

**2019 Rocky River Main Branch Environmental Monitoring
Biological, Water Quality, and Habitat Study**



**Water Quality and Industrial Surveillance
Environmental Assessment Division**

May 2020

Introduction

In 2019, the Northeast Ohio Regional Sewer District (NEORSD) conducted water quality assessments including water chemistry sampling, habitat assessments, and fish and macroinvertebrate community surveys on the Main Branch of the Rocky River, a tributary to Lake Erie, and Abram Creek, which is tributary to the Rocky River Main Branch. The objective of this study was to evaluate the impacts of Combined Sewer Overflows (CSOs) and other environmental factors on the streams, as well as assess the overall water quality at five sites on the Rocky River Main Branch and two sites on Abram Creek (Table 1). During the 2019 sampling season, seven stream locations were evaluated between Rocky River Main Branch river mile (RM) 11.85 downstream to RM 2.50, including Abram Creek RM 3.72 and RM 0.04 — the confluence of this stream being at Rocky River Main Branch RM 10.38. Sampling at Rocky River Main Branch RM 8.30 and RM 2.50 is required by the Ohio Environmental Protection Agency (Ohio EPA) National Pollution Discharge Elimination System (NPDES) Permit No. 3PA00002*GD.

Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by the Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the *2019 Rocky River Environmental Monitoring* study plan approved by Ohio EPA on May 14, 2019. All sampling and environmental assessments occurred between June 15, 2019 and September 30, 2019 (through October 15 for fish sampling assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b). The results gathered 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 the Invertebrate Community Index (ICI). Water chemistry data was validated per the methods outlined by the Ohio EPA (2018a) and compared to the Ohio Water Quality Standards for their designated use to determine attainment (Ohio EPA 2018b). An examination of the individual metrics that comprise the IBI, MIwb, and ICI was used in conjunction with the water chemistry data and QHEI results to assess the health of the stream.

Table 1 indicates the sampling locations with respect to river mile, latitude and longitude, description, and the types of surveys conducted. Figure 1 is a study area map, noting the location of each sampling location evaluated during the 2019 study. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD WQIS Division.

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Table 1. Rocky River Main Branch and Abram Creek Sampling Locations

Waterbody	Description	Latitude	Longitude	River Mile	Station ID	Sampling Conducted
Rocky River	Downstream of Cedar Point Road	41.4083	-81.8852	11.85	T01W19	F, M, C
	Downstream of Abram Creek	41.4173	-81.8616	10.20	T01W15	F, M, C
	Upstream of Puritas Road Bridge	41.4354	-81.8436	8.30	501810	F, M, C
	Downstream of Morely Ford near Green Barn	41.4644	-81.8219	4.80	T01W07	F, M, C
	Upstream of Hilliard Boulevard	41.4699	-81.8233	2.50	T01W04	F, M, C
Abram Creek	Upstream of Railroad Tracks west of Plant Lane	41.3915	-81.8368	3.72	501760	F, M, C
	Upstream of confluence with Rocky River	41.4176	-81.8668	0.04	T01W79	F, M, C

F = Fish community biology (includes habitat assessment)

M = Macroinvertebrate community biology

C = Water column chemistry

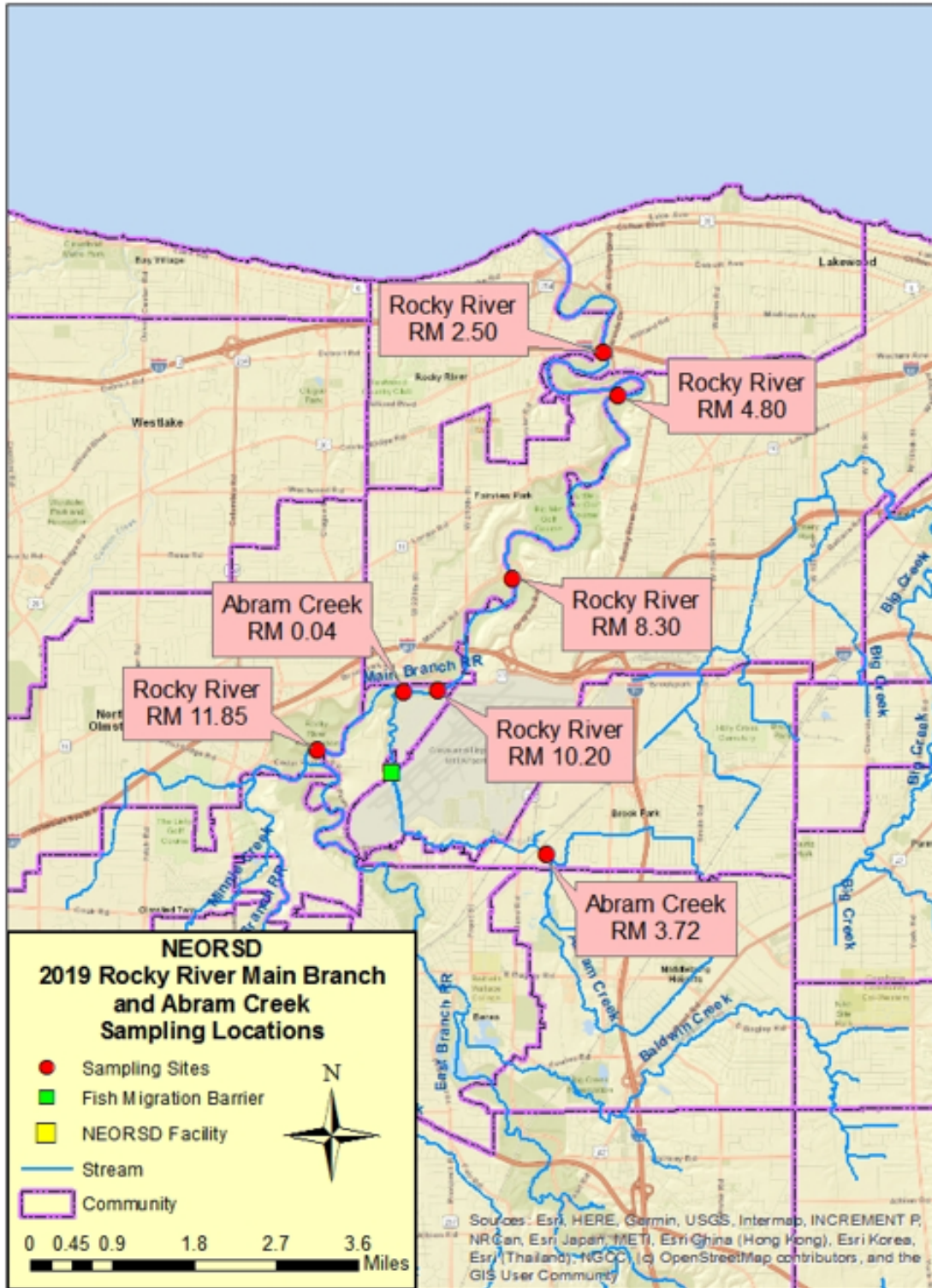


Figure 1. 2019 Rocky River and Abram Creek Monitoring Sites

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The main branch of the Rocky River, downstream of RM 12.10 to the mouth, has been assigned an aquatic use designation described as warmwater habitat (WWH), and is a primary contact recreation water according to the Ohio EPA Water Quality Standards (2018b). Additionally, the Rocky River has been designated as a seasonal salmonid habitat from RM 6.40 downstream to the confluence with Lake Erie. A list of the full beneficial use designations for Rocky River Main Branch and Abram Creek are listed in Table 2.

The current and verified aquatic life use for the entire length of Abram Creek is WWH (2020). In November 2015, the Ohio EPA released *Beneficial Use Support Document Rocky River* following the agency’s 2014 biological assessment of the creek. In the document, the Ohio EPA recommended that the headwaters of Abram Creek (RM 1.0 upstream to RM 4.3) be designated MWH (channel modified) in consideration of the present hydromodifications – a six-foot tall lowhead dam and a culvert that extends between RMs 1.0 and 1.9, which act as permanent fish barriers, lowering the potential of upstream segments to support assemblages of aquatic organisms consistent with the WWH biocriteria. In the July 2020 draft *Biological and Water Quality Study of the Rocky River and Select Tributaries*, however, the agency cited focused local and regional interest in restoration of Abram Creek and the promotion of collaboration among all interested or affected parties as reason for the section of stream to retain the WWH ALU. Ceding to local requests, the Ohio EPA maintained the WWH designation and will reevaluate Abram Creek in 2029, unless otherwise needed.

