metrics may be important in explaining why fish species are present or absent at a site. A more detailed description of the QHEI can be found in Ohio EPA's (2006a), *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*. QHEI sheets for each site evaluated are available upon request from WQIS.

Results and Discussion

All of the sites 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 (Ohio EPA, 2003). The most downstream site exceeded a score of 75, which indicates that it has 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 (Ohio EPA, 1999).



All of the sites that were evaluated had two high-influence modified warmwater habitat (MWH) attributes: no sinuosity and sparse instream cover (Table 4). As indicated previously, the presence of these characteristics may be detrimental to the establishment of a warmwater habitat fish community. However, these sites also had only two or three moderate influence MWH attributes, related to embeddedness and silt cover, and the rest were more typical of a warmwater habitat site. Warmwater habitat characteristics found at all the sites included no channelization or full recovery from it, good development, fast currents and eddies, and a maximum depth greater than 40cm. Even though these sites had two high-influence attributes each, the abundance of warmwater habitat characteristics most likely make it still possible for these sites to meet warmwater habitat attainment for fish in terms of available habitat.

Table 4. Qualitative Habitat Evaluation Index scores and physical attributes																																
			WWH Attributes																													
River Mile	QHEI Score	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinousity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or no Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max. Dept <40 cm (WD, HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attribute**
														High Influence						Moderate Influence												
8.30	70.50	Good	x			x			x		x		4			x	x		2		x								x	x		3
4.80	68.00	Good	x	x		x			x		x		5			x	x		2										x	x		2
2.50	76.25	Excellent	x	x		x			x		x		5			x	x		2										x	x		2

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2011. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station in Berea, is given in Table 5. 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 200 meters for 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 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.

Table 5. Sampling Dates and River Flows

Date	Sites sampled (RMs)	Daily Mean Flow (CFS*)
7/1/11	8.30, 4.80, 2.50	65
9/1/11	2.50	67
9/2/11	8.30, 4.80	69

*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*. The metrics used in the wading site IBI are shown in Table 6.

Table 6. Index of Biotic Integrity Metrics for Wading Sites
1. Number of Native Species
2. Number of Darter Species
3. Number of Sunfish Species
4. Number of Sucker Species
5. Number of Intolerant Species
6. Proportion of Tolerant Species
7. Proportion of Omnivores
8. Proportion of Insectivores
9. Proportion of Top Carnivores
10. Number of Individuals
11. Proportion of Simple Lithophils
12. Proportion of Individuals with DELTS

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.

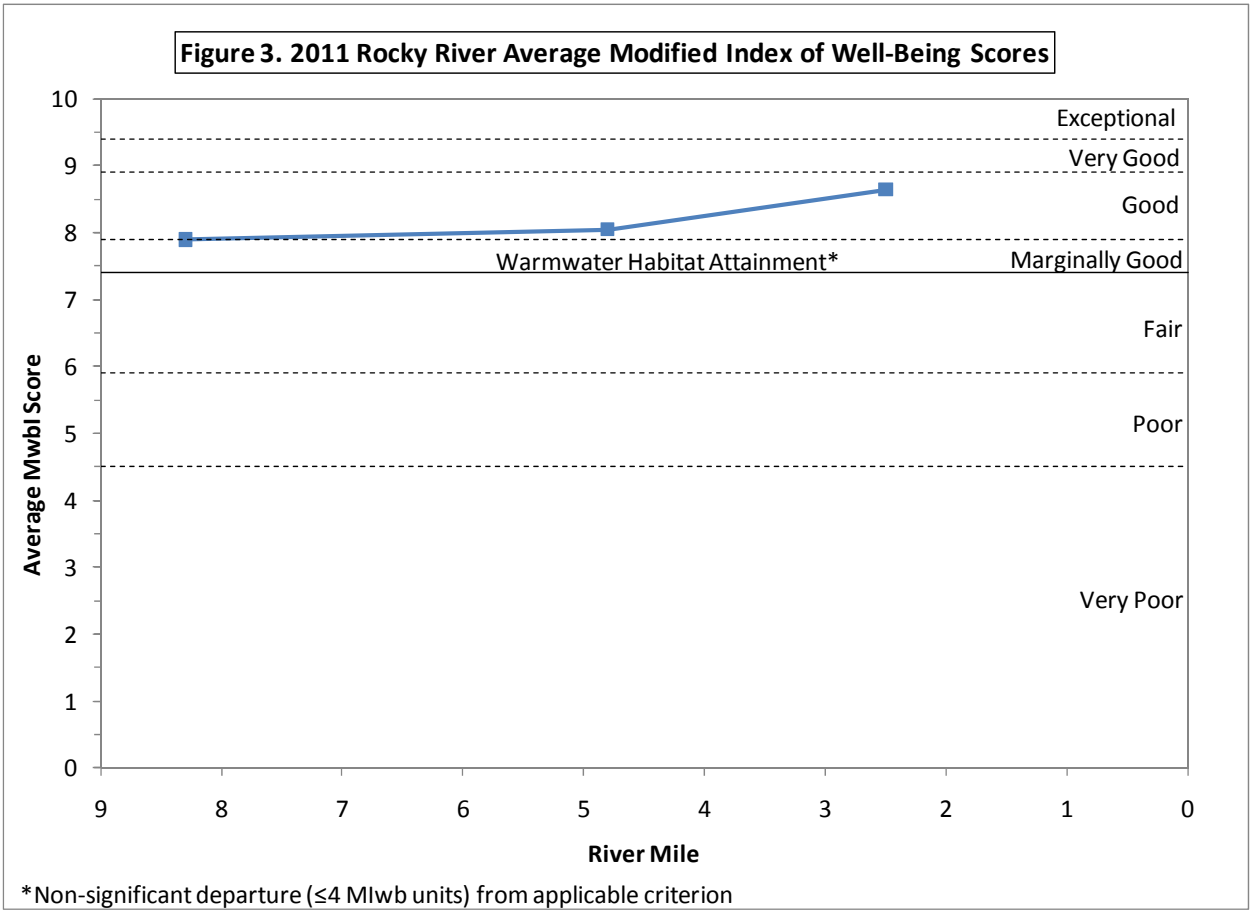
All of the sites had average MIwb scores in attainment of the warmwater habitat criterion (Table 7, Figure 3) and rated *Good*. The scores for the IBI also met the criterion and were considered *Good* (Figure 4). For both indices, the scores increased from upstream to downstream, indicating that NEORSD CSOs were not having enough of an impact on the river to significantly alter the fish community.

