NORTHEAST OHIO REGIONAL SEWER DISTRICT

2012 East Branch Rocky River Environmental Monitoring

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 1993, the Berea Wastewater Treatment Plant (WWTP) was decommissioned and flows from the plant were redirected to the Northeast Ohio Regional Sewer District's (NEORSD) Southerly Wastewater Treatment Center. Environmental monitoring on the East Branch Rocky River was conducted by NEORSD in 1993 and 1995, prior to and after decommissioning of the Berea WWTP, to determine the health of the stream and any impacts from the WWTP. In 2000, fish community biology sampling was conducted. The sampling that was done in 1995 indicated some slight improvements in the fish and macroinvertebrate communities at both sites; sampling in 2000 also indicated further improvements in the fish community. Since that time, no comprehensive sampling had been conducted at those locations, so any further improvements in water quality had not been documented.

During the course of the study, fish communities, benthic macroinvertebrate communities, stream habitat and water chemistry in the East Branch Rocky River at River Miles (RM) 3.40 and 3.10 were surveyed. The results from these surveys were used to characterize the overall fish and macroinvertebrate community health in the river. Fish and macroinvertebrate community health was evaluated through the use of Ohio EPA's Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI). An examination of the specific characteristics of the biological communities was used in conjunction with water quality data, the NEORSD Macroinvertebrate Field Sheet, and Qualitative Habitat Evaluation Index (QHEI) results in order to identify impacts to the communities. Results were also compared to historic data to show temporal as well as spatial trends. Finally, water chemistry data were also compared to the Ohio Water Quality Standards to determine attainment of applicable uses (Ohio EPA, 2009).

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

Figure 1. Sampling Locations

Table 1. Sample Locations				
Location	Latitude	Longitude	River Mile	Purpose
Upstream of former Berea WWTP	41.3836	-81.8641	3.40	Determine changes in fish, macroinvertebrates, water chemistry, and habitat following decommissioning of Berea WWTP
Downstream of former Berea WWTP	41.3861	-81.8644	3.10	Determine changes in fish, macroinvertebrates, water chemistry, and habitat following decommissioning of Berea WWTP

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between July 31through August 29, 2012, on East Branch Rocky River at RMs 3.40 and 3.10. Techniques used for sampling and analyses followed the Ohio EPA Ohio EPA *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2012) and *Surface Water Field Sampling Manual* (2013). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% 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, 2013).

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

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.

Mercury analysis for all of the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if East Branch Rocky River 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 river.

Water chemistry Certificate of Analysis (COA) reports for each site are available upon request from the NEORSD WQIS division.

Results and Discussion

There was one duplicate and one field blank sample collected during the study. For these samples, most of the QA/QC requirements were met. There was only one parameter in which the RPD between the duplicate samples was greater than the acceptable level. This occurred for ammonia at RM 3.40 on August 8th and resulted in the data being rejected because the RPD was seven times greater than what was considered to be acceptable.

For the field blank that was collected, there was some evidence of blank contamination. The concentrations of both dissolved reactive phosphorus and nitrite were high enough that the data in the river samples from that day needed to be listed as estimated. It is unclear how the field blank became contaminated and may be due to inappropriate sample collection, handling in the field and/or in the laboratory, contaminated blank water and/or interference during analysis.

The final QA/QC check for the samples that were collected was for paired parameters. Based on these comparisons, data for chromium and hexavalent chromium on two of the sampling dates was qualified as being estimated, while the data from the other three sampling dates was rejected. However, because none of the measured values were close to the applicable criteria, rejection of those data points did not affect the ability to determine whether the criteria were attained.

Table 2. 2012 East Branch Rocky River *E. coli* Densities (colony-forming units/100mL)		
Date	RM 3.40	RM 3.10
7/31/12	200	180
8/7/12	200	155
8/14/12*	867	1400
8/21/12*	967	733
8/29/12*	517	767
Seasonal Geomean	444	467

* Wet weather event

From the remainder of the water quality sampling, it was found that these sites failed to meet the applicable recreation criteria. The bacteriological criteria for *E. coli* consist of two components: a seasonal geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 30-day period. For those streams designated Class A primary contact recreation streams, these criteria are 126 colony-forming units (CFU)/100mL and 298 CFU/100mL, respectively. For both sites, the seasonal geomean was greater than 126 colony-forming units (cfu)/100 mL and all of the 30-day periods had more than ten percent of the days with densities greater than 298 cfu/100mL (Table 2). Generally, there were not any significant differences between the two sites. Three of the sampling events were collected during or after wet-weather, which could account for the elevated densities found on those days. Potential sources of bacterial contamination include stormwater runoff, septic tanks and effluent from upstream wastewater treatment plants.

