NORTHEAST OHIO REGIONAL SEWER DISTRICT

2010 Mill Creek Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2010, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys at two locations in Mill Creek. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio Environmental Protection Agency (EPA) in Fish Community Biology, Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2010 Mill Creek Environmental Monitoring* approved by Ohio EPA on June 18, 2010.

The purpose of sampling was to compare the biological communities and water chemistry upstream and downstream of NEORSD-owned combined sewer overflows (CSOs). The data from the site downstream of all NEORSD CSOs on Mill Creek were used to determine the extent to which the fish and macroinvertebrate communities may have been impacted by those CSOs or other environmental factors. Macroinvertebrate and water chemistry sampling at the downstream site is required by Ohio Environmental Protection Agency (EPA) in accordance with the District's National Pollutant Discharge Elimination System (NPDES) permit for combined sewer overflows (Ohio EPA Permit No. 3PA00002*FD). Fish sampling was also conducted to determine the attainment status of each location.

Figure 1 is a map of the sampling locations evaluated 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.

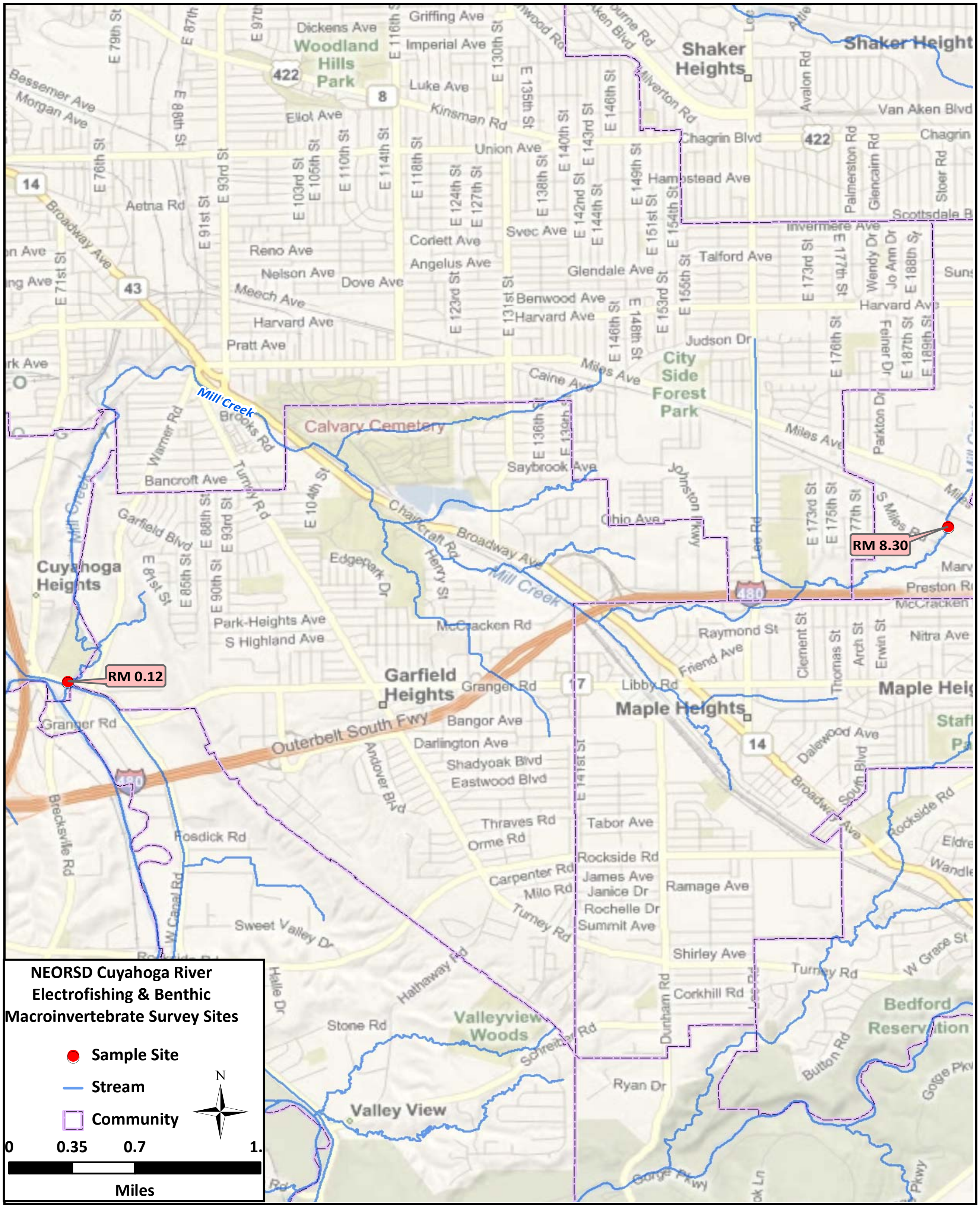


Figure 1. Sample Locations

Table 1. Sample Locations					
River Mile	Latitude	Longitude	Description	Quadrangle	Purpose
8.30	41.4305°N	81.5442°W	Upstream of South Miles Road	Shaker Heights	Evaluate chemistry, habitat, fish, & macroinvertebrates upstream of NEORSD CSOs
0.12	41.4178°N	81.6387°W	Upstream of Canal Road	Cleveland South	Evaluate chemistry, habitat, fish, & macroinvertebrates in support of Ohio EPA Permit #3PA00002*FD and prior to erosion control remediation

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times at RM 8.30 and six times at RM 0.12 from June 23, 2010 to July 28, 2010. The extra sampling event at RM 0.12 was due to a requirement in Ohio EPA Permit No. 3PA00002*FD. Techniques used for the 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. Bacteriological samples were collected in a sterilized plastic bottle treated with sodium thiosulfate. 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 either a YSI-556 MPS Multi-Parameter Water Quality Meter, a Hach HQ10 LDO Probe or YSI 600XL sonde.

