NORTHEAST OHIO REGIONAL SEWER DISTRICT

2017 Sagamore Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

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Introduction

The lower Cuyahoga River has been designated as one of 42 Great Lakes Areas of Concern (AOC) by the International Joint Commission. Past monitoring indicated impairment of aquatic biota in the river and was the basis for the establishment of Total Maximum Daily Loads (TMDLs) for the Lower Cuyahoga River. The causes of impairment to the river were classified as organic enrichment, toxicity, low dissolved oxygen, nutrients, and flow alteration (Ohio EPA, 2003). Recent monitoring by the Northeast Ohio Regional Sewer District (NEORSD), however, has shown recovery of the biological community in some reaches of the river. Further monitoring throughout the watershed is necessary to determine what areas may be still impaired.

In 2017, NEORSD conducted environmental assessments including water chemistry sampling, habitat assessments, and fish and macroinvertebrate community surveys on Sagamore Creek, a tributary to the Cuyahoga River. The objective of this study was to conduct environmental monitoring on Sagamore Creek in addition to five other tributaries to the Cuyahoga River as part of NEORSD's general watershed monitoring program. Portions of the tributary data collected will provide additional information to support the continued monitoring of the lower Cuyahoga AOC and the potential delisting of some beneficial use impairments.

Sampling was conducted by the NEORSD Environmental Assessment group of the Water Quality and Industrial Surveillance (WQIS) Division, and occurred from June 15 through September 30, 2017 (through October 15 for fish sampling assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b). 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 *2017 Cuyahoga River Tributaries Environmental Monitoring* approved by Ohio EPA on May 12, 2017.

Figure 1 is a study area map, noting the location of the sampling location evaluated during the 2017 study. Table 1 indicates the sampling location for the study site on Sagamore Creek with respect to river mile, latitude/longitude, description, and the types of surveys conducted. A digital photo catalog of the sampling location is available upon request by contacting the NEORSD WQIS Division.