Table 2. Use Designations for the Rocky River Main Branch and Abram Creek													
Stream	Beneficial Use Designation												
	Aquatic Life Habitat (ALU)							Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Rocky river - State route 10 (RM 6.4) to the mouth	+	+			+				+	+		+	
-confluence of East and West branches (RM 12.1) to state route 10	+	+							+	+		+	
Abram Creek – airport culvert (RM 1.0) to the mouth		+							+	+		+	
-all other segments		+							+	+		+	
SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.													

Water Chemistry & Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between June 18, 2019 and July 30, 2019. Techniques used for sampling and analyses followed the *Ohio EPA*

Surface Water Field Sampling Manual for water quality parameters and flows (2018a). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and one 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid, and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (dissolved reactive phosphorus) was filtered using a 0.45- μ m PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency not less than 5% 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).

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

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, 2018a).

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

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.

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

Results and Discussion

For QA/QC purposes, two duplicate samples were collected over the course of the sampling. The first duplicate sample was collected in the Rocky River Main Branch on June 18, 2019 at RM 4.80. For this sample, all chemical parameters were calculated to have RPD values within the acceptable range. The second duplicate sample was collected in Abram Creek on July 2, 2019, at RM 0.04 (Table 3). Analytical comparison of the original and duplicate samples yielded a RPD of 95.8 when quantifying the total suspended solids (TSS) in each sample. Given that the acceptable threshold of the calculated RPD is ≤ 29.2 , both data points must be rejected, as defined

in the Ohio EPA Surface Water Field Sampling Manual (2018a). Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity, and/or improper handling of samples.

Table 3. Duplicate sample with RPD greater than acceptable					
Stream	River Mile	Date	Parameter	Acceptable RPD	Actual RPD
Abram Creek	0.04	7/2/19	TSS	29.2	95.8

Two field blanks were collected during the sampling period: the first occurred on June 18, 2019, at Rocky River RM 11.85, and the second on July 17, 2019, at Rocky River RM 2.50. On June 18, 2019, two water quality parameters showed potential field blank contamination: arsenic data was downgraded to “level 2” and selenium data was rejected (Table 4). The field blank on July 16, 2019, also showed potential contamination with chemical oxygen demand (COD) results being rejected. It is unclear how the field blanks became contaminated and may be due to inappropriate sample collection, handling, contaminated blank water and/or interference during analysis. As defined in the Ohio EPA Surface Water Field Sampling Manual (2018a), when a result/field blank result falls within the range of $< 3x \text{ Result} \leq 5x \text{ Blank}$, it should be downgraded to “level 2 data” – describing that the analyte is likely present, but with poor confidence in the numerical result. Additionally, if $\text{Result} \leq 3x \text{ Blank}$, results must be rejected as insufficiently different from blank results.

Table 4. Parameters affected by possible blank contamination		
Parameter	Qualifier	Reason
As	Downgraded “level 2”	$< 3x \text{ Result} \leq 5x \text{ Blank}$
Se	Rejected	$\text{Result} \leq 3x \text{ Blank}$
COD	Rejected	$\text{Result} \leq 3x \text{ Blank}$

Paired parameters were evaluated for QA/QC purposes on all samples where one parameter is a subset of another. No paired parameters exceeded the relative percent difference threshold; therefore, all paired parameters were accepted as valid. However, total dissolved solids, a sub-parameter of total solids, yielded a higher numeric value in one sample. Consequently, these parameters were downgraded to estimated values (Table 5).

Table 5. Unacceptable Paired Parameter RPDs						
Stream	River Mile	Date	Paired Parameters	Acceptable RPD (%)	Actual RPD (%)	Qualifier
Abram Creek	0.04	7/24/2019	TS/TDS	16.2	0.4	J
J=Result is estimated.						

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The primary contact recreation criteria for the Rocky River consists of two components: an *Escherichia coli* (*E. coli*) criterion not to exceed a statistical threshold value (STV) of 410 colony counts per 100 milliliters in more than ten percent of the samples taken during any ninety-day period, and a ninety-day geometric mean criterion of 126 colony counts/100mL (Ohio EPA 2018b). In accordance with Ohio EPA procedure and practice to qualify *E. coli* exceedances for the Primary Recreation criteria, the geometric mean and STV are only calculated and compared when a minimum of five bacteriological samples have been collected. The STV of 410 colony counts/100mL in more than ten percent of the samples taken was exceeded at all sampling sites in 2019. Additionally, all sites exceeded the ninety-day geometric mean criterion of 126 colony counts/100mL (Table 6, 7). Three of the five sampling dates were conducted during a wet-weather event¹, which may lead to elevated *E. coli* densities due to CSOs, sanitary sewer overflows, and urban runoff. Other likely sources of the elevated *E. coli* densities include failing household sewage treatment systems (HSTs), illicit discharges, and wildlife. The results of the water chemistry and bacteriological samples were compared to the applicable water quality standards to determine attainment status for those designated uses.

Table 6. 2019 Rocky River Main Branch <i>E. coli</i> Densities (MPN/100mL)					
Date	RM 11.85	RM 10.20	RM 8.30	RM 4.80	RM 2.50
6/18/2019*	1,476	2,388	1,946	2,442.5	2,982
6/25/2019*	14,520	12,100	12,760	8,820	11,620
7/2/2019	368	212	180	254	206
7/9/2019	632	4,280	4,570	304	263
7/16/2019*	2,008	1,377	8,650	4,200	2,290
90-day Geomean	1,585	2,049	2,815	1,475	1,339

	Exceeds statistical threshold value
	Exceeds geometric mean criterion for 90-day period

*Wet-weather event: 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.

¹ Wet-weather event: 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 7. 2019 Abram Creek <i>E. coli</i> Densities (MPN/100mL)						
Date	7/2/2019	7/9/2019	7/16/2019*	7/24/2019*	7/30/2019*	90-day Geomean
RM 3.72	236	783	1,815	4,410	640	989
RM 0.04	300	414	81,640	282	1,653	1,364
	Exceeds statistical threshold value					
	Exceeds geometric mean criterion for 90-day period					
	*Wet-weather event: 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.					

Statewide water quality criteria for the Protection of Aquatic Life requires that waters designated as a WWH must maintain a dissolved oxygen (DO) Outside Mixing Zone Minimum (OMZM) concentration of 4 mg/L at any time (Ohio EPA 2018). Abram Creek RM 3.72 was the only sample location which failed to meet the DO criterion and exhibited low oxygen water column measurements for all sampling events conducted during the 2019 field season. This is likely due to the slow-moving water of the wetland type habitat that characterizes much of the assessment zone in this section of impounded stream. The sampling site is also located 750 meters downstream of Lake Abram and its surrounding marsh which contains an abundance of decomposing underwater vegetation and stagnated water flow. The field DO measurement exceedances for RM 3.72 can be viewed in Table 8 below.

Table 8. Abram Creek RM 3.72 Field DO exceedances (mg/L)		
Date	Result	Criterion
7/2/2019	3.4	4
7/9/2019	2.1	4
7/16/2019	1.7	4
7/24/2019	3.8	4
7/30/2019	2.1	4


Mercury analyses for all sampling events were completed using EPA Method 245.1. The detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), therefore, it generally cannot be determined if sites were in attainment of those criteria. This type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. Water chemistry sampling at all sites in 2019 generally yielded mercury concentrations below the method detection limit for EPA Method 245.1. It is undetermined whether the use of EPA Method 1631E, a low-level method, instead of EPA Method 245.1, would have resulted in exceedances of the criteria.

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In 2015, the Ohio EPA Nutrients Technical Advisory Group released a proposed Stream Nutrient Assessment Procedure (SNAP) designed to determine the degree of impairment in a stream due to nutrient enrichment. The SNAP assigns designations for quality of surface waters based on factors including DO swings, benthic chlorophyll *a*, total phosphorous, and dissolved inorganic nitrogen (Ohio EPA 2015b). NEORSD did not collect benthic chlorophyll *a* in 2019; however, nutrient concentrations were assessed for general watershed monitoring purposes. DO swings were measured at a data sonde located at Rocky River RM 4.20.

Table 9 shows the 2019 nutrient concentrations for all sampling sites. The results of dissolved inorganic nitrogen (DIN) and total phosphorous (TP) were compared to Table 2 listed in the SNAP document (Figure 2). According to this section of SNAP, all sites on the Rocky River Main Branch received an ecological risk narrative level described as “levels typical of working landscapes; low risk to beneficial use if allied responses are within normal range,” (Ohio EPA 2015). Abram Creek at RM 0.04 was calculated to be at an ecological risk narrative level described as “levels typical of developed lands; little or no risk to beneficial uses.” The sampling site at Abram Creek RM 3.72 showed slightly elevated concentrations of DIN and TP; according to the SNAP analysis chart it received an ecological risk narrative level described as “levels typical of enriched conditions, low risk to beneficial use if allied responses are within normal ranges.”