Benthic and water column chlorophyll *a* sampling was also conducted once at both locations in 2010. For the benthic samples, a total of fifteen rocks were collected from three locations in the river. The algal mass from a portion of each rock was scraped off and composited to form a slurry. Water column samples consisted of grab samples collected from the river in the same vicinity as the benthic samples. Chemical and physical water quality parameters measured in conjunction with the chlorophyll *a* samples included total phosphorus, dissolved reactive phosphorus, nitrate+nitrite, alkalinity, turbidity and suspended solids.

Results and Discussion

Both sites are designated warmwater habitat, agricultural water supply, industrial water supply, and Class B primary contact recreation. When the results from the sampling were compared to the applicable water quality standards for these designated uses, it was found that most of the criteria were met. One of the exceptions to this was for *E. coli*. The seasonal geometric mean (161 colony-forming units/100mL [CFU/100mL]) and single sample maximum (density shall not be greater than 523 CFU/100mL in more than 10% of the samples in a 30-day period) components of the criteria were exceeded at both sites (Table 2). Although the *E. coli* results for each site varied by sampling event, the overall seasonal geometric mean was similar. Four out of the six sampling events were considered to be wet weather[1], which could explain the elevated densities found on those days. However, the densities measured on the dry weather days also contributed to the exceedances. This indicates that there may be some direct bacterial discharges to Mill Creek, especially at RM 8.30, which is not downstream of any CSOs.

Table 2. *E. coli* Densities (CFU/100mL)

Sample Date	RM 8.30	RM 0.12	Wet Weather Sampling Event (NEORSD RSY Rain Gauge)
6/23/2010	3,667	4,524	Yes
6/30/2010	1,341	650	Yes
7/7/2010	435	278	No
7/14/2010	1,320	3,059	Yes
7/21/2010	440	950	Yes
7/28/2010	---	560	No
Seasonal Geometric Mean	1,026	1,079	---

[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 were considered wet weather samples. Rainfall data taken from NEORSD Southerly WWTP (RSY) Rain Gauge.

The human health nondrinking and wildlife outside mixing zone averages for mercury may have been exceeded for the site at RM 0.12 for all of the 30-day periods in which at least two samples were collected. There was one sample collected (6/30/2010) with a mercury concentration greater than the minimum detection limit (MDL). However, because the MDL for mercury is greater than the criteria and some of the measured concentrations were estimates, it is unknown whether the criteria were actually exceeded.

