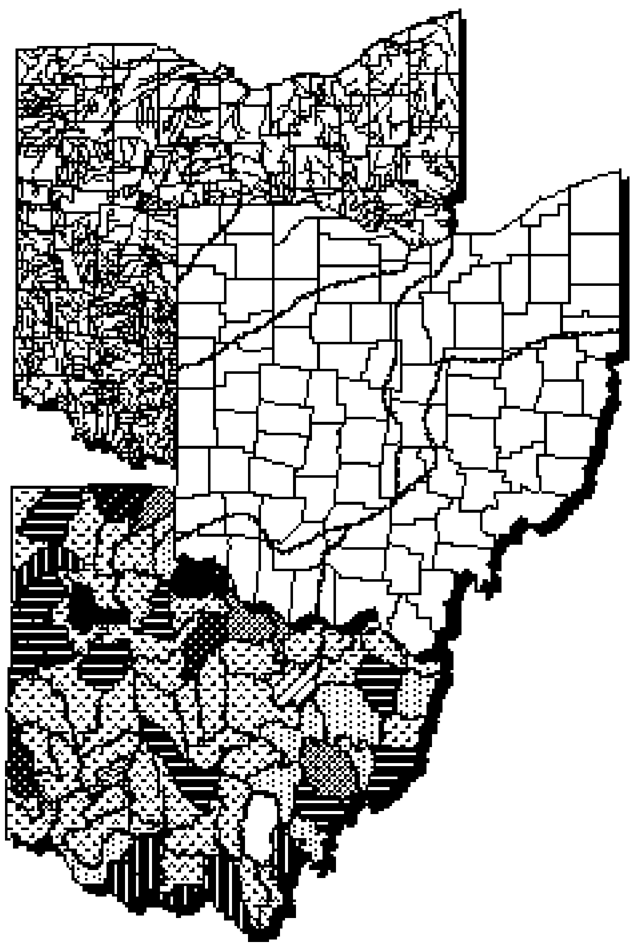
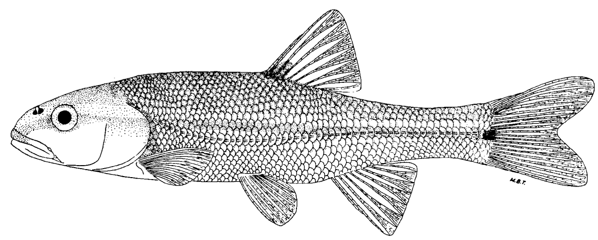
State of Ohio
Environmental Protection Agency

Ecological Assessment Unit
Division of Surface Water

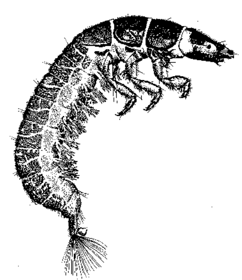
Biological and Water Quality Study of the Little Cuyahoga River and Tributaries

Summit and Portage Counties





Creek Chub (Semotilis atromaculatus)



Hydrospychid Caddisfly
(Hydropsyche sp.)

April 14, 1998

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43216-1049

Biological and Water Quality Study of the Little Cuyahoga River, 1996

Summit County

April 14, 1998

OEPA Technical Report
Number MAS/1997-12-9

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
Ecological Assessment Unit
1685 Westbelt Drive
Columbus, Ohio 43228
and
Water Quality Section
Northeast District Office
2110 East Aurora Road
Twinsburg, Ohio 44087

TABLE OF CONTENTS

Appendix tables containing results from chemical grab samples and biological sampling are available electronically on the internet at http://chagrin.epa.ohio.gov/.

NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio’s surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents new publications by Ohio EPA have become available. The following publications should also be consulted as they represent the latest information and analyses used by Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

These documents and this report can be obtained by writing to:

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377

Acknowledgements

Paul Anderson and Steve Tuckerman- CSO assessment and water chemistry evaluation.

Jack Freda - macroinvertebrate community assessments.
Robert Miltner - Fish community assessments, water and sediment chemistry evaluation, and TSD editor.
Jeff DeShon, Marc Smith and Chris Yoder - Reviewers.

Water chemistry analysis was provided by the Ohio EPA Division of Environmental Services Numerous college interns and district office staff assisted in the collection of field samples. Brian Deyo and Sean McGary helped with the arduous task of collecting fish. Sara Engle and Matt Coffee helped collect macroinvertebrate samples. Landowners who granted permission for site access are duly appreciated.

FOREWORD

What is a Biological and Water Quality Survey?
A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 250-300 sampling sites.

Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1]), and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators
A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach is outlined in Figure 1 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health,

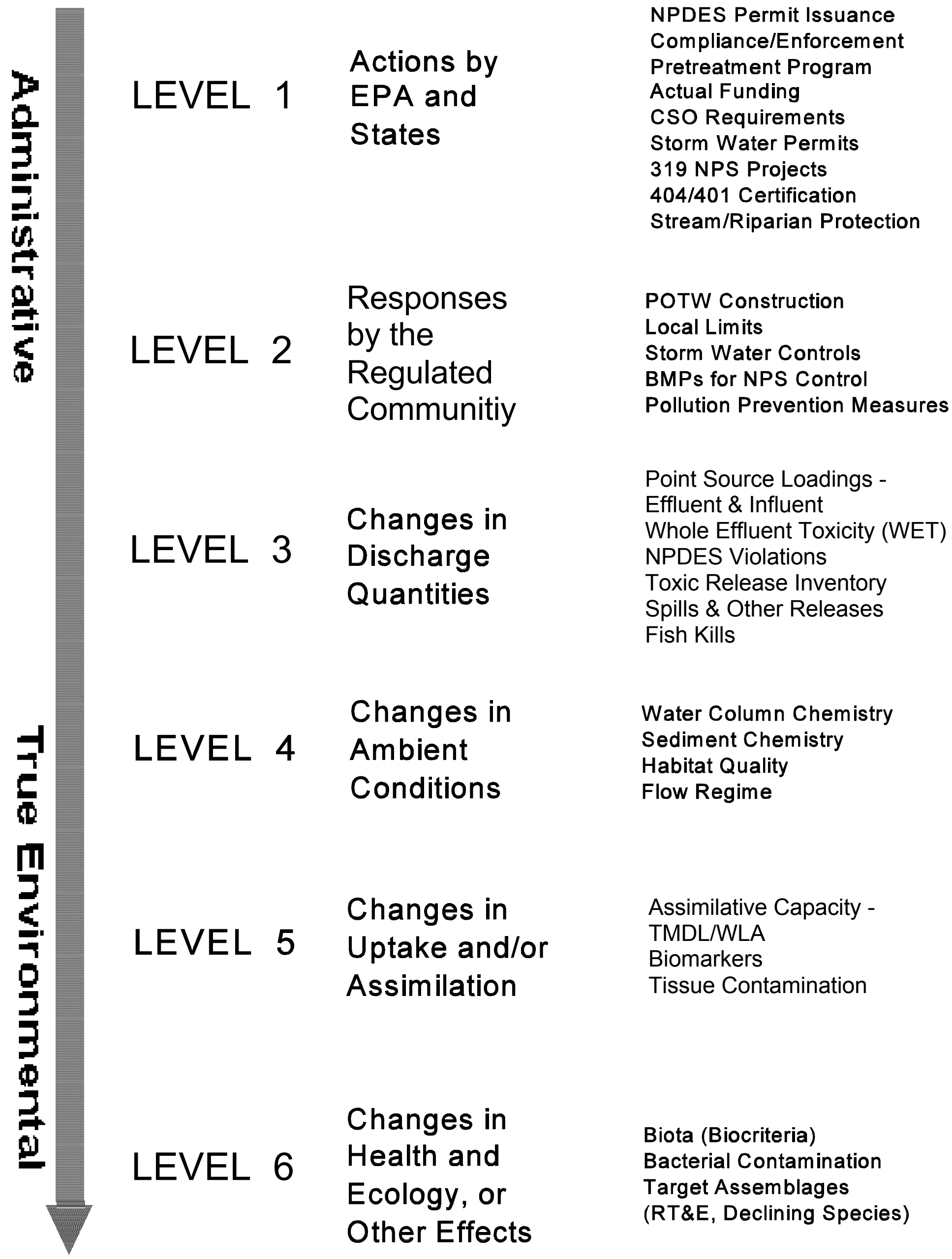


Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Uses

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses.

The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio s best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2. drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health are detailed in other documents.

INTRODUCTION

The Little Cuyahoga River study area consisted of the Little Cuyahoga River downstream from Mogadore Reservoir (River Mile [RM] 11.3) to the mouth (RM 0.2), and included the following tributaries (RM at confluence): Union Oil tributary (11.6), Wingfoot Lake Outlet (11.1), Roosevelt Ditch (8.6) Springfield Lake Outlet (7.0), Camp Brook (4.1), and the Ohio Canal (2.1). See Table 3 for a specific list of sampling locations and geographic reference.

Specific objectives of this study were:

1) evaluation of impacts to water quality and aquatic life from combined sewer overflows (CSOs),

2) determination of attainment status of aquatic life and non-aquatic life use designations, and recommend changes where appropriate, and

3) comparison of results from this survey with previous surveys to assess changes in water quality and biological integrity.

SUMMARY

Every location sampled in the Little Cuyahoga River subbasin in 1996, over 11.8 miles, was in **non-**attainment of the biological criteria for the Warmwater Habitat (WWH) aquatic life use designation (Table 1). The fish community throughout this reach exhibited poor and very poor quality. Exceedences of the Primary Contact Recreation (PCR) fecal coliform bacteria criterion were documented at all mainstem sampling locations except for RM 11.3. The highest dry weather concentrations were observed in tributaries and the mainstem reach subject to CSOs. Similarly, biological communities were most severely impaired at locations receiving CSO discharges. Information generated by the City of Akron Water Pollution Control Station (WPCS) has indicated that CSO discharges can occur with as little as 0.15 inches of rainfall. Combined sewer discharges occur throughout the year, averaging 8.53 MGD of combined effluent to the Cuyahoga river and tributaries. In the Little Cuyahoga River subbasin CSOs discharged a total of 2.96 billion gallons of combined sewage and stormwater, or approximately 95% of the total discharge by the Akron CSO system. CSOs represent a major source of biological impairment in the Little Cuyahoga River and the Cuyahoga River (OEPA 1998).

Despite pollutant loadings by CSOs, nutrient concentrations generally fell within a distribution given by least impacted reference streams. However, between Bank Street (RM 5.1) and Camp Brook (RM 4.1), total Kjeldahl nitrogen (TKN) increased and nitrate-nitrite concentrations decreased coinciding with an increase in total phosphorus concentrations suggesting the increase in phosphorus spurred the uptake of nitrate-nitrogen. Following the inputs of phosphorus,

concentrations decreased rapidly, demonstrating the river was able to assimilate the input under low flows.

Fecal coliform bacteria counts in water quality grab samples increased longitudinally downstream from RM 11.3 to RM 5.1 (Bank Street), then leveled off. At least one in five samples collected under low flow conditions exceeded the average Primary Recreation Contact standard of 1,000 colonies/100 ml at all sampling locations in the area of Akron's CSOs, whereas upstream from the CSOs, fecal coliform counts were within Water Quality Standards during dry weather.

Overall, a slight lessening in the severity of biological impairment was evident in 1996 relative to 1986 (Figure 2), owing to the cessation of direct industrial discharges to the mainstem and tributaries, elimination of separate sewer overflows, and reduction in discharges via CSOs due to improved pretreatment requirments and maintence of CSOs by the City of Akron. Compared to 1986, relative abundance of several invertebrate taxa resistant to toxins was supplanted by less tolerant forms in 1996, implying reduced toxicity coincident with defunct industrial discharges, and associated spills and other releases. The Area of Degradation Value (ADV), a measure of both the severity and magnitude of departure from the biological criteria, for the ICI in 1996 was 50% that measured in 1986. The difference was greatest between RMs 9.7 and 5.1 (Figure 2). However, sediments in the Little Cuyahoga River, Camp Brook, the Springfield Lake Outlet, and to a lesser extent the Wingfoot Lake Outlet, remain contaminated with toxic organic chemicals (polynuclear aromatic hydorcarbons and polychlorinated biphenyls) and metals. The levels of contaminats found are likely to be deleterious to benthic communities. At RM 7.3, where sediment contamination was most severe, the elevated relative abundance of *Cricotopus bicinctus*, a toxics tolerant midge, coupled with low numbers of other invertebrate species demonstrates the impact from contaminated sediments. Furthermore ICI scores were negatively correlated with sediment lead concentrations and the poorest fish community was measured at the location having the highest lead concentration (RM 4.1). Sources of sediment contamination are most likely urban stormwater runoff, CSO discharges, construction of I-76, and legacy pollutants from industrial discharges.

RECOMMENDATIONS

As most of the Little Cuyahoga River subwatershed is highly urbanized, stormwater retention and treatment controls paired with riparian habitat restoration are needed as part of a broad prescriptive approach towards rehabilitating impaired beneficial uses within and downstream from the catchment. Because stormwater enters the stream via combined sanitary sewers in the lower six miles of the river and several tributaries, stormwater discharges to the stream are grossly polluted with a toxic mix of domestic and industrial sewage. Therefore, reductions of combined sewer discharges needs to be a primary goal toward restoration of aquatic life in both the Little Cuyahoga River and the Cuyahoga River mainstem.

Little Cuyahoga River

Status of Aquatic Life Uses

The entire Little Cuyahoga River is in **non**-attainment of biological criteria for the existing WWH aquatic life use designation. The Little Cuyahoga River subwatershed is highly urbanized, and therefore altered hydrology and urban runoff represent a significant source of impairment limiting aquatic life use potential. However, the generally good performance of the macroinvertebrate community upstream from all CSO discharges relative to the fair performance in the reach subject to CSOs demonstrates that substantial improvement in biological performance is possible with remediation of CSO impacts. Therefore, the current WWH use designation should be retained.

Status of Non-aquatic Life Uses

Numerous exceedences of the Primary Contact Recreation (PCR) water quality criterion for fecal coliform bacteria were documented throughout the Little Cuyahoga River. The PCR designation should be retained given the proximity of residential housing and park settings adjacent to the river in the Elizabeth Park area and because the stream dimentions support the use designation.

Other Recommendations

Mitigation of CSO discharges is recommended to reduce the severity and frequency of fecal coliform bacteria exceedences, especially during dry weather. The severity of past pollution and habitat degradation throughout the entire Little Cuyahoga River catchment has resulted in the extirpation of sensitive and intermediate tolerant fish species (e.g., mottled sculpin, darters, hog sucker, stoneroller, sand shiner) in the headwaters and the upper Little Cuyahoga mainstem. CSO discharges and low-head dams in the middle reach are apparently an effective barrier to recolonization, and consequently, must be addressed in future planning.

Future Monitoring Concerns

Until substantial improvements are made to the existing sewage collection system, no recovery in biological communities is anticipated. Therefore, further intensive biological monitoring to elucidate CSO impacts is unnecessary until improvements in the collection system are documented. However, the magnitude and fate of pollutants exported to the Cuyahoga River mainstem should be quantified. Biological montitoring at several key sites to document long term recovery trends and in conjunction with biological and water quality surveys of the Cuyahoga River mainstem are recommended. Fecal coliform bacteria monitoring during recreational use periods is recommended.

Union Oil Tributary

Status of Aquatic Life Uses

Biological communities in the Union Oil tributary were in **non**-attainment of the existing WWH biological criteria. Additional time is necessary to determine if biological communities can recover from previous point source pollution and habitat degradation.

Status of Non-aquatic Life Uses

All designated non-aquatic life uses are appropriate and should be retained.

Other Recommendations
Channel "improvements" such as dredging and removal of riparian vegetation should not be conducted in the future so that local and downstream hydrologic stability is increased.

Future Monitoring Concerns
Given the lack of recolonization sources, little recovery is expected for the fish community. The lower numbers of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa recorded in 1996 compared to 1986, however, suggests habitat degradation from channel "maintenance" activities continue to impair the biological communities. Should barriers to recolonization be removed and the habitat allowed to recover, monitoring to assess biological recovery may then be warranted.

Wingfoot Lake Outlet
Status of Aquatic Life Uses
Biological communities were in **non**-attainment of WWH biological criteria. The poor habitat may preclude establishment of a normal WWH fauna. Should future monitoring demonstrate a continued lack of attainment in the absence of other stressors (*e.g.*, increased suburbanization or the recovery of the Little Cuyahoga River), and should petitioning lead to other channel maintenance activities, a Modified Warmwater Habitat use designation may be warranted. However, as recovery potential exists, the current WWH use designation should be retained.

Status of Non-aquatic Life Uses
All non-aquatic life use designations are appropriate and should be continued.

Other Recommendations and Future Monitoring Concerns
The causes and sources of impairment at RM 1.3, where the performance of the fish community suggested organic enrichment, were not identified, and therefore, are future monitoring concern.

Roosevelt Ditch
Status of Aquatic Life Uses
Roosevelt Ditch is not presently designated in the WQS. As the macroinvertebrate comunity did not meet the criterion for WWH in 1996, and as Roosevelt Ditch is a drainage ditch flowing through high density residential neighborhoods, a Modified Warmwater Habitat use designation is appropriate. However, the physical habitat and macroinvertebrate community were severely impacted by sewer line construction, so additional monitoring will be needed to verify this designation.

Status of Non-aquatic Life Uses
A Secondary Contact Recreation use designation should apply based on the size and dimentions of the ditch.

Other Recommendations and Future Monitoring Concerns
Roosevelt Ditch should be surveyed in the next 5-year basin cycle to assess recovery from sewer line construction and to make an appropriate use designation.

Springfield Lake Outlet
Status of Aquatic Life Uses
Biological communities were in **non**-attainment of the designated WWH biological criteria, however no change in the use designation is recommended as the physical habitat was of sufficient quality to expect a WWH fauna.

Status of Non-aquatic Life Uses
Springfield Lake Outlet currently holds a Secondary Contact Recreation use designation. Because 3 ft deep pools over a surface area of greater than 100 ft^2 exist, the use designation should be changed to Primary Contact Recreation.

Other Recommendations and Future Monitoring Concerns
Recovery of the fish community in Springfield Lake Outlet will likely be tied to recovery in the Little Cuyahoga River. Therefore, only following CSO remediation in the Little Cuyahoga and dam removal should future biological monitoring reveal improvement in the fish community. However, monitoring of toxics from polluted runoff and legacy pollution using macroinvertebrates is warranted to determine recovery trends.

Camp Brook
Status of Aquatic Life Uses
Biological communities were in **non**-attainment of the designated WWH biological criteria, however no change in the use designation is recommended as the physical habitat was of sufficient quality to support a WWH fauna, and existing habitat impairment appeared to be related to upstream construction activities.

Status of Non-aquatic Life Uses
Existing non-aquatic life uses are appropriate.

Other Recommendations and Future Monitoring Concerns
The CSO on Camp Brook is a significant source of impairment both in Camp Brook and the Little Cuyahoga River, and needs to be remediated. Until such time, further biological monitoring to elucidate CSO impacts is not warranted.

Ohio Canal
Status of Aquatic Life Uses
Biological communities were in **non**-attainment of the designated MWH biological criteria.

Status of Non-aquatic Life Uses

The Ohio Canal currently holds a Secondary Contact Recreation use designation. Because 3 ft deep pools greater than 100 ft^2 exist, the use designation should be changed to Primary Contact Recreation.

Other Recommendations and Future Monitoring Concerns

CSO discharges to the Ohio Canal are a significant source of impairment both in the canal and the Little Cuyahoga River, and needs to be remediated. Until such time, further biological monitoring to characterize CSO impacts is not warranted.

Table 1. Aquatic life use attainment status for stations sampled in the Little Cuyahoga River basin based on data collected July-September, 1996. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Comment
Little Cuyahoga River *Erie-Ontario Lake Plane WWH (existing)*						
11.3/11.2	22*	NA	24*	57.0	**NON**	Dst Mogadore Res. & wetlands
11.0	25*	4.3*	36	58.0	**NON**	Mogadore industrial park
9.7	20*	4.7*	42	67.0	**NON**	Ust Akron, background
8.5/8.4	24*	4.1*	40	49.5	**NON**	Ust CSOs, increasingly urban
7.3/7.1	21*	4.6*	32[ns]	52.5	**NON**	Ust CSOs, heavily urbanized
7.1/7.0	21*	4.7*	28*	59.0	**NON**	dst eliminated thermal disch.
5.1	20*	4.5*	26*	56.0	**NON**	Dst CSOs, heavily urbanized
4.2	19*	3.0*	20*	75.5	**NON**	Dst CSOs & landfill
4.1	21*	2.2*	P*	71.0	**NON**	Dst Campbrook CSOs
2.9	23*	6.5*	F*	66.0	**NON**	Dst CSOs, high gradient
1.8	25*	5.2	16*	61.5	**NON**	Dst CSOs & Ohio Canal
0.3/0.2	24*	6.5*	24*	68.0	**NON**	Dst CSOs, adj landfill
Union Oil Tributary *Erie-Ontario Lake Plane WWH (existing)*						
1.5/0.5	30*	NA	F*	50.0	**NON**	Background
Wingfoot Lake Outlet *Erie-Ontario Lake Plane WWH (existing)*						
3.2	--	NA	F*		**(NON)**	Background
1.3	26*	NA	--	34.5	**(NON)**	Ust Mogadore industrial park
0.1	26*	NA	MG[ns]	44.0	**NON**	Dst Mogadore industrial park
Roosvelt Ditch *Erie-Ontario Lake Plane (MWH proposed)*						
0.1	--	--	P*	--	**(NON)**	Sewer line construction
Springfield Lake Outlet *Erie-Ontario Lake Plane WWH (existing)*						
0.1	26*	NA	F*	55.0	**NON**	Dst eliminated point sources

Table 1. Continued.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Comment
Camp Brook *Erie-Ontario Lake Plane WWH (existing)*						
1.0	24*	NA	P*	48.5	**NON**	Ust rack 12 CSO
0.2	20*	NA	P*	61.0	**NON**	Dst rack 12 CSO
Ohio Canal *Erie-Ontario Lake Plane MWH (existing)*						
0.1	--	NA	20*	NA	**(NON)**	Dst North St

Ecoregion Biocriteria: Erie-Ontario Lake Plain
(OAC 3745-1-07, Table 7-14)

	IBI			MIwb[a]			ICI	
Site Type	WWH	EWH	MWH[d]	WWH	EWH	MWH[d]	WWH	MWH[d]
Headwaters	40	50	24				34	22
Wading	38	50	24	7.9	9.4	6.2	34	22

a - MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

b - A qualitative narrative evaluation based on best professional judgement and sampling attributes such as community composition, EPT taxa richness, and QCTV scores was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates. P = Poor, F = Fair, MG = Marginally Good.

c - Use attainment status based on one organism group is parenthetically expressed.

d - Modified Warmwater Habitat criteria for channel modified habitats.

ns - Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb uits). Underlined scores are in the Poor or Very Poor range.

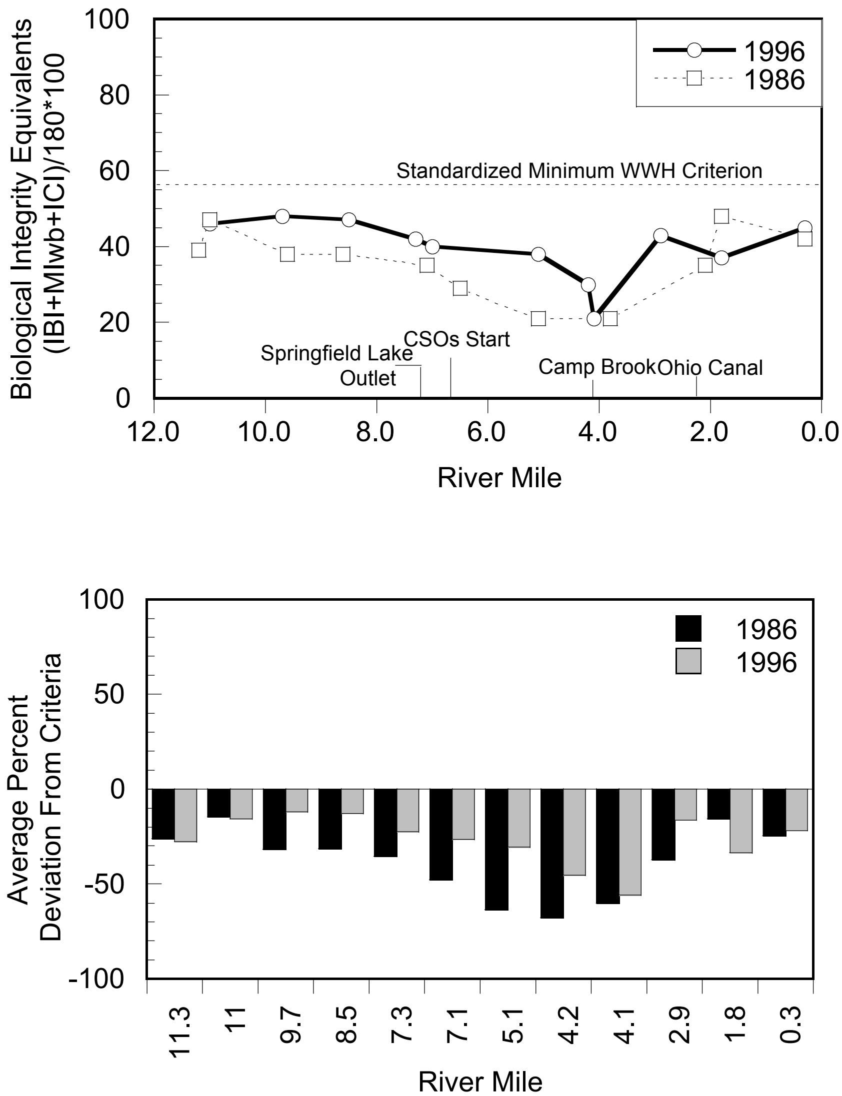


Figure 2. Upper plot shows composite biological index (IBI, MIwb and ICI) scores standardized to a common scale (i.e., 0 - 100) for 1986 and 1996. The composited scores are termed Biological Integrity Equivalents (BIE). The lower plot depicts the average percent deviation (*i.e.*, the ADV expressed as percent deviation from biological criteria) of IBI, MIwb and ICI scores from minimum Warmwater Habitat biological criterion by river mile for 1986 and 1996.

Public Lakes and Reservoirs

Monitoring and assessing the condition of natural lakes, impounded stream reservoirs, and upground drinking water supply reservoirs, is one component of the Ohio EPA five year surface water quality monitoring strategy. Reservoirs act as watershed sinks for the upstream releases of nutrients, soil, pesticides, and toxic pollutants. Thus, the assessment of reservoirs is one way to monitor the combined effects that both point source and non-point source pollutant loadings have on surface water quality. Natural lakes, many over 10,000 years old, are unique water resources and are commonly associated with rare and endangered plant and animal species. In Ohio, lakes and reservoirs are the primary recreational and public drinking water resource for millions of citizens.