Allied response indicators include 24-hour dissolved oxygen swings and benthic chlorophyll *a* concentrations. While NEORSD did not collect benthic chlorophyll *a* during this study, daily DO swings were collected from the data sonde located at RM 4.20. The Ohio EPA defines wide DO swings which may have a negative effect on aquatic life as swings greater than 6.5 mg/L daily. Daily measurements from June 15, 2019 to October 14, 2019, reported only one occurrence of a twenty-four hour DO fluctuation reaching 6.65 mg/L. The remaining days were all calculated to have diel DO swings below the 6.5 mg/L threshold, indicating that nutrient concentrations display a low risk of causing impairment of the Rocky River beneficial uses.

Table 9. Nutrient Results for the Rocky River used in 2019 SNAP Analysis							
Stream	River Mile	Geomean DIN (mg/L)	StdDev DIN	Geomean Total-P (mg/L)	StdDev Total-P	Geomean DRP (mg/L)	StdDev DRP
Rocky River	11.85	1.436	1.004	0.097	0.065	0.023	0.012
	10.20	1.349	0.785	0.117	0.132	0.029	0.020
	8.30	1.597	1.971	0.112	0.120	0.026	0.017
	4.80	1.168	0.324	0.119	0.126	0.025	0.015
	2.50	1.112	0.352	0.115	0.106	0.025	0.012
Abram Creek	3.72	0.386	0.155	0.191	0.036	0.051	0.032
	0.04	0.146	0.390	0.072	0.024	0.017	0.011
 Data used in Table 2 of SNAP (Ohio EPA, 2015b)							

		← DECREASING RISK				
TP Conc. (mg/l)		DIN Concentration (mg/l)				
		<0.44	0.44 < 1.10	1.10 < 3.60	3.60 < 6.70	≥6.70
DECREASING RISK ↑	<0.040	background levels typical of least disturbed conditions	levels typical of developed lands; little or no risk to beneficial uses	levels typical of modestly enriched condition in phosphorus limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; otherwise atypical condition with moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
	0.040- <0.080	levels typical of developed lands; little or no risk to beneficial uses	levels typical of developed lands; little or no risk to beneficial uses	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
	0.080- <0.131	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated; increased risk with poor habitat	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.0% of observations)
	0.131- <0.400	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors
	≥0.400	atypical condition (1.3% of observations)	atypical condition (1% of observations);	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors

"allied responses" = allied response indicators (24-hour DO swing, benthic chlorophyll)

Figure 2. Table 2 of the Stream Nutrient Assessment Procedure (Ohio EPA, 2015b)

Land Cover Analysis

A land cover analysis of the Rocky River watershed was performed in 2017. The United States Geologic Survey StreamStats Program was used to obtain a watershed polygon representing the watershed that drains the confluence of the Rocky River and Lake Erie. The corresponding watershed polygon was then imported to ArcMap 10.3 and the intersect tool was used to combine the watershed with the National Land Cover Database, 2011 (Homer et. al 2015). The resulting Figure 3 represents the different land cover types within the Rocky River watershed.

Rocky River Overall Watershed Land Cover

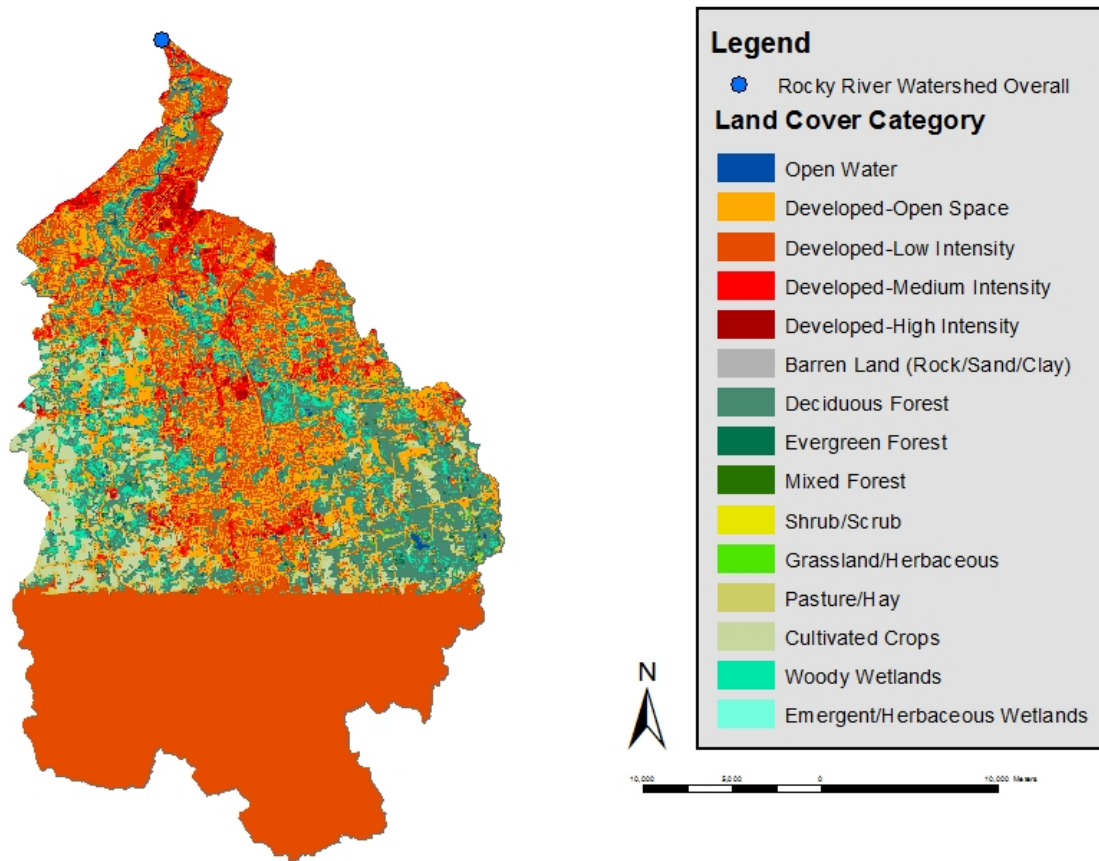


Figure 3. Rocky River Land Cover Map

Highly urban and developed watersheds have been linked to negative water quality and hydrology effects. Pollutants associated with urban runoff include sediments, nutrients, pathogens, oxygen-demanding matter, heavy metals, and salts (Schueler 1987). The northern section of the Rocky River watershed is highly developed, located between the suburban communities of Lakewood and Rocky River, while the southern parts of the watershed consists of a more forested land cover, yet still exhibiting a large proportion of developed land. Highly developed land consists of a vast landscape of impervious surfaces that are designed to remove rainfall as quickly as possible. These highly developed areas lead to increased peak discharges, increased erosion, and increased pollutants transferred to the stream (USEPA 1993). The large amounts of developed and urban landscape that the Rocky River watershed experiences may have a negative effect on the overall water quality.

Habitat Assessment

Methods

An instream habitat assessment was conducted on the Rocky River Main Branch and Abram Creek in 2019 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 values greater than 60 on streams greater than 20 square miles and 55 at streams less than 20 square miles suggests that sufficient habitat exists to support a warmwater fish community. Scores greater than 75 (70 for headwater sites) frequently demonstrate habitat conditions that can support exceptional warmwater faunas (Ohio EPA 2006). 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.

Individual components of the QHEI can also be used to evaluate whether a site is capable of meeting its WWH designated use. This is done by categorizing specific attributes as indicative of either a WWH or modified warmwater habitat (MWH) (Rankin 1995). Attributes that are considered characteristic of MWH are further classified as being a moderate or high influence on fish communities. As modified habitat attributes increase to a MWH:WWH ratio at or greater than 1.0-1.5, the likelihood of achieving WWH attainment of the IBI scores declines (Yoder and Rankin, 1996).

Results and Discussion

Rocky River Main Branch

The main branch of the Rocky River received *Good to Excellent* narrative ratings based on QHEI scores calculated at each sampling site from RM 11.85 downstream to RM 2.50. The average scores of the five assessment zones combined to give the reach a mean QHEI of 72.6. All QHEI scores for the Rocky River Main Branch exceed the Ohio EPA's target score of 60, which suggests that sufficient habitat exists to support a warmwater fish community.