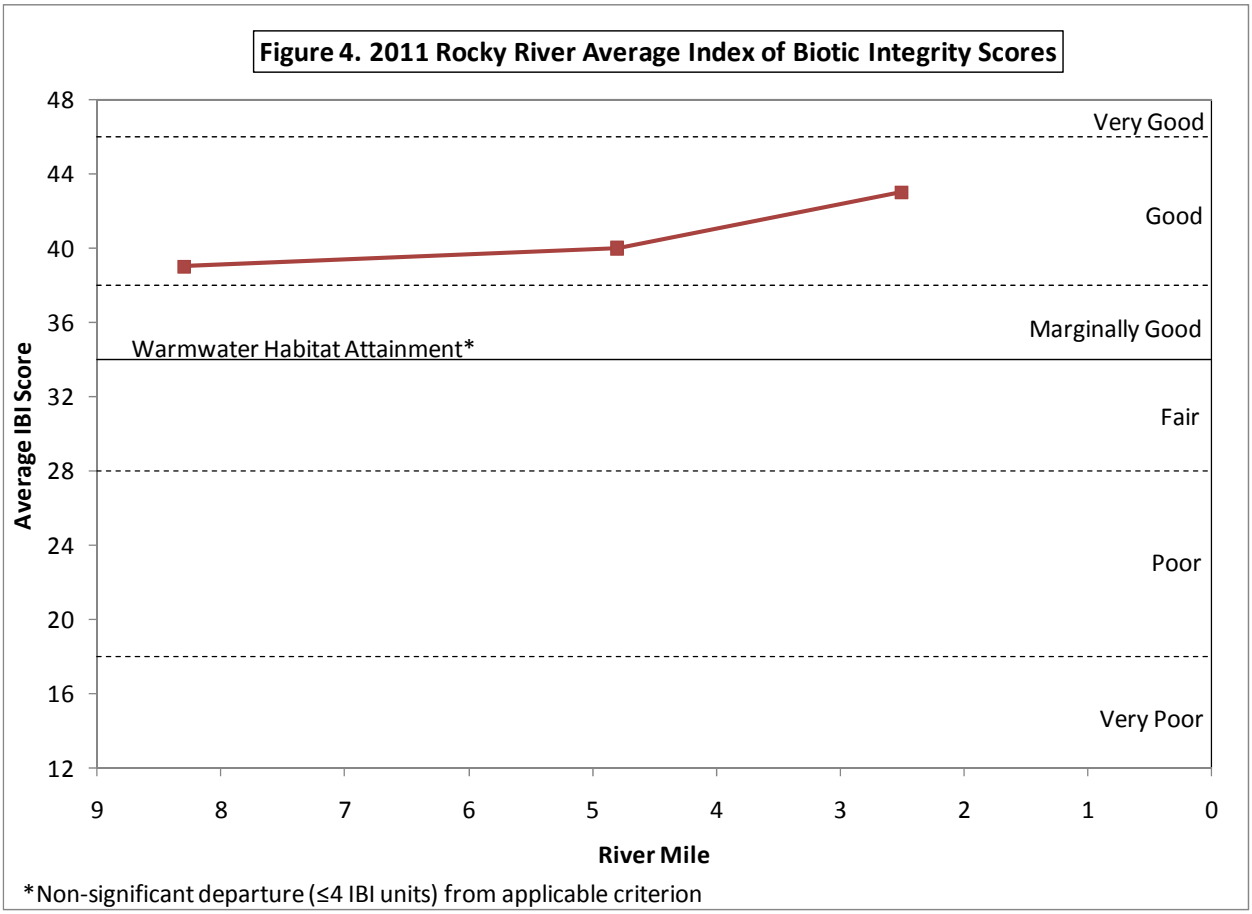
Table 7. 2011 Rocky River IBI and MIwb Results