Summary

Three publicly owned lakes and reservoirs, Nesmith Lake, Summit Lake and Mogadore Reservoir, were sampled in 1996 as part of the Ohio EPA 5-year Cuyahoga River watershed assessment (Table 2). All three lakes were judged as hypereutrophic based on levels of algal production. Seasonal algal production was relatively stable in Summit and Nesmith lakes, whereas Mogadore Reservoir showed a significant increase in chlorophyll-a concentrations from spring to summer. The wide variation in algal production in Mogadore Reservoir may be related to a combination of lack of flow over the dam during the summer, nutrient regeration, and/or high nutrient loadings from the watershed.

Assessments of Summit Lake and Nesmith Lake showed **non** attainment of designated aquatic life and recreational uses. Mogadore Reservoir showed partial attainment for these uses (Table 2). The bottom waters of Summit Lake had elevated levels of chlorides and total dissolved solids (TDS), most likely from the upstream discharge of the Akzo Salt Company. Summit Lake also had highly elevated levels of six heavy metals in the bottom sediments (Zn, As, Cd, Cr, Pb, Hg), an indication of impaired lake condition for the bottom sediment Lake Condition Index (LCI) metric. Nesmith Lake showed highly elevated levels of As, Pb, and Zn in the sediment. Polychlorinated biphenyls (PCBs) were found in the sediment of both Nesmith Lake and Summit Lake, and have bioaccumulated into the food web of both lakes. Elevated levels of PCBs in bottom feeding fish tissue have resulted in a public health advisory against eating Carp and Catfish in Summit Lake and Nesmith Lake. Recent information provided by the Ohio Department of Health indicates that elevated levels of mercury exist in the Largemouth Bass of Mogadore Reservoir, and they have issued a consumption advisory of no more than one meal per month for Largemouth Bass. The public drinking water supply potential for each lake is limited by anoxic bottom waters in the summer resulting in the release of ammonia-N, iron, and manganese from the sediments into the bottom waters, with Summit Lake showing non-attainment of the PWS potential use and partial PWS attainment for Nesmith Lake and Mogadore Reservoir.

The water quality of all three lakes is affected by the control of inflow and outflow water. The upper watershed inflow for Mogadore Reservoir has been diverted into the feeder canal

Table 2. Summary of attainment/non-attainment status for lakes/reservoirs sampled in the Cuyahoga River basin in 1996.

	Recreation	Fish Consumption	Public Water Supply	Aquatic Life
Lake Nesmith	**NON**	**NON**	PARTIAL*	PARTIAL
Summit Lake	**NON**	**NON**	PARTIAL*	**NON**
Mogadore Resv.	PARTIAL	PARTIAL	PARTIAL**	PARTIAL

*Fish consumption advisory for Carp and Bullhead Catfish ---PCBs, City of Akron Health Department Advisory.
** ODH advisory for Largemouth Bass, mercury advisory--one meal per month recommended by ODH.

for Lake Hogdson, the primary drinking water supply for the city of Ravenna. Thus Mogadore Reservoir does not receive natural water inflow volume during low inflow periods. During the summer the only outflow from the reservoir is by hypolimnetic withdrawal, no water flows over the lake dam. The hydrology of Nesmith Lake and Summit Lake is regulated by the flow through the Ohio Canal Portage Lakes system controlled by the State of Ohio, Department of Natural Resources. Neither of these natural lakes has a dam structure. Summit Lake is the only lake in Ohio that can have its flow regulated so that it flows simutaneous out from both ends, one direction is to the Ohio River basin and the other direction to the Lake Erie basin. It lies on the summit of the continental divide in Ohio.

Based on the data collected during the 1996 survey, the following Lake Condition Index scores were obtained (Summit Lake = 36.9; Mogadore Reservoir = 41.7; and Lake Nesmith = 44.2). In general, higher LCI scores indicate a greater degree of degradation of overall lake ecosystem health. In Ohio, lakes with LCI scores greater than 30.0 LCI points require more intensive study to determine appropriate lake restoration and watershed management techniques, whereas lakes with LCI scores less than 25.0 represent higher quality lakes that need to be protected from future loadings of pollutants.

Recommendations

The sources of nutrients leading to the hypereutrophic conditions extant in all three lakes needs to be identified. Additional monitoring of PCBs in fish tissue for Nesmith Lake and Summit Lake and mercury in the tissue of largemouth bass of Mogadore Reservoirs needs to be conducted. The effects of modifications in the hydrology of Mogadore Reservoir needs to be investigated, including the use of hypolimnetic water. The effect that the hypolimnetic release has on the water quality of the Little Cuyahoga River needs to be further identified. The sediment quality of Summit Lake and Nesmith Lake and the connecting canal system needs to be further assessed to determine if dredging to remove toxic levels of pollutants needs to be conducted. Based on the elevated LCI scores, all three lakes should have lake and watershed management plans developed in order to restore full beneficial uses.

Study Area

The Little Cuyahoga River subwatershed drains the Akron metropolitan area and is among the most urbanized and densely populated in the state. Housing density within the subbasin is most dense in political subdivisions located along the course of the river, and tends to increase from upstream to downstream (Figure 3A). Urban runoff is a well documented source of nonpoint pollution to surface waters (see review by Schuler, 1994), the effects of which on aquatic life are usually exacerbated where sanitary and stormwater sewers are combined and discharge into receiving streams (Yoder and Rankin, 1996).

City of Akron Combined Sewer System

The combined stormwater and sewer system operated by the City of Akron is fully described in a report submitted to the Ohio EPA in 1995 (City of Akron, 1995). The following description of the system is a summary derived largely from the report.

Of the 1,160 miles of sewers connected to the City of Akron Water Pollution Control Station (WPCS), 188 miles consist of combined sewers, which service approximately 21 percent of the total service area. All areas serviced with combined sewers are located within the City of Akron, and can be divided into three general service areas consisting of the Little Cuyahoga/Main Outfall Sewer area (servicing east Akron, Tallmadge, and the Camp Brook areas), the Ohio Canal Interceptor (servicing central and south Akron as well as the Kenmore area), and the North Side Interceptor (which services the north side of Akron and Cuyahoga Falls). Forty-one regulating structures control flows to 38 identified combined sewer outfalls (CSOs). The approximate locations of the CSOs and their discharge locations are shown schematically in Figure 3B.

The CSOs in the City of Akron sewer system discharge to the Ohio Canal (6 CSOs), Camp Brook (1 CSO), the Little Cuyahoga River (23 CSOs), and the Cuyahoga River (6 CSOs) following rain events, with dry weather flows all diverted to the Akron WPCS under normal operating conditions. Other conditions relating to the maintenance of the regulating structures or malfunctions such as sewer line blockages, water main breaks, vandalism, etc. may also give rise to periodic discharges from the CSOs. As required by a Consent Agreement with the US EPA and the City of Akron WPCS's monthly operating report (MOR) requirements, the City of Akron has developed an extensive data gathering system for measuring discharges from the CSOs. Much of these data have been reported in studies of the impacts of the CSO discharges on the receiving water bodies (City of Akron, 1995; City of Akron, 1996), and the data is also routinely reported to the Ohio EPA as part of the MORs for the Akron WPCS. Data for discharges from the CSOs within the City of Akron sewer system in 1996 are summarized starting on page 22. Specific sampling locations used in this study to assess impacts from CSOs are listed in Table 3.

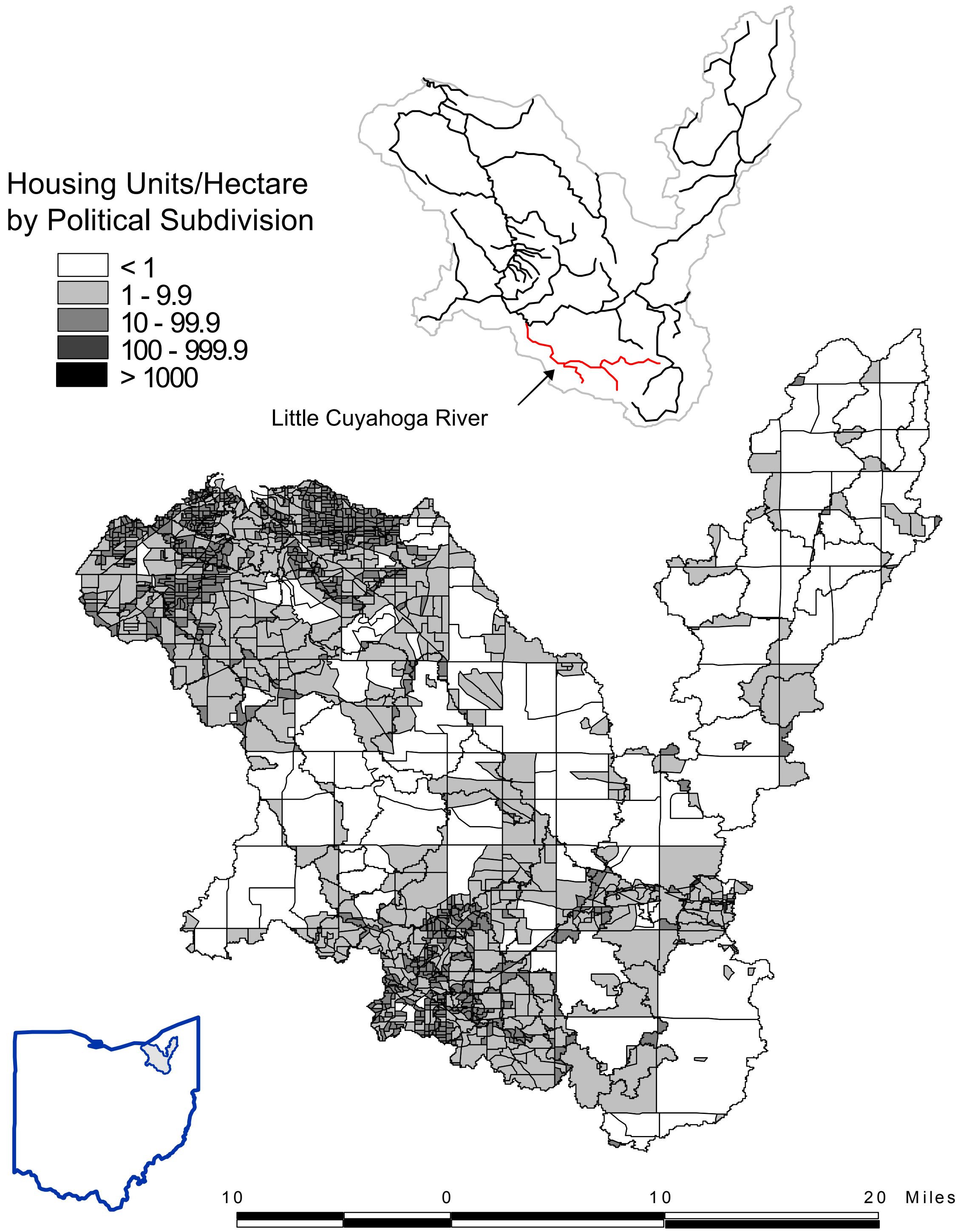


Figure 3A. Housing Density per hectare within the Cuyahoga River drainage basin and location of the Little Cuyahoga River subbasin.

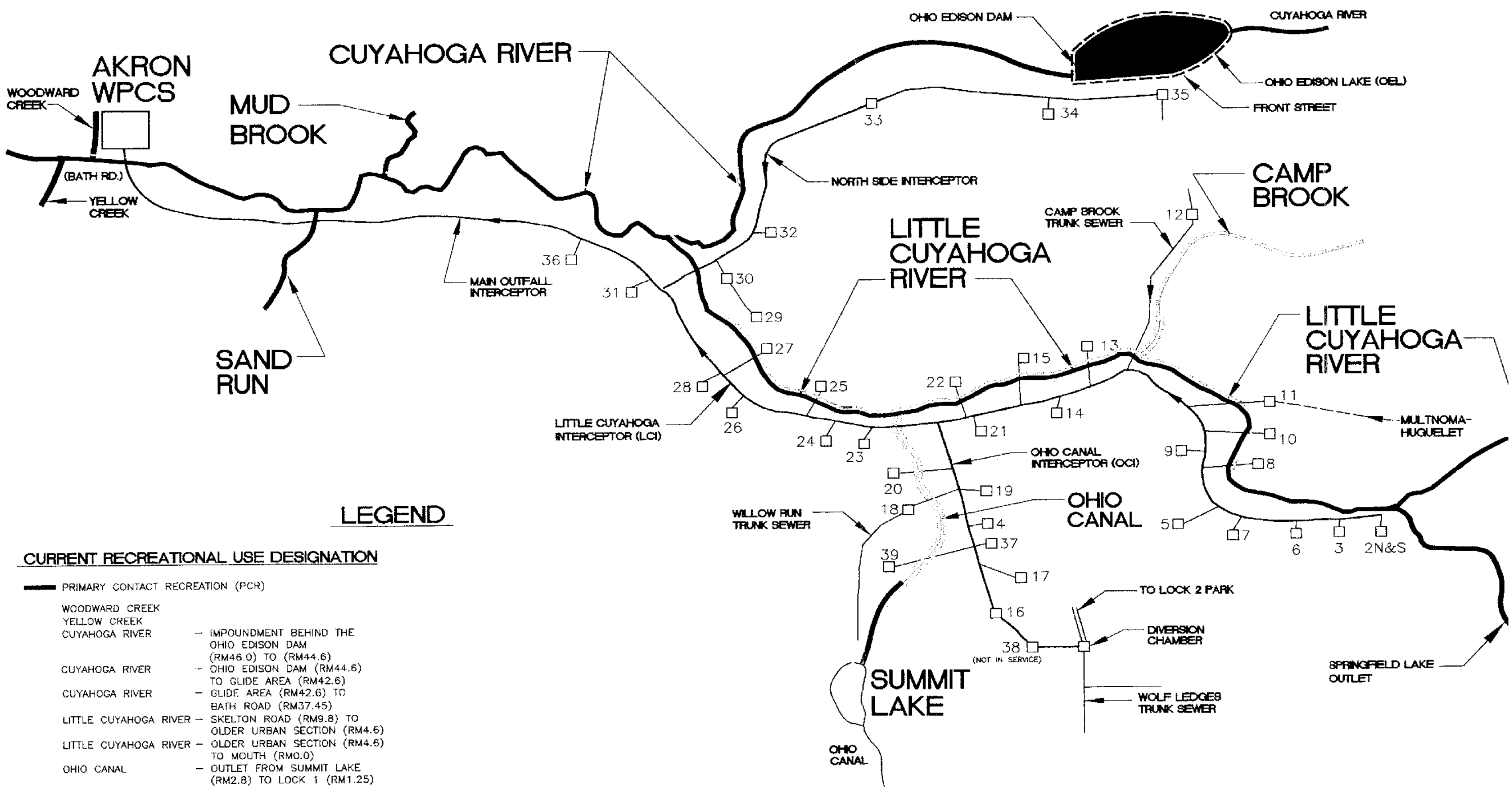


Figure 3B. Schematic of the City of Akron combined sewer system. Source: City of Akron, 1995.

Table 3. Sampling locations in the Little Cuyahoga River study area, 1996 (C - conventional water chemistry, S - sediment metals, B - quantitative artificial substrate macroinvertebrate sample, B_q - qualitative macroinvertebrate sample, F - fish, D - Datasonde®).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 Minute Quadrangle Map
Little Cuyahoga River				
11.75	S	41 03 49/81 23 40	At Route 532	Akron, East
11.3	F	41 03 24/81 23 56	Adj Universal Materials	Akron East
11.2	B, C	41 03 29/81 25 56	Dst Universal Materials	Akron East
11.0	B, F	41 03 18/81 24 00	Mogadore Police Station	Akron East
10.95	C, S	41 03 17/81 24 01	Gilchrist Road	Akron East
9.7	B, F	41 03 18/81 25 17	Ust Skelton Road	Akron East
9.67	C, S	41 03 21/81 25 23	Ust Skelton Road	Akron East
8.5	F	41 03 52/81 26 37	Dst SR 91	Akron East
8.4	B	41 03 52/81 26 38	Dst SR 91	Akron East
8.21	C,S	41 03 52/81 26 45	Dst SR 91	Akron East
7.3	F	41 03 44/81 27 38	Ust Springfield Lake Outlet	Akron East
7.15	B, C	41 03 37/81 27 46	Ust Springfield Lake Outlet	Akron East
7.0	B, F	41 03 37/81 27 47	Dst Springfield Lake Outlet	Akron East
6.41	C, S	41 03 33/81 28 19	Dst Seiberling Rd.	Akron, East
5.11	B, C, F	41 04 24/81 29 05	Bank Street	Akron East
4.2	B, C, F	41 05 05/81 29 11	Ust Camp Brook	Akron East
4.08	C, F	41 05 08/81 29 15	Dst Camp Brook	Akron East
3.85	B_q, C, S	41 05 15/81 29 27	North Street	Akron East
2.9	F	41 05 29/81 30 48	Elizabeth Park	Akron West
2.46	C	41 05 26/81 30 40	Elizabeth Park	Akron West
2.2	B_q	41 05 31/81 30 54	Dst Elizabeth Park	Akron West
1.85	C, S	41 05 40/81 31 18	Otto Street	Akron West
1.8	B_q, F	41 05 40/81 31 20	Otto Street	Akron West
0.3	C, F, S	41 06 53/81 31 39	Police firing range	Akron West
0.2	B	41 06 55/81 31 41	Police firing range	Akron West
Union Oil Tributary				
1.5	F	41 04 45/81 23 46	Newton Road	Akron East
0.5	B_q, C, S	41 04 07/81 23 49	Southeast Avenue	Akron East

Table 3. Continued.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 Minute Quadrangle Map
Wingfoot Lake Outlet				
3.18	C, B_q	41 01 18/81 22 22	Waterloo Road	Suffield
1.3	F	41 02 33/81 23 10	Sundowner Drive	Suffield
0.05	B_q, C, F, S	41 03 17/81 23 55	At mouth	Akron East
Roosevelt Ditch				
0.13	C, B_q	41 03 58/81 26 07	Ust Gilchrist Rd.	Akron, East
Springfield Lake Outlet				
0.10	B_q, F	41 03 31/81 27 47	Ust mouth	Akron East
0.05	C	41 03 14/81 27 47	Near mouth	Akron East
Camp Brook				
1.61	B_q	41 05 41/81 28 01	Brittain Road	Akron East
1.0	F	41 05 29/81 28 29	Shoshone Street	Akron East
0.46	C, S	41 05 29/81 29 07	Ust Rack 12	Akron, East
0.1	B_q, F	41 05 32/81 29 12	Ust North Street	Akron East
0.05	C	41 05 10/81 29 13	At mouth	Akron East
Ohio Canal				
0.18	B, C	41 05 28/81 31 04	North Street	Akron West

METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995. Chemical, physical and biological sampling locations are listed in Table 3.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-14). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical endpoints are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location - Full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (see Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location.

The attainment status of aquatic life uses (*i.e.,* Full, partial, and non-attainment) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-17). The biological community performance measures used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (Warmwater Habitat

[WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is full if all three indices (or those available) meet the applicable biocriteria, partial if at least one of the indices does not attain and performance is fair, and non-attainment if all indices fail to attain or any index indicates poor or very poor performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

Lake Sampling
All chemical, physical, and laboratory methods and procedures follow those specified in the manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 1989a). Field measurements for pH, temperature, dissolved oxygen, and conductivity were collected through the water column at fixed intervals. Duplicate samples for chlorophyll-a analysis were collected at 0.5 meters depth and filtered through Whatman GF/C 1.2 micron glass microfiber filters. Chlorophyll-a concentration is determined using a Turner Model fluorometer modified for chlorophyll-a analysis. Secchi disk depth is measured using a standard 20 cm diameter black and white disk. Plankton samples are collected using a 11.5 cm diameter, 63 micron mesh Wisconsin plankton tow. Duplicate samples are collected from vertical tows down to twice the measured Secchi disk depth. This depth is used to approximate the plankton community in the photic zone of the water column. Zooplankton samples are fixed in 5% formalin and preserved in 75% ethyl alcohol post. Phytoplankton samples are preserved in a Lugols iodine solution.

The attainment or non-attainment of designated uses for lakes and reservoirs in Ohio is determined using a multi-parameter Ohio Lake Condition Index (LCI) assessment technique (Davic and DeShon; 1989, Ohio EPA, 1996 Water Resource Inventory Report, Vol. III). Fourteen metrics are assessed to determine the biological, chemical, physical, and aesthetic conditions of the lake or reservoir. Attainment of designated uses (e.g., aquatic life, recreation, public water supply, human fish consumption) is determined by the relative number of threatened and impaired metric conditions for each designated use. Criteria used to determine metric conditions include exceedences of Ohio water quality standards (3745-1 of OAC) and best professional judgement.

Habitat Assessment
Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still

support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Macroinvertebrate Community Assessment
Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. During the present study, macroinvertebrates collected from the natural substrates were also evaluated using an assessment tool currently in the field validation phase. This method relies on tolerance values derived for each taxon, based upon the abundance data for that taxon from artificial substrate (quantitative) samples collected throughout Ohio. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected are weighted by its abundance on the artificial substrates. The mean of the weighted ICI scores for the taxon results in a value which represents its relative level of tolerance on the 0 to 60 scale of the ICI. For the qualitative collections in the Little Cuyahoga study area, the median tolerance value of all organisms from a site resulted in a score termed the Qualitative Community Tolerance Value (QCTV). The QCTV shows potential as a method to supplement existing assessment methods using the natural substrate collections. Use of the QCTV in evaluating sites was restricted to relative comparisons between sites and was not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Macroinvertebrate samples were collected from nineteen stations in the Little Cuyahoga River, Union Oil Tributary, Wingfoot Lake Outlet, Springfield Lake Outlet, Camp Brook, and the Ohio Canal in 1996 (Table 3). Artificial substrate (quantitative) and natural substrate (qualitative) sampling were the methods used in the Little Cuyahoga River and Ohio Canal while only natural substrates were sampled in the other tributaries. Lists of macroinvertebrate taxa and ICI metric scores from each site in the study area are available electronically on the Ohio EPA Division of Surface Water home page at http://chagrin.epa.ohio.gov/.

Fish Community Assessment
Fish communities were sampled twice at the same location on the Little Cuyahoga River mainstem at 4 to 5 week intervals. Tributatries were sampled once. All samples were collected using either the longline or wading electrofishing methodology. Lists of fish species and their relative abundance and IBI metric scores from each site in the study area are available electronically on the Ohio EPA Division of Surface Water home page at http://chagrin.epa.ohio.gov/.

Area of Degradation Value (ADV)
An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1995) portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the

biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance (Figure 3). The "magnitude" of impact refers to the vertical departure of each index below the biocriterion or the upstream level of performance. The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile. The results are expressed as ADV/mile to normalize comparisons between segments, sampling years, and other streams and rivers. The ADV in this study was simplified to an average percent deviation from respective criterion for the IBI, ICI and MIwb (Figure 2).

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked togather. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

AREA OF DEGRADATION VALUE (ADV)

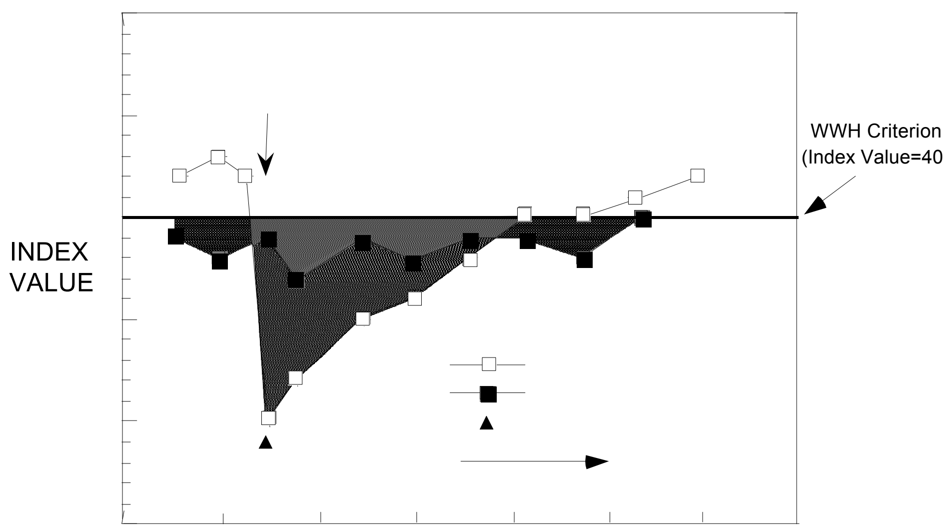


Figure 4. Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). the index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle); the filled boxes and dashed shading (area of departure) represent a typical response to a nonpoint source or combined sewer overflow impact. The blended shading represents the overlapping impact of the point and nonpoint sources.

RESULTS AND DISCUSSION

CSO Discharge Assessment
Of the 3,620 discharges from CSOs in the Little Cuyahoga River watershed in 1996, 19.7 percent were to the Ohio Canal. However, 75.5 percent of the total volume of 2.97 billion gallons, or approximately 6 million gallons per day (MGD) of combined sewer effluent, was discharged to the Ohio Canal (Figure 5). The great majority of this flow was from Rack 18 (the Willow Run Trunk CSO) which discharged a total of 2.1 billion gallons to the Ohio Canal in 1996. This CSO contributed 95 percent of the Ohio Canal total CSO discharge and 71 percent of the total CSO discharge within the Little Cuyahoga River watershed. Rack 18 CSO is located in the culverted portion of the Ohio Canal within the downtown Akron area.

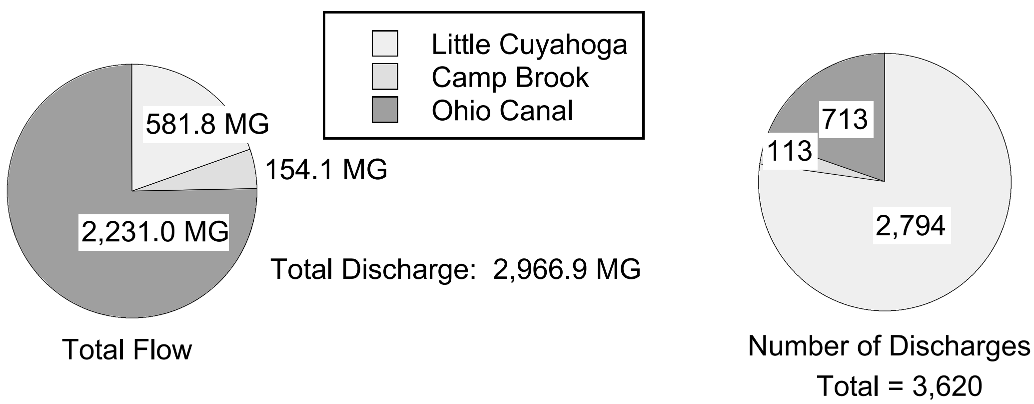


Figure 5. Number of CSO discharge events and total volume of discharge for the Little Cuyahoga River subbasin, 1996.