The best types substrate at the Rocky River RM 2.50 assessment zone consisted of boulder slabs and cobble with a moderate to heavy silt narrative. Moderate to sparse amount of instream cover included pools greater than 70 cm, boulders, and woody debris. Development of the riffle/run/pool complex was rated good to excellent, which indicates that riffles were deep, well-defined, and a distinct transition was observed between the riffles and pools. Pool widths measuring less than riffle widths, a moderate overall embeddedness, and a shale substrate origin are all attributes that lowered the overall QHEI score.

Rocky River RM 4.80 exhibited a substrate that most prominently consisted of bedrock and cobble with a normal silt narrative. Moderate to sparse amount of instream cover included pools greater than 70 cm, boulders, and woody debris. Development of the riffle/run/pool complex was rated fair to good, which means defined riffles were present with larger substrates; pools varied

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in depth and there is a distinct transition between pools and riffles. Pool widths measuring less than riffle widths, a moderate overall embeddedness, and a shale substrate origin are all attributes that lowered the overall QHEI score.

The most prominent substrate present at Rocky River RM 8.30 consisted of cobble and bedrock with a moderate silt quality. Sparse instream cover included shallows, boulders, oxbows, and woody debris. The development of the riffle/run/pool complex was rated fair to good, with a low sinuosity and high to moderate stability. The habitat at RM 8.30 lacked instream cover, had a moderate amount of silt present in the substrate, and had pools widths measuring less than riffle widths; all which are attributes that negatively affected the overall QHEI score.

Rocky River RM 10.20 showed a substrate that prominently consisted of bedrock and sand with a normal silt narrative. A sparse amount of instream cover included boulders, root mats and rootwads, overhanging vegetation, aquatic macrophytes, and woody debris. Development of the riffle/run/pool complex was rated fair which means riffles are poorly developed or absent, although pools are more developed with greater variation in depth. Substrate origin and lack of instream cover, combined with a lack of sinuosity and fair channel development, all contributed to a lower overall QHEI score.

The assessment zone at Rocky River RM 11.85 prominently consisted of bedrock and cobble with a normal to moderate silt narrative. Moderate to sparse amount of instream cover included pools greater than 70 cm, boulders, oxbows, and woody debris. Development of the riffle/run/pool complex was rated good which means defined riffles were present with larger substrates; pools varied in depth and there is a distinct transition between pools and riffles. A shale substrate origin and a moderate amount of silt present in the substrate are attributes that lowered the overall QHEI score.

Abram Creek

The QHEI scores at Abram Creek RM 0.04 and RM 3.72 were calculated at 61.5 and 62.5, respectively, with both scores corresponding to a *Good* narrative rating. The QHEI assessment at both Abram Creek sites exceeded the Ohio EPA's target score of 60, which suggests that sufficient habitat exists to support a warmwater fish community.

The best types substrate at the Abram Creek RM 0.04 assessment zone consisted of gravel and bedrock with a normal to moderate silt quality. Sparse instream cover included shallows, undercut banks, boulders, and woody debris. The development of the riffle/run/pool complex was rated fair, with a moderate sinuosity and low stability. A sparse amount of instream cover, a moderate silt quality, and a shale substrate origin are all attributes that lowered the overall QHEI score.

The most prominent substrate present at Abram Creek RM 3.72 consisted of boulders/slabs and silt with a moderate to heavy silt quality. A moderate amount of instream cover included the presence of higher-quality habitats of deep pools, boulders, and woody debris. The development of the riffle/run/pool complex was rated fair, with a moderate sinuosity and low stability. The presence of a silt substrate, a moderate to heavy silt quality narrative, and moderate to extensive amount of embeddedness are attributes which negatively affected the overall QHEI score.

Influential Habitat Attributes

Table 10 lists attributes defined by the Ohio EPA which have both positive and negative influences on the fish community. Negative influences have been identified as attributes that can have the greatest influence on whether the system can support a WWH fish community. Note that the habitat rating is used to determine if the habitat can support a robust fish community and does not necessarily reflect what type of community is found at the site.

Table 10. 2019 Qualitative Habitat Evaluation Index Scores and Physical Attributes

				MWH Attributes																														
				WWH Attributes								High Influence						Moderate Influence																
Stream	River Mile	QHEI Score	Narrative Rating	No Channelization or Recovered Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	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 Depth < 40 cm (WD, HW sites)	Total High Influence Attributes	Recovering Channel	Heavy/Moderate Silt Cover	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 Attributes	(MWH-H.I.+1) / (WWH+1) Ratio	(MWH M.I.+1) / (WWH+1) Ratio	
Rocky River Main Branch	11.85	79.00	Excellent	X	X		X		X	X	X	X	8				X		1		X											2	0.2	0.3
	10.20	66.50	Good	X					X	X			3			X	X	X	3				X							X		2	1.0	0.8
	8.30	63.00	Good	X	X	X			X		X		5				X		1	X		X	X					X	X		5	0.3	1.0	
	4.80	79.00	Excellent	X	X	X		X	X	X	X	X	8				X		1			X	X									2	0.2	0.3
	2.50	75.50	Excellent	X	X	X		X	X		X		6			X	X		2	X		X						X	X		4	0.4	0.7	
Abram Creek	3.72	62.50	Good	X	X		X	X	X		X		6	X					1	X		X	X					X	X		5	0.3	0.9	
	0.04	61.50	Good	X	X		X		X	X	X	X	7				X		1	X		X									2	0.3	0.4	

High quality WWH attributes at all sites except RM 10.20 on the Rocky River Main Branch included boulder/cobble substrates, fast current, and a maximum overall depth greater than 40 centimeters (cm); a transition to sand/bedrock substrate of limestone origin, with fair development and a maximum depth less than 40 cm was exhibited from RM 11.85 to 10.20. Factors that consistently contributed to moderate influence attributes at the Rocky River sites included low sinuosity, heavy/moderate silt cover, and fair development. A lack of overall instream cover at all sites contributed to the high influence MWH attributes.

Boulder and gravel substrates, moderate sinuosity, fast currents, and maximum depths greater than 40 cm are included in the high quality WWH attributes at Abram Creek RM 3.72 and 0.04. Moderate influence MWH attributes included fair development and heavy to moderate silt cover at both sites; additionally, RM 3.72 exhibited an extensive level of overall and riffle embeddedness. A silt substrate at RM 3.72 and sparse instream cover at the RM 0.04 assessment zones contributed to the high influence MWH attributes on Abram Creek.

Fish Community Biology

Methods

Two quantitative electrofishing passes were conducted at each site on the Rocky River and Abram Creek in 2019. A list of the dates when the surveys were completed, along with daily average flow measured at the United States Geological Survey gage station near Berea, Ohio (USGS# 04201500) is given in Table 11. Corresponding data for the Abram Creek flow gage (USGS# 04201526) near Brook Park, Ohio can be found in Table 12. Sampling was conducted using a roller pram and longline electrofishing techniques which consisted of shocking all habitat types within the 0.15- and 0.20-kilometer sampling zones while moving from downstream to upstream. The methods 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 to species, counted, and/or 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 11. Rocky River Sampling Dates and River Flows		
Date	Sites sampled (RMs)	Daily Mean Flow (CFS)
07/29/2019	11.85	58.6
08/02/2019	4.80	70.8
08/28/2019	2.50, 8.30	66.4
08/30/2019	10.20	28.2
09/26/2019	4.80	18.6
10/03/2019	11.85	21.7
10/04/2019	8.30	18.2
10/07/2019	2.50	15.8
10/08/2019	10.20	14.0

Table 12. Abram Creek Sampling Dates and River Flows		
Date	Sites sampled (RMs)	Daily Mean Flow (CFS)
08/26/2019	0.04	2.33
08/30/2019	3.72	2.18
10/04/2019	3.72	1.55
10/08/2019	0.04	1.48

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of the two Ohio EPA indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb). The IBI incorporates twelve

community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish abundance 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 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:
$$MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$$

$\bar{H}(No.)$ = 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

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

The Rocky River and Abram Creek are located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follows the EOLP IBI metric scoring. The 12 IBI metrics utilized for wading and headwater sites are listed in Table 13. The WWH IBI scoring criterion in the EOLP is 40 for headwater streams and 38 for wading streams. The WWH MIwb scoring criterion in the EOLP is 7.9 for wading sites. The MIwb is not applicable for headwater sites where drainage areas are less than 20 mi². A site is considered to be within nonsignificant departure (NSD) if the score falls within 4 IBI units or 0.5 MIwb units of the criterion (Table 14).