As part of QA/QC measures, field blanks were collected twice during the sampling. The results from analysis of the field blanks showed that there were twenty-seven instances in which the concentration of a measured parameter was higher than the detection limit. In all of these instances, the results were similar to those obtained during an analysis of the bottles used during sample collection. Therefore, it does not appear that there was any contamination of these samples during either handling or transport.

Duplicate samples were also collected twice during the sampling. The results for 43 parameters measured from each of the duplicates were compared by calculation of relative percent differences. There were nine instances in which the relative percent difference between the duplicate samples was greater than 30%, the acceptable level for field duplicates. For six of the instances in which this occurred, the measured values were less than ten times the practical quantitation limit (PQL). Therefore, the low concentration being measured is considered to be the reason for the greater than acceptable differences, and not because of any sampling or analytical errors. The three instances with an RPD greater than 30% and measured values greater than ten times the PQL were all from the same sample. Two of the three parameters were total suspended solids and turbidity. Because the latter is directly influenced by the former, it is possible that floating debris could have led to the relatively high RPD for both. It is uncertain why the RPD was higher than acceptable for *E. coli* because the sample was collected during dry weather.

Sampling for benthic and water column chlorophyll *a* levels was also conducted one time at each site. Benthic chlorophyll *a* samples were collected to determine algal biomass that is attached to the stream substrate. Water column chlorophyll *a* samples were collected to determine algal biomass that has sloughed off from the substrate. Results from this sampling showed that there was a much higher chlorophyll *a* concentration at the site at RM 8.30 (Table 3). Both of the sites, though, had concentrations that were below recommended values to prevent eutrophication in streams with drainage areas less than 500 mi^2 (Miltner, 2010), indicating that excess algal production is not a problem in Mill Creek. Although nutrients may not be a major problem, they could be having some impact on algal production; the site at RM 8.30 had a higher phosphorus concentration and higher chlorophyll *a* levels than the downstream site.

Table 3. Chlorophyll *a* sampling results		
	RM 8.30	RM 0.12
Benthic Chlorophyll *a* (mg/m2)	142.3	61.1
Water Column Chlorophyll *a* (ug/L)	7.31	0.72
Alkalinity (mg/L CaCO3)	163.3	126.9
Total Suspended Solids (mg/L)	6.0	6.8
Turbidity (NTU)	2.38	5.93
Total Phosphorus (mg/L)	0.064	0.03
Soluble Reactive Phosphorus (mg/L)	0.036	0.004
Nitrate +Nitrite (mg/L)	0.282	1.112
Canopy Cover (Average Degrees Open)	95.7	85.33

Habitat Assessment

Methods

Habitat assessments were conducted one time at each site in 2010 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 (2006), *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 the NEORSD Water Quality and Industrial Surveillance Division, Environmental Assessment Section.

Results and Discussion

The QHEI scores for both sites achieved a *Good* rating and met the goal of 60 set by the Ohio EPA (2003), see Table 4. Sites meeting this goal are expected to be capable of attaining the warmwater habitat designated use. However, 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 its 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).

When characterizing the habitat at the sites on Mill Creek, it was found that both had one high influence attribute, sparse instream cover. The site at RM 0.12 also had five moderate influence attributes, while the site at RM 8.30 had four (Table 4). Because the number of these attributes exceeded what can be expected at sites meeting attainment of the IBI criterion, habitat could be a limiting factor in establishment of a healthy fish population in Mill Creek at these sites.

Table 4. Qualitative Habitat Evaluation Index scores 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 Substrates	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**
8.30	63.75	Good	x						x		x		3				x		1					x	x				x	x		4
0.12	68.00	Good							x		x	x	3				x		1	x	x			x	x				x			5

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2010. A list of the dates surveys were completed, along with flow as measured at the United States Geological Survey gage station on the Cuyahoga River in Independence, 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 150 meters in length 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 DELT anomalies (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	Site sampled (RMs)	Daily Mean Flow (CFS*)
7/1/10	0.12	383
7/8/10	8.30	269
9/8/10	0.12	235
9/9/10	8.30	210

*Provisional data

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of Ohio EPA's 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 12 individual metric scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor* or *Very Poor*.