Rack 22 (the North Hill Trunk CSO at Howard Street) contributed 61 percent of the flow or 96.9 million gallons (MG) from CSOs to to the Little Cuyahoga River mainstem. Rack 12 on Camp Brook discharged a total of 154.1 MG in 1996, equivalent to an average discharge of 0.422 MGD, accounting for 5.2 percent of the total reported CSO discharges to the Little Cuyahoga River watershed in 1996.

The greatest number of discharges from CSOs in the Little Cuyahoga River watershed during 1996 occurred during the months of April, May and June (Figure 6). However, the greatest volumes of discharge reported in the MOR's occurred during June, August and September.

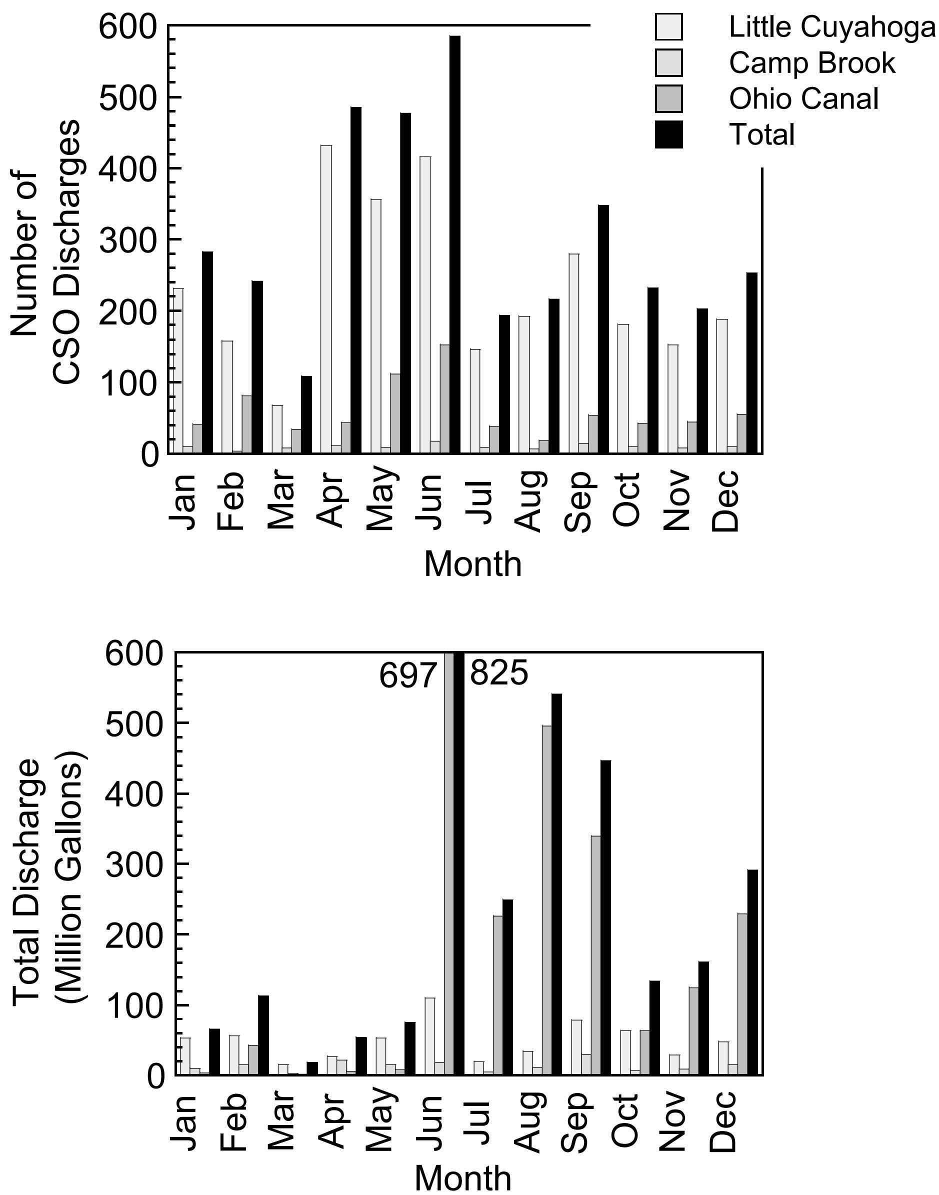


Figure 6. Number (left) and total volume (right) of CSO discharges in the Little Cuyahoga River basin by month, 1996.

Discharges during these three months accounted for 61 percent of the total volume discharged from CSOs in the Little Cuyahoga River watershed. It should be noted, however, that there is no data available for discharges from Rack 18 to the Ohio Canal for the months of January through May, 1996. Data for these months could not be reported due to equipment problems. Consequently, a potentially significant amount of CSO flow is unaccounted.

The average daily discharge from CSOs in the Little Cuyahoga River watershed was 8.13 MGD for 1996. During the months of June, July and August, 1996, the average discharge was 19.90 MGD (Table 4).

The number of discharge events ranged from zero discharges in a month (several of the CSOs) to 47 discharges in a month (Rack 14 in June) in the Little Cuyahoga River watershed during 1996. Rack 14 (the North Forge St. CSO) also had the most discharge events during 1996, with a total of 326 reported in the MOR's During 1996, each CSO had an average of 10.4 discharge events per month. Table 4 gives a monthly breakdown for discharge volumes within the Little Cuyahoga River watershed.

Cuyahoga River Mainstem CSOs:

As with the CSOs in the Little Cuyahoga River watershed, there were data gaps in the reporting of CSO discharges noted in the MOR's due to vandalism and equipment problems. Data were available for all of the CSOs which discharge directly to the Cuyahoga River for at least nine months during 1996 except for Rack 34, for which data was available for only six months.

The discharge of combined sewage effluent directly to the Cuyahoga River from the six CSOs located along the river from approximately RM 45.1 to 41.9 contributed only 4.7 percent of the total CSO discharge from the City of Akron sewer system in 1996 (Figure 7). The great majority of the flow from CSOs entered the Cuyahoga River from the Little Cuyahoga watershed during this period.

The four CSOs located on the Cuyahoga River upstream of the confluence with the Little Cuyahoga River (Racks 32, 33 and 35) contributed 36.6 percent of the total flows of CSOs discharged directly to the Cuyahoga River in 1996 (Figures 6 and 7). During 1996, the average discharge from CSOs directly to the Cuyahoga River was 0.148 MGD upstream from the confluence with the Little Cuyahoga River and 0.256 MGD downstream from that point.

The greatest number of CSO discharges directly to the Cuyahoga River occurred during the months of January, April and June in 1996 (Figure 7). These three months accounted for 42 percent of the total number of discharge events. The number of discharge events was relatively uniform between the CSO locations, with the total number of releases ranging from a total of 74 (Rack 34) to 137 (Rack 31) during 1996. The average number of releases from individual CSOs ranged from 7.4 (Rack 32) to 19.6 (Rack 36) discharge events per month.

The greatest volume of combined sewage discharges for CSOs discharging directly to the Cuyahoga River occurred in February, April, June, September and December (Figure 7). During the fall and winter months, the CSOs located downstream of the confluence with the Little Cuyahoga River discharged the greatest volume of combined effluent (85 percent of the total discharge). However, during the spring, this pattern reversed itself, with 64.7 percent of the discharge from CSOs occurring from CSOs located downstream from the Little Cuyahoga River. The mechanism for this seasonality is currently unknown.

Using the MOR data submitted by the City of Akron, the average discharge event from a CSO discharging directly to the Cuyahoga River released 0.198 MG of untreated combined effluent to the river. In contrast, the average CSO discharge event for CSOs in the Little Cuyahoga River watershed released 0.819 MG of combined effluent.

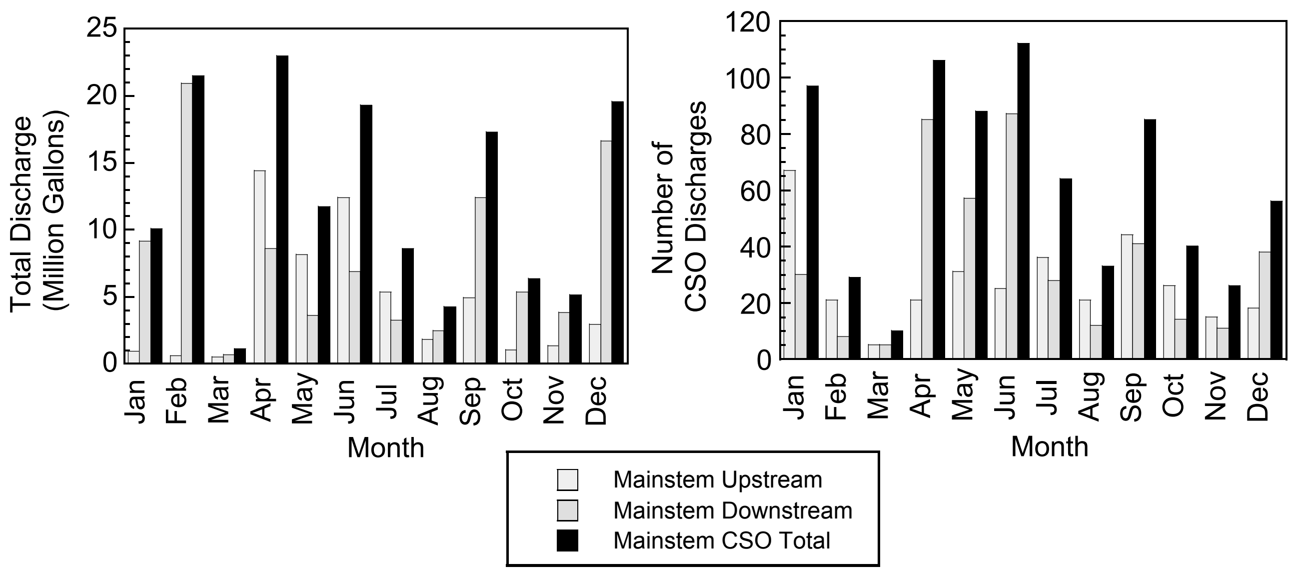


Figure 7. Total volume and number of CSO discharges in the Cuyahoga River mainstem by month, 1996.

In summary, the City of Akron combined sewer system is a significant source of pollutant loadings to both the Little Cuyahoga River and the Cuyahoga River. Information generated by the City of Akron WPCS has indicated that CSO discharges can occur with as little as 0.15 inches of rainfall. Combined sewer discharges occur throughout the year, and their cumulative impact results in an average discharge of 8.53 MGD of combined effluent to the Cuyahoga river and tributaries throughout the year (Table 4). CSO discharges within the Little Cuyahoga River watershed far outnumber those directly to the Cuyahoga River (Figure 8). However, given the high gradient within the Little Cuyahoga River drainage, these discharges find their way rapidly to the Cuyahoga River mainstem. It is beyond the scope of the present study to calculate the actual loadings of pollutants to the Cuyahoga River downstream from the City of Akron from these releases, but given the large number of releases and the quantity of combined sewage discharged, it can be inferred that these discharges are causing a significant negative impact on biological communities in the Cuyahoga River. As most of the CSOs are located in high gradient reaches of the Little Cuyahoga River, its tributaries, and the Cuyahoga River, it is likely that the impact of these releases is expressed in the extensive biological impairment observed in the comparitively lower gradient segment of the Cuyahoga River mainstem within the Cuyahoga Valley National Recreation Area.

Table 4. Totalized flows from CSOs in the City of Akron Sewer System for 1996[1]

Month	Cuyahoga River, upstream from the Little Cuyahoga[2] (MG)	Little Cuyahoga River Watershed[3] (MG)	Cuyahoga River, downstream from the Little Cuyahoga[4] (MG)	Total Flow (MG)	Average discharge (MGD)
January	0.91	65.15	9.15	75.21	2.43
February	0.59	112.35	20.88	138.82	4.96
March	0.47	17.54	0.65	18.66	0.60
April	14.37	53.12	8.59	76.08	2.54
May	8.12	74.87	3.59	86.57	2.79
June	12.39	825.02	6.88	844.30	28.14
July	5.33	249.16	3.23	257.72	8.31
August	1.80	540.13	2.45	544.38	17.56
September	4.92	445.84	12.37	463.13	15.44
October	1.02	132.79	5.33	139.14	4.49
November	1.34	160.78	3.79	165.91	5.53
December	2.93	290.18	16.63	309.74	9.99
1996 total	54.18	2,966.91	93.55	3,114.64	8.53

[1]Source: monthly operating reports submitted by the City of Akron WPCS.

[2]Racks 32, 33, and 35.

[3]Racks 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, and 37.

[4]Racks 31, 34, and 36.

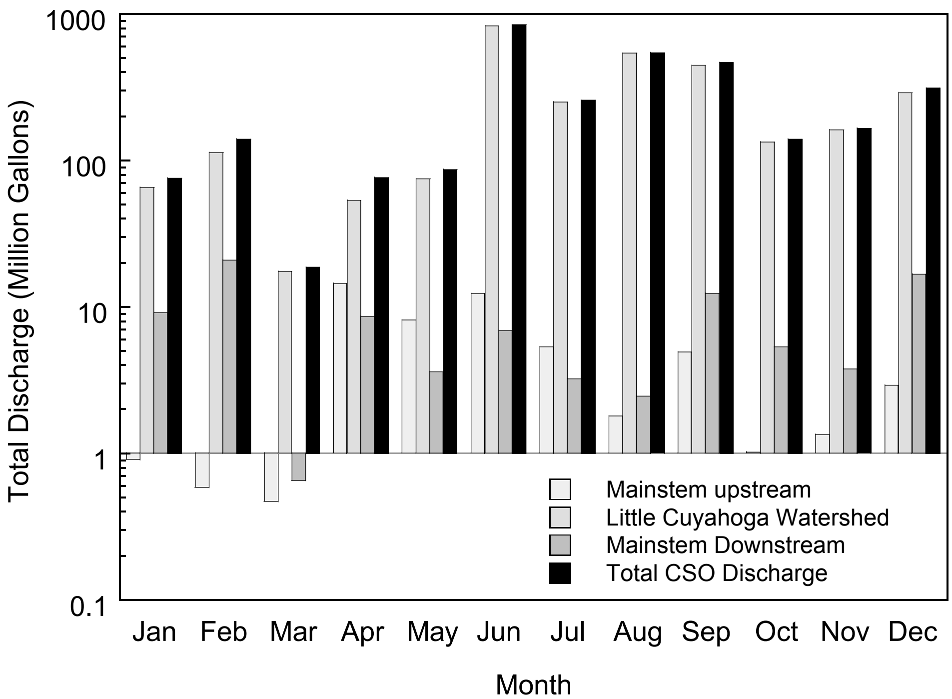


Figure 8. Total monthly volume of discharges from the City of Akron CSOs to the Little Cuyahoga River in relation to CSO discharges in the Cuyahoga River mainstem upstream and downstream from the Little Cuyahoga River, 1996.

Spills

Eighty-two spills were recorded by the Ohio EPA within the Little Cuyahoga River subbasin between 1989 and 1996. Of those, only nine have the spilled substance or chemical identified. Of the nine identified, two were sewage, two were brine and the other five were all different chemicals, mostly petroleum products. The incidence of spills relative to the size of the subwatershed is high and suggests that spills may also contribute to biological impairment. Some spills may be intercepted by the sewer system and diverted to the WWTP and not enter the stream.

Fish Kills

Within the Little Cuyahoga subbasin for the period of 1991 to 1996, only one fish kill was reported for an unnamed tributary to Springfield Lake Outlet on 10/16/96. The cause was unknown. The low number of fish kills compared to the relatively high occurrence of spills may be an artifact of the fish communities throughout the subbasin being composed primarily of tolerant fishes, or the spilled substances entered the sewage system and not the stream directly.

1996 Lakes and Reservoirs Assessed in the Little Cuyahoga River Watershed

Three publicly owned lakes or reservoirs were sampled in 1996 as part of the Ohio EPA 5-year Cuyahoga River watershed assessment (Table 5). A summary of selected data collected for each lake/reservoir is provided in Tables 6-8. Additional raw data are available through the US EPA STORET national database retrieval system or by contacting the appropriate Ohio EPA District Office. A brief narrative of the overall condition of each lake is provided below.

Table 5. List of Ohio public lakes, ponds, reservoirs sampled in 1996 in the Cuyahoga River basin.

Water body ID#	Lake Name	County	Eco-region	Surface Area (acres)	Lake Uses	Lake Type
OH10 33-355	Lake Nesmith	Summit	3	80	R	NL
OH10 33-352	Summit Lake	Summit	3	100	R	NL
OH88 04-312	Mogadore Reservoir	Portage	3	900	R,WS	DPI

R= recreation, WS=public water supply; NL = natural lake; DPI= damed permanant impoundment.

Nesmith Lake

Nesmith Lake is a 80 acre natural lake that is part of the Portage Lakes system. The outflow from the lake is regulated by the State of Ohio via a series of locks and dams. Current lake uses include shore fishing, boating, and shoreline wading. No swimming beaches are located on the lake. The 1996 sampling effort included water column field profile data; chemical samples for the surface and bottom waters; a single sediment sample for heavy metals, pesticides, and PCBs; and a fecal coliform bacteria sample. The L-1 sample location was in the deep hole of the nearly circular lake located at lat: 41/01/36; long: 81/33/04.

The results of the 1996 assessment of Nesmith Lake indicate that 8 of 12 measured LCI metrics showed less than full use condition (Table 6) and that the lake was in non attainment for full aquatic life and recreational uses, and partial attainment for potential public water supply (Table 2). Results of fish tissue sampling in late 1980s and again in 1992 indicate the Carp and Bullhead Catfish have elevated levels of PCBs in fish tissue. The City of Akron has issued a public consumption advisory for these two species of fish. The sediment of the lake showed elevated levels of PCBs, As, Pb, and Zn. The source of the PCB is most likely from the Summit Equipment and Supply Company superfund site, which released PCBs into a drainage ditch that flows into Nesmith Lake. The site and ditch sediment has been remediated. The level of PCBs in five composite fillets collected by Ohio EPA is 1992 was 1400 ug/kg. No PCBs were detected in Largemouth Bass composite fillet samples. The bottom waters were anoxic in the summer which resulted in the release of Mn and ammonia-N into the water from the lake sediments. Nutrient enrichment has resulted in blooms of algae with summer chlorophyll-a values in the 48 to 57 ug/l range, an indication of a hypereutrophic nutrient condition (Table 7). The source(s) of the nutrients are unknown. The number of fecal coliform bacteria was measured at 53/100 ml, well below the 100/100 ml bathing water standard.

Data collected over time for trophic condition indicate there has been no significant change in trophic state over time (i.e. +- 4 TSI points). TSI changed from a value of 68 in 1979 to a value of 69.5 in 1996 (note: the spring TP value was not included in the 1996 TSI calculation due to potential analytical error). Fish tissue data on PCBs in Carp collected in 1992 indicates a reduction in concentration from tissue samples collected in 1980. Future monitoring of PCBs in Carp and Catfish are needed to determine if the consumption public health advisory should be continued.

Summit Lake

Summit Lake is a 100 acre natural lake that is part of the Portage Lakes system. Lake access is owned by the city of Akron. The flow out of the lake is regulated by the State of Ohio via a series of locks and dams. Current lake uses include shore fishing, and boating. No swimming beaches are located on the lake. The 1996 sampling effort included water column field profile data; chemical samples for the surface and bottom waters; a single sediment sample for heavy metals, pesticides, and PCBs. A fecal coliform bacteria sample was collected near the public boat ramp The L-1 sample station was located in the center of the lake at the south end deep hole at lat 41/03/12; long: 81/32/43.

The results of the 1996 assessment of Summit Lake indicate that 7 of 13 measured LCI metrics showed less than full use condition (Table 6) and that the lake was in non attainment for aquatic life, recreational uses, and public water supply designated uses (Table 2). The City of Akron has issued a public consumption advisory for Carp and Bullhead Catfish. Results of fish tissue sampling by Ohio EPA in 1992 indicate that Carp had measurable but not elevated levels of PCBs in fish tissue. No PCBs were detected in Largemouth Bass collected from Summit Lake. The sediment of the lake showed highly elevated levels of As, Pb, Cd, Cr, Hg and Zn. The bottom waters were anoxic in the summer which resulted in the release of Mn and ammonia-N into the water from the lake sediments. Nutrient enrichment has resulted in blooms of algae with summer chlorophyll-a values in the 31 to 37 ug/l range, an indication of a hypereutrophic nutrient condition (Table 7).

The source(s) of the nutrients are unknown, but urban runoff and CSOs are two potential sources. The number of fecal coliform bacteria was measured at 13/100 ml at the boat dock area, well below the 100/100 ml bathing water standard. The lake showed elevated levels of chlorides and total dissolved solids (TDS), most likely a result of the discharge from the Akzo Salt Company discharge. Local fisherman indicate that the lake has a good population of largemouth bass, with many individual over 12 inches in length.

Table 6. Summary of Ohio LCI metric assessments for lakes/reservoirs sampled in the Cuyahoga River basin in 1996.

Lake	SD	IBI	NM	A	NP	PPO	PPM	P	N	F	V	S	B	M
Lake Nesmith	t(m)	ne	t(bpj)	fu(m)	t(m)	ne	fu(m)	t-h(m)	t-h(m)	t(m)	t(bpj)	I(m)	fu(m)	fu(m)
Summit Lake	t(m)	fu(bpj)	fu(bpj)	fu(m)	t(m)	ne	fu(m)	t-e(m)	t-h(m)	t(m)	t(bpj)	I(m)	fu(m)	fu(m)
Mogadore Resv.	t(m)	fu(bpj)	fu(bpj)	t(m)	t(m)	ne	fu(m)	t-h(m)	t-h(m)	t(m)	ne	t(m)	fu(m)	fu(m)

SD=secchi depth, IBI=fish Index of Biotic Integrity, NM=nuisance macrophytes, A=aesthetics, NP=nonpriority pollutants, PPO=priority organics, PPM=priority metals, P=algal production(chlorophyll-a), N=nutrients (total phosphorus), F=fish tissue contamination, V=volume loss due to sedimentation, S=sediment contamination, B=bacteria contamination (fecal coliform), M=mine drainage. Metric Conditions: fu=full use, t=threatened, I=impaired, m= monitored, bpj=best professional judgement, e=eutrophic, h=hypereutrophic, ne=not evaluated.

Data collected over time for trophic condition indicate that Summit Lake is getting more nutrient enriched, with a change in Carlson Trophic State Index (TSI) value of 67 in 1986 to a TSI of 76 in 1996 (Table 7). Future monitoring of PCBs in Carp are needed to determine if the consumption public health advisory should be continued.

Mogadore Reservoir

Mogadore Reservoir is a 900 acre impoundment located in the headwaters of the Little Cuyahoga River. The lake is owned and managed by the city of Akron. Current lake uses include fishing, a swimming beach, and boating. The 1996 sampling effort included water column field profile data; chemical samples for the surface and bottom waters; a single sediment sample for heavy metals, pesticides, and PCBs collected near the dam at station L-1 (lat: 41/03/51; long: 81/22/18); surface water trophic state samples only at station L-2 (lat: 41/03/32; long: 81/21/03), located just west of the State Route 43 bridge, and a fecal coliform bacteria sample collected at the public swimming beach.

The results of the 1996 assessment of Mogadore Reservoir indicate that 7 of 12 measured LCI metrics showed less than full use condition (Table 6) and that the lake was in partial use attainment for aquatic life, recreational uses, and public water supply designated uses (Table 2). Fish tissue samples indicated elevated level of mercury in Largemouth Bass. The Ohio Department of Health has proposed that consumption of Largemouth Bass be limited to one meal per month. Zinc was elevated in a sample of the bottom sediment.

Mogadore Reservoir showed extreme variation in water clarity and chlorophyll-a concentrations between the spring and summer values. Secchi disk values decreased from 4.0 m to 0.7 m and chlorophyll values increased from 4.5 ug/l to 346.2 ug/l. The seasonal extremes are the most divergent of any lakes sampled by the Ohio EPA in northeast Ohio. The lake has a long history of algal blooms in the summer. While collecting a fecal bacteria sample on August 28th at the swimming beach an extensive bloom of blue green algae was observed, with a strong odor.

Table 7. Results of chlorophyll-a, total phosphorus, Secchi depth, and Carlson Trophic State Index (TSI) values for lakes/reservoirs sampled in the Cuyahoga River basin in 1996.

Lake	Site	Date (m/d/y)	Chl-a (ug/l)	TSI (chl)	SD (M)	TSI (SD)	TP (ug/l)	TSI (TP)	Final TSI	Trophic State
Nesmith lake	L-1	5-8-96	53.97	70	0.96	61	**	**		
	L-1	7-24-96	56.93	70	0.53	69	48	60		
	L-1	8-20-96	47.97	69	0.61	67	80	67	69.5	Hypereutrophic
Summit Lake	L-1	5-9-96	31.04	64	1.10	59	**	**		
	L-1	7-24-96	32.38	65	0.77	64	35	55		
	L-1	8-20-96	36.75	66	0.81	63	38	57	65.5	Hypereutrophic
Mogadore Resv.	L-1	5-6-96	2.99	41	4.06	40	**	**		
	L-1	7-22-96	47.21	68	1.07	59	34	55		
	L-1	8-19-96	167.8	81	0.71	65	70	65	74.5	Hypereutrophic
	L-2	5-6-96	4.53	45	3.12	44	**	**		
	L-2	7-22-96	70.39	72	0.78	64	61	63		
	L-2	8-19-96	346.2	88	0.48	71	100	71	80	Hypereutrophic

** Spring TP data not included in trophic state analysis due to potential error in laboratory analysis.

It is possible that the lake management practice of releasing water only from the hypolimneon in the summer may help contribute to the seasonal problems with blooms of algae. City personnel indicated that about 4.0 mgd is released from the bottom waters of the lake, while no water flows over the surface of the dam for most of the summer. While this lake management practice does have the ability to release bottom water nutrients from anoxic water in the summer months. It also has the potential to accumulate algae in the upper waters of the lake if no water flows over the lake dam. The constant realease of bottom waters can also break summer temperature stratification thus leading to complete lake mixing during high winds. That this process may be occurring in Mogadore Reservoir is seen from the field profile data for water temperature as shown in Table 8. At best only a weak summer thermocline was found in the summer samples.. Mixing of high nutrient anoxic bottom water into the surface water during the summer could be a cause of the excessive blooms of surface water algae observed in the reservoir. Diversion of inflow water also has the potential to limit the flushing of surface water algae out of Mogadore Reservoir. Thus it appears that the wide seasonal variation in algal production in Mogadore Reservoir may be related to a combination of causes including lack of flow over the dam during the summer, nutrient regeration, and/or high nutrient loadings. Although the lake is highly nutrient enriched the recreational fishery of Mogodore Reservoir is viewed to be acceptable, with largemouth bass and bluegill the most common species captured. It is unlikely that the swimming beach is utilized to its fullest potential given the odorous blue green algae bloom that was observed during the August sampling.