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

Table 13. IBI Metrics	
Wading sites	Headwater sites (<20 sq. miles)
Number of indigenous fish species	Number of indigenous fish species
Number of darter species	Number of darter species
Number of sunfish species	Number of headwater species
Number of sucker species	Number of minnow species
Number of intolerant species	Number of sensitive species
Percent tolerant species	Percent tolerant species
Percent omnivore species	Percent omnivore species
Percent insectivore species	Percent insectivore species
Percent of top carnivore species	Percent pioneering species
Number of individuals (minus tolerants)	Number of individuals (minus tolerants)
Percent of simple lithophilic spawners	Number of simple lithophilic species
Percent DELT anomalies	Percent DELT anomalies

Table 14. Fish Community Biology Scores in the EOLP Ecoregion							
Ohio EPA Narrative	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
IBI Score - Headwater	12-17	18-27	28-35	36-39	40-45	46-49	50-60
IBI Score – Wading	12-17	18-27	28-33	34-37	38-45	46-49	50-60
MIwb Score (Wading only)	0-4.4	4.5-5.8	5.9-7.3	7.4-7.8	7.9-8.8	8.9-9.3	≥9.4
Ohio EPA Narrative	Non-Attainment			NSD	Attainment		
NSD – Non-Significant Departure of WWH attainment							

Results and Discussion

Rocky River Main Branch

Three assessment sites on the Rocky River Main Branch (RMs 8.30, 4.80, 2.50) were calculated to be in full attainment for the WWH aquatic life use criterion. The Rocky River site at RM 11.85 also achieved attainment status but included an average IBI score within the non-significant departure range of the WWH attainment biocriterion. The assessment zone at RM 10.20 was in non-attainment of the State of Ohio’s aquatic life use designation with an average IBI score of 30 and a MIwb score of 7.2, which indicates an Ohio EPA narrative rating of *Fair*. The complete fish assessment scores for 2019 can be viewed in Table 15.

Table 15. 2019 Fish Community Assessment Scores							
Waterbody	River Mile	1 st Pass		2 nd Pass		Average	
		IBI	MIwb	IBI	MIwb	IBI	MIwb
Main Branch Rocky River	11.85	38	8.6	30*	7.2*	34 ^{ns}	7.9
	10.20	28*	7.4 ^{ns}	32*	6.9*	30*	7.2*
	8.30	40	8.5	40	8.2	40	8.4
	4.80	44	9.1	42	9.4 ^E	43	9.3
	2.50	50 ^E	9.9 ^E	44	9.4 ^E	47	9.7 ^E
Abram Creek	3.72	<u>20</u> *	--	<u>20</u> *	--	<u>20</u> *	--
	0.04	34*	--	46	--	40	--

*Significant departure from biocriterion (>4IBI; >0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range
^{ns} non-significant departure from biocriterion (≤4IBI; ≤0.5 MIwb units)
^E Exceptional WWH score

Fish community assessments in the segment of the Rocky River Main Branch from RM 8.30 downstream to RM 2.50 indicated very good water quality conditions. The assessment zone at RM 2.50 was calculated to have an average MIwb metric score of 9.7; this corresponds to the highest Ohio EPA narrative, classified as an *Exceptional WWH*. Utilizing the IBI metric, RM 2.50 received an overall narrative rating of *Very Good* with an average score of 47. The first electrofishing pass at RM 2.50 rated as *Exceptional* from an assessment IBI score of 50 and a MIwb score of 9.9. An MIwb score during the second pass at RM 2.50 was calculated at 9.4 and a narrative rating of *Exceptional*.

The Rocky River sampling zone at RM 4.80 scored slightly lower during electrofishing assessments but was still well within the WWH criterion. The overall MIwb score of 9.3 and IBI score of 43 correlated with narrative ratings of *Very Good* and *Good*, respectively. The assessment zone at RM 8.30 was calculated to be in full aquatic life attainment, receiving an averaged IBI score of 40 and MIwb score of 8.4, with an overall narrative rating of *Good*. Additionally, the assessment zone at RM 11.85 resulted in attainment of the WWH biocriterion, receiving an average MIwb score of 7.9 and a *Good* narrative rating, although the final IBI score (34) for the assessment zone at RM 11.85 fell within the non-significant departure range of the WWH attainment designation.

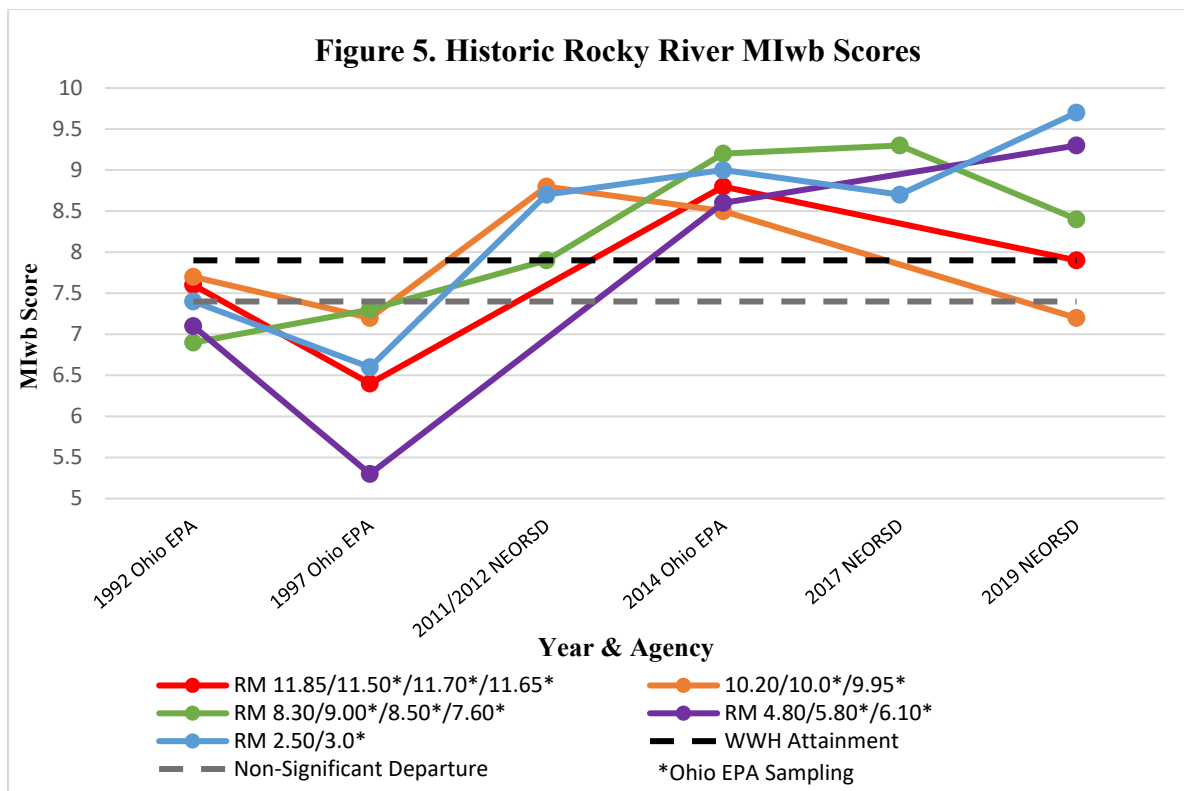
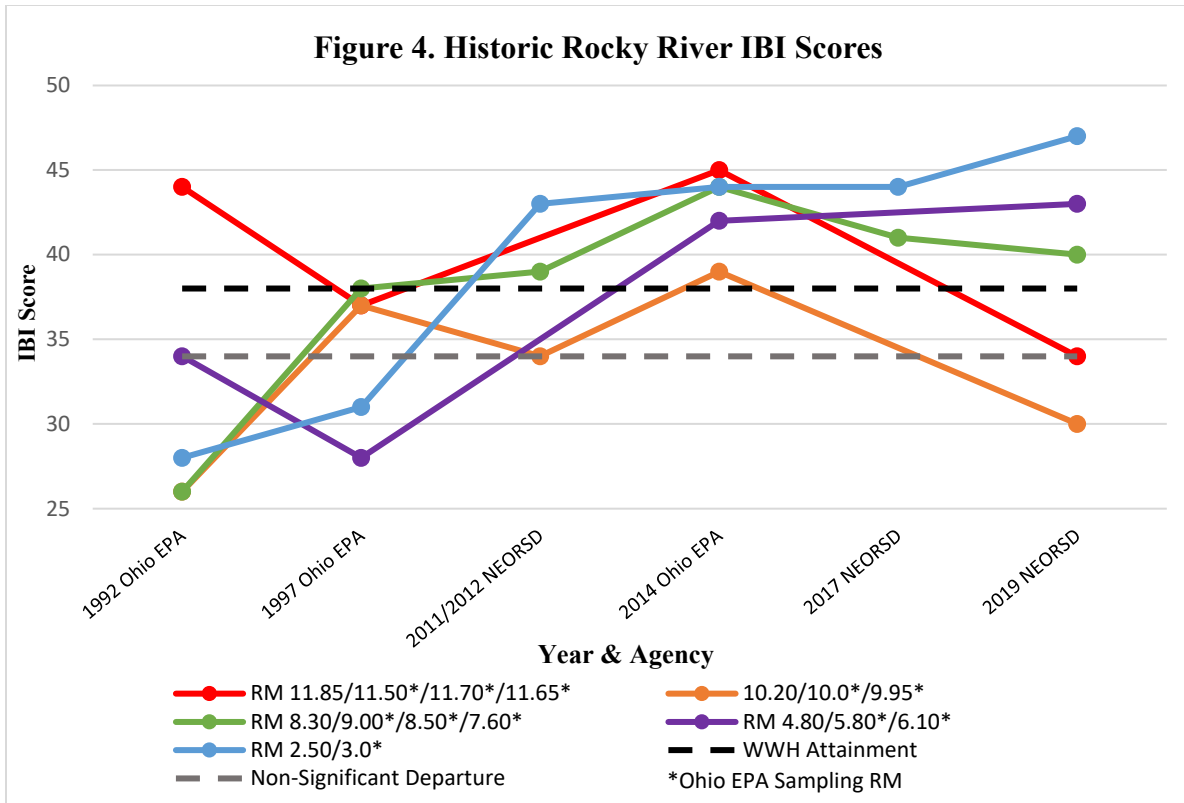
Historic IBI and MIwb scores indicate that RM 10.20 has been in full or partial attainment of WWH status dating back to the bioassessment conducted by the Ohio EPA in 1997. The fish survey conducted by the NEORS in 2020 showed that Rocky River at RM 10.20 resulted in fish community assessment scores with significant departure from the WWH aquatic life use criterion. The sampling zone at RM 10.20 exhibited the presence of high influence MWH attributes, specifically sparse instream cover and the lack of well-developed pools and runs and is located downstream of the North Olmsted Wastewater Treatment Plant (WWTP) mixing zone at RM 11.30. These factors may have combined to cause an adverse effect on fish community biology and influenced impairment of this section of stream, despite the site achieving attainment status in the past. The first electrofishing pass received a narrative rating of *Fair* based on the IBI score of