Lists of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD Water Quality and Industrial Surveillance Division, Environmental Assessment Section.

Results and Discussion

Both sites were in non-attainment of the criterion for the IBI (Table 6). The downstream site rated in the *Fair* category and scored higher than the upstream site, which rated only *Poor*. Compared to 2009, the score at the downstream site was lower, while the one at the upstream site was similar (Figure 2).

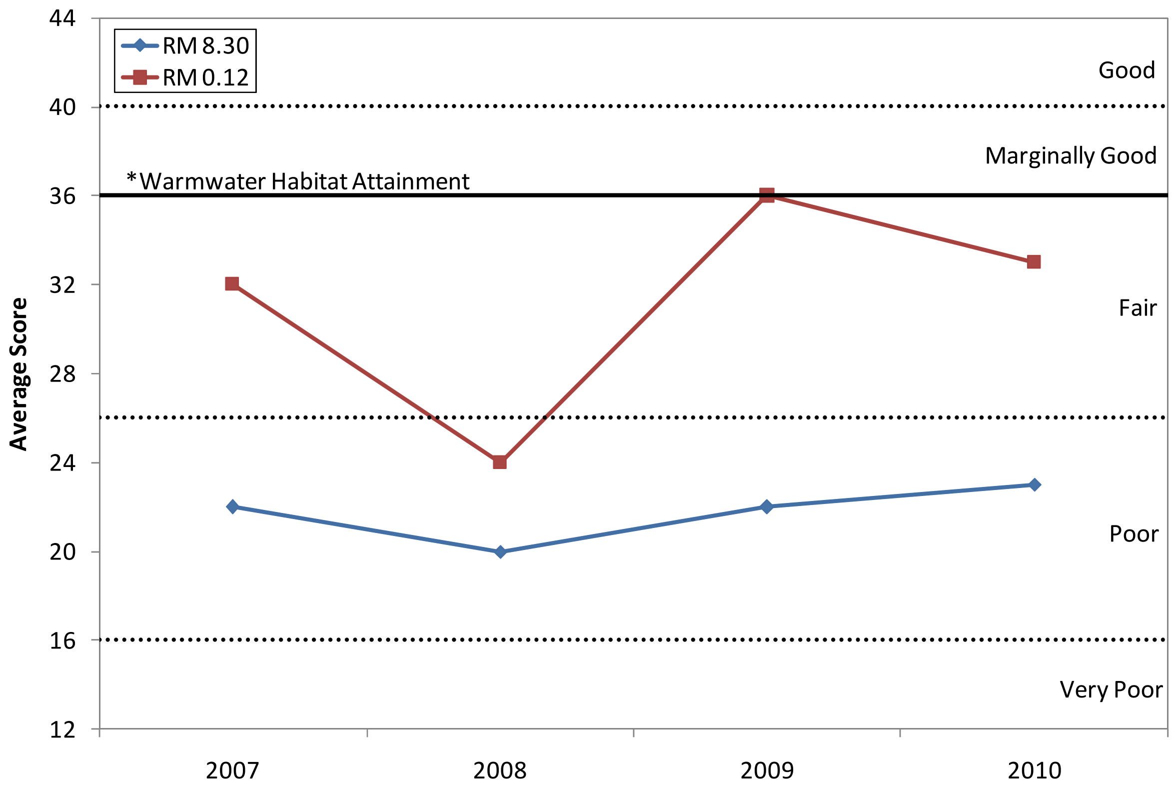
Table 6. 2010 Mill Creek IBI Scores

Location	River Mile	1st Pass	2nd Pass	Average
Upstream of South Miles Road	8.30	24	22	23
Upstream of Canal Road	0.12	28	38	33

Over both passes, only four different species were collected at RM 8.30, all of which were highly pollution tolerant. These were the same species that were collected in 2008 and 2009. The IBI metrics that received the highest score possible for both passes included proportion of omnivores and proportion of fish with DELTs. Most of the other metrics did poorly (score of “1”) for at least one of the passes. There are several possible reasons why this site is not meeting attainment of the IBI criterion. This site also has some habitat limitations, such as inadequate in-stream cover, that may make it less likely that a healthy fish community will be present. In addition, this site is adjacent to a landfill that may be a source of pollutants. Finally, the presence of a natural barrier (Mill Creek Falls) may be preventing the introduction of new fish from downstream locations.