Data collected over time indicates that Mogodore Reservoir is maintaining itself at a highly nutrient enriched hypereutrophic condition during the summer months. There has been little change in final TSI values from 1990 (TSI =72) to 1996 (TSI=74.5). Very clear water in the spring continues to exist. Future monitoring of the health of the overall game fishery is needed to quantify the long-term effect of hypereutrophic nutrient enrichment. More intensive sampling of fish tissue for all game fish species is need to determine the extent of mercury contamination. The feasibility of stopping the practice of summer release of hypolimnetic water and instead allowing the lake to discharge over the dam surface needs to be investigated.

Table 8. Results of chemical/physical sampling (field parameters) in selected lakes in the Cuyahoga River basin in 1996.

Lake	Location	Date	Depth (m)	Temp C	DO (mg/l)	pH (SU)	Conductivity (Umhos/cm)
Nesmith Lake	L-1	05/08/96	0.5	14.2	12.2	8.9	614
			1.0	14.1	12.1	8.9	613
			1.5	14.0	12.1	8.9	612
			2.0	13.9	12.0	8.85	609
			2.5	13.8	11.8	8.85	609
			3.0	13.8	11.7	8.8	609
			3.5	13.8	11.4	8.8	609
			4.0	13.1	5.5	8.2	609
			4.5	12.4	2.2	7.8	599
			5.0	11.9	0.35	7.6	594
			5.5	11.5	0.3	7.55	592
			6.0	11.2	0.3	7.4	592
	L-1	07/24/96	0.5	24.9	11.5	9.1	810
			1.0	24.8	11.5	9.1	809
			2.0	24.7	11.4	9.1	808
			3.0	22.9	2.5	7.9	803
			4.0	16.6	2.3	7.2	824
			5.0	14.7	0.2	7.0	836
	L-1	08/20/96	0.5	25.6	12.5	9.3	893
			1.0	25.4	12.7	9.4	888
			1.5	25.1	10.2	9.3	886
			2.0	23.9	9.0	9.2	870
			2.5	23.4	5.35	8.8	868
			3.0	22.6	0.4	7.9	871
			3.5	20.3	0.3	7.3	924
			4.0	18.1	0.2	7.2	949
			4.5	15.4	0.11	7.0	971
			5.0	14.5	0.06	6.9	990
			5.5	14.2	0.02	6.9	997

Table 8. Continued.

Lake	Location	Date	Depth (m)	Temp C	DO (mg/l)	pH (SU)	Conductivity (Umhos/cm)
Summit Lake	L-1	05/08/96	0.5	14.8	11.8	8.4	1160
	(South)		1.0	14.6	11.8	8.4	1159
			2.0	14.0	12.0	8.5	1151
			3.0	14.0	11.7	8.4	1173
			4.0	13.8	9.8	8.2	1190
			5.0	12.2	7.9	8.0	1199
			6.0	12.3	7.5	7.9	1304
			7.0	12.0	6.0	7.75	1427
			8.0	10.8	4.4	7.6	1560
			9.0	9.0	2.5	7.6	1520
			10	8.8	1.9	7.5	1620
	L-1	07/24/96	0.5	25.2	10.8	8.5	1736
			1.0	25.0	10.5	8.4	1720
			2.0	24.8	10.2	8.3	1709
			3.0	24.2	7.1	7.9	1701
			4.0	23.3	2.2	7.5	1683
			5.0	18.8	0.5	7.5	1682
			6.0	17.1	0.4	7.4	1756
			7.0	13.0	0.5	7.4	1907
			8.0	11.3	0.4	7.4	2065
			9.0	10.5	0.4	7.4	2162
			10	9.9	0.4	7.4	2185
			11	9.8	0.3	7.4	2175
	L-1	08/20/96	0.5	25.3	10.8	8.65	1707
			1.0	25.0	10.8	8.7	1694
			2.0	23.7	5.7	8.1	1657
			3.0	23.7	4.2	7.9	1726
			4.0	23.2	1.7	7.7	1712
			5.0	20.0	0.45	7.65	1912
			6.0	14.7	0.4	7.5	2053

Table 8. Continued.

Lake	Location	Date	Depth (m)	Temp C	DO (mg/l)	pH (SU)	Conductivity (Umhos/cm)
Summit Lake	L-1		7.0	11.7	0.34	7.4	2239
			8.0	10.6	0.28	7.3	2393
			9.0	10.2	0.28	7.3	2433
			10	10.0	0.26	7.1	2420
			11	10.1	0.21	7.0	2429
Mogadore Reservoir	L-1 (At Dam)	05/06/96	0.5	13.9	10.4	8.2	290
			1.0	13.9	10.3	8.2	290
			1.5	13.9	10.2	8.2	289
			2.0	13.8	10.2	8.2	289
			2.5	13.8	10.1	8.2	287
			3.0	13.7	10.1	8.2	287
			3.5	13.7	10.1	8.2	287
			4.0	13.7	10.0	8.2	287
			4.5	13.7	10.0	8.2	287
			5.0	13.7	9.9	8.2	287
			5.5	13.45	8.7	8.0	287
	L-1	07/22/96	0.5	24.5	11.9	8.9	444
			1.0	24.52	11.9	8.9	445
			2.0	24.1	11.5	8.8	445
			3.0	23.9	6.8	8.2	448
			4.0	23.4	5.0	8.0	447
			5.0	20.1	2.25	7.8	484
			5.5	19.0	1.9	7.65	484
	L-1	08/19/96	0.5	25.8	15.8	9.6	406
			1.0	24.8	9.45	9.2	420
			2.0	23.3	2.56	8.3	413
			3.0	23.0	0.51	7.9	416
			4.0	22.7	0.33	7.9	428
			5.0	22.2	0.29	7.75	445

Surface Water Quality

Little Cuyahoga River

Median concentrations of total Kjeldahl nitrogen (TKN) and nitrate-nitrite in water quality grab samples collected from the Little Cuyahoga River approximated median concentrations for reference sites in the Erie-Ontario Lake Plain (EOLP) ecoregion (Figure 9). Median concentration of ammonia-nitrogen and total phosphorus generally ranged between the median and 90th percentile for ecoregion reference sites; however, median concentrations of ammonia at RM 0.3 exceeded the 90th percentile and were elevated compared to upstream concentrations (Figure 9). The rise in ammonia concentration at RM 0.3 may indicate a dry weather CSO discharge, deamination of organic nitrogen from CSOs, leachate from the adjacent landfill or a highly reducing environment in the substrate. Also, concentrations of total phosphorus were highly elevated, exceeding the 95th percentile for reference sites in at least one grab sample at most sites.

Although nutrient concentrations generally fell within a distribution given by reference streams, when considered in total, a pattern is evident. Between Bank Street (RM 5.1) and Camp Brook (RM 4.1), TKN concentration increased while nitrate-nitrite concentration decreased, coinciding with an increase in total phosphorus concentrations, suggesting the increase in phosphorus spurred uptake of inorganic nitrogen. Following the inputs of phosphorus, concentrations decreased rapidly, demonstrating the river was able to assimilate the input under low flows.

Fecal coliform bacteria counts in water quality grab samples also increased longitudinally downstream from RM 11.3 to RM 5.1 (Bank Street) before leveling off (Figure 10). At least one in five samples collected under low flow conditions exceeded the average Primary Recreation Contact criteria of 1,000 colonies/100 ml at all sampling locations in the area of Akron's CSOs, whereas upstream from the CSOs, fecal coliform counts were within Water Quality Standards. The Bank Street location had the highest median colony count at 1,100 col./100 ml, with four of five samples exceeding the Primary Contact Recreation standard. Potential sources for fecal coliform bacteria contamination during dry weather, beyond dry weather CSO overflows, are contributions from tributary streams (see below), leakage from sewer breaks, or remnants from wet weather CSO releases, and urban runoff.

Sampling for fecal coliform bacteria was also conducted during a wet weather event to assess the impact of a rain event and associated increased flows or combined sewer discharges on bacteria levels in the Little Cuyahoga River. Samples were collected on September 12, 1996 during and after a local rainfall event of 0.72 inches. The samples were collected sequentially from the mouth to RM 11.3. An additional sample was collected from the Cuyahoga River downstream from the confluence with the Little Cuyahoga River at RM 41.6, and at the mouths of the Ohio Canal, Camp Brook, the Springfield Lake Outlet, Roosevelt Ditch, and the Wingfoot Lake Outlet. Since the sampling effort lasted over a period of slightly less than two hours (8:05 to 10:03 AM), and a significant amount of rain had fallen prior to the sampling, it is unlikely that the maximum impacts of discharges from the combined sewer outfalls (i.e. the "first flush" effects) can be assessed with these results. However, the results of the wet weather sampling document that rainfall events cause dramatic increases in the amount of fecal coliform bacteria within the Little Cuyahoga River, with fecal coliform bacteria counts exceeding the Secondary Contact Recreation maximum of 5,000 col./100 ml at all of the sampling stations downstream from State Route 91 (RM 8.5) (Figure 10, Table 9). The contributions by CSOs were evident in the sharp increases downstream from the uppermost City of Akron CSO (rack 2 - downstream from Massilon Road (RM 7.1)), and downstream from Camp Brook at North St. (RM 4.1), where the fecal coliform count increased from 28,000 colonies/100 ml to 67,000 colonies/100 ml. Fecal coliform bacteria counts remained extremely high from North St. (RM 4.1) to the mouth, ranging from 53,000 to 67,000 colonies/100 ml. The impacts of CSO discharges from the rain event were also evident within the Cuyahoga River mainstem at RM 41.6 downstream from the Little Cuyahoga River, where the fecal coliform bacteria count was 190,000 colonies/100 ml.

Although pollutant loadings by CSOs apparently contribute to high fecal coliform bacteria levels even during dry weather, the loadings did not adversely affect dissolved oxygen levels as reflected in water quality grab samples and continuous Datasonde® monitoring (Figure 11). Note, however, that the continuous monitors were deployed in late summer (16 September 1996) after water temperatures had cooled to less than 19°C. Daytime dissolved oxygen concentrations were well above the minimum and average Water Quality Standards criterion throughout the study period at all of the monitoring stations except for RM 11.3 (Figure 11). Low dissolved oxygen concentrations at RM 11.3 are attributable to loadings of oxygen demanding parameters by Mogadore Reservoir and adjacent wetlands where chemical oxygen demand (COD) was highest (Figure 11). COD in the water column remained relatively low at the stations downstream from RM 11.3, with slight increases noted at RM 5.1 (Bank St.) and RM 1.8 (Otto St.) where the median values were 18 mg/l. As previously discussed, it is highly likely that the increase noted at Bank Street is the result of sewage entering upstream. The increase noted at Otto St. may have been the result of contributions from the Ohio Canal which joins the Little Cuyahoga River at RM 2.0. The median COD value for the Ohio Canal was also 18 mg/l. These slight increases under low flow conditions appeared to be rapidly assimilated in the stream. Median COD values ranged from <10 mg/l to 15 mg/l at the remainder of the sampling stations.

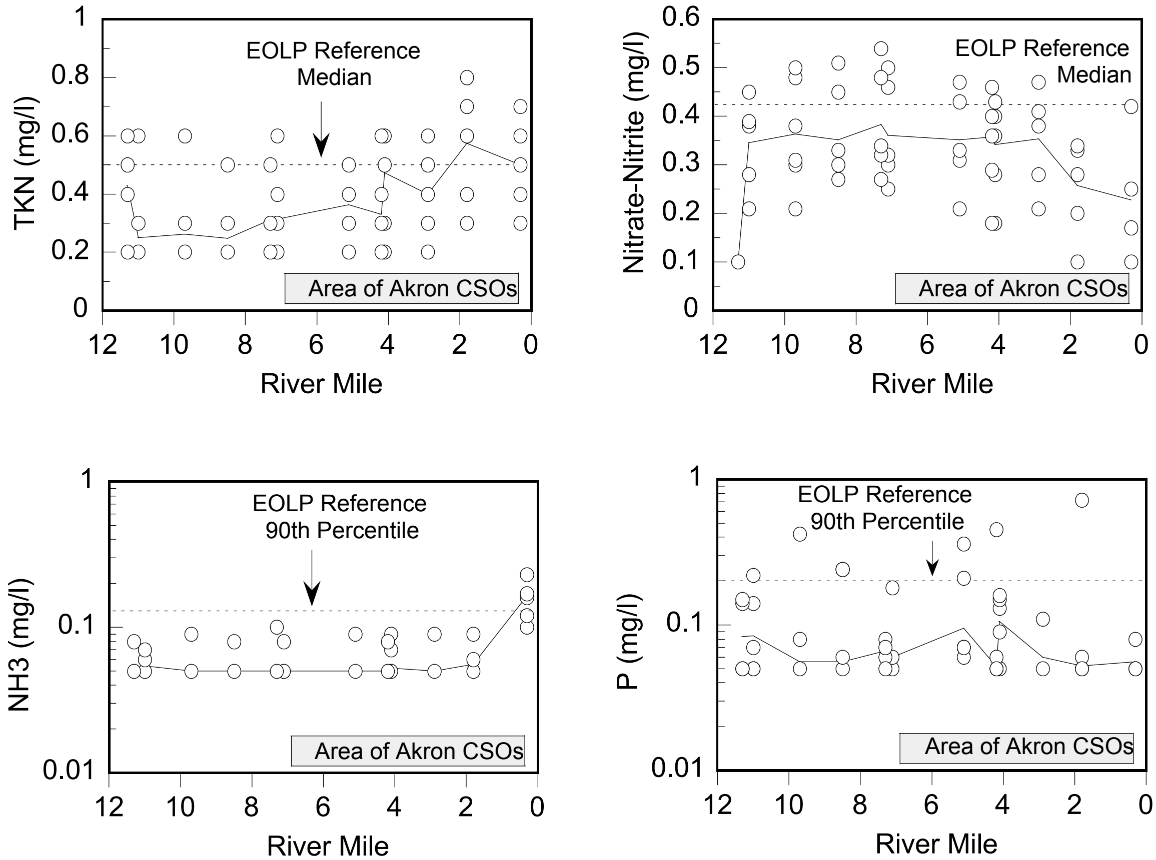


Figure 9. Clockwise from top left, concentrations of total Kjeldahl nitrogen (TKN), nitrate-nitrite nitrogen, ammonia-nitrogen (NH_3) and phosphorus (P) in water quality grab samples collected from the Little Cuyahoga River, 1996, in relation to the area of Akron combined sewer overflow (CSO) discharge.

The effects of urban runoff on water quality in the Little Cuyahoga River were evident in the data for conductivity and total dissolved solids (TDS) (Figure 12). Although the TDS concentration was well below the WQS of 1,500 mg/l, both conductivity and TDS concentrations exhibited steady increases in a downstream direction. Conductivity readings increased from a median of 399 umhos/cm at RM 11.3 to 1,180 umhos/cm at the mouth (RM 1.8). TDS concentrations exhibited a similar pattern, with median TDS concentrations increasing from 284 mg/l at RM 11.3 to 682 mg/l at Otto St. (RM 1.8). Both conductivity and TDS concentrations decreased slightly between Otto St. and the mouth to 1,060 umhos/cm and 608 mg/l, respectively. Increasing conductivity and concentrations of TDS result from increased ions, and presumably, increased pollutants.

Heavy metal concentrations were below Water Quality Standards at all locations sampled during low flows. Concentrations of lead increased going downstream, reflecting increased inputs from urban runoff. Zinc, a metal with wide application in automotive parts, was most concentrated at RM 5.1 downstream from a scrap yard (Figure 13). Coincidentally, fecal coliform levels were also highest at RM 5.1, suggesting a dry weather overflow or sewer line break. Whether zinc was entering the sewage system via storm drains or direct discharge is unkown. The trend of increasing concentration with proximity to urban nonpoint sources and the area of CSO discharge under low flows suggests that wet weather discharges are likely to carry much higher, possibly toxic concentrations, especially the first flush. For example in 1986, a first flush effect was captured where concentrations of copper and zinc exceeded maximum Water Quality Standards, and contained highly elevated levels of lead.

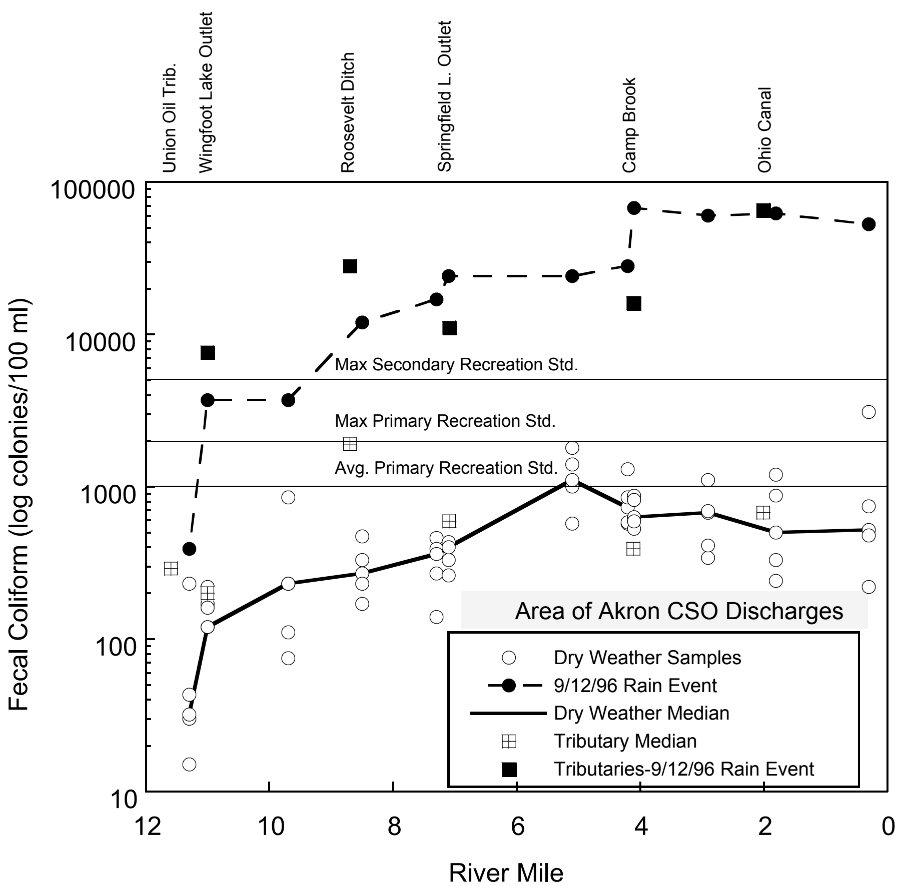


Figure 10. Fecal coliform bacteria colonies in water quality grab samples collected from the Little Cuyahoga River, 1996 in relation to the area of CSO discharges and major tributaries. Note one set of samples was collected during a rain event.

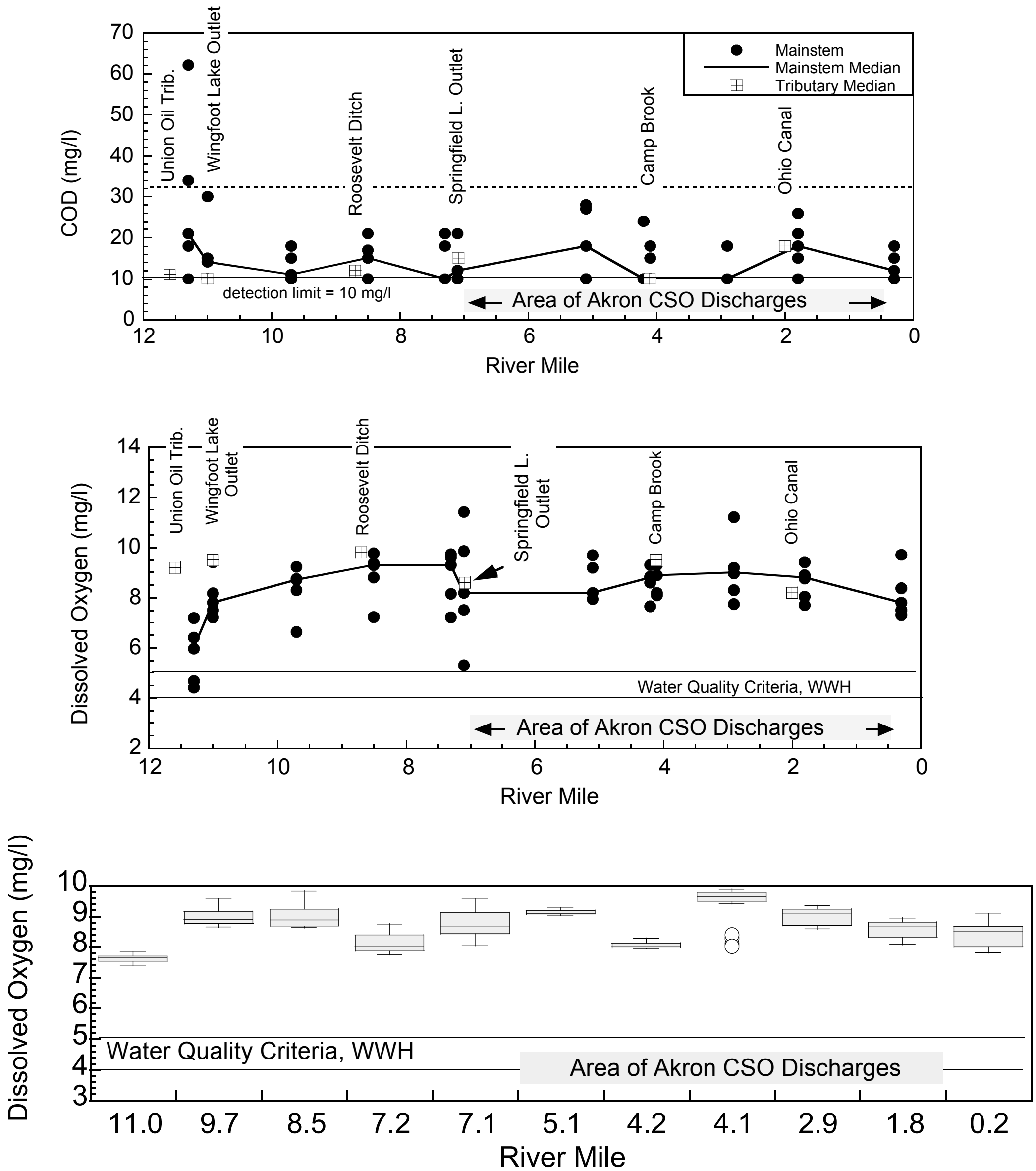


Figure 11. Chemical oxygen demand (COD - top) and dissolved oxygen (middle) concentrations measured in water quality grab samples, and distributions of dissolved oxygen concentrations measured hourly over a 48 h interval (bottom) from the Little Cuyahoga River, 1996 in relation to the area of CSO discharges and major tributaries.

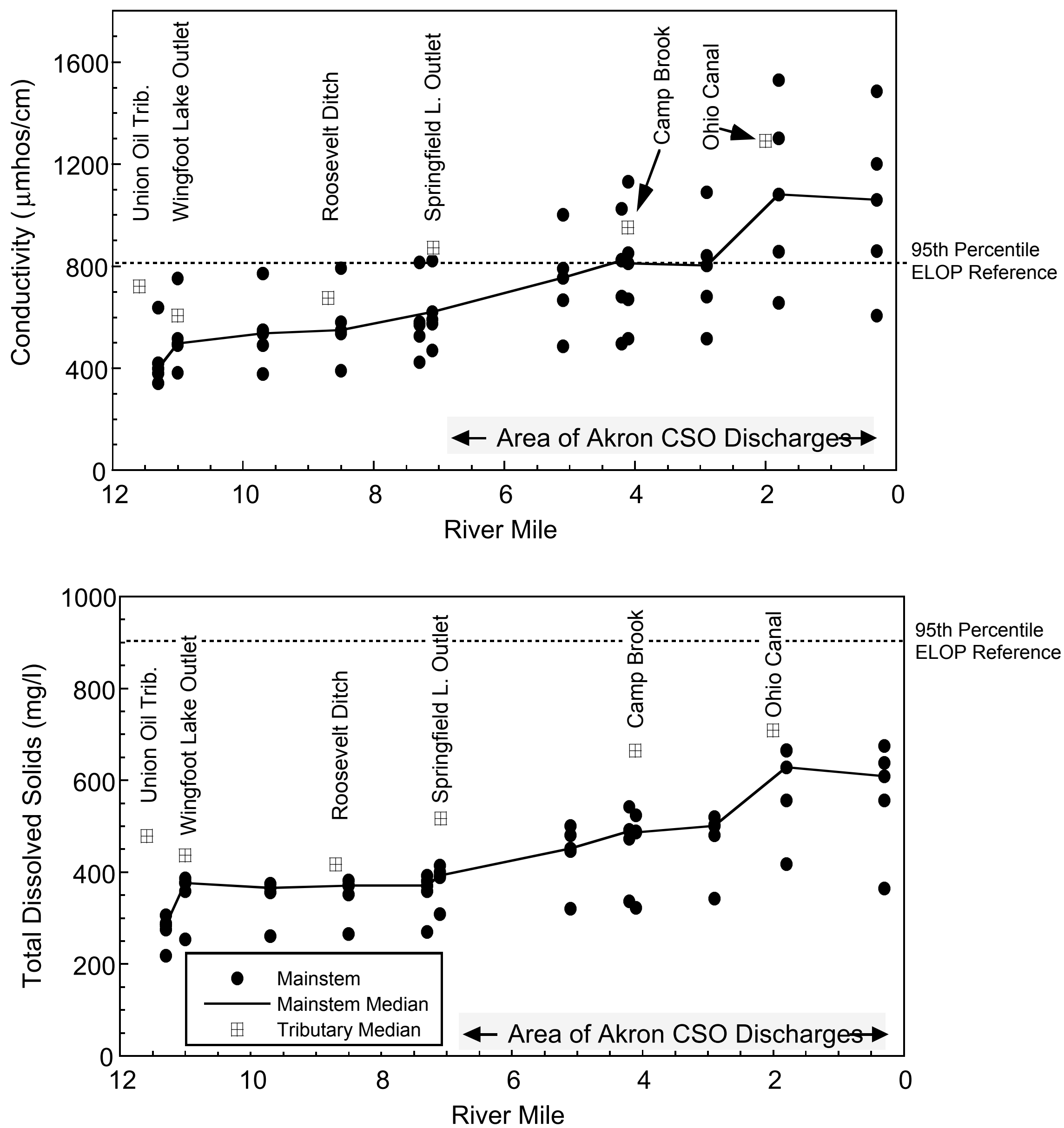


Figure 12. Conductivity (top) and total dissolved solids concentrations (bottom) measured in water quality grab samples collected from the Little Cuyahoga River, 1996 in relation to the area of CSO discharges and major tributaries.