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28 – a slightly higher rating of *Marginally Good* was produced using the MIwb metric that fell within the non-significant departure range of the WWH attainment status. The second pass at RM 10.20 was calculated to have an IBI score of 32 and MIwb score of 6.9, averaging to an overall IBI of 30 and MIwb of 7.2 with a narrative rating of *Fair*. Low diversity amongst sucker and pollution-intolerant species, combined with a low abundance of insectivores and lithophilic spawning species, indicates a habitat limited environment at RM 10.20. Additionally, the proportion of top carnivore species collected at the sample location may be misleading due to the small size of the fish (average weight less than 0.075 pounds), further indicating a lack of suitable habitat for larger predators.

Three fish species listed by Ohio EPA as pollution intolerant were collected on the Rocky River in 2019: rosyface shiners (*Notropis rubellus*), mimic shiners (*Notropis volucellus*), and stonecat madtoms (*Noturus flavus*). While the presence of fish listed as pollution intolerant is generally a sign of good water quality within the river, no sampling site received a metric score greater than 3 based on the number of intolerant species. This may indicate the effects of the highly urbanized watershed on water quality throughout the sampling reach. The efforts by NEORSD and local municipalities to eliminate dry and wet weather sanitary sewage discharges to the river may have helped improve the fish community. A continued effort may help these sites meet the criteria of an exceptional warmwater habitat in the future.

The Rocky River has historically been monitored by the Ohio EPA since 1981. Improvements to the Rocky River fish community have been noted, as fish community scores struggled to meet WWH attainment prior to 1997 (Figures 4, 5) (Ohio EPA, 1993, 1999b) and are now in partial or full attainment along most Rocky River sites. Significant improvements and elimination of several WWTPs discharging to the Rocky River have resulted in declines in ammonia concentrations, although nutrient concentrations are still elevated compared to Ohio reference sites. However, bacteria densities still indicate sewage contamination throughout the watershed.

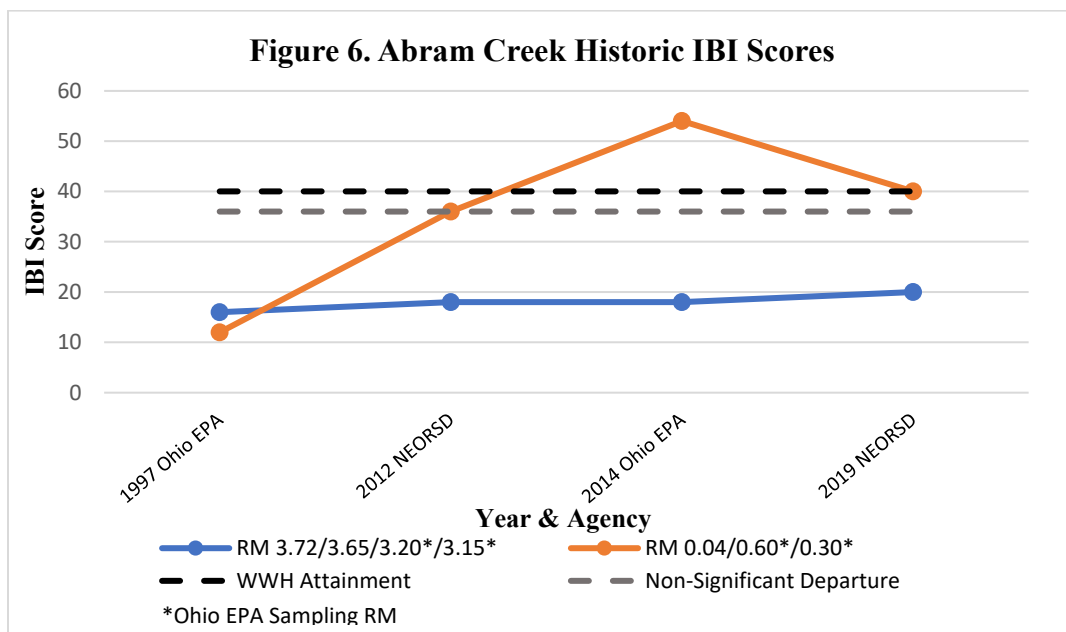


Abram Creek

Abram Creek RM 0.04 met the attainment status of the WWH aquatic life use designation with an average IBI score of 40 and narrative rating of *Good*. The first electrofishing pass at RM 0.04 produced an IBI of 34 and rated as *Fair* but increased by 12 points to a score of 46 and a rating of *Very Good* on the second pass. This is due in part to an increase in the number of species collected, increase in pollution-sensitive species, and greater proportion of insectivorous species collected during the assessment. The increased quantity of fish collected on the second pass may be caused by seasonal variability in fish populations. Overall, Abram Creek at RM 0.04 had an average IBI score calculated at 40 and a narrative rating of *Good*.

The section of Abram Creek surveyed at RM 3.72 failed to meet the WWH attainment status criterion. The IBI score calculated at this site for both electrofishing passes was 20, averaging to a score of 20 and receiving an overall narrative rating of *Poor*. Consistent OMZM exceedances referenced in Table 8 indicate that the low oxygen environment at RM 3.72 would have difficulty supporting a substantial aquatic community, with some field DO measurements indicating near hypoxic conditions. The assessment zone at RM 3.72 is located upstream of a waterfall and a mile-long culverted section of the creek that act as fish barriers, reducing the overall number of species able to access the upper reach. No more than 10 species were collected on each electrofishing pass, and of these species, more than ninety-six percent were comprised of the pollution-tolerant type. An absence of darter and headwater species collected at RM 3.72 also contributed to a reduction in the IBI score.

Abram Creek RM 0.04 was in full aquatic life use attainment, but showed a decline compared to the historical sampling done by the Ohio EPA (2014). An improvement in quality was seen from the 2012 NEORS D biological assessment, which previously found this section of stream to be in the non-significant departure range. The sampling site at RM 3.72 showed only slight improvement compared to the previous assessment and continues to exhibit poor fish community attributes. A chart displaying the historic IBI scores for Abram Creek can be seen in Figure 6 below.



Macroinvertebrate Sampling

Methods

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. Sampling was conducted at all locations listed in Table 1. 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 collected macroinvertebrate specimens were sent to *EA Engineering, Science, and Technology, Inc.* 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 NEORS WQIS department.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA’s Invertebrate Community Index (ICI). The ICI consists of ten community metrics (Table 16), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa collected. The sum of the individual metric scores result in the overall ICI score. This scoring evaluates the macroinvertebrate community against Ohio EPA’s reference sites for each specific eco-region. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 17) and a site is considered within NSD if the score falls within 4 ICI units.