While the downstream site also did not meet attainment of the IBI criterion, the second pass was within non-significant departure (≤4 IBI units) from it. This pass had the highest score ever received at this site. The lower score received during the first pass may have been due to problems with the connection between the Mill Creek Interceptor and the Mill Creek Tunnel. On some occasions during wet weather events, the gravity drop connection into the tunnel cannot handle the higher flow volumes. This results in a direct discharge into Mill Creek from the interceptor. In the five weeks prior to the first electrofishing pass, there were five such discharges totaling 6.242 million gallons. There were no discharges in the five weeks prior to the second electrofishing pass, which may have allowed the fish community to recover. Overall, the IBI score at RM 0.12 has fluctuated from being *Poor* to *Marginally Good* in the last few years. This indicates that this site is still in a general state of recovery and could possibly more consistently meet warmwater habitat attainment if improvements in water quality continue. Such improvements may come from completion of the Mill Creek Tunnel, which is expected to be fully functional in 2011. This site may also continue to benefit from improvements in the fish community within the Cuyahoga River. A larger number of fish species was found at RM 0.12 compared to the upstream site. The proximity of the Cuyahoga River to this site means that Mill Creek is most likely receiving an influx of fish migrating upstream from the river, and it is expected that improvements there will also result in improvements in Mill Creek.

Figure 2. Mill Creek Average IBI Scores



*Non-significant departure (≤4 IBI Units) from applicable criterion

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 AMT (Ravenna, Ohio) for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b).

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 results 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

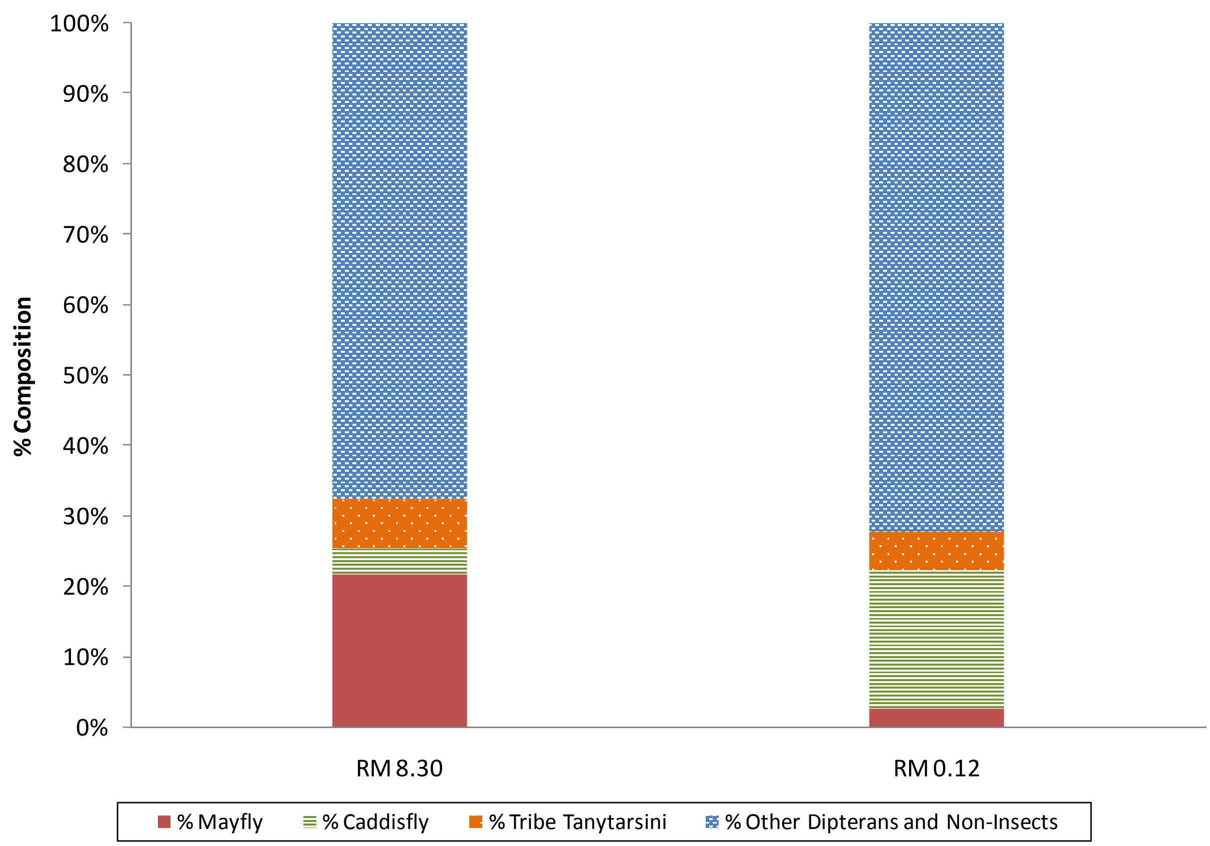
The ICI scores at both sites were relatively similar (Table 7). The site at RM 8.30 scored in the *Marginally Good* category and was in non-significant departure (≤4 ICI units) from the Erie-Ontario Lake Plain criterion, effectively attaining it. This is the first time that this site has been in attainment of the criterion. The site at RM 0.12 scored slightly lower and fell into the *Fair* narrative rating.