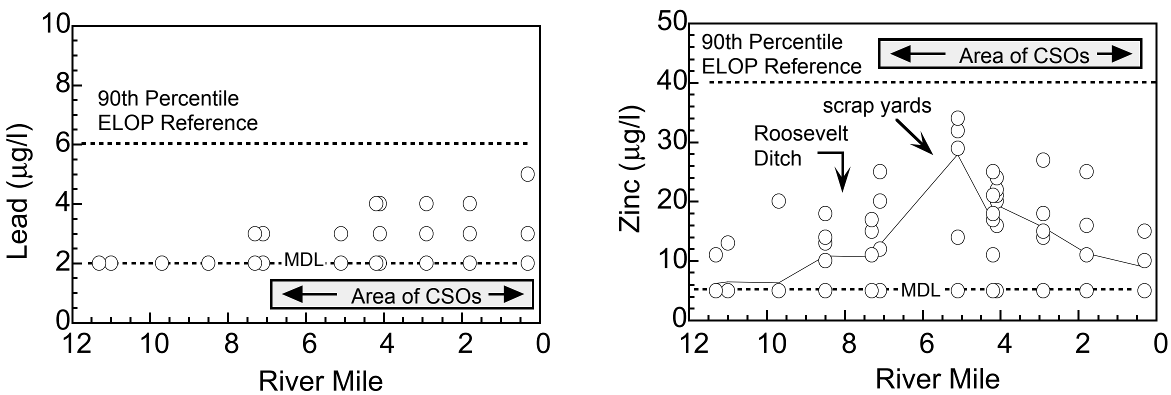


Figure 13. Concentrations of metals in surface water grab samples collected from the Little Cuyahoga River, 1996, in relation to the area of Akron CSO discharges.

Tributaries

Total dissolved solids concentrations were highest in tributaries with the greatest degree of urban development, paralleling the trend observed in the Little Cuyahoga mainstem (Figures 14 and 12). Fecal coliform bacteria counts, despite a lack of CSO outfalls, were highest in Roosevelt Ditch due either to soil disturbance from construction activities, problems with the sewerage collection system, or both. However, fecal coliform counts were generally elevated in the tributaries with CSOs compared to the Union Oil and Wingfoot Lake Outlet tributaries. Dry weather exceedences of the Primary Contact criteria were found in two of four samples collected in both the Ohio Canal and Springfield Lake Outlet. The Ohio Canal receives CSO discharges, but the not Springfield Lake Outlet. The source of fecal coliform contamination in Springfield Lake Outlet was not determined. Other than the elevated fecal coliform levels, median concentrations of water quality parameters were generally below the 75th percentile for headwater reference sites within the EOLP ecoregion (Figures 14-16) suggesting loadings of nutrients and oxygen demanding parameters are quickly flushed or assimilated following rain events. Concentrations of phosphorus, nitrate-nitrite, zinc and lead were highest in Roosevelt Ditch, again likely due to recent soil disturbance. As with the Little Cuyahoga mainstem, the elevated concentrations of metals and fecal coliform under dry weather, low flow, conditions suggests the potential for toxic concentrations during rain events is high, and may be the most important chemical factors limiting aquatic life.

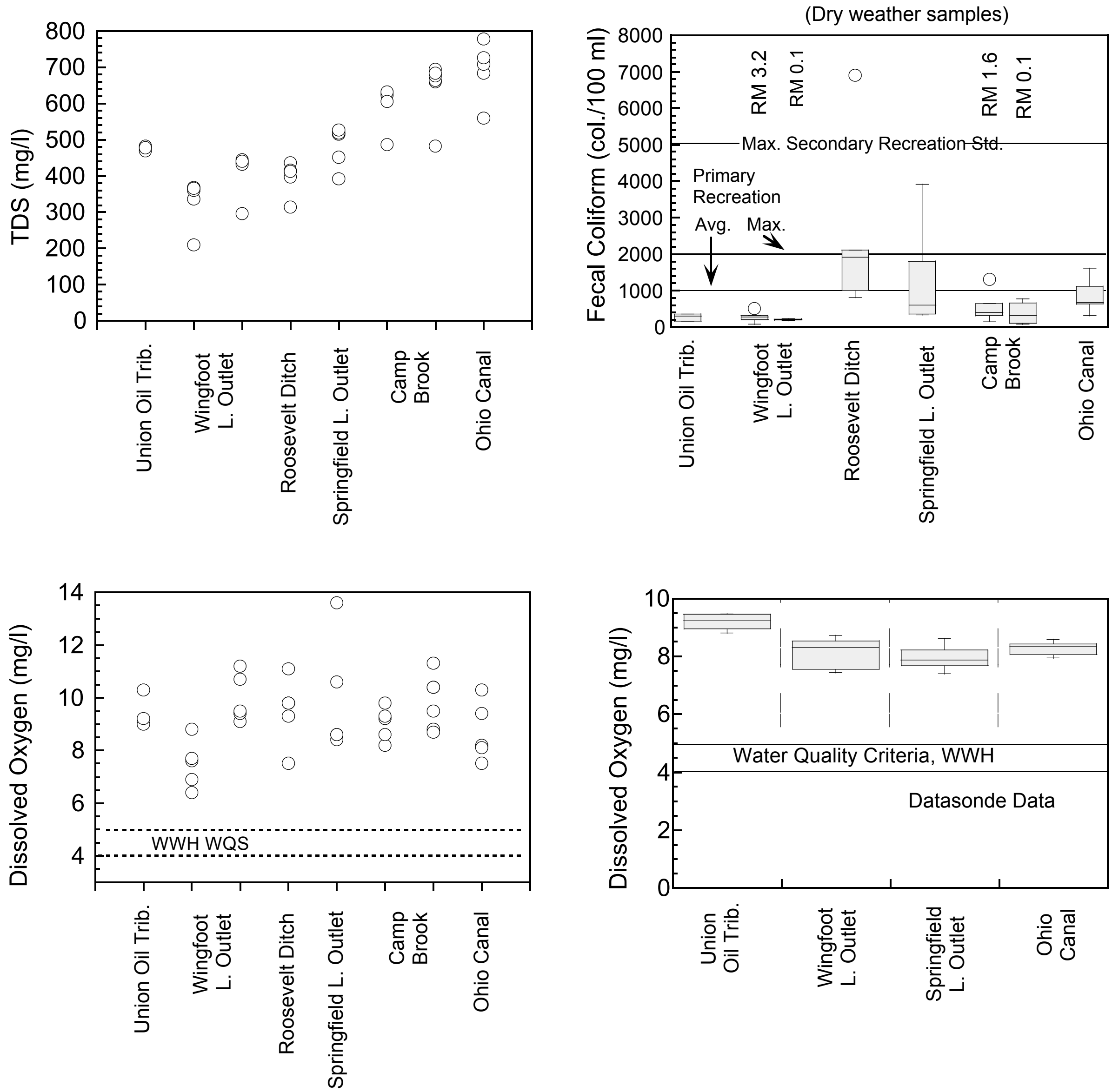


Figure 14. Left to right from top left, concentrations of total dissolved solids (TDS), fecal coliform colonies and dissolved oxygen measured in water quality grab samples, and distributions of dissolved oxygen concentrations measured hourly over a 48 h interval for tributaries to the Little Cuyahoga River, 1996.

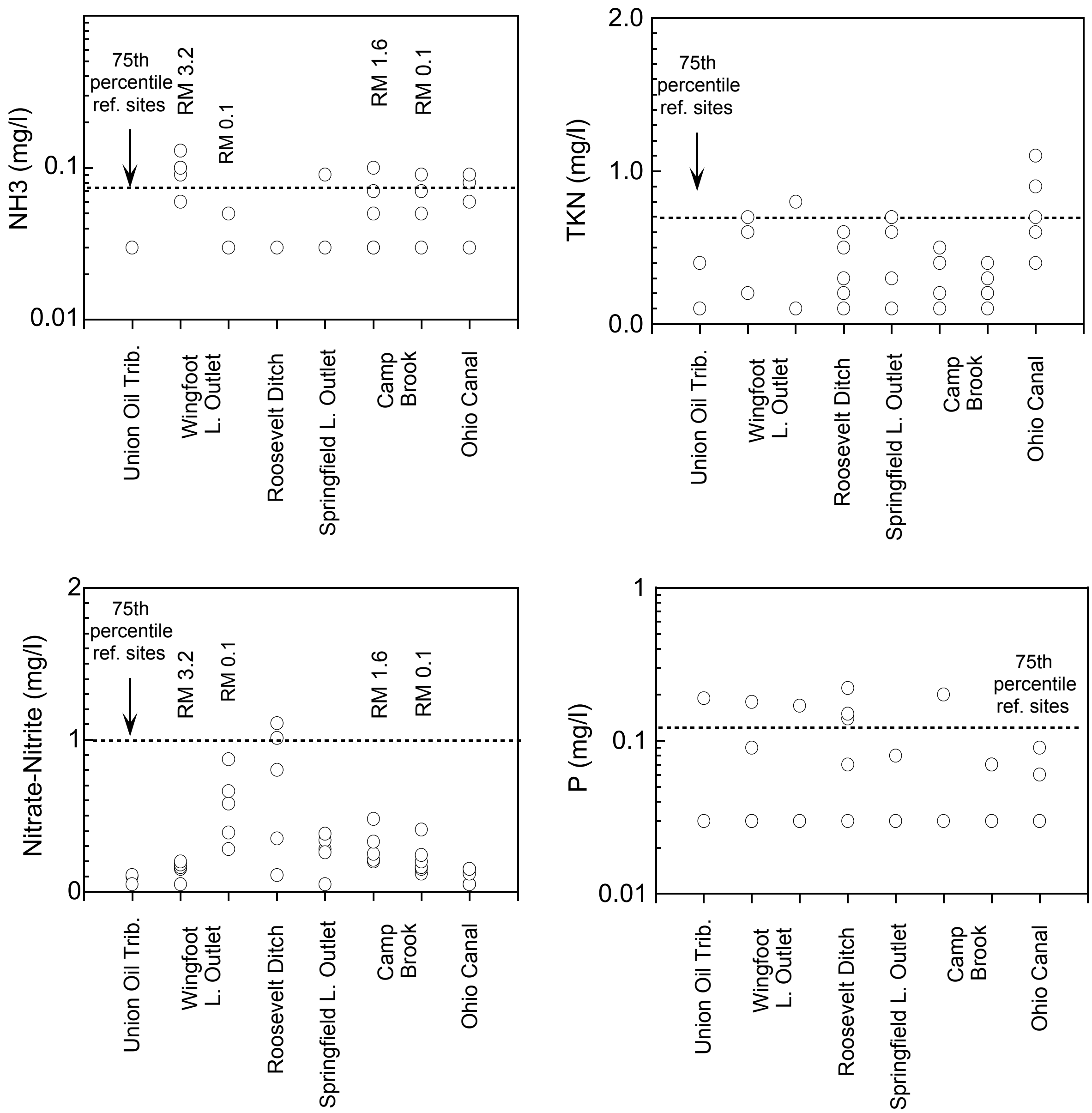


Figure 15. Clockwise from top left, concentrations of total Kjeldahl nitrogen (TKN), ammonia (NH3), nitrate-nitrite, and phosphorus (P) in water quality grab samples collected from tributaries to the Little Cuyahoga River, 1996. Reference site percentiles are for the Erie-Ontario Lake Plain.

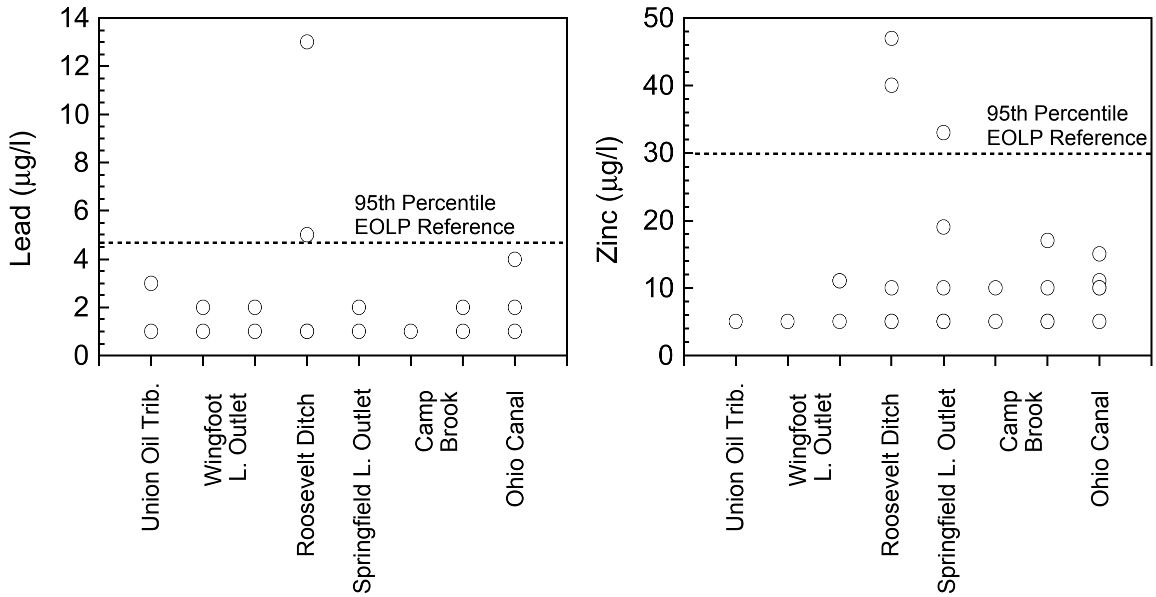


Figure 16. Concentrations of zinc (left) and lead (right) measured in water quality gra samples collected from tributaries to the Little Cuyahoga River, 1996.

Table 9. Exceedances of the Ohio Water Quality Standards in the Little Cuyahoga River and sampled tributaries, 1996.

Stream/ River Mile	Parameter		Concentration or Value
Little Cuyahoga River	11.3	Dissolved Oxygen	4.7[*];4.4[*]
	11.0	Fecal Coliform	3,700[##]
	9.7	Fecal Coliform	3,700[##]
	8.5	Fecal Coliform	12,000[###]
	7.3	Fecal Coliform	17,000[###]
	7.1	Fecal Coliform	24,000[###]
	5.1	Fecal Coliform	1,000[#]; 1,400[#]; 1,100[#]; 1,800[#]; 24,000[###]
	4.2	Fecal Coliform	1,300[#]; 28,000[###]
	4.1	Fecal Coliform	67,000[###]
	2.9	Fecal Coliform	1,100[#]; 60,000[###]
	1.8	Fecal Coliform	1,200[#]; 62,000[###]
	0.3	Fecal Coliform	3,100[##]; 53,000[###]
Wingfoot Lake Outlet	0.1	Fecal Coliform	7,600[###]
Roosevelt Ditch	0.1	Fecal Coliform	1,000[#]; 6,900[###]; 2,100[##]; 1,900[#]; 28,000[###]
Springfield Lake Outlet	0.1	Fecal Coliform	1,800[#]; 16,000[###]
Camp Brook	1.6	Fecal Coliform	1,300[#]; 16,000[###]
	0.1	Fecal Coliform	16,000[###]
Ohio Canal	0.2	Fecal Coliform	1,600[#]; 1,100[#]; 65,000[###]

[*] Concentration below the 24 hour average Water Quality Standard of 5.0 mg/l.
[#] Exceeds the average Primary Contact Recreation standard for fecal coliform bacteria of 1,000 col./100 ml.
[##] Exceeds the average Secondary Contact Recreation standard for fecal coliform bacteria of 2,000 col./100 ml.
[###] Exceeds the maximum Secondary Contact Recreation standard for fecal coliform bacteria of 5,000 col./100 ml.

Surface Water Quality Trends

Little Cuyahoga River

The elimination of sanitary and process wastewater discharged from industries directly to the Little Cuyahoga River has resulted in improved water quality. Mean concentrations of TKN, COD, lead and zinc decreased, especially in the lower river, between 1986 and 1991 reflecting the cessation of point source discharges (Figure 17). Mean concentrations of ammonia also decreased in 1996 compared to 1986; however, ammonia concentrations showed the same longitudinal pattern between years with the highest concentrations occurring in the area of CSO discharge. The highest mean concentration of NH_3-N was recorded in 1991, following cessation of point source discharges, downstream from Camp Brook. There, the concentration in one grab sample was 1.61 mg/l exceeding the 30 day average WWH water quality standard, and giving further evidence of continued impacts from CSO discharge. Overall, the reduction in pollutant loads appears to have resulted in slightly higher mean dissolved oxygen concentrations in the low gradient upper reach.

Tributaries

Concentrations of most water quality parameters were similar between 1986 and 1996 (Figure 18 and 19). Notable exceptions were the decrease in COD, TKN, lead and zinc in the Ohio Canal, and lead and zinc in Springfield Lake Outlet owing to the elimination of industrial process wastewater discharges. High concentrations of TKN, ammonia and fecal coliform bacteria in the Ohio Canal relative to other tributaries indicates the continued presence, at the time of sampling, of a dry weather CSO discharge.

Sediment Quality

Sediment contamination in the Little Cuyahoga River basin reflects the highly urbanized state of the watershed. The number of polynuclear aromatic hydrocarbons (PAHs) detected was high compared to rural or agricultural watersheds. PAHs are the byproduct of incomplete gasoline and diesel combustion, and the primary constituent of coal tar (i.e., creosote). A common pathway for their presence in sediments is from contaminated urban runoff, and leaching from railroad ties and grades. Coincidentally, the highest concentrations of PAHs were found immediately downstream from where the river is sandwiched between a major railroad yard and a multilane highway, I-76, undergoing renovations (RM 7.3, Table 10). Most concentrations found above the detection limit were likely to affect only the most sensitive benthic invertebrates. However, of the four tributaries sampled, the most urbanized, Springfield Lake Outlet and Camp Brook, had the highest PAH concentrations. Concentrations of PAHs found at RM 7.3, and in the Springfield Lake Outlet and Camp Brook are likely to impact a high proportion of the benthic species, and therefore represent a cause of impairment. Concentrations of total PAHs at RM 7.3 were comparable to the grossly polluted Little Scioto River. Moreover, concentrations of anthracene, chrysene, flouranthrene, phenanthrene and pyrene at RM 7.3 exceeded 95% of the values from all sediment samples in the Ohio EPA database; benzo(a)anthracene and benzo(a)pyrene exceeded 90% of the values.

Concentrations of the polychlorinated biphenyl (PCB) variety Aroclor 1260 were highest in Camp Brook and downstream from it in the Little Cuyahoga River, suggesting contamination originating in Camp Brook. The concentrations found were likely to affect a significant portion of the benthic community. Overall, PCB contamination was found mainly in the highly urban and industrialized reach of the mainstem downstream and including RM 5.1, and in the Springfield Lake Outlet. PCBs were below detection limits at all other locations, except for RM 11.0, and in the Wingfoot Lake Outlet at RM 3.1.

The presence in sediment samples of bis(2-Ethylhexyl) phthalate, a plasticizer used in polymer products, implies contamination of surface waters from industrial sources. Although bis(2-Ethylhexyl)phthalate can biodegrade rapidly under aerobic conditions, it is persistent in anaerobic sediments suggesting the contamination was not necessarily of recent origin. Other contaminants detected likely resulted from atmospheric deposition (e.g., mercury, DDT and its metabolites), and persistence in the environment from historical use (e.g., pesticides and PCBs). The high concentration of mercury in sediments collected immediately downstream from Mogadore Reservoir (RM 12.7) likely shows the reservoir is acting as sink. Mercury was elevated in tissue samples of Largemouth bass collected from Mogador Reservior.

Concentrations of metals (other than mercury), when compared to statewide reference sites, generally fell within the range of slightly to moderately elevated at most locations, reflecting the urbanized character of the drainage (Table 11). As with organic contaminants, metal concentration at most sites may negatively affect highly sensitive benthic invertebrates and fishes.

Paralleling the longitudinal pattern evident in the water column, levels of lead tended to increase going downstream, such that lead concentrations were highly elevated and likely to impact a large proportion of the benthic community. Extremely elevated and highly toxic levels of lead were also found in the Springfield Lake Outlet.

Copper was unusually distributed among sites. Concentrations were highly and extremely elevated immediately downstream from Mogadore Reservoir and the Wingfoot Lake Outlet, respectively. Copper sulfate is a herbicide commonly used to control aquatic macrophytes in reservoirs, so a link may exist. Extremely elevated concentrations were also detected near the mouths of the Wingfoot Lake Outlet and Little Cuyahoga River. That concentrations in the Little Cuyahoga River doubled between RM 0.3 and RM 0.1, indicates a localized source of contamination.

Similar to copper, iron concentrations were highly or moderately elevated downstream from Modgadore Reservior, and in Wingfoot Lake Outlet and Springfield Lake Outlet. Coldwater invertebrate taxa were collected at each location indicating an influx of groundwater. The groundwater may deposit iron in the sediments.

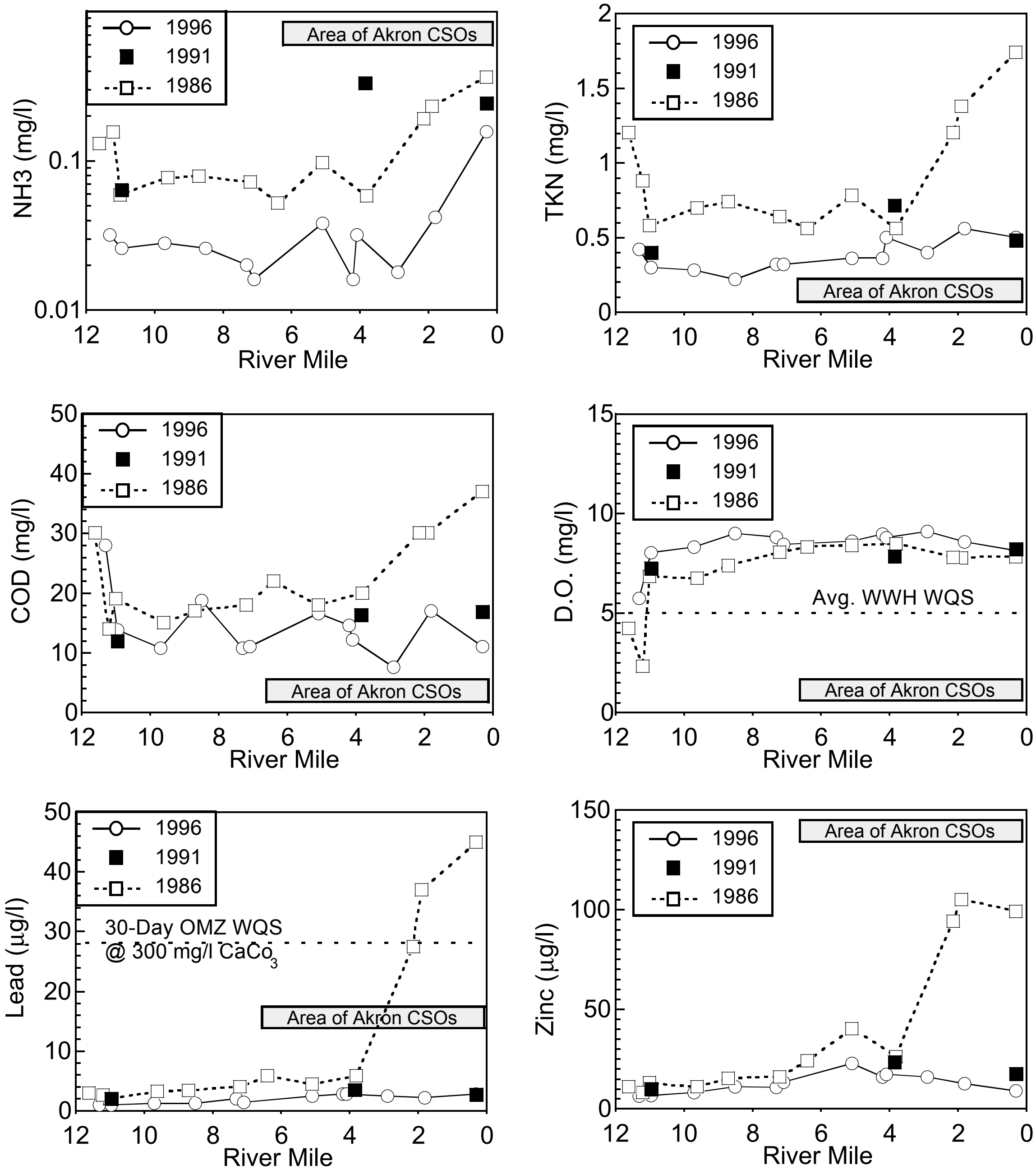


Figure 17. Trends in mean concentrations of select parameters measured in water quality grab samples collected from the Little Cuyahoga River, 1986 and 1996. OMZ stands for Outside Mixing Zone.