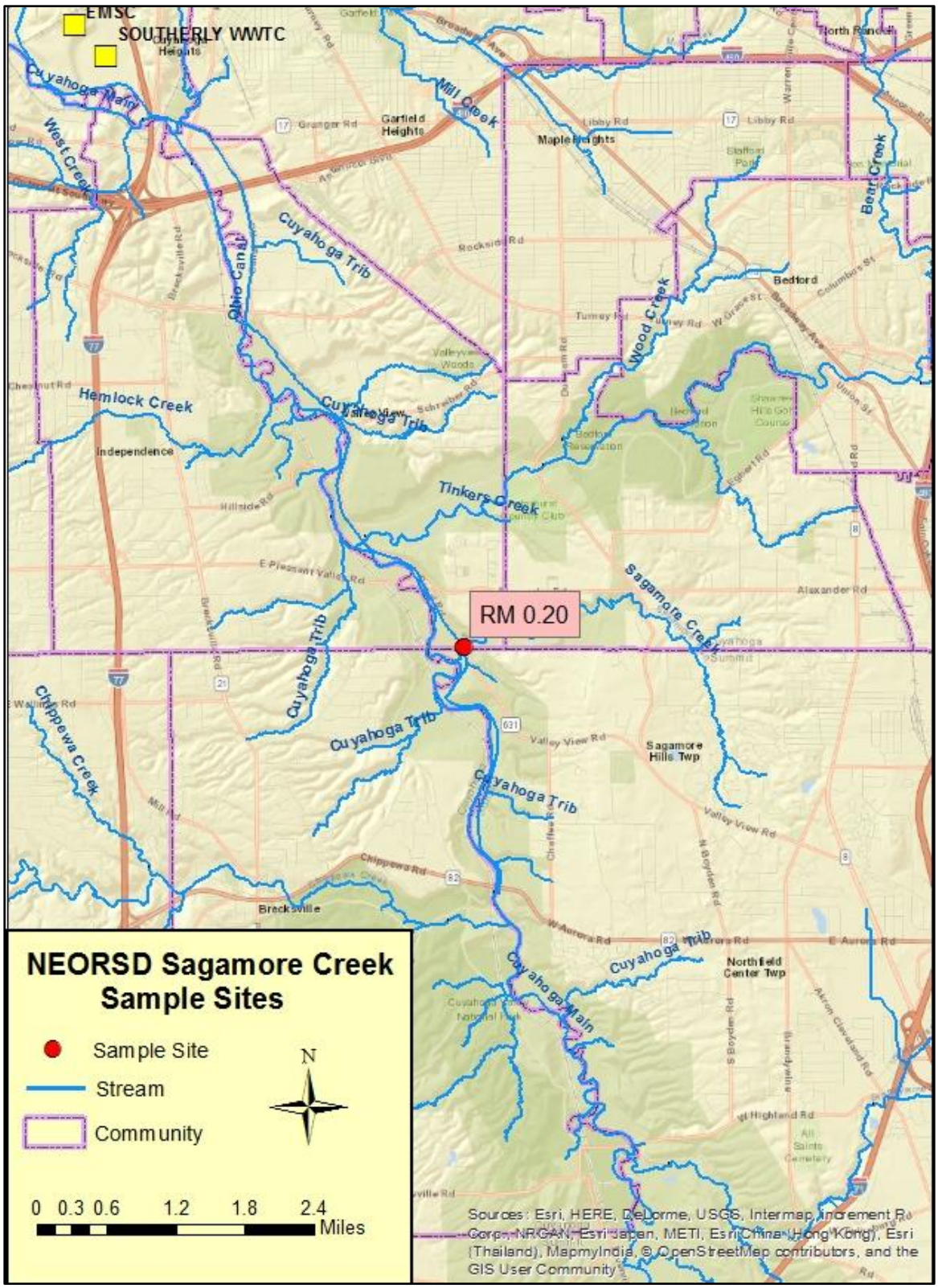

Figure 1. 2017 Sagamore Creek Monitoring Site

Table 1. Sagamore Creek Evaluated Site						
Site Location	Latitude	Longitude	River Mile	Description	HUC 8	Purpose
Sagamore Creek	41.3514	-81.5923	0.20	Upstream of Canal Road	04110002 - Cuyahoga	General watershed monitoring.

Water Chemistry Sampling

Methods

Five separate water chemistry and bacteriological sampling events were conducted between July 26 and August 23, 2017. Techniques used for sampling and analyses were conducted according to methods found in *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2015b). 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-µm 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 either a YSI 600XL sonde or YSI EXO1 sonde. Duplicate samples and field blanks were each collected 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).

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

x= is the concentration of the parameter in the primary sample
y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2015b).

Formula 2: Acceptable % RPD = $[(0.9465x^{-0.344})*100] + 5$
x = sample/detection limit ratio

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

Mercury analysis for all sampling events was completed 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 OMZA, it generally cannot be determined if Sagamore Creek was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the stream.

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

Results and Discussion

For the 2017 study, one duplicate sample and one field blank were collected for quality assurance and quality control (QA/QC) purposes. The duplicate sample was collected at RM 0.20 on August 23, 2017. Two parameters in the duplicate sample, aluminum (Al) and total suspended solids (TSS), were rejected based on RPD values outside of the acceptable RPD range (Table 2). This instance in which the acceptable RPD was exceeded occurred during a wet-weather event[1], which may have caused an increase in stream flow and potential for run-off.

Table 2. Duplicate Parameter Analysis

Site	Date	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
RM 0.20	8/23/2017*	*Al*	49.1	67.4	Rejected
		TSS	89.3	180.0	Rejected

* - Wet Weather Event

One field blank sample was collected at RM 0.20 on August 2, 2017. For the field blank, there were seven parameters that showed possible contamination. It is unclear how the field blank became contaminated and may be due to inappropriate sample collection, handling, and/or contaminated blank water. Table 3 lists water quality parameters that were listed as estimated based on Ohio EPA data validation protocol.

[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 3. Parameters Affected by Possible Blank Contamination
Cr
DRP
Ni
Zn

Paired parameters for all samples collected from RM 0.20 were evaluated for QA/QC purposes. The comparisons revealed no rejected data for the sampling site, and only one set of parameters with estimated data (Table 4). Because there were no exceedances associated with these parameters, qualification of these results did not significantly change the overall water chemistry assessment of Sagamore Creek.

Table 4. Paired Data Parameter Analysis

Date	Site	Parameter	Data Pair	Acceptable RPD (%)	Actual RPD (%)	Qualifier
8/9/2017	RM 0.20	*TP*	*DRP*	42.7	9.8	Estimated

Sagamore Creek is designated Coldwater Habitat (CWH), Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation. The primary contact recreational use criteria apply for *Escherichia coli* (*E. coli*). The water chemistry samples collected at each site were compared to the applicable Ohio Water Quality Standards for the designated uses to determine attainment (Ohio EPA, 2015a).