Both sites had communities with approximately the same number of total taxa and similar compositions in terms of tribe Tanytarsini midges and other dipterans and non-insects (Figure 3). The two sites differed in that RM 8.30 had a greater proportion of mayflies, while RM 0.12 had a greater proportion of caddisflies. While, generally, mayflies and caddisflies are considered to be indicators of good water quality, there are differences in pollution tolerances within each group. Of the mayflies and caddisflies collected in Mill Creek, the site at RM 0.12 had more organisms categorized as being pollution sensitive than the other site. However, the downstream site also had a much greater percentage of organisms considered to be tolerant to pollution, indicating potential water quality issues at this location (Table 7). This may have been due to the direct discharges from the Mill Creek Interceptor that occurred when the HDs were installed.

Table 7. Macroinvertebrate Results						
Location	River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant
Upstream of South Miles Road	8.30	**30**	353	37	5	8.3
Upstream of Canal Road	0.12	28	235	38	8	34.9

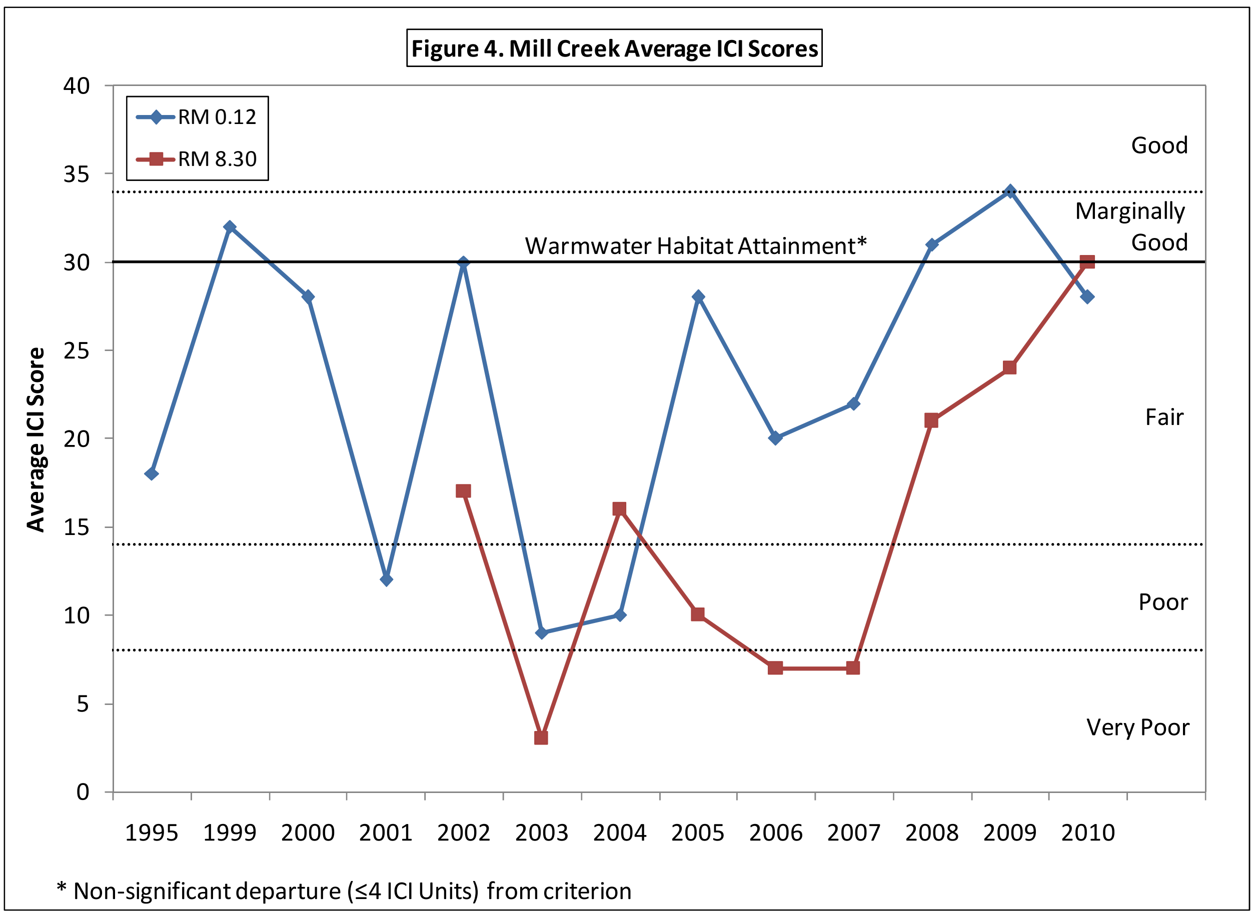
Bold indicates non-significant departure from criterion