No other water quality criteria were exceeded, and the mercury results did not indicate any contamination in the river. When compared to data collected prior to decommissioning of the WWTP, the ammonia concentrations at the downstream site were much lower afterward the decommissioning, while the phosphorus concentrations were only somewhat lower. For the other parameters, the concentrations were generally the same.

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on East Branch Rocky River in 2012 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 60 or more suggests that sufficient habitat exists to support a fish community that meets the warmwater habitat criterion (Ohio EPA, 2003). 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 site at RM 3.40 had a QHEI score of 77 and rated "Excellent" while the site at RM 3.10 scored a 72.5 with a rating of "Good." Both sites met the target goal of 60 set by the Ohio EPA. Sites meeting this goal are expected to meet the warmwater habitat designated use (Ohio EPA, 2003). Because the upstream site exceeded a score of 75, it would also be expected to support exceptional warmwater habitat fish communities. These scores are similar to what was found when habitat evaluations were conducted at those sites in 1993 and 1995.

In addition to examining overall QHEI scores, individual components of the index can also be used to evaluate whether a site is capable of attaining the warmwater habitat designated use (Table 3). 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).

The East Branch of the Rocky River in the section that was studied consisted of a highly stable cobble/bedrock substrate that also had a large number of boulders and shallows in slow water providing instream cover. The warmwater habitat attributes shared by both sites included no channelization and pools greater than 0.4 meters. The upstream site also had good development, while the downstream one had moderate instream cover and normal overall embeddedness. For moderate influence characteristics, both of the sites had low sinuosity, no fast current, and moderate riffle embeddedness. The only high influence characteristic at either site was sparse instream cover at the upstream one. Using Ohio EPA's guidelines, these sites should be capable of meeting the warmwater habitat criteria for fish.

Table 3. Qualitative Habitat Evaluation Index scores and physical attributes

			WWH Attributes										**MWH 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 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**
3.40	77.00	Excellent	x			x					x		3				x		1						x			x	x	x		4
3.10	72.50	Good	x					x		x	x		4						0					x	x			x		x		4

Fish Community Assessment

Methods

One quantitative electrofishing pass was conducted at each site in 2012. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station in Berea, is given in Table 4. Sampling was conducted using wading electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.20 kilometers for each site. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 4. Sampling Dates and River Flows

Date	Site sampled (RM)	Daily Mean Flow (CFS*)
9/13/12	3.10	49
9/14/12	3.40	47

*Provisional data

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor* or *Very Poor*. The 12 metrics utilized for wading are listed in Table 5.

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

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

N = Relative numbers of all species excluding species designated as highly tolerant, hybrids, or exotics

B = Relative weights of all species excluding species designated as highly tolerant, hybrids, or exotics

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

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 WQIS Division.

Results and Discussion

The two sites on the East Branch of the Rocky River that were assessed in 2012 had MIwb scores that met the WWH criterion of 7.9 (Table 7). The score at the downstream site was higher than the one upstream and also met the criterion for exceptional warmwater habitat of 9.4. A greater number of fish and overall weight resulted in the better score at RM 3.10; the diversity scores for both sites were very similar.

For wading sites in the Erie-Ontario Lake Plain, an IBI score of 38 is needed in order to meet the WWH criterion. Scores within 4 IBI units are also considered to be in non-significant departure of the criterion, effectively meeting it. In 2012, both sites were in attainment of the criterion. The site at RM 3.40 scored a 44, which was higher than the score of 36 at RM 3.10 (Table 6). The higher score at the upstream site may be due to the slightly better habitat there and not due to any lasting impacts from the wastewater treatment plant.