Water chemistry sampling at RM 0.20 in 2017 revealed mercury concentrations that were below the method detection limit for EPA Method 245.1. It is expected, that the use of EPA Method 1631E, a low-level method, instead of EPA Method 245.1, would have resulted in exceedances of the criteria throughout the sampling period. Mercury may be introduced into Sagamore Creek from urban runoff within the watershed. Apart from the probable mercury exceedances, Sagamore Creek RM 0.20 met all other water quality criteria for the 2017 sampling season.

The Primary Contact Recreation criteria for Sagamore Creek include an *E. coli* criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts/100mL in more than ten percent of the samples taken during any 90-day period, and a 90-day geometric mean criterion of 126 colony counts/100mL (Ohio EPA, 2015a). All sampling events at RM 0.20 met the geomean and STV criteria for the 90-day periods (Table 5).

Table 5. *E. coli* Sampling Results				
Site	Sample Date	Sample Density (Most Probable Number /100ml)	90-Day Geometric Mean (Colony Counts /100ml)	Statistical Threshold Value (% Days >410 Colony Counts /100ml)
RM 0.20	7/26/2017	66	37.6	0.0
RM 0.20	8/2/2017	52	32.7	0.0
RM 0.20	8/9/2017	63	28.0	0.0
RM 0.20	8/16/2017	6	18.7	0.0
RM 0.20	8/23/2017*	58	58.0	0.0

* - Wet-Weather Event

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. SNAP assigns designations for quality of surface waters based on factors including dissolved oxygen (DO) swings, benthic chlorophyll *a*, total phosphorus, and dissolved inorganic nitrogen (Ohio EPA, 2015c). NEORSD did not assess DO swings or benthic chlorophyll *a* in 2017; however, nutrients were assessed.

Table 6 displays the calculated mean nutrient concentrations for Sagamore Creek RM 0.20 in 2017. The results of dissolved inorganic nitrogen and total phosphorus were compared to Table 2 listed in the SNAP document. According to this section of SNAP, the site analyzed on Sagamore Creek exhibits "background levels typical of least disturbed conditions," (Ohio EPA, 2015c). This indicates that neither phosphorus or nitrogen are of a significant concern as a primary source of impairment at this site.

Table 6. 2017 Sagamore Creek Nutrient Concentrations		
Site	Total Phosphorus Geometric Mean (mg/L)	Dissolved Inorganic Nitrogen Geometric Mean (mg/L)
RM 0.20	0.035	0.211

Habitat Assessment

Methods

An instream habitat assessment was conducted once at the sampling site on Sagamore Creek in 2017 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel

morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score of 55 for headwater sites or more suggests that sufficient habitat exists to support a fish community that attains the WWH criterion. A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

The stream segment at RM 0.20 was assessed on July 18, 2017. A QHEI score of 77 was calculated with a narrative rating of *Excellent* (Table 7), exceeding the WWH target score of 55 for a headwater stream, and therefore the ability to support a healthy fish community within the reach. Predominant substrate types within the reach were cobble and gravel. Instream cover was sparse at the time of assessment, with only minimal amounts of undercut banks, rootwads, rootmats, boulders, and logs/woody debris. There were also only small amounts of pools deeper than 70cm, which serve as fish refuge areas. Lack of channelization of the stream reach, minimal to no erosion of the stream reach banks, and the presence of quality riffles with excellent substrate stability were all beneficial factors that positively contributed to the overall score at this site (Table 8).

Table 7. 2017 Sagamore Creek QHEI Results

River Mile	Date	QHEI Score	Narrative
0.20	7/18/2017	77	*Excellent*

Table 8. Sagamore Creek Qualitative Habitat Evaluation Index Score and Physical Attributes																																
														MWH Attributes																		
			WWH Attributes											High Influence						Moderate Influence												
River Mile	QHEI Score	Habitat 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	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**
0.20	77.00	Excellent	x	x		x	x		x	x	x	x	8				x		1													0

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at RM 0.20 on Sagamore Creek in the 2017 sampling season. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers for this 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.

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of the Ohio EPA Index of Biotic Integrity (IBI). 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 twelve 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 twelve metrics utilized for headwater sites are listed in Table 9.