Table 16. 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

Table 17. Invertebrate Community Index (ICI) Range for EOLP Ecoregion								
Ohio EPA Narrative	Very Poor	Poor	Low Fair	Fair	Marginally Good	Good	Very Good	Exceptional
ICI Score	0-6	8-12	14-20	22-28	30-32	34-40	42-44	46-60
Ohio EPA Status	Non-Attainment				NSD		Attainment	
NSD – Non-Significant Departure of WWH attainment								

Results and Discussion

Rocky River Main Branch

In 2019, each Rocky River Main Branch macroinvertebrate sampling site, excluding RM 10.20, were found to be in full attainment of the WWH aquatic life use criterion for invertebrate community biology. Each site resulted in ICI scores in the range of 34-40 and received an overall narrative rating of *Good*. RM 10.20 scored just below the NSD threshold with an ICI score of 28. Historical data was used to compare temporal trends between Ohio EPA’s 1992, 1997, and 2014 bioassessments and the macroinvertebrate community biology scores from the NEORS D 2017 and 2019 assessments of the Rocky River Main Branch (Table 18). Ohio EPA’s 1992 macroinvertebrate community biology scores show all sites to be in non-attainment or in the non-significant departure range of the ICI WWH criterion. Since then, considerable improvement of the macroinvertebrate community was observed leading up to the 2014 Ohio EPA assessment. However, recent trends indicate a decline in the ICI scores from two sites (RMs 8.30, 2.50) in 2017 and in four out of five sites from the most recent macroinvertebrate assessment performed by NEORS D in 2019.

Table 18. Historic Rocky River Main Branch ICI Scores						
	1992 Ohio EPA	1997 Ohio EPA	2011/2012 NEORS D	2014 Ohio EPA	2017 NEORS D	2019 NEORS D
RM 11.85/11.60* /11.50*/11.65*	MG	48	N/A	50	N/A	34
RM 10.20/9.80* /10.0*/9.95*	F	G	34	44	N/A	28
RM 8.30/9.00*	30	30	44	G	36	34
RM 4.80/5.80*	MG	G	N/A	40	N/A	40
RM 2.50/2.90* /3.00*	MG	46	N/A	42	36	36
*Ohio EPA Sampling River Mile a- Narrative evaluation used in lieu of ICI numeric score (Exc.=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor; VP=Very Poor)						

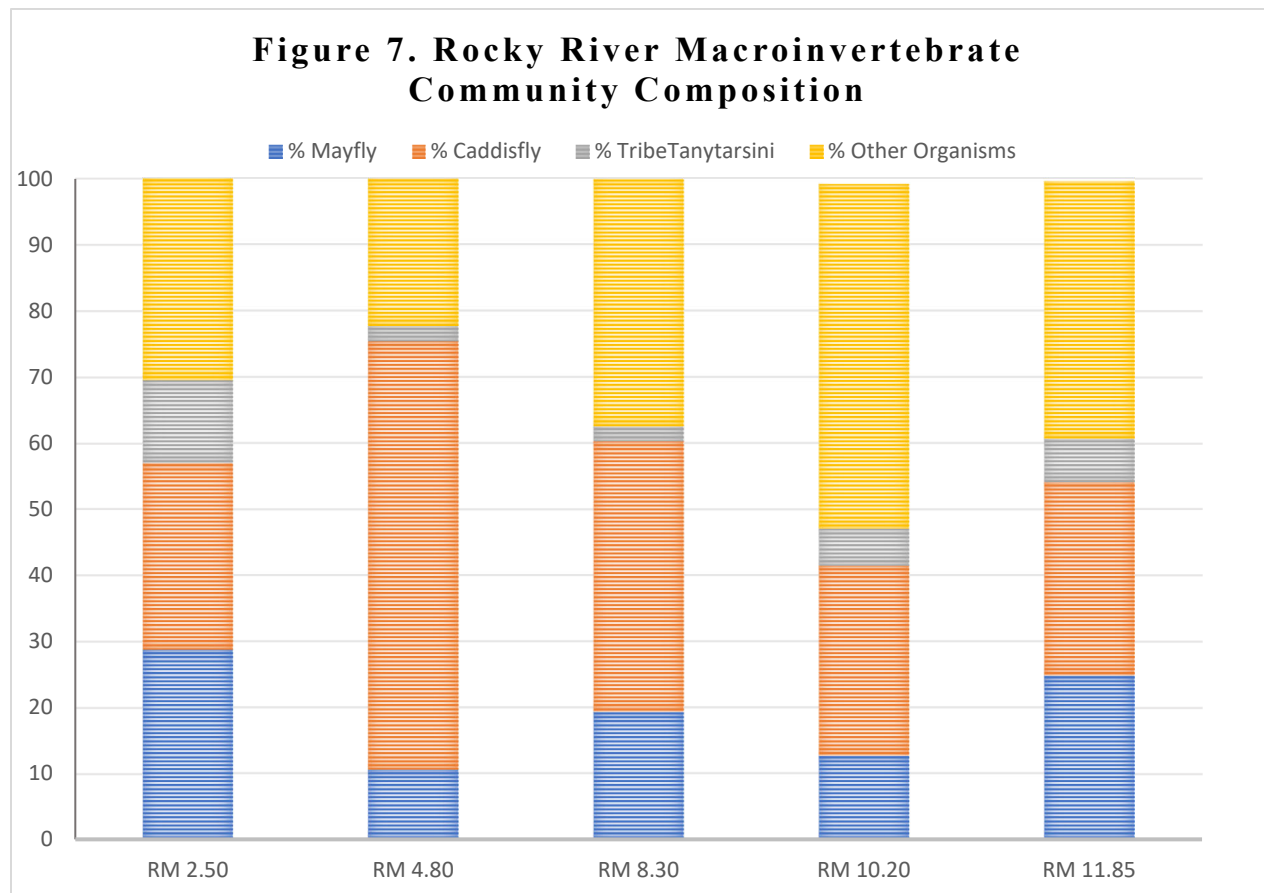
Table 19 displays a more detailed description of the Rocky River assessment sites. All sites displayed a diverse and abundant EPT taxa composition and low proportion of pollution-tolerant species. The assemblage of macroinvertebrates collected shows that sites at RMs 2.50, 4.80, and 11.85 contain an established population of organisms that are considered sensitive to water pollution, with RM 11.85 being comprised of 43.3% sensitive organisms. The sample site at RM 4.80 showed to have the greatest ratio of pollution tolerant organisms at 4.3%, yet yielded an ICI score of 40, the highest of all the sites. At least two of the ten ICI metrics were scored at a 6 at each site along the Rocky; with a slight improvement in the number of EPT taxa and a lower

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percentage of other diptera and non-insects, RM 10.20 has the future potential to reach full attainment for the WWH aquatic life use criterion.

Table 19. 2019 Rocky River Main Branch Macroinvertebrate Results							
River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant Organisms	% Sensitive Organisms	Narrative Rating
11.85	34	2556	48	10	1.2	43.3	Good
10.20	28	2074	42	10	1.2	14.6	Fair
8.30	34	5022	36	8	0.6	19.4	Good
4.80	40	4620	44	11	4.3	25	Good
2.50	36	2742	38	11	0	32.1	Good

Figure 7 displays the macroinvertebrate community composition for each sample site. All sites displayed a high number of total taxa which consisted mostly of caddisfly taxa, accounting for 64.77% of the macroinvertebrates collected at RM 4.80. Mayfly, as well as other diptera and non-insects were present in moderate amounts, with tribe tanytarsini midges present, but rarer. Caddisfly and mayfly taxa are generally considered to be pollution-sensitive species and an indicator of good water quality. The two taxa combined to equal more than 54% of the total macroinvertebrate population at each Rocky River sampling site – the exception being RM 10.20, which only saw a collective 41.51% mayfly and caddisfly ratio.



Abram Creek

Two sites were assessed for macroinvertebrate assemblages on Abram Creek during the 2019 field season; only the HD at RM 3.72 was able to be retrieved. A narrative rating of the sampling site at RM 0.04 is provided in lieu of an ICI numeric score. The macroinvertebrate community at RM 3.72 received a narrative rating of *Low Fair* with a score of 18 and failed to meet the aquatic life use WWH attainment bicriterion (Table 20). Contributing factors to the ICI metric score were the absence of mayfly taxa, lack of EPT taxa, and large number of dipteran and other non-insects collected – all taxa collected were comprised of 89.44% of the latter, with tanytarsini midges and caddisflies contributing 8.38% and 2.17%, respectively. Nearly a quarter of all organisms collected from the HD were classified as tolerant species, compared to none being classified as sensitive.