Table 6. East Branch Rocky River IBI and MIwb Results

	IBI		MIwb	
Year	RM 3.40	RM 3.10	RM 3.40	RM 3.10
1993	29	25	4.7	6.3
1995	*34*	30	7.2	7.2
2000	**42**	**38**	**8.1**	**8.2**
2012	**44**	*36*	**9.2**	**9.6**

Bold = meets WWH criterion [IBI ≥38; MIwb ≥7.9]
Italics = non-significant departure from WWH criterion [IBI ≥34; MIwb ≥7.4]

When examining individual metrics of the IBI, it was found that both sites scored the lowest metric score of "1" for the number of intolerant species. The only intolerant species collected was rosyface shiners at the upstream site. Bacterial contamination, as indicated by the *E. coli* densities in the river, and any other pollutants associated with wet weather may be one set of stressors preventing a greater number of intolerant species from inhabiting the river. The downstream site also scored a "1" for the number of sunfish species. A lack of habitat types preferred by sunfish species could be a possible reason for why more were not present. The rest of the metrics for both sites scored either a "3" or "5", indicating a generally healthy fish community.

Previous fish assessments showed improvements in the community in 1995 and 2000 at both locations. The IBI scores received in 2012 were similar to the ones from 2000, while the MIwb scores were higher. The increased MIwb scores were due to a much higher number of fish that were collected in 2012. These results suggest that most

of the major improvements in the fish community occurred within the first decade after the WWTP was decommissioned and may have leveled off since then. It should be noted, however, that in the Cuyahoga River, increases in MIwb scores typically preceded those for the IBI. As water quality improved, a greater number of fish moved into an area and was reflected by an increase in biomass directly measured by the MIwb. As water quality continued to improve, the composition of the fish community was altered as more pollution-sensitive fish were better able to survive within that particular habitat. Possibly, this may also be happening in the East Branch of the Rocky River. If so, it could be expected that IBI scores there may improve again in upcoming years.

Macroinvertebrate Sampling

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

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (OEPA 1987a). The ICI consists of ten community metrics (Table 7), 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 7. 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