Table 9. Index of Biotic Integrity (IBI) Metrics (Headwater)
Total Number of Native Species
Number of Darters & Sculpins
Number of Headwater Species
Number of Minnow Species
Number of Sensitive Species
Percent Tolerant Species
Percent Pioneering Species
Percent Omnivores
Percent Insectivores
Number of Simple Lithophils
Percent DELT Anomalies
Number of Fish

According to *Biological Criteria for the Protection of Aquatic Life, Volume II* (1987a), there is presently no IBI criterion for the CWH use. A stream may be designated CWH by the predominance, not necessarily just presence, of designated CWH non-salmonid species in the fish community found within the reach.

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

Results and Discussion

For the 2017 electrofishing events, Sagamore Creek RM 0.20 averaged an IBI score of 45, narratively *Good* (Table 9)[2]. The first electrofishing pass, completed on July 18, 2017, achieved an IBI score of 48, narratively *Very Good*. Contributing to this high score, 14 of 15 total species collected were considered native fish, apart from rainbow trout (*Oncorhynchus mykiss*). However, rainbow trout are considered a designated CWH taxa (and a salmonid species), and comprised about 10% of the total sample collection during this event. As this was the only CWH designated taxa found, the reach does not meet the requirements for fish species for CWH. Additionally, four native darter species were present in this reach including the johnny darter (*Etheostoma nigrum*), greenside darter (*Etheostoma blenniodes*), rainbow darter (*Etheostoma caeruleum*), and the barred fantail darter (*Etheostoma flabellare*). Of the fish collected in this sample, 78.1% classified as intermediate or better with regard to pollution tolerance. Having a higher proportion of sensitive species is another indicator of good water quality.

For the second pass, completed on August 15, 2017, Sagamore Creek RM 0.20 achieved an IBI score of 42, narratively *Good*. There were minimal differences in overall sample population composition in comparison to the first pass sample. Again, the only CWH-applicable taxa present was the rainbow trout, comprising only 8.6% of the total sample population during this sampling event. The slight decline in IBI score on the second pass can be explained by the loss of two total taxa, namely two darter species (johnny and greenside), which are also native and sensitive taxa. As well, the total sample population collected declined from 506 individuals in the first pass to 382 in the second. This decline in overall sample size may be attributed to sampling effort, weather, or seasonal population drifts.

Based on the calculation of the QHEI score from the stream habitat assessment that was conducted, Sagamore Creek at RM 0.20 has the ability to sustain a healthy and diverse fish population. The presence of sensitive and native species dominance in the sample reach would support that score.

[2] IBI score range thresholds and narrative ratings are based on warm water habitat (WWH) biocriteria designated by Ohio EPA as outlined in Table P. 8-13 of Biological Criteria for the Protection of Aquatic Life: Volume II (Ohio EPA, 1987a).

Table 9. 2017 Sagamore Creek IBI Results					
	1st Pass		2nd Pass		Average
River Mile	Date	IBI (*Narrative Rating*)*	Date	IBI (*Narrative Rating*)*	IBI (*Narrative Rating*)*
0.20	07/18/2017	48 (*Very Good*)	08/15/2017	42 (*Good*)	45 (*Good*)
* - Based on Ohio EPA WWH Biocriteria Thresholds					

Macroinvertebrate Community Assessment

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 the Sagamore Creek sampling location 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 macroinvertebrate samples were sent to Third Rock Consulting of Lexington, Kentucky, 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 are available upon request from the NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (Ohio EPA 1987b, DeShon 1995). The ICI consists of ten community metrics (Table 10), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa. The total of the individual metric scores result in the overall score. This scoring evaluates the community against Ohio EPA's reference sites for each specific eco-region.

Table 10. ICI Metrics	
Total Number of Taxa	Percent Caddisflies
Number of Mayfly Taxa	Percent Tanytarsini Midges
Number of Caddisfly Taxa	Percent Other Diptera and Non-insects
Number of Dipteran Taxa	Percent Tolerant Organisms (As Defined)
Percent Mayflies	Number of Qualitative EPT Taxa

According to *Biological Criteria for the Protection of Aquatic Life, Volume II* (1987a), there are presently no ICI criteria for the CWH use. However, according to the Volume II text, Ohio EPA does list macroinvertebrate taxa that are indicative of CWH.

Results and Discussion

The HD sampler was successfully recovered from RM 0.20 during the 2017 field season. Combined with qualitative macroinvertebrate sampling on the day of HD retrieval, this allowed for a calculated ICI score to assess the sampling site.