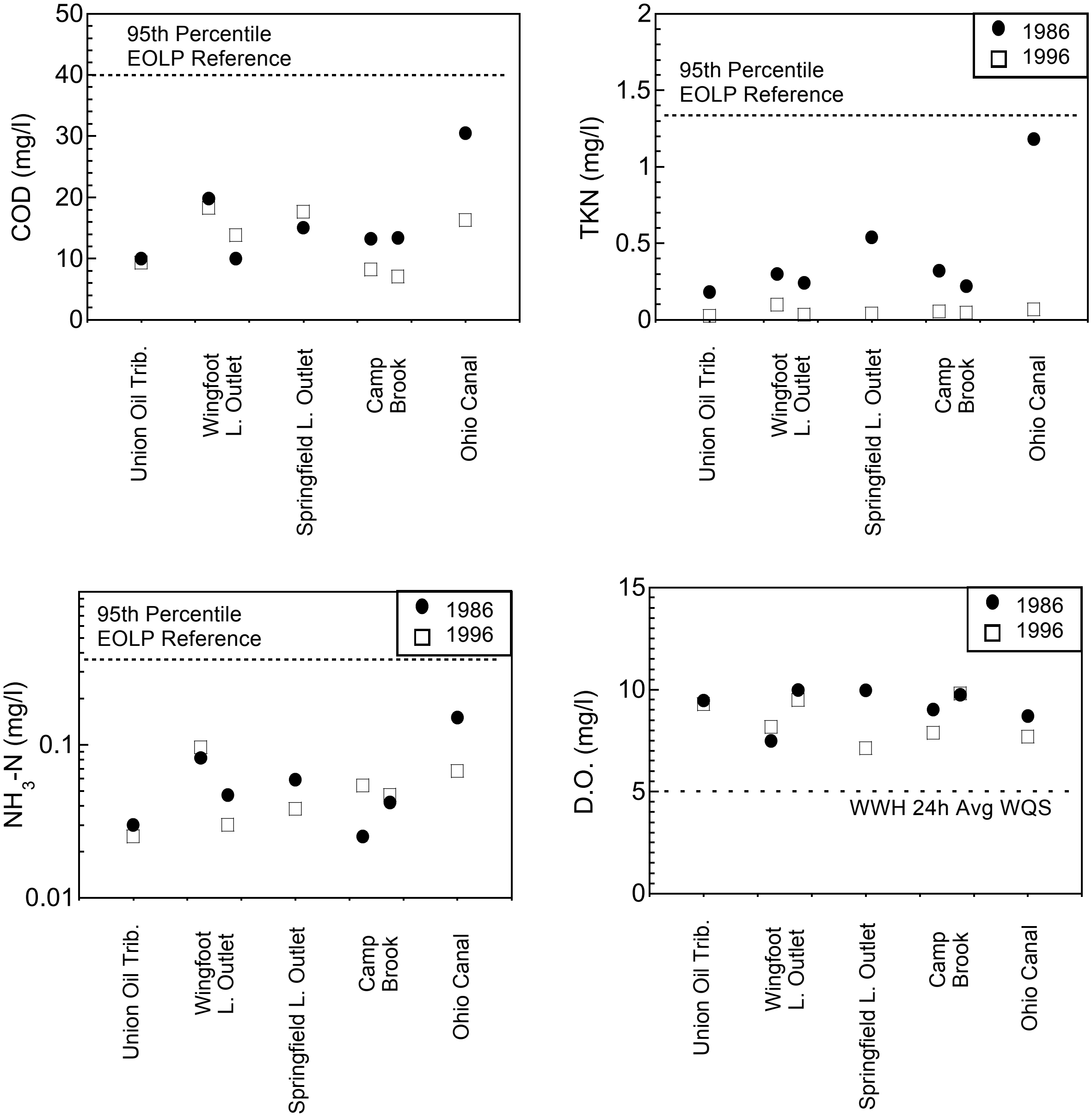


Figure 18. Mean concentrations of select water quality parameters in grab samples collected from tributaries to the Little Cuyahoga River, 1986 and 1996.

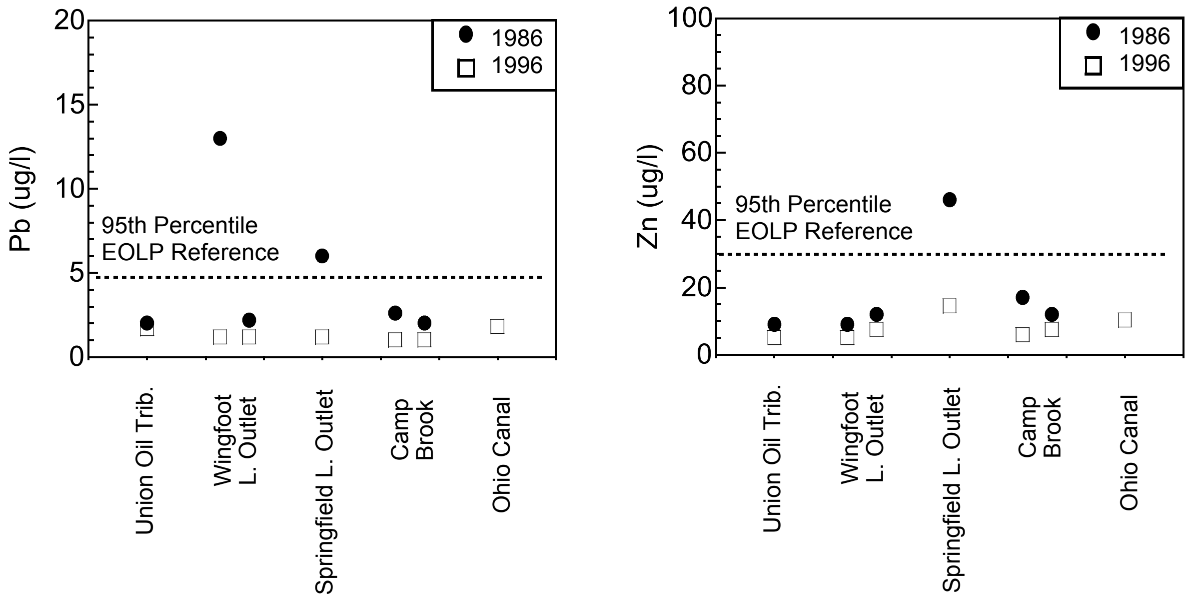


Figure 19. Mean concentrations of select water quality parameters in grab samples collected from tributaries to the Little Cuyahoga River, 1986 and 1996.

Table 10. Concentrations of polynuclear aromatic hydorcarbons (PAHs), and pesticides and polychlorinated biphynels (PCBs) in sediments collected from the Little Cuyahoga River selected tributaries, 1996. Concentrations in bold typeface represent values that are likely to have at least a moderate to strong negative effect on the benthic community, and concentrations in italic typeface may negatively affect only the most sensitive benthic speices according to thresholds given in Long and Morgan (1991) or Persuad et al. (1993).

Contaminant	River Mile											
	12.7	11	9.7	8.5	7.3	7.1	5.1	4.2	4.1	1.8	0.3	0.1
PAHs ($mg\bullet kg^{-1}$)												
Acenaphthene	<1.0	<0.6	<0.7	<0.6	**6.2**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	<1.0	<0.6	<0.7	<0.6	**9.9**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene	<1.0	<0.6	*1.0*	*1.5*	**13.5**	*1.3*	<0.5	<0.5	*0.5*	*0.6*	*0.7*	*1.5*
Benzo(a)pyrene	<1.0	<0.6	*0.8*	*1.2*	**8.1**	*1.1*	*0.5*	<0.5	*0.5*	*0.6*	*0.6*	*1.5*
Benzo(b)fluoranthene	<1.0	<0.6	1.1	1.5	7.2	1.2	0.6	<0.5	0.6	0.7	0.6	1.6
Benzo(g,h,i)perylene	<1.0	<0.6	<0.7	*0.8*	*3.6*	*0.7*	<0.5	<0.5	*0.5*	*0.5*	*0.5*	*1.4*
Benzo(b&k)fluoranthene	<1.0	<0.6	*0.7*	*1.0*	*7.8*	*1.0*	<0.5	<0.5	*0.5*	*0.6*	*0.6*	*1.4*
bis(2-ethylhexyl)phthalte	<1.0	1.1	1.0	11.9	3.8	2.9	0.6	<0.5	0.7	<0.5	0.5	0.9
Butylbenzyl Phthalate	<1.0	<0.6	<0.7	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5
Chysene	<1.0	<0.6	*1.3*	*1.9*	**12.9**	*1.6*	*0.7*	<0.5	*0.7*	*0.8*	*0.7*	*2.0*
Dibenz(a,h)Anthracene	<1.0	<0.6	<0.7	<0.6	**1.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenzofuran	<1.0	<0.6	<0.7	<0.6	4.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4Dichlorobenzene	<1.0	<0.6	<0.7	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	<1.0	<0.6	*2.7*	**4.1**	**36.1**	**3.6**	*1.2*	0.6	*1.3*	*1.9*	*1.7*	**3.8**
Fluorene	<1.0	<0.6	<0.7	<0.6	**8.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1,2,3,-cd)pyrene	<1.0	<0.6	<0.7	*0.9*	*4.1*	*0.8*	*0.5*	<0.5	*0.5*	*0.6*	*0.6*	*1.4*
3&4Methylphenol	<1.0	<0.6	<0.7	<0.6	1.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylnaphthalene	<1.0	<0.6	<0.7	<0.6	**1.4**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	<1.0	<0.6	<0.7	<0.6	1.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	<1.0	<0.6	1.2	**2.2**	**40.0**	**2.3**	0.5	<0.5	0.6	1.0	0.7	**2.0**
Phenol	<1.0	<0.6	<0.7	<0.6	*1.4*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene	<1.0	<0.6	*2.1*	**3.2**	**27.1**	**2.8**	*1.1*	*0.5*	*1.1*	*1.5*	*1.4*	**2.9**
Sum of PAH	NA	>**1.1**	*>11.2*	*>30.2*	**200.4**	*>19.3*	*>5.7*	>1.1	*>7.5*	*>9.7*	*>8.6*	*>20.4*

Table 10. Continued.

Contaminant	River Mile											
	12.7	11	9.7	8.5	7.3	7.1	5.1	4.2	4.1	1.8	0.3	0.1
Pesticides and PCBs (µg•kg^{-1})												
4,4'-DDD	<10.0	<5.4	<6.3	<6.0	<5.0	<4.9	<4.9	<4.9	<4.8	<4.7	<4.3	
4,4'-DDE	<10.0	<5.4	<6.3	<6.0	<5.0	<4.9	<4.9	<4.9	<4.8	<4.7	<4.3	
4,4'-DDT	<10.0	<5.4	**9.5**	**9.0**	**74.0**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**	
Dieldrin	<10.0	<5.4	**9.5**									
Methoxychlor	<10.0	7.2	<6.3	9.9	14.0	6.3	13.0	2.45	7.6	14.0	9.0	
PCB-1242	<50.0	<62.0	<32.0	<30.0	<25.0	<25.0	<26.0	<26.0	<26.0	<26.0	<26.0	
PCB-1248	<50.0	*310.0*	<32.0	<30.0	<25.0	<25.0	*290.0*	*94.0*	*96.0*	*80.0*	*46.0*	
PCB-1254	<50.0	<62.0	<32.0	<30.0	<25.0	<25.0	<26.0	<26.0	<26.0	<26.0	<26.0	
PCB-1260	<50.0	<62.0	<32.0	<30.0	<25.0	<25.0	*50.0*	*39.0*	*430.0*	*400.0*	*110.0*	
PCB-Total	NA	**>310.0**	NA	NA	NA	NA	>340.0	>133.0	>**526.0**	>**480.0**	>156.0	

Table 10. Continued.

Contaminant	Location				
	Union Oil Trib (RM1.5)	Wingfoot Lake Outlet (RM 3.9)	(RM 0.5)	Sprinfield Lake Outlet (RM 2.9)	Camp Brook (RM 0.1)
PAHs (mg•kg^{-1})					
Acenaphthene	>0.5	>0.7	<1.0	>0.7	>0.5
Anthracene	>0.5	>0.7	<1.0	>0.7	0.8
Benz(a)anthracene	>0.5	>0.7	<1.0	**2.6**	**1.1**
Benzo(a)pyrene	>0.5	>0.7	<1.0	**2.9**	**0.9**
Benzo(b)fluoranthene	>0.5	>0.7	<1.0	3.1	**1.1**
Benzo(g,h,i)perylene	>0.5	>0.7	<1.0	2.5	**0.6**
Benzo(b&k)fluoranthene	>0.5	>0.7	<1.0	2.9	0.6
bis(2-ethylhexyl)phthalte	>0.5	>0.7	<1.0	1.5	>0.5
ButylbenzylPhthalate	>0.5	>0.7	<1.0	>0.7	>0.5
Chysene	>0.5	>0.7	<1.0	**3.5**	**1.3**
Dibenz(a,h)Anthracene	>0.5	>0.7	<1.0	**0.9**	>0.5
Dibenzofuran	>0.5	>0.7	<1.0	>0.7	>0.5
1,4Dichlorobenzene	>0.5	>0.7	<1.0	>0.7	>0.5
Fluoranthene	>0.5	*1.2*	<1.0	**7.2**	**3.2**
Fluorene	>0.5	>0.7	<1.0	>0.7	>0.5
Indeno(1,2,3,-cd)pyrene	>0.5	>0.7	<1.0	2.5	**0.6**
3&4Methylphenol	>0.5	>0.7	<1.0	>0.7	>0.5
2-Methylnaphthalene	>0.5	>0.7	<1.0	>0.7	>0.5
Naphthalene	>0.5	>0.7	<1.0	>0.7	>0.5
Phenanthrene	>0.5	*0.9*	<1.0	*3.9*	**2.8**
Phenol	>0.5	>0.7	<1.0	>0.7	>0.5
Pyrene	>0.5	*0.9*	<1.0	**5.8**	**2.4**
Sum of PAH	NA	*>3.0*	NA	>39.3	>**15.4**

Table 10. Continued.

Contaminant	Location				
	Union Oil Trib (RM1.5)	Wingfoot Lake Outlet (RM 3.9)	(RM 0.5)	Sprinfield Lake Outlet (RM 2.9)	Camp Brook (RM 0.1)
Pesticides and PCBs (µg•kg^{-1})					
4,4'-DDD	<5.2	<7.0	*11.0*	*14.0*	<4.7
4,4'-DDE	<5.2	<7.0	*13.0*	<6.8	<4.7
4,4'-DDT	<5.2	<7.0	<9.6	<6.8	<4.7
Dieldrin	<5.2	<7.0	<9.6	<6.8	<4.7
Methoxychlor	<5.2	9.8	27.0	18.0	<4.7
PCB-1242	<26.0	<26.0	24.0	<34.0	<24.0
PCB-1248	<26.0	*81.0*	24.0	*66.0*	<24.0
PCB-1254	<26.0	48.0	24.0	<34.0	<24.0
PCB-1260	<26.0	*19.0*	*24.0*	*110.0*	**370.0**
PCB-Total	NA	*>148.0*	*NA*	*>176.0*	***>**370.0*

Table 11. Concentrations of metals ($mg \bullet kg^{-1}$) in sediments collected from the Little Cuyahoga River and its tributaries, 1996. Concentrations in bold typeface represent values that are likely to have at least a moderate to strong negative effect on the benthic community, and concetrations in italic typeface may negatively affect only the most sensitive benthic species according to thresholds given in Long and Morgan (1991) or Persuad et al. (1993). Superscripts indicated ranges of concentrations from statewide reference sites in Ohio.

River Mile	Ar	Cd	Cr	Cu	Fe	Pb	Hg	Zn
Little Cuyahoga								
12.7	NA	0.4	7.5	*80.8*[H]	**69345**[H]	*38.6*[S]	**6.1**	NA
11.0	NA	0.2	11.2	*28.9*[S]	*30386*[S]	28.0	0.0	NA
9.7	*11.5*	*0.7*[S]	*28.0*[S]	*16.0*	*20500*	*39.0*[S]	0.0	*156*[M]
8.5	*11.8*	*0.7*[S]	25.0[S]	*23.0*[S]	*20000*	*39.0*[S]	0.1	*230*[H]
7.3	*7.1*	0.4	18.0	*17.0*	17200	*64.0*[M]	0.0	*155*[M]
7.1	5.6	0.4	21.0[S]	14.0	11600	*37.0*[S]	*1.4*	*148*[M]
5.1	*8.2*	0.5	*26.0*[S]	*21.0*	*21300*	*108.0*[H]	0.0	*211*[M]
4.2	*13.4*[S]	0.4	7.5	*28.0*[S]	17800	*109.0*[H]	0.1	*155*[M]
4.1	*9.2*	*0.6*[S]	17.0	*31.0*[S]	16900	**120.0**[H]	0.1	*165*[M]
1.8	*12.4*[S]	0.3	21.0[S]	*17.0*	16800	*46.0*[S]	0.0	*130*[S]
0.3	*16.3*[S]	*0.7*[S]	21.0[S]	*51.0*[M]	*25300*	**111.0**[H]	*0.2*	*235*[H]
0.1	NA	0.5	13.5	*100.7*[X]	11945	*96.5*	NA	NA
UnionOilTributary								
0.6	NA	0.1	1.4	0.1	NA	6.5	0.0	NA
WingfootLakeOutlet								
3.1	NA	*0.6*[S]	*29.4*[M]	*105.4*[X]	**98119**[H]	*63.7*[M]	0.1	NA
0.5	NA	*4.1*[M]	*39.4*[M]	**112.1**[X]	**67800**[H]	*65.9*[M]	0.1	NA
SpringfieldLakeOutlet								
2.9	NA	*4.1*[M]	12.5	*85.6*[H]	**44854**[M]	**162.7**[X]	0.1	NA
CampBrook								
0.1	NA	0.1	3.5	11.9	11230	10.7	0.0	NA

[S] - Slightly Elevated
[M] - Moderately Elevated
[H] - Highly Elevated
[E] - Extremely Elevated

Physical Habitat for Aquatic Life

Little Cuyahoga River

Physical habitat in the Little Cuyahoga River was generally capable of supporting a warmwater stream community. Two somewhat distinct reaches are evident based on the relative proportion of modified to warmwater habitat attributes (Table 12). The upstream reach, RM 11.3 to RM 5.1 is characterized by modified habitat attributes, specifically channel modifications, siltation, low channel development, and substrate and riffle embeddedness. The mean QHEI score for the reach was 57.0 ± 12.6 SD, N = 7, inferring a marginal ability to support warmwater stream faunas. The low ratio of high influence modified habitat attributes (those showing the strongest statistical relationship with the IBI; Rankin 1989) to warmwater habitat attributes further indicates an ability to support WWH stream faunas. Headwater wetlands account for some of the modified attributes, specifically small substrate size and low channel development. Channel modifications within the reach, excluding the segment between RMs 7.1 and 5.1, are associated with freeway construction activities, and do not represent regular channel maintenance, meaning that recovery of positive habitat attributes will occur over time.

The high gradient in the downstream reach, from RM 4.2 to the mouth, augments habitat quality by minimizing deposition of fines and facilitating recovery from past channel modifications. As a result, warmwater habitat attributes were more prevalent than modified attributes and QHEI scores improved ($\bar{x}$ = 68.4 ± 9.6 SD, N = 5). In contrast to the upstream reach, boulder, cobble and gravel substrates were more common, the channel was more sinuous and developed, and fast current and eddies were formed. Despite these improvements, flows spiked by stormwater runoff destabilized the channel, and although silt deposition was minimized by the high gradient, substrates, especially at the two downstream most sites, were embedded by sand.

Springfield Lake Outlet

Springfield Lake Outlet at the mouth flows through a recovering but poorly developed channel with substrates composed of a mix of natural and artificial cobbles embedded by sand and silt. Severe bank erosion was noted, suggesting flows spiked by stormwater. Collectively, the habitat was marginally suited to supporting warmwater communities.

Wingfoot Lake Outlet

Wingfoot Lake Outlet is a channelized course generally lacking habitat attributes associated with normal streams. The site at RM 1.3 had only one positive attribute, deep pools. The QHEI score was 34.5. However, the high gradient should foster redevelopment of positive habitat attributes, so recovery is expected. The channel at the mouth, facilitated by high gradient, had established some free flowing character. Cobbles and gravels were exposed, fast current and eddies were present, and modest channel development was acquired, but the QHEI score of 44.0 reflected the limited habitat.

Unnamed Tributary to the Little Cuyahoga River (Union Oil Tributary)

The Union Oil tributary was previously channelized, and as such, the habitat is now dominated by modified attributes and is impaired. The channel had limited development and sinuosity, substrates were embedded by sand and silt, and cover was composed mostly of overhanging vegetation. But, as it is not actively maintained and has a gradient sufficient to foster recovery, the channel has reestablished several warmwater attributes; specifically, cobbles and gravels were exposed, woody debris supplied some cover, and several deep pools were formed.

Camp Brook

Recent construction near Britain Road, combined with stormwater discharge, imparted modified habitat qualities to Camp Brook at RM 1.0. The channel and banks had become destabilized, carrying a large bed-load of sand that reduced channel development and rendered riffles nonfunctional. Downstream at RM 0.2, more warmwater habitat attributes were present. The channel, though previously channelized, had recovered a free flowing character owing to a high gradient. Boulder, cobble and gravel substrates were present, the channel was well developed, and riffles were functional. Effects of stormwater discharges were evident in the wide, shallow and unstable riffles. Overall, the physical habitat in Camp Brook was marginally capable of supporting warmwater communities.

Table 12. QHEI matrix for sites sampled in the Little Cuyahoga River sub-basin, 1996.

Key QHEI Components

			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
River Mile	QHEI	Gradient (ft/mile)	No channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max. Depth > 40cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	**Total H.I. MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**	**MWH H.I./WWH Ratio**	**MWH M.I. WWH Ratio**
(19-030) Little Cuyahoga River																																		
11.3	57.0	13.51	■			■	■	■	■		■		6		●		●		2	▲	▲			▲					▲	▲	▲	6	0.43	1.29
11.0	58.0	9.71		■				■			■		3						0	▲				▲	▲			▲	▲	▲		6	0.25	1.75
9.7	67.0	9.17	■			■	■	■	■		■		6						0		▲			▲				▲	▲	▲		5	0.14	0.86
8.5	49.5	13.51		■					■		■		3				●		1	▲	▲			▲	▲				▲	▲		6	0.50	2.00
7.3	52.5	17.24					■	■	■		■		4	●					1	▲	▲			▲	▲				▲	▲		6	0.40	1.60
7.1	59.0	17.24	■	■			■	■	■		■		6						0	▲	▲			▲					▲	▲		5	0.14	0.86
5.1	56.0	45.45		■				■	■		■		5				●		1	▲				▲	▲				▲	▲		5	0.33	1.17
4.2	75.5	15.38	■	■		■	■	■	■	■	■	■	9						0				▲									4	0.10	0.20
4.1	71.0	41.67	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
2.9	66.0	27.78		■		■		■	■	■	■		6						0	▲	▲			▲	▲				▲	▲		6	0.10	1.00
1.8	61.5	26.32	■			■	■	■	■	■	■		7						0	▲					▲				▲	▲		4	0.14	0.63
0.3	68.0	10.53	■	■				■	■		■		5						0					▲	▲				▲	▲		4	0.13	0.83
(19-031) Springfield Lake Outlet																																		
0.1	55.0	27.03	■			■	■	■	■		■		7						0	▲				▲					▲	▲		4	0.13	0.63
(19-032) Wingfoot Lake Outlet																																		
1.3	34.5	43.48									■		1	●	●	●	●		4	▲	▲			▲	▲			▲	▲		▲	7	2.50	6.00
0.1	44.0	62.50	■				■	■	■		■		5			●			1	▲	▲			▲	▲				▲	▲		6	0.33	1.33
(19-050) Union Oil Trib. to L. Cuyahoga																																		
1.2	50.0	22.73		■				■			■		3			●	●		2	▲				▲	▲	▲		▲				7	0.75	2.50
(19-051) Camp Brook																																		
1.0	48.5	27.03	■	■			■						3				●	●	0					▲				▲	▲		▲	4	0.75	1.75
0.2	61.0	45.45	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10

Biological Assessment: Macroinvertebrate Communities, 1986 - 1996

Little Cuyahoga River
Artificial substrate samples were retrieved from ten of twelve stations in the Little Cuyahoga River from RM 11.2, upstream from the Wingfoot Lake Outlet, to RM 0.2 near the confluence with the Cuyahoga River (Table 13, Figure 20). After initially reflecting *fair* quality at RM 11.2 (ICI = 24), communities improved between the Wingfoot Lake Outlet and Springfield Lake Outlet (RM 11.0-7.1) and ranged from *marginally good* to *very good* (ICIs = 32 - 42). Benthic communities were degraded, ranging from *fair* to *poor* (ICIs = 16 - 28), downstream from Springfield Lake Outlet and the Akron urban area (RM 7.0-0.2) based on ICI scores and the quality of the community collected from natural substrates (Table 13). Prior to 1996, benthic sampling in the Little Cuyahoga River was conducted in 1986 at thirteen stations between RMs 12.6 and 0.3 and in 1991 at three location between the Wingfoot Lake Outlet and the mouth (RMs 11.0, 3.8, and 0.3; Figure 20). In 1984, a qualitative sample was collected from RM 1.8, downstream from the Ohio Canal (Table 13).

ICI scoring trends show improvements in portions of the Little Cuyahoga, particularly in the middle reaches between Skelton Road and the Springfield Lake Outlet (RMs 9.7 - 7.0) and the Springfield Lake Outlet and Camp Brook (RMs 7.0 - 4.2). Communities in 1996 ranged from marginally good to very good in the upstream section compared to the fair range in 1986 (Figure 20). Between Springfield Lake Outlet and Camp Brook, ICI scores remained below the WWH criterion. Communities improved slightly from the *poor* and lower *fair* ranges documented in 1986 to the *fair* and upper *fair* ranges in 1996. Further downstream in the Akron urban area, trends were less definitive due to loss or disturbance of samplers. Most sites experienced positive change with a lessening of severe toxic impacts in the mainstem and improvement in the Ohio Canal since 1986. However, downstream from all sources in the Akron area, ICI scores at the mouth of the Little Cuyahoga River have remained consistently in the fair range with little change over the past decade.

Sampling upstream from Wingfoot Lake Outlet at RM 11.2 yielded identical ICI scores of 24 (fair range) in both 1986 and 1996. Dissolved oxygen depletion has been a historical problem in the lake and wetland influenced section of the river upstream from Wingfoot Lake Outlet. The 1996 results suggest minimal change in the upper reaches of the mainstem.

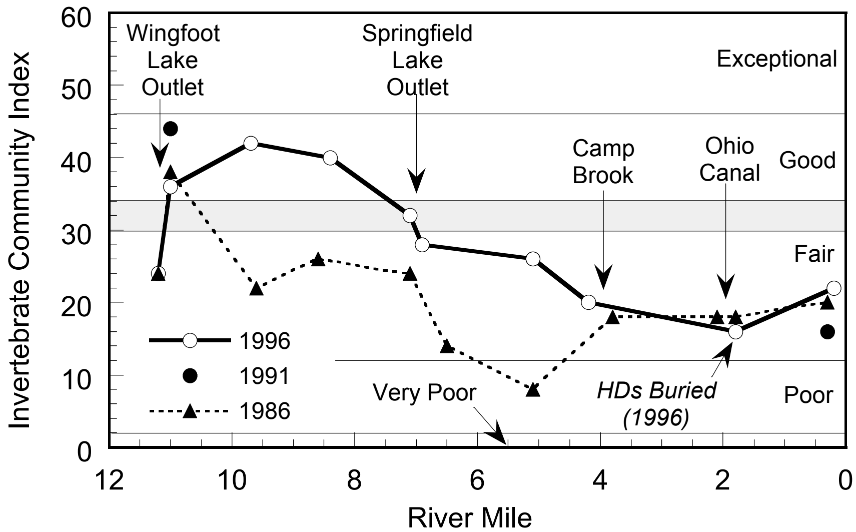


Figure 20. Longitudinal trend of the Invertebrate Community Index (ICI) in the Little Cuyahoga River, 1986, 1991 and 1996. Shaded area represents nonsignificant departure from the WWH criterion.