Figure 3. Macroinvertebrate Community Composition



When comparing all the results obtained at RM 0.12 since sampling began in 1995, it can be seen that for many years, there was a great amount of variability in the ICI scores (Figure 4). Between 2006 and 2009, however, there was an increase in scores every year, indicating generally improving water quality at this location. The score in 2010, though, was six ICI units lower than in 2009. As discussed previously, one reason for the decrease in scores may be the presence of combined wastewater in the creek from the Mill Creek Interceptor or other undocumented sources.

Similar to the downstream site, the site at RM 8.30 also showed some variability in the first few years after sampling began in 2002. Since 2007, however, there has been a steady increase in scores at this site, with the highest score in 2010. The location of the HD sampler was moved in 2010 to a location with more consistent higher flow, a possible explanation for the increased score.



Conclusions

Sampling conducted on Mill Creek in 2010 indicates possible impacts to the creek due to direct discharges from the Mill Creek Interceptor during wet weather events. There was a decrease in scores for both the fish and macroinvertebrate communities at the downstream site, with neither being in attainment of applicable criteria. The upstream site at RM 8.30 had a poorer fish community, but a healthier macroinvertebrate community than the downstream site; it was in partial attainment of the biocriteria. The lack of a healthier fish community may be due to natural barriers in the river, such as Mill Creek Falls, that prevent migration of new fish species from the Cuyahoga River. Both sites had exceedances of the bacteriological criteria, suggesting that combined sewage is the main source of pollution in the creek. Once construction on a connection between the Mill Creek Interceptor and the Mill Creek Tunnel that is capable of handling higher flow volumes during wet weather events is complete, it is expected that there will be an improvement in the biological communities downstream of that location.

With the exception of 2010, data collected at these sites in recent years had indicated a recovery in the macroinvertebrate community at both sites and the fish community at the downstream site. The improvements at the downstream site are possibly due to improvements in water quality as more of the Mill Creek Tunnel comes on line and CSO events are reduced. There is still uncertainty, however, in the extent of this recovery within the creek. It is possible that attainment of the biocriteria may be occurring farther up in the stream than just near the mouth. Because of this, a more comprehensive survey, covering a wider range of sampling locations, should be conducted in upcoming years. This will allow for a determination of the degree in which the biological communities within Mill Creek are improving and whether any improvements are due to District facilities such as the Mill Creek Tunnel.

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