		1st Pass		2nd Pass		Average	
Location	River Mile	IBI	MIwb	IBI	MIwb	IBI	MIwb
Upstream of Mastick Road	8.30	**38**	*7.8*	**40**	**8.0**	**39**	**7.9**
Near Tyler Barn	4.80	*36*	*7.6*	**44**	**8.5**	**40**	**8.1**
Upstream of Hilliard Boulevard	2.50	**44**	**8.7**	**42**	**8.6**	**43**	**8.7**

Bold = meets WWH criterion [IBI ≥38; MIwb ≥7.9]

Italics = non-significant departure from WWH criterion [IBI ≥34; MIwb ≥7.4]





The individual metrics in the IBI were also examined to determine any possible overall trends in specific components 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 to exceptionally 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.

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 2011, there were several instances in which a metric scored a "1" for both passes. The number of darter species (RMs 8.30 and 2.50) and the number of sucker species (RM 8.30) are two examples of this occurring. Many members of both these groups are categorized as pollution sensitive, and their absence may indicate water quality impacts at these sites because habitat did not appear to be limiting.

Finally, all of the sites received a score of "1" for both passes for the number of intolerant species. Three different intolerant fish were collected on the Rocky River in 2011: rosyface shiners (*Notropis rubellus*), mimic shiners (*Notropis volucellus*), and

stonecat madtoms (*Noturus flavus*). The presence of these species is a sign of the generally good water quality within the river. However, no more than two of these species were ever collected during the same survey at individual sites, resulting in the low scores received.

The overall fish survey results for the Rocky River suggest the presence of a healthy community that is not greatly impacted by water quality issues. Elimination of dry and wet weather sanitary and combined sewage inputs to the river may help to improve the fish community further and allow it to meet the criteria for exceptional warmwater habitats.

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

The overall aquatic macroinvertebrate community in the 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

HDs were successfully retrieved at the two most upstream sites, while the downstream one was lost halfway through the installation period. The ICI scores for both