During each survey, communities at RM 11.0 appeared to benefit from the influx of cool, well oxygenated waters immediately downstream from the Wingfoot Lake Outlet. Communities bracketing the confluence improved from *fair* to *good* in 1986 and 1996 and *very good* communities (ICI=44) were found in 1991. However, improvements in 1986 were short lived and ICI score dropped to the *fair* range less than two miles downstream. Tolerant organism percentages rose sharply with increased distance downstream (Figure 21-upper plot) while more sensitive mayfly, caddisfly and Tanytarsini midge percentages fell and remained low throughout the remainder of the mainstem. In contrast, 1996 communities maintained *good* to *very good* quality throughout the stretch before declining to *marginally good* immediately upstream from Springfield Lake Outlet (RM 7.1). Primary reasons for improvements were increased mayfly and caddisfly predominance coupled with reductions in the percentages of pollution tolerant snails (the genera *Ferrissia* and *Physella*) and the midge taxon *Polypedilum (P) fallax* group. Collections between the Wingfoot Lake and Springfield Lake Outlets also included several cold-water taxa and unique varieties of mayflies and caddisflies that were not found downstream in the Akron urban area. One concern in this reach was the continued presence of the toxic tolerant midge *Cricotopus bicinctus*, which tended to increase in abundance between RM 11.3 and RM 7.1, with a peak at RM 7.3 (Figure 21-lower plot). The peak at RM 7.3 corresponded to sediments highly contaminated with PAHs. The declining macroinvertebrate community performace between RM 9.6 and upstream from the area of CSO discharge in 1996 (RM 7.1) probably reflects the cumulative effects of increasing urban runoff, highway construction runoff, contaminated sediments and possibly small industrial discharges.

Improving community perfomance downstream from the Springfield Lake Outlet in 1996 relative to 1986, appears related to cessation of industrial discharges, and the associated toxicity, to the Akron CSOs. The improvement resulted in a 50% decrease in magnitude of deviation from the biological criterion for the ICI in that reach. The presence of greater numbers of hydropsychid caddisflies, Tanytarsini midges, and EPT taxa was the main reason for the increased ICI scores in 1996 compared to 1986. Relative abundance from the natural substrates shifted from the highly tolerant midges or oligochaetes found in 1986 to more pollution intermediate baetid mayflies and hydropsychid caddisflies in 1996. These factors, coupled with decreased relative abundance of the midge *Cricotopus bicinctus,* indicated reduced toxicity and improved water quality conditions since 1986 (Figure 21-lower plot). *C. bicinctus* apparently resist toxic wastes and have been shown to increase in abundance when various stresses eliminate more sensitive species (Simpson and Bode, 1980). Although the relative abundance of *C. bicinctus* has decreased, its continued presence combined with low ICI scores and low numbers of EPT taxa is diagnostic of a toxic response (Yoder and Rankin, 1995). The relative abundance of *C. bicinctus* was highest at RM 7.3, where concentrations of PAHs were highest and present in concentrations expected to severely impact benthic communities. Though high relative abuandance of *C. bicinctus* upstream from the CSOs and the increasing relative abundance of all tolerant organisms in the area of CSOs (Figure 21) demonstrates that both CSOs and either urban nonpoint pollution, a point source(s) not specifically addressed in this study, or legacy contamination are causes of impairment. A significant negative correlation does exist between increasing sediment lead concentrations and ICI scores in the Little Cuyahoga River (Pearson correlation coefficient = -0.67700; P = 0.0315).

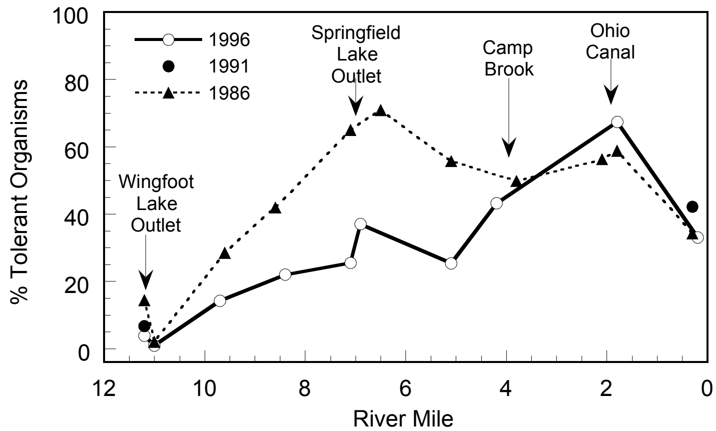
Sampling in Akron suggested slight improvements throughout most of the Akron urban area and downstream from the Ohio Canal. In addition to improvements in some ICI scores, macroinvertebrate relative abundance from the natural substrates shifted from the highly tolerant midges or oligochaetes found in 1986 to more pollution intermediate baetid mayflies and hydropsychid caddisflies in 1996, reflecting cessation of direct industrial discharges. An exception to the improving trend was noted at RM 3.8, downstream from Camp Brook. The evaluation declined from *fair* (ICI=18) in 1986 to *poor* in 1991 and 1996 based on the low numbers of total taxa and EPT taxa from the natural substrates (artificial substrate samplers were lost both years). The declining trend may result from more severe impacts from Camp Brook (see page 55) or reflect slight differences between the natural substrate and artificial substrate evaluations. The latter seems at least partially responsible since the poor condition of natural substrate communities in 1991 and 1996 still reflected slight improvement over comparable collections in 1986.

Artificial substrates at RM 2.2 near Elizabeth Park were lost in 1996 due to vandalism so the evaluation was based on qualitative sampling. Increases in taxa richness (21) EPT taxa (five), and improved community composition were primary reasons for the upgrade from *poor* to *fair* between RMs 3.8 and 2.2. A strong organic chemical odor (styrene?) was noted from a pipe immediately upstream from RM 2.2.

Downstream from the Ohio Canal at RM 1.8, sediment deposition over the artificial substrate probably had a negative influence on the ICI score (16 = lower fair range). However, the score was in line with the degraded condition of the natural substrate community where 22 total taxa and only four EPT taxa were collected. Numbers of EPT taxa were well below ecoregional expectations and would result in a "0" metric score for Qual.EPT richness. A strong organic chemical odor was also noticed at RM 1.8 as the chemical volatilized in turbulent flow over a low-head dam adjacent to Otto Street. The odors continued to be noted as far downstream as RM 0.2. While the effects of the compound(s) is unknown, its presence was evidence of discharges from the Akron sewer system entering the river. Previous sampling upstream and downstream from the Ohio Canal found fair quality in 1986 (ICIs = 18). Macroinvertebrate communities reflected gross impacts from toxic substances and raw sewage inputs. At RM 0.2, the ICI in 1996 was 22 (*fair*). The low numbers of mayflies on the artificial substrates (two taxa; 1.6%), low EPT taxa richness from the natural substrates (three), and high percentage of tolerant taxa (33.1%) reflect continued impact downstream from Akron. The macroinvertebrate community near the mouth has changed the least during the past decade (Table 13), demonstrating persistent impairment near the mouth of the river.

Because of the loss or disturbance of artificial substrates, trends in QCTV scores based on qualitative sampling results were also evaluated for longitudinal trends. Except for RM 11.2 (upstream Wingfoot Lake Outlet), QCTV scores between Wingfoot Lake Outlet and the Springfield Lake Outlet (RMs 11.0-7.1) in 1996 were similar to the 1986 results, but scored above the low performance range associated with *fair* or *poor* quality. Scores in the Akron urban area were variable but consistently higher in 1996 than 1986 values. Trends in each survey year show declines in performance downstream from Camp Brook (RM 3.8) and the Ohio Canal (RM 1.8) and poor performance near the mouth at RM 0.2 (Figure 22).

The high but variable QCTV scores through Akron in 1996 was unusual and considered the result of several factors. These included low taxa richness at the impacted sites, a predominance of pollution intermediate or moderately tolerant taxa, and the general lack of severe degradation through the reach. Under these circumstances, the presence or absence of a few taxa per site could skew the median scores (*i.e.*, the QCTV) up or down sharply. Macroinvertebrates throughout the lower seven miles of the mainstem were considered moderately, or moderately to severely impacted.



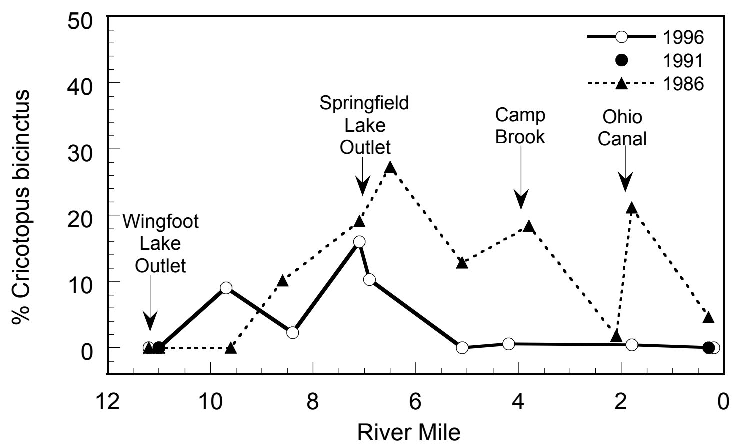


Figure 21. Relative abundance of tolerant organisms (top) and the toxic tolerant midge *Cricotopus bicinctus* (bottom) in macroinvertebrate samples collected from the Little Cuyahoga River, 1986, 1991 and 1996.

Table 13. Summary of macroinvertebrate data collected from artificial substrate samplers (quantitative sampling) and natural substrates (qualitative sampling) in the Little Cuyahoga River basin study area, July to September, 1984-1996.

Stream River Mile	Density (# /Sq.Ft.)	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
Little Cuyahoga River (1996) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*								
11.2	1220	31	28	38	2	30.3	24*	Fair
11.0	1052	26	25	38	6	38.9	36	Good
9.7	440	33	48	61	8	33.9	42	Very Good
8.4	140	39	30	55	8	NA	40	Good
7.1	531	33	34	42	8	34.6	32[ns]	Marg. Good
7.0	498	36	26	43	6	32.6	28*	Fair
5.1	108	25	19	32	6	39.2	26*	Fair
4.2	227	20	24	30	5	38.2	20*	Fair
3.8	NA	NA	12	12	3	29.2	P*	Poor
2.2	NA	NA	21	21	5	38.9	F*	Fair
1.8	83	21	22	31	4	32.6	16*	Fair
0.2	284	29	24	42	3	29.8	22*	Fair
(1991)								
11.0	714	42	40	61	7	34.0	44	V.Good
3.8	NA	NA	17	17	3	31.4	P*	Poor
0.3	613	28	28	39	4	30.1	16*	Fair
(1986)								
12.6	618	15	32	37	3	24.6	14*	Fair
11.7	1125	20	26	37	1	23.5	10*	Poor
11.2	388	19	26	33	4	38.5	24*	Fair
11.0	990	23	31	42	6	38.9	38	Good
9.6	216	28	35	45	6	32.0	22*	Fair
8.6	324	31	33	47	8	34.6	26*	Fair
7.1	299	26	25	39	6	32.6	24*	Fair
6.5	157	26	28	38	2	27.7	14*	Fair
5.1	103	20	18	30	4	29.2	8*	Poor
3.8	338	25	23	31	5	25.1	18*	Fair
2.1	506	33	16	34	3	25.1	18*	Fair
1.8	1124	28	24	34	5	22.8	18*	Fair
0.3	675	33	32	45	5	31.3	20*	Fair
(1984)								
1.8	NA	NA	28	28	3	25.1	P*	Poor

Table 13. Continued.

Stream River Mile	Density (# /Sq.Ft.)	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
Union Oil Tributary (1996) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*								
0.5	Qual. Only	--	34	--	4	35.3	F*	Fair
(1986)								
1.6	Qual. Only	--	40	--	6	32.6	F*	Fair
0.5	Qual. Only	--	46	--	8	34.2	MG[ns]	Marg.Good
Wingfoot Lake Outlet (1996) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*								
3.2	Qual. Only	--	19	--	4	34.2	F*	Fair
0.1	Qual. Only	--	32	--	6	35.5	MG[ns]	Marg.Good
(1986)								
3.2	Qual. Only	--	38	--	8	34.4	G	Good
0.5	Qual. Only	--	29	--	6	39.2	MG[ns]	Marg.Good
0.1	Qual. Only	--	21	--	5	35.9	MG[ns]	Marg.Good
Roosevelt Ditch (1996) *Erie Ontario-Lake Plain: MWH Use Designation (Proposed)*								
0.1	Qual. Only	--	19	--	2	33.9	P*	Poor
Springfield Lake Outlet (1996) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*								
0.1	Qual. Only	--	24	--	3	30.1	F*	Fair
(1986)								
3.5	Qual. Only	--	21	--	0	31.4	P*	Poor
0.5	Qual. Only	--	21	--	2	32.3	F*	Fair
0.1	Qual. Only	--	13	--	1	30.1	P*	Poor
Camp Creek (1996) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*								
1.6	Qual. Only	--	10	--	3	38.3	P*	Poor
0.1	Qual. Only	--	7	--	1	38.9	P*	Poor
(1986)								
1.6	Qual. Only	--	17	--	2	32.6	P*	Poor
0.1	Qual. Only	--	16	--	2	27.5	P*	Poor

Table 13. Continued.

Stream River Mile	Density (# /Sq.Ft.)	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
Ohio Canal (1996) *Erie-Ontario Lake Plain: MWH Use Designation (Existing)*								
0.1	884	20	18	24	3	32.2	20*	Fair
(1986)								
0.2	1047	22	19	25	3	22.8	<u>10</u>*	Poor

Ecoregion Biocriteria: Erie Ontario Lake Plains (EOLP)
(from OAC 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH[d]
ICI	34	46	22

[a] EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).
[b] Qualitative Community Tolerance Value (QCTV) is calculated as the median tolerance value of all taxa collected during qualitative (*i.e.,* natural substrate) sampling.
[c] A narrative evaluation based on qualitative sampling results and best professional judgement is used when quantitative data is not available for calculation of the Invertebrate Community Index (ICI).
[d] Modified Warmwater Habitat for channel modified areas.
* Significant departure from ecoregion biocriteria (>4 ICI units); *poor* and *very poor* results are underlined.
[ns] Nonsignificant departure from biocriterion (≤4 ICI units).

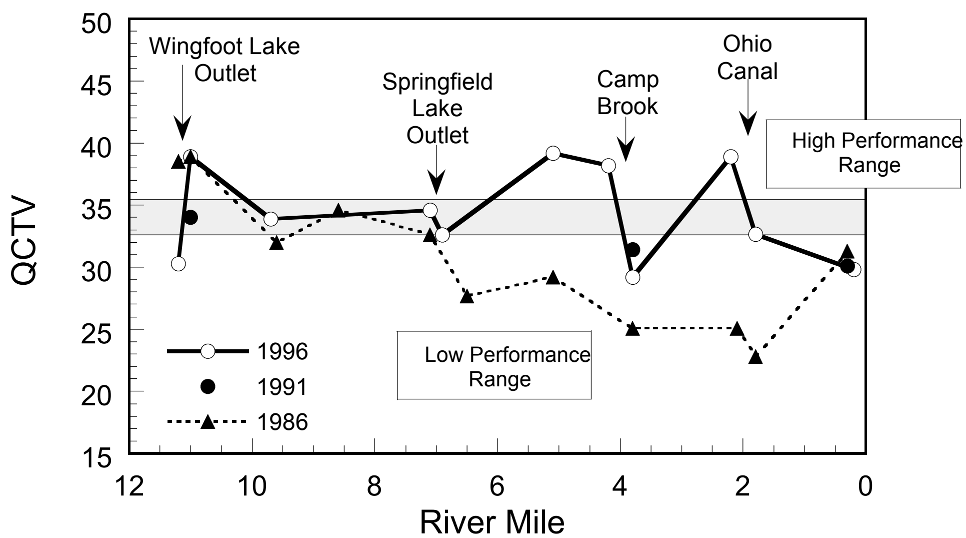


Figure 22. Qualitative Community Tolerance Value (QCTV) scores for samples collected from the Little Cuyahoga River, 1986, 1991 and 1996.

The City of Akron sampled the Little Cuyahoga River mainstem twice at eleven sites between RM 9.8 (Skelton Road) and the mouth in 1994 (City of Akron 1995). Additional sampling was also conducted at selected sites in the basin in 1995 (Malcolm Pirnie 1996). The samples were collected using artificial substrate samplers and generally followed Ohio EPA methodologies. However, from descriptions in the report, several critical aspects of sample collection and analysis appeared to differ from Ohio EPA methods. Also, a review of the raw data found many taxa listed that have not been collected by Ohio EPA or recorded from Ohio. These factors could influence ICI scoring and lead to concerns about the accuracy of the results.

A summary of the Akron macroinvertebrate sampling evaluations is provided in Table 14. Communities maintained a marginally good condition at two stations upstream and downstream from the Springfield Lake Outlet (RMs 9.8 and 6.8) and remained in the marginally good or upper fair range at RM 5.2. A series of Akron CSOs discharge to the river between RMs 6.8 and 5.2. (Goodyear property to Bank Street). The ICIs declined to fair and poor quality between Bank Street and the Ohio Canal (RMs 4.7 to 2.8), an area of increasingly urbanized land use, additional CSO discharges, and nonpoint runoff sources.

The main difference between the Akron and Ohio EPA surveys was the good or marginally good conditions encountered by Akron in four of six quantitative samples immediately downstream from the Ohio Canal (RMs 2.0-1.8). The remaining two samples from this stretch were in the *fair* range (ICIs=20). Ohio EPA results from RM 1.8 were considered *fair* based on the low quality of the natural substrate community and low EPT taxa richness. The ICI of 16 was also *fair* but may have been negatively affected by sediment deposition over the artificial substrates. Some improvement downstream from the Ohio Canal would not be unexpected given the improved conditions at the mouth of the canal (see below) and a lessening of severe toxic influences in the Akron area since 1986. However, natural substrate communities in both the Akron and Ohio EPA surveys performed well below ecoregional expectations, suggesting continued impairment through this reach.

All ICI scores near the mouth of the Little Cuyahoga River were in the *fair* range over the past decade. The five Ohio EPA and City of Akron samples collected from RMs 0.1-0.3 ranged from 16 to 22 between 1986-96. In the Akron report, substrate instability in the lowest reaches of the river was considered the cause of decline in ICI scores. However, artificial substrates reflect conditions in the water column becuase they control for variation in habitat quality on a local scale Therefore, the fair quality of the ICI scores was considered an indicator of water quality impairment, most likely from upstream sources.

Union Oil Tributary

Qualitative sampling was conducted in both 1986 and 1996 at RM 0.5. The 1996 sample included 34 total taxa and was predominated by net-spinning caddisflies, baetid mayflies, riffle beetles, and midges. Three taxa indicative of cold water habitats (the caddisfly *Ceratopsyche slossonae*, and midges *Prodiamesa olivarica* and *Micropsectra sp*) were also collected, suggesting groundwater moderates ambient stream temperatures. EPT taxa richness (4) was low and fell below that expected for similar streams in the ecoregion. The QCTV score (35.3) was also marginal and fell in the range between high and low performance. While no obvious pollution impacts were observed, community performance was considered *fair* due primarily to low EPT taxa richness Community performance declined from *marginally good* to *fair* between 1986 and 1996. The primary reason for the lower evaluation was low EPT taxa richness (four in 1996) compared to eight in 1986. QCTV scores were intermediate between the high and low performance range during both years (Table 13).

Wingfoot Lake Outlet

Qualitative samples were collected immediately downstream from Wingfoot Lake (RM 3.2) and near the mouth (RM 0.1) in 1986 and 1996. The sample collected at RM 3.2 showed declines in taxa richness, EPT taxa richness, and population densities (*i.e.*, from high to low) between surveys In addition, several coldwater taxa found in 1986 were not collected during the 1996 survey. Water quality evaluations based on the macroinvertebrates declined from *marginally good* in 1986 to *fair* in 1996. Collections from RM 0.1 received marginally good evaluations during each survey. A few coldwater taxa were collected in both years, and a pollution sensitive mayfly, *Baetis frondalis,* in 1996.

Roosevelt Ditch

Sampling in Roosevelt Ditch by the City of Akron in 1995 and Ohio EPA in 1996 resulted in very different evaluations. The Akron sample from RM 0.1 was considered *good* while the Ohio EPA evaluation from the same location was *poor*. Differences between the evaluations are related to sewer line maintenance next to the site in 1996.

Springfield Lake Outlet

Qualitative sampling at the mouth of the outlet improved from *poor* to *fair* between 1986 and 1996. While still degraded, 1996 collections represented a significant improvement over the earlier survey. In 1986 only thirteen taxa were found and, except for damselflies in margin habitats, densities were extremely low. EPT taxa richness was limited to a single mayfly individual of the genus *Baetis.* Water temperature was noticeably warmer downstream from the Goodyear Aerospace thermal discharge and the community composition suggested toxic conditions. After elimination of the discharge, taxa richness (24), EPT taxa richness (3) and population densities (low to moderate) increased in 1996. Continued impacts in 1996 are probably related to urbanization, industrial landuse or other sources. City of Akron sampling in 1995 found *poor* quality macroinvertebrate communities at the mouth of Springfield Lake Outlet with an ICI score of 6.

Table 14. Summary of macroinvertebrate data collected in 1994 and 1995 from artificial substrate samplers (quantitative sampling) and natural substrates (qualitative sampling) in the Little Cuyahoga River basin study area as reported by the City of Akron (1995) and Malcolm Pirnie (1996).

Stream River Mile	Event 1 (July 94) ICI	Narrative Evaluation	Event 2 (Sept. 94) ICI	Narrative Evaluation
Little Cuyahoga River (1994) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*				
9.8	32^{ns}	Marg. Good	30^{ns}	Marg. Good
6.8	30^{ns}	Marg. Good	12*	Poor
5.2	32^{ns}	Marg. Good	26*	Fair
4.7	14*	Fair	10*	Poor
4.3	8*	Poor	10*	Poor
4.2	8*	Poor	14*	Fair
2.8	0*	Poor	18* (estimated)	Fair
2.1	20*	Fair	34	Good
1.9	--	--	22*	Fair
1.8	36	Good	32^{ns}	Marg. Good
0.1	20*	Fair	20*	Fair
Camp Brook (1994) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*				
0.5	10*	Poor	18*	Fair
0.1	0*	Poor	6*	Poor
Ohio Canal (1994) *Erie-Ontario Lake Plain: MWH Use Designation (Existing)*				
2.7	14*	Fair	8*	Poor
0.1	14*	Fair	6*	Poor
Little Cuyahoga River (1995) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*				
11.4	8*	Poor		
1.8	34	Good		
Springfield Lake Outlet (1995) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*				
0.1	6*	Poor		
Camp Brook (1995) *Erie-Ontario Lake Plain: WWH Use Designation (Existing)*				
1.6	--	Very Poor (Qual. sample)		
1.6	--	Very Poor (Qual. sample)		
0.5	24*	Fair		

Table 14. Continued.

Stream River Mile	Event 1 (July 94) ICI	Narrative Evaluation	Event 2 (Sept. 94) ICI	Narrative Evaluation
Roosevelt Ditch (1995) *Erie-Ontario Lake Plain: MWH Use Designation (Proposed)*				
0.1	--	Good (Qual. sample)		

Ecoregion Biocriteria: Erie-Ontario Lake Plains (EOLP)
(from OAC 3745-1-07, Table 7-14)

INDEX	WWH	EWH	MWH[a]
ICI	34	46	22

* Significant departure from ecoregion biocriteria (>4 ICI units); *poor* and *very poor* results are underlined.
[ns] Nonsignificant departure from biocriterion (<4 ICI units).
[a] Modified Warmwater Habitat for channel modified areas.

Camp Brook
Camp Brook communities were *poor* upstream and downstream from a large Akron CSO in both 1986 and 1996. Taxa richness and organism densities were low in 1986 but experienced additional sharp declines in 1996 (Table 13). Sites in 1996 were virtually without benthic populations with only 7-10 taxa found in extremely low densities. A potential source of impact was an unnamed tributary immediately downstream from RM 1.6; the tributary was severely iron stained, substrates were covered with flocculent orange solids, and a cursory examination found no organisms present. Collections upstream from the unnamed tributary at RM 1.6 were also low in species richness (10) and density (very low) suggesting impacts prior to the confluence. Conditions appear to have declined throughout the length of Camp Brook since 1986, possibly owing to increased development within the subwatershed.

Samples collected by the City of Akron in 1994 and 1995 received *very poor* to *fair* evaluations at four stations upstream from Akron CSO Rack #12 between RMs 1.6 and 0.5. Downstream from Rack #12, a 1994 sample from RM 0.1 that was not affected by sediment deposition, scored in the poor range (ICI=6). Bioassay sampling conducted by Akron found varying levels of acute and chronic toxicity throughout the length of Camp Brook in 1994 and 1995.

Ohio Canal
Communities near the mouth improved from *poor* (ICI=10) to *fair* (ICI=20) between 1986 and 1996. A major reason for the improvement was a sharp decline in the percentages of tolerant organisms (from 62.4% in 1986 to 9.5% in 1996). Conversely, the abundance of hydropsychid

caddisflies, and toxic intolerant midges of the *Rheotanytarsus exiguus* group (absent in 1986) increased during the same period. The predominant taxon collected from the artificial substrates shifted from the pollution tolerant *Polypedilum (P) illinoense* in 1986 to the more intermediate *Polypedilum (P) convictum* in 1996. These changes indicate a significant shift from the grossly polluted and toxic conditions observed in 1986 when strong septic and organic chemical odors were noted and the numerous hygiene and contraceptive devices observed were evidence of raw sewage discharges. Some septic odors continued to be noted in 1996 and the macroinvertebrates indicated improved but still impaired conditions. Elimination of a large dry-weather sewage discharge by the City of Akron in 1994 and reduced toxicity associated with termination of industrial discharges are possible reasons for the improving trend.

City of Akron sampling from the mouth of the Ohio Canal in 1994 yielded ICI scores in the low *fair* (Event #1 ICI=14) and *poor* (Event #2 ICI=10) ranges. The low scores were attributed to slow current velocities over the artificial substrates, but the above mentioned dry weather discharge likely exerted a negative influence.

Biological Assessment: Fish Communities, 1986 - 1996

Little Cuyahoga River

IBI scores were uniformly depressed at all locations sampled in the Little Cuyahoga River in 1996 (Table 15, Figure 23). However, several proportional metrics varied longitudinally according to the sources and causes of biological impairment (Figure 24). Habitat marginally suited to supporting WWH stream faunas is an overlying source of impairment in the upper reaches between RM 5.0 and Mogadore Reservoir given a mean QHEI score of 57.0 ± 2.1 SE. Physical habitat improves substantially downstream, and, based on a mean QHEI score of 68.4 ± 2.4 SE, is not limiting. The proportion of tolerant fishes decreased and number of species increased in the reach with good habitat (Figure 9), either in response to improved habitat quality, or increased gradient. The high gradient of the reach with good habitat minimizes exposure time to episodes of poor water quality and provides aeration. However, IBI scores were not significantly correlated with habitat ($t = -1.08$, $P = 0.3068$), strongly suggesting that other impacts override the relationship.