Sagamore Creek RM 0.20 received an ICI score of 48 with a narrative rating of *Exceptional*, for 2017[3]. Of the 43 total taxa found within the sample, only one taxon collected during qualitative sampling, *Boyeria grafiana*, was indicative of CWH. As this was the only indicator species found, it is evident that the sample population does not meet attainment of the CWH use. Contributing metrics that positively influenced the ICI score included Percent Caddisflies and Number of Caddisfly Taxa, which comprised the following taxa: *Cheumatopsyche sp.*, *Ceratopsyche morosa*, *Ceratopsyche sparna*, *Hydropsyche sp.*, and *Hydroptila sp*. This sampling site also had a positive contribution from the Percent Total Mayflies metric, which accounted for 35.83% of the total sample population. Additionally, only six of the macroinvertebrate taxa collected in both the HD and qualitative sample are designated as moderately tolerant to tolerant to pollution according to the Ohio EPA Macroinvertebrate Taxa List (Ohio EPA, 2018). The dominant proportion of the sample population collected classified as facultative or better, which supports the high ICI score. The presence of quality riffle habitat, along with substrate stability within the sample reach, may have been a positive influence on the macroinvertebrate community, which supports that Sagamore Creek RM 0.20 is able to support a diverse and healthy macroinvertebrate population.

Conclusions

The results of the water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys conducted by NEORSD indicate that environmental or human stressors do not heavily impact the Sagamore Creek watershed. Bacteriological sampling showed no exceedances for *E. coli* for any of the sampling events in the 2017 season. With no other exceedances for any of the water quality standards for the Aquatic Life Use, this stream is in full attainment for water quality.

While technically no criterion has been established for IBI for use determination of CWH, the fish community present at the Sagamore sampling location was not indicative of a CWH population. However, this is not to say that the population was poor. Overall, the fish community averaged an IBI score of 45 (narratively *Good*), which would have exceeded the minimum WWH score required and contributed to the attainment of the biocriterion for aquatic life use. Quality riffle habitat, as well as stability within the stream, facilitated Sagamore Creek's suitability to sustain a healthy fish population that would have surpassed WWH standards. Higher water temperatures, possibly caused by lack of shade

[3] ICI score range thresholds and narrative ratings are based on warm water habitat (WWH) biocriteria designated by Ohio EPA as outlined in Table P. 8-13 of Biological Criteria for the Protection of Aquatic Life: Volume II (Ohio EPA, 1987a).

due to sparseness of overall in-stream cover, and shallow reaches minimizing refuge pools, may have been a contributing factor to the lack of dominance of coldwater species inhabiting the stream.

Similar to the absence of a criterion for IBI, there is also no established criterion for macroinvertebrates and ICI for use determination of CWH. Macroinvertebrate population analysis of the Sagamore Creek sample location did not indicate a CWH attaining assemblage, as only one taxon was collected from the site. If this location was assessed based on WWH standards, the overall ICI score of 48 (narratively *Exceptional*), would have surpassed the minimum score required for WWH aquatic life use attainment.

The upper reach of Sagamore Creek (upstream of RM 2.30) has a WWH aquatic life use designation. Apart from the previously mentioned suspected causes, this upstream influence may be one of the larger reasons that the lower reach is not able to achieve CWH attainment. Migration of fish and macroinvertebrates through natural or weather-related methods downstream may cause population shifts and not allow CWH indicator taxa to dominate the reach. While not attaining overall for CWH use standards, it is evident, however, that the lower reach of Sagamore Creek near the confluence of the Cuyahoga River is healthy and able to sustain diverse macroinvertebrate and fish communities.

Table 10. 2017 Sagamore Creek Survey Results

River Mile	Aquatic Life Use Attainment Status	Average IBI Score (*Narrative Rating*)	ICI Score (*Narrative Rating*)	QHEI Score (*Narrative Rating*)	Water Quality Exceedances
0.20	NON*+	*45* *Good*	*48* *Exceptional*	77 *Excellent*	None

* - CWH Attainment Based on Indicator Species as Listed in *Biological Criteria for the Protection of Aquatic Life, Volume II*

\+ - WWH biocriterion attainment: IBI score of 40; ICI score of 34 (Non-significant departure: ≤4 IBI units; ≤4 ICI units)

Acknowledgments

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

Kelsey Amidon
Nya Dreyfuss, Author
Seth Hothem
Jillian Knittle
Mark Matteson
Mario Meany
Denise Phillips
John Rhoades
Eric Soehnlen
Justin Telep
Nicole Velez

WQIS Interns: Hannah Boesinger, James Ferritto, Sarah Foley, Alex Johnson

Analytical Services Division – Completed analysis for all water chemistry sampling

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