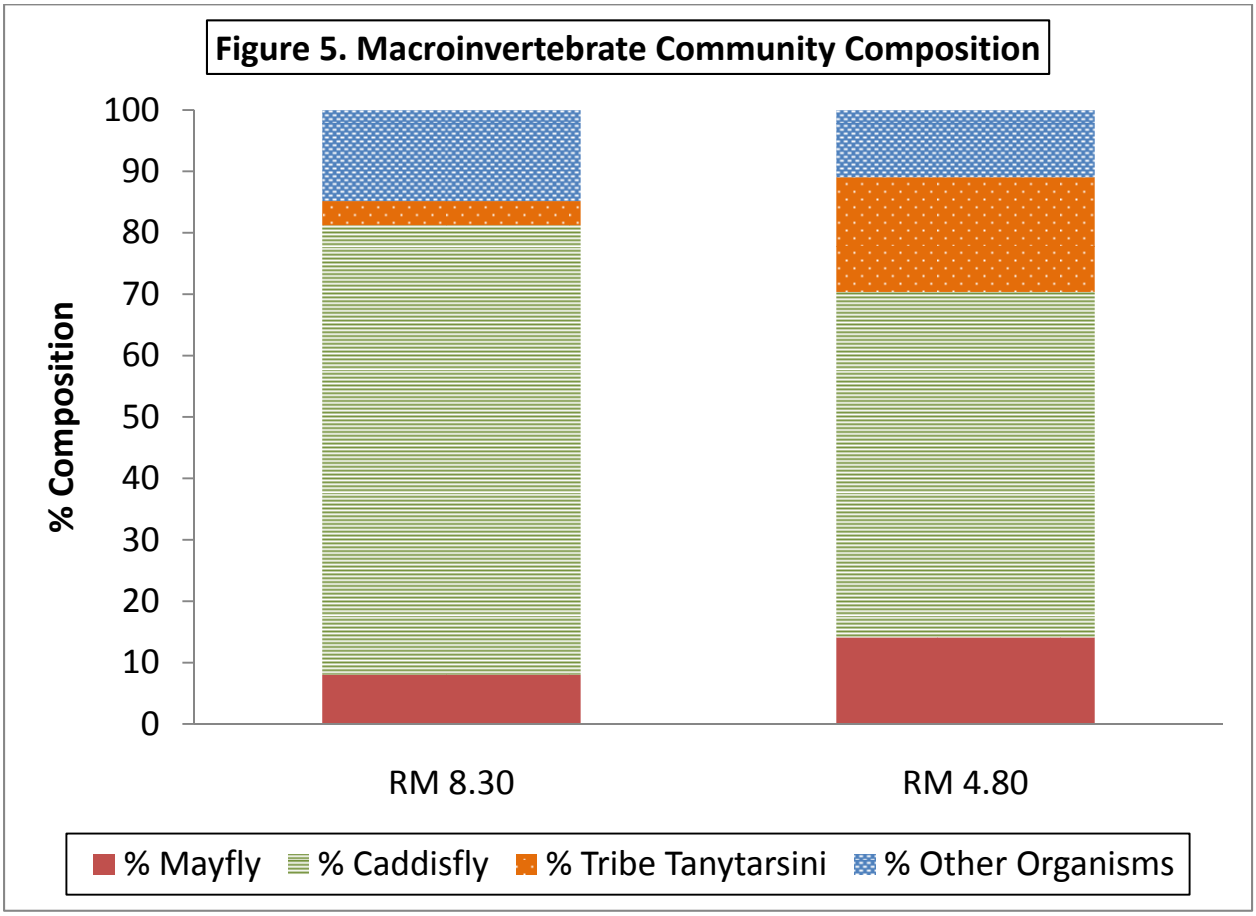
of the upstream sites met the WWH criterion of 34 and were also in non-significant departure (≤4 ICI units) of the criterion for exceptional warmwater habitats (Table 8). Both sites had a high number of total taxa and a relatively low percentage of organisms considered to be pollution tolerant. The majority of the community consisted of caddisflies (Figure 5), which, as a whole, are considered to be pollution-sensitive. All of these characteristics indicate that the water quality is generally good in the river at these locations.

Table 8. Macroinvertebrate Results

Location	River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant Organisms	Narrative Rating
Upstream of Mastick Road	8.30	**44**	436	62	11	5.5	*Very Good*
Near Tyler Barn	4.80	**42**	898	63	14	0.2	*Very Good*
Upstream of Hilliard Boulevard	2.50	NA	NA	NA	8	NA	NA

Bold indicates meets warmwater habitat criterion

Because no HD was retrieved at RM 2.50, only a qualitative sample was used to characterize that site. Due to weather conditions, the sample was not collected until early October, which was a few weeks later than the other sites, and included a total of 30 taxa, eight of which were EPT taxa. Both of these were lower than the upstream sites. Some of the sample, however, was spilled during transport from the river to the truck. If it had not been, and if the sample had been collected earlier in the season, it most likely would have been similar to the other two. It is therefore expected that if an HD would have been collected at this site, the ICI would have been in attainment of the WWH criterion.



Conclusions

Sampling was conducted in 2011 on the Rocky River to determine if NEORSD CSOs or other potential sources of pollution were negatively impacting the water quality and biological communities in the river. The results from the water chemistry sampling indicated that bacteriological inputs, possibly from CSOs or other wet weather sources, may be impacting the river; the recreational water quality standards were not met at any of the sites.

The impact from bacteriological contamination on the biological community, however, appears to be minimal. Two of the sites were in full attainment of all applicable warmwater habitat biocriteria, and in some instances, were close to meeting the exceptional warmwater habitat biocriteria. The most downstream site was in full attainment of the fish criteria. Due to the loss of the HD, an ICI score could not be calculated; it is expected, though, that this site would have been in full attainment of the criteria. Overall, the Rocky River in the section of the river that was assessed appears to

be a high quality stream with good habitat and healthy fish and macroinvertebrate communities.

Acknowledgements

Field activities and report review completed by the following, except where otherwise noted:

Jonathan Brauer
Kristina Granlund
Seth Hothem, Author
Ron Maichle
Jill Novak
Francisco Rivera
John Rhoades
Tom Zablotny
Analytical Services Division – Completed analysis for all water chemistry sampling

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