Table 20. 2019 Abram Creek Macroinvertebrate Results							
River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant Organisms	% Intolerant Organisms	Narrative Rating
3.72	18	1762	30	3	23.4	0	<i>Low Fair</i>

The HD at Abram Creek RM 0.04 was found to be buried at the time of qualitative sample collection on August 5, 2019. The qualitative sample results and field narrative ratings were compared to previous data collected by the NEORSD from this site in 2012, and to the Ohio EPA guidance for macroinvertebrate data analysis given in *Biological Criteria for the Protection of Aquatic Life: Vol III* (Ohio EPA, 1987b). Table 21 shows the numbers of taxa, EPT taxa, sensitive taxa, and tolerant taxa, in qualitative samples as well as the historical ICI score and narrative rating. In 2012, Abram Creek RM 0.04 obtained an ICI score of 42 (*Very Good*) due primarily to the following metrics: number of caddisfly taxa, percent caddisflies, percent tanytarsini midges, percent other dipterans and non-insects, and percent tolerant organisms. The 2012 quantitative sample was dominated by tanytarsini midges, which made up 54.1% of the collected specimens. Four tanytarsini taxa were present in both the qualitative and quantitative samples in 2012. This impacted multiple metrics in 2012 including: percent tanytarsini midges, percent other dipterans and non-insects, and percent tolerant organisms, leading to the high ICI score of 42 obtained in 2012. In 2019, while the number of qualitative EPT, sensitive, and tolerant taxa were identical to these numbers in 2012, an approximate 30% drop in total qualitative taxa was observed. This included a complete absence of tanytarsini midges in the qualitative sample in 2019. This indicates that the above-mentioned metrics influenced by the large tanytarsini population in 2012 would most likely have declined in score in 2019, had the HD been recovered. The lead QDC assigned a field narrative rating of *Fair* to the site, based on the high relative abundance of Chironomidae and Simuliidae, and low abundance and diversity of EPT taxa at the site. Additionally, the numbers of qualitative EPT taxa and sensitive taxa at this site in 2019 fell below the expected values for the *Fair* narrative rating published by the Ohio EPA in *Biocriteria Manual Volume III*. Based on the above factors a narrative rating of *Low Fair* was assigned to Abram Creek RM 0.04 in 2019.

Table 21. ICI Narrative Assessment of Abram Creek 0.04						
Year	Total Taxa	EPT Taxa	Sensitive Taxa	Tolerant Taxa	ICI Score	Narrative Rating
2012	32	5	1	9	42	<i>Very Good</i>
2019	23	5	1	9	N/A	<i>Low Fair</i>

Table 22 shows historic ICI scores for Abram Creek. A decline in water quality in 2019 is noted for both sites, as Ohio EPA monitoring in 2014 previously indicated a *Fair* macroinvertebrate community at each one. Compared to the most recent bioassessment performed by the NEORS in 2012, the site at RM 3.72 saw an improvement from the ICI score of 6 while the RM 0.04 site indicated a decline in narrative rating from *Very Good* to *Low Fair*.

Table 22. Historic Abram Creek ICI Scores					
	1992 Ohio EPA	1997 Ohio EPA	2012 NEORS	2014 Ohio EPA	2019 NEORS
RM 3.72/3.40*/3.65/3.15*	N/A	18	6	F	18
RM 0.04/0.30*/0.20*	8	26	42	F	LF
*Ohio EPA Sampling River Mile a- Narrative evaluation used in lieu of ICI numeric score (Exc.=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor; VP=Very Poor))					

Conclusions

For the 2019 sampling season, all Rocky River Main Branch sites except RM 10.20 met full attainment of the WWH aquatic life criteria (Table 23). The fish community received an *Exceptional* narrative rating at RM 2.50, with three other sites receiving *Good* to *Very Good* narratives based on the IBI and MIwb indices. The macroinvertebrate community received a *Good* narrative based on the ICI score when also excluding RM 10.20. Both bioassessments displayed fish and macroinvertebrate species that are considered intolerant to water pollution, which is generally a sign of good water quality within the river. While the overall QHEI score indicate that habitat is not a limiting factor, there were some specific characteristics that may be preventing the aquatic biota from reaching WWH criterion. The fish survey at RM 10.20 was the only assessment with low abundance of intolerant, insectivore, sucker, and lithophilic species which contributed considerably to IBI and MIwb scores that fell out of range of WWH attainment for the first time in twenty-three years. Despite the aforementioned factors, the assessment site at RM 10.20 is exhibiting a broad range of species diversity but it lacks a functional biological community,

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preventing it from reaching attainment status. Overall, the Rocky River narrowly missed having all locations achieve full WWH attainment. The biological communities at these locations have the potential to achieve exceptional WWH criteria as water quality issues continue to be addressed.

Table 23. 2019 Rocky River Biomonitoring Results						
River Mile	Aquatic Life Use Attainment Status	IBI <i>(Narrative Rating)</i>	MIwb <i>(Narrative Rating)</i>	ICI <i>(Narrative Rating)</i>	QHEI <i>(Narrative Rating)</i>	Water Quality Exceedances
11.85	Full	34 <i>Marginally Good</i>	7.9 <i>Good</i>	34 <i>Good</i>	79 <i>Excellent</i>	<i>E. coli</i>
10.20	Non	30 <i>Fair</i>	7.2 <i>Fair</i>	28 <i>Fair</i>	66.50 <i>Good</i>	<i>E. coli</i>
8.30	Full	40 <i>Good</i>	8.4 <i>Good</i>	34 <i>Good</i>	62.50 <i>Good</i>	<i>E. coli</i>
4.80	Full	43 <i>Good</i>	9.3 <i>Very Good</i>	40 <i>Good</i>	79 <i>Excellent</i>	<i>E. coli</i>
2.50	Full	47 <i>Very Good</i>	9.7 <i>Exceptional</i>	36 <i>Good</i>	75.50 <i>Excellent</i>	<i>E. coli</i>

Historical sampling completed by Ohio EPA, along with sampling done by the NEORS D shows continuing improvements to water quality at Rocky River RM 2.50 and 4.80. The remaining sampling sites included in the 2019 Rocky River bioassessment saw an overall decline in fish and macroinvertebrate community scores. Figures 4 and 5 show that the historic Rocky River Main Branch bioassessments failed to meet full WWH aquatic life criterion. More recent sampling from NEORS D and the Ohio EPA showed that these same sections of Rocky River were able to meet attainment status of the WWH aquatic life criterion, which may correlate with improvements in water quality. Improvements from 1992 to present include the elimination of nine WWTPs contributing approximately 10 MGD of treated wastewater effluent from the Rocky River basin, the discontinued use of urea as a deicing agent at Cleveland Hopkins International Airport, and the elimination of sanitary sewage illicit discharges. Despite this, a decline in quality of biological assemblages at 3 of the 5 sampling sites on the Rocky River shows there are still contributing factors affecting water quality with the potential to negate improvements displayed in recent years.

Exceedances of the recreational water quality standards for *E. coli* occurred at all Rocky River sites, which may be due to sanitary sewage contamination. Potential sources of sanitary sewage include CSOs, sanitary sewer overflows, failing HSTs, illicit discharges, wildlife, and urban runoff. Nutrient levels show that the Rocky River displays nutrient levels typical of working landscapes, and current levels display a low risk of causing impairment of the Rocky River beneficial uses.

Table 24. 2019 Abram Creek Biomonitoring Results					
River Mile	Aquatic Life Use Attainment Status	IBI <i>(Narrative Rating)</i>	ICI <i>(Narrative Rating)</i>	QHEI <i>(Narrative Rating)</i>	Water Quality Exceedances
3.72	Non	20 <i>Poor</i>	18 <i>Low Fair</i>	62.50 <i>Good</i>	<i>E. coli</i> Field DO
0.04	Partial	40 <i>Good</i>	N/A <i>Low Fair</i>	61.50 <i>Good</i>	<i>E. coli</i>

Overall, the assessment zone at Abram Creek RM 0.04 showed a quality fish community presence in earning a *Very Good* narrative rating in the latter part of the sampling season. RM 3.72 showed a slight improvement in IBI but still scores in the *Poor* narrative rating range, with field DO exceedances taking place throughout the 2019 sampling. Abram Creek continues to show impairment in the biological community assemblages regardless of good quality habitat, with this most recent assessment indicating a decline from the previous Ohio EPA assessment performed in 2014. Table 24 above shows a composite of these bioassessment scores and narrative ratings obtained from Abram Creek in 2019.

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