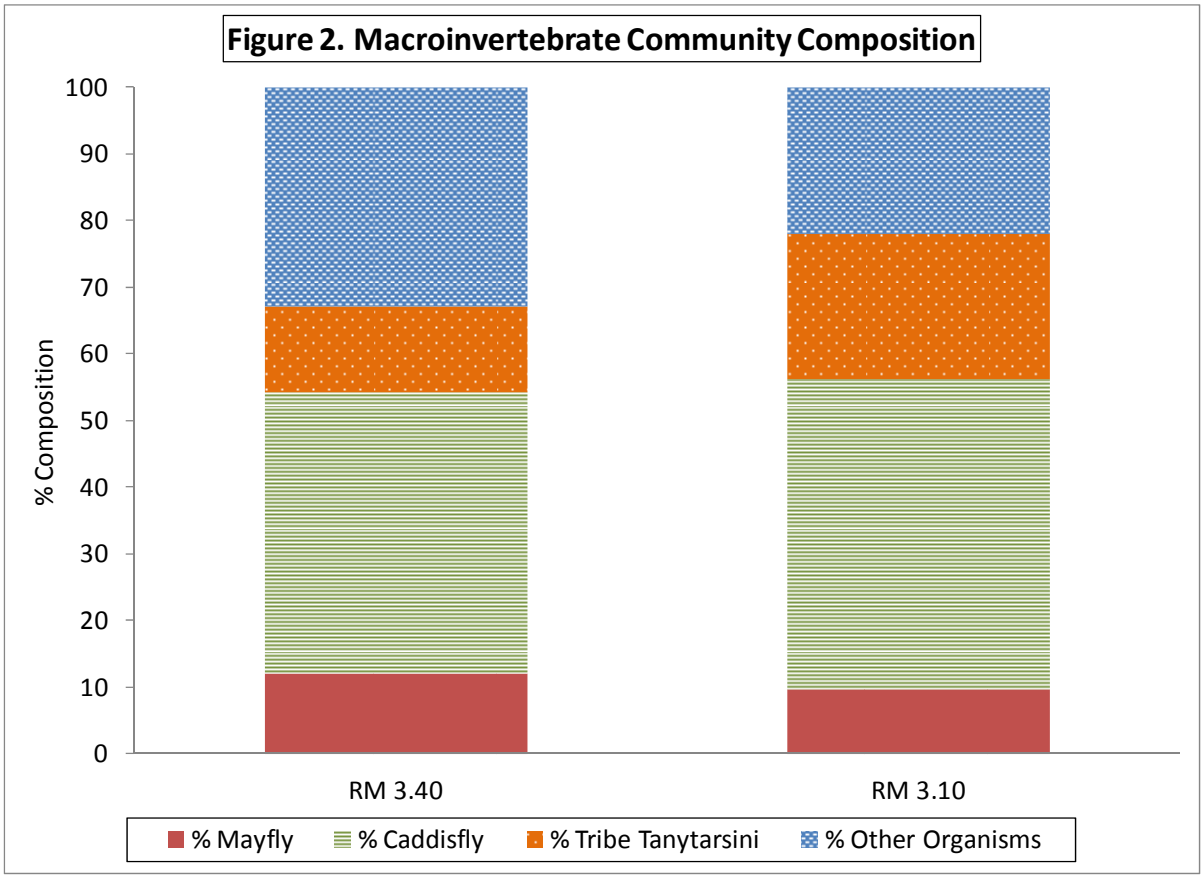
Results and Discussion

The ICI criterion for the Erie-Ontario Lake Plain is 34; both of the sites exceeded this value (Table 8). The site at RM 3.10 had a slightly higher ICI score, due to a higher percentage of Tanytarsini midges and a lower percentage of other dipterans and non-insects. For other community characteristics, the sites were similar, with approximately the same organism density, number of EPT taxa, percent tolerant organisms, and percent mayflies and caddisflies (Figure 2).

Table 8. Macroinvertebrate Results

River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant Organisms	Narrative Rating
3.40	**38**	615	55	9	2.1	*Good*
3.10	**42**	576	50	8	2.1	*Very Good*

Bold indicates meets warmwater habitat criterion



Relatively low metric scores of "2" were received at both sites for number and percentage of mayflies and number of EPT taxa in the qualitative sample. The upstream site also had a score of "2" for percentage of Tanytarsini midges. All of these metrics are related to the number of pollution-sensitive organisms in the river. Lower scores suggest that, similar to the fish community, wet weather sources of pollution may be negatively impacting the macroinvertebrate community.

Previous sampling at these sites in 1993 and 1995, prior to and after decommissioning of the WWTP, did not include installation of HDs, so a direct quantitative comparison between conditions could not be made. Past results based on qualitative sampling did indicate, though, general improvements in the macroinvertebrate community after the WWTP was taken offline. Particularly, there was less indication of organic pollution in the stream in 1995 compared to 1993. Because the qualitative samples in 1995 and 2012 were similar, it appears that the improvements in the stream occurred relatively quickly and have been maintained.

Conclusions

Water chemistry sampling indicated the generally good water quality at these sites, with no significant differences between the two. Exceedances of water quality criteria only occurred for bacteria. The results also indicated that improvements in nutrient concentrations occurred following decommissioning of the WWTP; other parameters did not change significantly afterwards.

Evaluations of fish and macroinvertebrate communities showed no significant changes since the last time that they were surveyed in 2000 and 1995; respectively. Both sites were in full attainment of the WWH biological criteria, with some of the scores also meeting or close to meeting exceptional warmwater habitat criteria and targets. Wet weather pollution may be having an impact on the number of pollution-sensitive fish and macroinvertebrates living in the river. Overall, though, the East Branch of the Rocky River within the vicinity of the WWTP appears to have recovered from any impacts that the effluent previously had on it. Fish and macroinvertebrate index scores may continue to increase occur if water quality conditions improve further.

Acknowledgements

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

Jonathan Brauer
Kristina Granlund
Seth Hothem, Author
Ron Maichle
Jill Novak
Francisco Rivera
John Rhoades
Tom Zablotny

WQIS Co-ops: Kelsey Amidon, Kelly Boreman, Jeff Gordon and Cole Musial

Analytical Services Division – Completed analysis for all water chemistry sampling

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