The proportion of simple lithophils decreased from upstream to downstream (Figure 24). Because lithophilic species rely on clean, stable, coarse substrates to spawn, a decreasing longitudinal trend suggests decreasing habitat quality with respect to channel stability and substrate embeddedness. Substrates were uniformly embedded whereas channel stability decreased. The decrease in channel stability in the downstream reach is directly related to the increasing amount of impervious surface and attendant stormwater from upstream to downstream. Therefore, impervious surfaces represent a source of impairment. Additionally, the low relative abundance of insectivores (Figure 24) reflects a fundamental disruption in macroinvertebrate production either through periodic disturbance from stormwater runoff, intermittent toxicity, poor water quality or combinations of all three.

Water quality as a source of impairment is indicated by the high relative abundance of pollution tolerant fishes. The cause of water quality impairment upstream from the first CSO may be linked to contaminated sediments. The incidence of anomolous deformities, erosion, lesions or tumors (DELTs) increased in a downstream direction corresponding to increasing sediment lead concentration, though the relationship was not statistically significant owing to the complete lack of DELTs at RM 4.1 where lead concentrations were highest. However, the fish community at RM 4.1 indicated a toxic response as five fewer species were present reative to upstream sites, the community was composed entirely of pollution tolerant fishes, relative abundance was low, and insectivores were virtually absent. Highly elevated levels of PAHs at RM 7.3 also corresponded to an increase in DELTs relative to upstream.

Table 15. Fish community indices from samples collected in the Little Cuyahoga River basin study area 1986 - 1996.

River Mile	Mean Number Species	Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean Miwb[a]	Mean IBI	Narrative Evaluation
Little Cuyahoga River (1996) *WWH Use Designation - Existing*								
11.3[D]	10.5	12	334	23.06	57.0	NA	22[*]	Poor
11.0[D]	9.5	11	184	25.47	58.0	4.3[*]	25[*]	Very Poor/Poor
9.7[D]	8.5	9	480	10.52	67.0	4.7[*]	20[*]	Poor
8.5[E]	7.5	8	519	7.13	49.5	4.1[*]	24[*]	Very Poor/Poor
7.3[D]	8.5	11	320	14.00	52.5	4.6[*]	21[*]	Poor
7.1[D]	9.0	10	303	14.22	59.0	4.7[*]	21[*]	Poor
5.1[D]	12.0	13	339	36.74	56.0	4.5[*]	20[*]	Poor
4.2[D‡]	8.0	9	494	8.26	75.5	3.0[*]	19[*]	Very Poor/Poor
4.1[D†]	5.5	7	278	10.12	71.0	2.2[*]	21[*]	Very Poor/Poor
2.9[E]	8.0	8	286	6.84	66.0	6.5[*]	23[*]	Fair/Poor
1.8[E]	13.0	18	166	15.42	61.5	5.2[*]	25[*]	Poor
0.3[E]	14.0	17	391	10.97	68.0	6.5[*]	24[*]	Fair/Poor
Little Cuyahoga River (1994- City of Akron)								
9.8	12.0	--	597	10.86	59.0	4.6[*]	26[*]	Poor
6.8	10.5	--	202	5.72	53.5	4.6[*]	26[*]	Poor
5.2	12.0	--	230	20.28	51.0	4.3[*]	19[*]	Very Poor/Poor
4.7	10.0	--	179	11.96	63.5	3.7[*]	22[*]	Very Poor/Poor
4.3[‡]	7.0	--	298	3.31	75.0	3.5[*]	22[*]	Very Poor/Poor
4.2[†]	4.5	--	134	5.04	81.0	1.9[*]	22[*]	Very Poor/Poor
2.8	10.5	--	1129	20.33	69.0	6.2[*]	27[*]	Fair
2.1	11.0	--	335	35.69	77.5	5.9[*]	23[*]	Fair/Poor
1.9	9.5	--	667	52.51	54.5	5.9[*]	23[*]	Fair/Poor
1.8	15.0	--	903	9.14	66.5	7.6[ns]	30[*]	M.Good/Fair
0.1	13.5	--	242	12.81	69.5	6.1[*]	27[*]	Fair/Poor
Little Cuyahoga River (1991)								
11.0	10.0	--	342	40.33	65.0	5.8[*]	28[*]	Poor/Fair
2.2	8.0	--	492	5.96	64.0	5.9[*]	26[*]	Fair/Poor
0.3	13.5	--	689	9.96	75.0	6.0[*]	22[*]	Fair/Poor
Little Cuyahoga River (1986)								
11.2	7.0	--	104	6.52	76.0	NA	23[*]	Poor
11.0	8.3	--	91	12.56	82.0	3.8[*]	26[*]	Very Poor/Poor
9.8	8.7	--	257	5.08	58.0	4.6[*]	23[*]	Poor
8.4	8.3	--	889	14.57	73.0	3.7[*]	23[*]	Very Poor/Poor
7.1	8.0	--	1041	8.79	72.0	3.3[*]	23[*]	Very Poor/Poor

Table 15. Continued.

River Mile	Mean Number Species	Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean Miwb[a]	Mean IBI	Narrative Evaluation
Little Cuyahoga River (1986)								
6.7	7.7	--	944	6.93	65.0	4.1[*]	18[*]	Very Poor/Poor
5.0	6.3	--	580	3.12	64.0	2.8[*]	15[*]	Very Poor
4.1	5.0	--	338	7.04	74.0	2.3[*]	22[*]	Very Poor/Poor
3.8	3.3	--	36	1.05	65.0	1.5[*]	13[*]	Very Poor
2.2	6.0	--	177	3.13	59.0	4.8[*]	21[*]	Poor
1.8	14.7	--	948	14.05	80.0	7.3[ns]	31[*]	M.Good/Fair
0.2	13.7	--	607	7.29	72.0	6.4[*]	24[*]	Fair/Poor
Union Oil Trib to L. Cuyahoga (1996)								
1.5[E]	10.0	10	630	11.76	50.0	NA	30[*]	Fair
Union Oil Trib to L. Cuyahoga (1986)								
1.5	3.3	--	149	--	41.0	NA	27[*]	Poor
0.3	7.7	--	331	--	74.0	NA	28[*]	Fair
Wingfoot Lake Outlet (1996)								
1.3[E]	8.0	8	934	23.63	34.5	NA	26[*]	Poor
0.1[E]	10.0	10	190	6.45	44.0	NA	26[*]	Poor
Wingfoot Lake Outlet (1986)								
3.1	6.3	--	278	1.02	70.0	NA	29[*]	Fair
0.5	4.3	--	94	2.47	61.0	NA	18[*]	Poor
0.1	9.3	--	474	6.26	66.0	NA	20[*]	Poor
Springfield Lake Outlet (1996)								
0.1[E]	6.0	6	378	5.93	55.0	NA	26[*]	Poor
Springfield Lake Outlet (1986)								
0.8	4.0	--	992	2.34	44.0	NA	16[*]	Very Poor
0.1	6.0	--	723	3.42	63.0	NA	24[*]	Poor
Camp Brook (1996)								
1.0[E]	5.0	5.0	314	2.37	48.5	NA	24[*]	Poor
0.2[E]	3.0	3.0	266	3.09	61.0	NA	20[*]	Poor
Camp Brook (1994- City of Akron)								
0.5	3.0	--	149	--	76.0	NA	21[*]	Poor
0.1	5.0	--	331	--	53.0	NA	20[*]	Poor

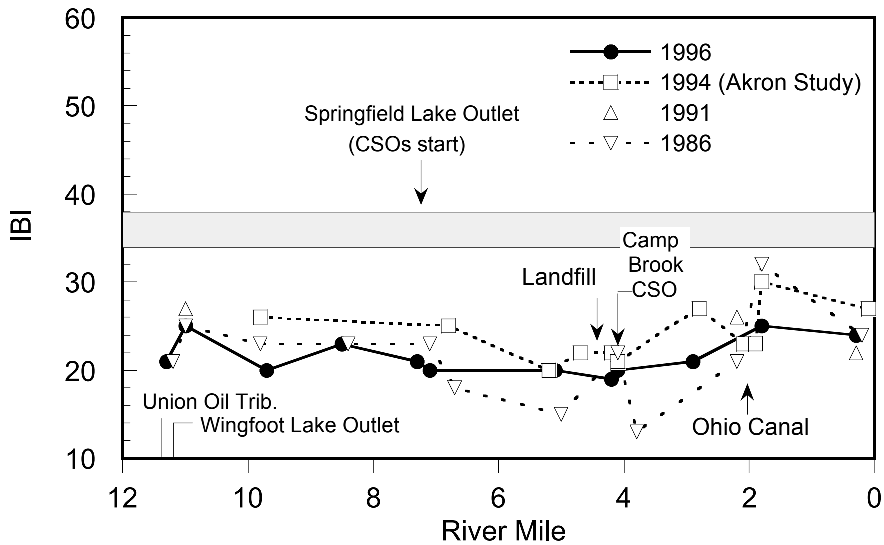
Table 15. Continued.

River Mile	Mean Number Species	Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean Miwb[a]	Mean IBI	Narrative Evaluation
Camp Brook (1986)								
1.5	2.7	--	61	0.47	74.0	NA	<u>18</u>*	Poor
0.1	2.0	--	106	0.44	67.0	NA	<u>17</u>*	Very Poor
Ohio Canal (1986)	*MMW Use Designation - Existing*							
1.5	5.3	7	259	20.9	29.0	5.9	<u>24</u>*	Poor
Ohio Canal (1994 - City of Akron)								
0.1	5.5	9	96	8.7	65.0	3.8	<u>22</u>*	Poor

Ecoregion Biocriteria: Erie-Ontario Lake Plain

Site Type	IBI WWH	IBI EWH	IBI MWH[c]	MIwb WWH	MIwb EWH	MIwb MWH[c]
Headwaters	40	50	24	NA	NA	NA
Wading	38	50	24	7.9	9.4	5.6

a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.
ns - Nonsignificant departure from biocriteria (≤4 IBI units or ≤0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
‡ - Upstream from Camp Brook.
† - Downstream from Camp Brook.



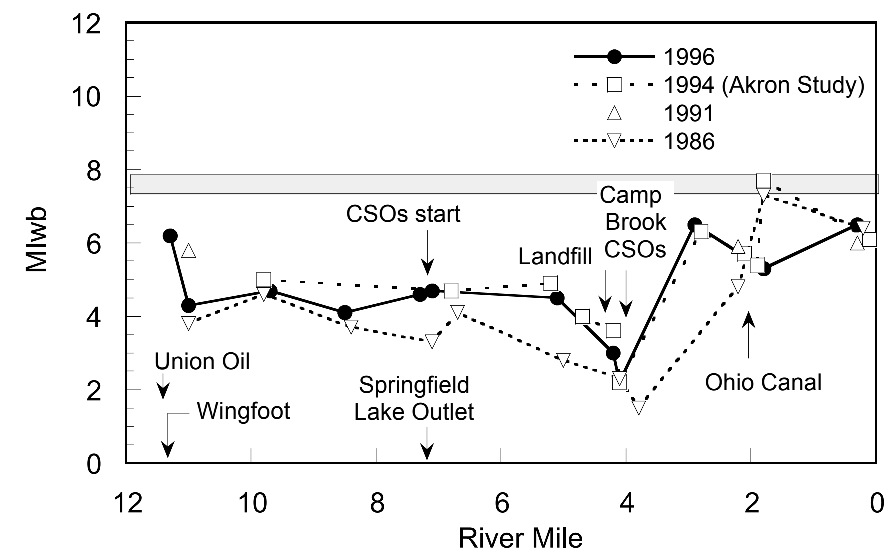


Figure 23. Index of Biotic Integrity (IBI) and Modified Index of Well-being (MIwb) scores for the Little Cuyahoga River plotted by river mile in relation to tributaries and CSOs, 1986, 1991, 1994 and 1996. The shaded box is the area of nonsignificant departure from the applicable WWH biological criterion.

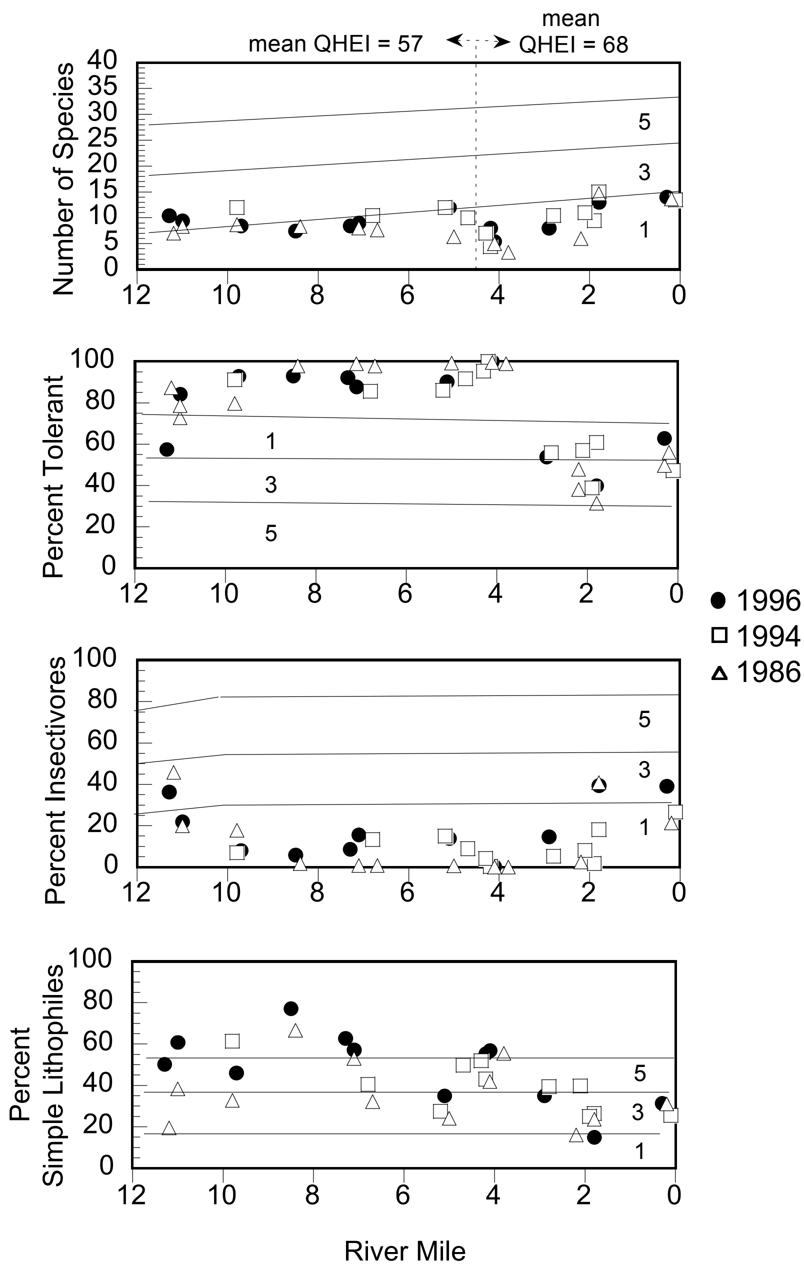


Figure 24. Individual fish community metrics derived from electrofishing samples of the Little Cuyahoga River, 1996, 1994 (Akron CSO study) and 1986 plotted by river mile.

The complete absence of intolerant species further implicates poor water quality as a source of impairment, and often is diagnostic of toxicity (Yoder and Rankin 1995). Additional evidence for a toxic response is given by the sharp decrease in MIwb scores in the vicinity of Camp Brook. CSOs are a documented source of toxicity and water quality degradation (see *Camp Brook* below); however, toxicity from scrap yard run-off or other causes may also be a significant source of impairment in the reach between RMs 5.1 and 4.1, as the decline in MIwb scores started upstream from Camp Brook. Although additional sources of impairment are likely considering the industrial landuses adjacent to the stream within the reach, the importance of CSOs is not obviated. CSO impairment from organic enrichment is inferred by the increasing MIwb scores in the lower reach where increased stream gradient and attendant reaeration helps assimilate loadings.

Fish communities sampled upstream from CSOs in headwater tributaries (i.e., the Union Oil tributary, Wingfoot Lake Outlet, Camp Brook upstream from CSO rack 12) rated either fair or poor, implying that conditions leading to or perpetuating degraded communities originate on the watershed scale (*i.e.*, previous channel modifications, wetland origins, urbanization, no centralized sewerage, residual sediment contamination), and not with point sources. Additionally, the upper reach appears to have been recolonized from a limited pool of species following a period of gross pollution, given that the fish community is composed of tolerant and headwater species, or those with a lentic affinity, and lacks intermediately tolerant species normally expected in low order streams (*e.g.*, stonerollers). The presence of stonerollers, greenside darters and hogsuckers in the lower reach, where water quality is demonstrably lower, suggests that an effective barrier(s) to recolonization exists.

Fish communities performed similarly in all years sampled (Table 15, Figure 23). IBI and MIwb scores did not differ significantly between 1986 and 1996 (Two-sample t-test, MIwb t = -0.81, P = 0.4278; IBI t = -0.17, P = 0.8695). However, a slight improvement for the reach between RM 7.0 and RM 2.0 is visually evident (Figure 23), and evident by the reduced number of stream miles rated as very poor in 1996 compared to 1986 (Table 16). The improvement is likely in response to the elimination and reduction of industrial discharges. Coincidently, the proportion of simple lithophils increased, while tolerant fishes and occurrences of DELT anomolies decreased slightly compared to 1986. All other metrics performed similarly. Results from sampling conducted for the City of Akron in 1994 produced essentially the same results as those from 1996.

Union Oil Tributary

The Union Oil Tributary was channel modified prior to sampling in 1986. Ten years of recovery has increased the number of species present from 2 to 10, and the IBI score from 24 to 30. Poor habitat quality and possibly on-site sewerage continue to impaired fish communities in the Union Oil tributary. The habitat is dominated by modified habitat attributes owing to the past channel modifications. Consequently, metrics sensitive to habitat quality (e.g., headwater species, darter and sculpin species, sensitive species) scored low; however, the species representing those metrics are not apparently found in the pool of species available for recolonization. Of the species found in the upper Little Cuyahoga River and the Wingfoot Lake Outlet, only johnny darters and brook stickleback were not found in the UnionOil tributary. Two on-site septic systems discharged in the sample reach, though neither showed visible signs of failure.

Wingfoot Lake Outlet

Wingfoot Lake Outlet is essentially a channelized ditch in varying states of recovery. QHEI scores were 34.5 and 44.0 at RMs 1.3 and 0.1, implying a limited ability to support WWH fish faunas. The poor performance of the fish community at RM 1.3, upstream from known point sources, reflects the poor habitat and possibly organic enrichment given the elevated abundance of omnivores.

Legacy pollution, in the form of contaminated sediments, and stormwater and as source of impairment starts near the inception of the Little Cuyahoga River. Effects of sediment contamination and stormwater runoff from industrial parks in the city of Mogadore were manifest at RM 0.1 in the increased proportion of pioneering fishes coupled with a decrease in insectivores relative to upstream. Sediment contamination appears to be a legacy of past industrial discharges given the elevated levels of PCBs which are not likely attributable to stormwater. Stormwater effects were manifest at least in lowering habitat quality, and likely contributed to toxicity given concentration of parkinglots, industrial parks and roads adjacent to the stream. IBI scores at RM 0.1 of Wingfoot Lake Outlet increased by 6 points owing to a decrease in the relative abundance of pioneering fishes and occurrence of DELT anomolies between 1986 and 1996.

Springfield Lake Outlet

Again, fish communities in Springfield Lake Outlet reflect a disturbed environment. Stormwater runoff negatively impacted both the habitat and fish community. Severe bank erosion and embedded and compacted substrates were habitat manifestations. The lack of darter, headwater and sensitive species, combined with a low relative abundance of insectivores evidenced effects on the fish community. Impacts to the fish community beyond habitat limitation is inferred from the high relative abundance of tolerant fishes and the absence of sensitive species, coupled with the same IBI score as RM 1.3 in Wingfoot Lake Outlet despite a 20 point swing in QHEI scores (Table 12). IBI scores did not differ between 1986 and 1996 at RM 0.1. However, similar to Wingfoot Lake Outlet, the proportion of pioneering fishes decreased, possibly linked to the reduction of discharges from the Goodyear Corporation. Severly contaminated sediments may be a cause for continued impairment and the apparent toxic response in the fish community.

Camp Brook

Camp Brook was sampled upstream and downstream from the Rack 12 CSO. Habitat at the upstream site was very poor due to a high bed load of sand caused by construction upstream and stormwater. Consequently, fish communities were severely impacted with only five species present. Though the bed load of sand was partially attenuated by RM 0.2, significantly improving habitat quality (Table 12), the fish community was slightly more degraded. The entire fish community at RM 0.2 was comprised of three tolerant species, white sucker, creek chub and blacknose dace. Obviously Rack 12 exacerbated existing impacts to Camp Brook. Impacts to the biological community from poor habitat, storm water, and a CSO did not diminish between 1986 and 1996. Results from sampling conducted by the City of Akron were consistent with those reported here.

Fish and Macroinvertebrate Community Performance Summary

Both fish and macroinvertebrate communities were moderately to severly depressed at nealy all locations in the Little Cuyahoga River and tributaries. An exception was the generally good macroivertebrate communityperformance in the Little Cuyaghoaga River upstream from the area of CSOs, and in Wingfoot Lake Outlet. The good performance found in 1996 within that reach was an improvement compared to 1986. The improvement resulted in a reduction in the Area of Degradation (ADV), with respect to the ICI, by roughly one half (Table 16). The elimination of direct discharge of process industrial wastewater after 1986, and subsequent water quality improment, is the reason for the improvement.

The lack of response in the fish community to elimination of industrial wastewater is caused by the absence of a pool of species available for recolonization. The lack of recolonization source is a direct result of the gross perturbations, both present and historic, occurring on a watershed scale. Those perturbations include channelizaiton of headwater tributaries, dams and CSOs in the lower Little Cuyahoga River, historic industrial pollution and residual sediment contamination, and high levels of imperviousness combined with an absence of stormwater retention.

Conitinued impairment in 1996 stems from a combination of legacy pollution as previously discussed, urban non-point pollution (including highway construction and stormwater) and CSOs. The causes of impairment appear addative given that macroinvertebrate performance begins to decline upstream from the CSOs, but is worst in the reach receiving CSO discharges. Similarly, the poorest fish communities were sampled in the reach having contamniated sediments and receiving CSO discharges. Despite the improved macroinvertabrate performance, the continued impairment in the fish community resulted in no change in attaiment status between 1996 and 1986

Table 16. Area of Degradation Values (ADV) comparing the longitudinal area of departure fom established numeric criteria and attainment status for the Little Cuyahoga River, 1996 and 1986.

			Miles by Attainment Status				Miles by Narrative Status				
Index	ADV	**ADV•mi^{-1}**	Full	Partial	NON	Poor/VP	Execpt.	Good	Fair	Poor	V. Poor
1996											
IBI	1402	**118.8**					0.0	0.0	0.0	11.8	0.0
MIwb	1525	**132.6**	0.0	0.0	**11.8**	11.8	0.0	0.0	1.7	5.1	4.7
ICI	633	**54.1**					0.1	4.0	7.6	0.0	0.0
1986											
IBI	1468	**125.4**					0.0	0.0	1.1	8.2	2.4
MIwb	1914	**166.4**	0.0	0.0	**11.7**	10.6	0.0	0.0	2.0	0.6	8.9
ICI	1173	**100.3**					0.0	0.9	9.4	1.4	0.0

References

Anonymous. 1992. Wastewater treatment/disposal for small communities, manual, EPA/625/R-92/005

City of Akron. December 1995. Final report for CSO system wide study. Three Volumes. City of Akron. Akron, Ohio.

Fausch, D.O., J.R. Karr and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Amer. Fish. Soc. 113:39-55.

Gammon, J.R. 1976. The fish populations of the middle 340 km of the Wabash River. Tech Report No. 86. Purdue University. Water Resources Research Center, West Lafayette, Indiana. 73 pp.

Gammon, J.R., A. Spacie, J.L. Hamelink, and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River. pp. 307-324. In: Ecological assessments of effluent impacts on communities of indigenous aquatic organisms. ASTM STP 703, J.M. Bates and C.I. Weber (eds.). Philadelphia, PA.

Gordon, N.D., T.A. McMahon, B.L. Finlayson. 1992. Stream Hydrology: An introduction for ecologists. John Wiley & Sons, Ltd. Chichesler, West Susex, England. 526 pp.

Hughes, R.M., D.P. Larsen, and J.M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. Env. Mgmt. 10(5): 629-635.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6 (6): 21-27.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. Env. Mgmt 5(1): 55-68.

Kelly, M.H., R. L.Hite. 1984. Evaluation of Illinois stream sediment data: 1974-1980. Illinois Environmental Protection Agency, Division of Water Pollution Control. Springfield, Illinois.

Leonard, P.M. and D.J. Orth. 1986. Application and testing of an Index of Biotic Integrity in small, cool water streams. Trans. Am. Fish. Soc. 115: 401-414.

Long, E.R. and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. Technical Memorandum NOSOMA 52. National Oceanic and Atmospheric Administration, Seattle, Washington.

Malcolm Pirnie. 1996. 1995 Biological addendum to the Akron CSO system-wide study report. City of Akron. Akron, Ohio.

Ohio Department of Natural Resources. 1960. Gazetteer of Ohio Streams, Report No. 12, Ohio Water Plan Inventory . Columbus, Ohio.

___ 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

___ 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

___ 1988a. Ohio nonpoint source assessment. Division of Water Quality Monitoring and Assessment, Nonpoint Source Management Section Columbus, Ohio.

___ 1988b. Biological and Water Quality Study of the Little Scioto River Watershed - Marion County , Ohio. Division of Water Quality Monitoring and Assessment, Columbus, Ohio.

___ 1989a. Addendum to biological criteria for the protection of aquatic life: Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

___ 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning and Assessment, Columbus, Ohio.

___ 1989c. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.

___ 1990a. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

___ 1990b. Compendium of biological results from Ohio rivers, streams and lakes: 1989 edition. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

____ 1990c. State of Ohio Nonpoint Source Assessment. Volume 5. Lake Erie West Region. Division of Surface Water, Nonpoint Source Program Management Section, Columbus, Ohio.

____ 1993. State of Ohio Water Quality Standards. Chapter 3745-1 of the Ohio Administrative Code.

____ 1994. Biological, Sediment and Water Quality Study of the Little Scioto River, Marion, Ohio. Division of Surface Water, Columbus, Ohio.

Omernik, J.M. 1988. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

Persaud, D., J. Jaagumayi, and A. Hayton. 1994. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ministry of the Environment, Public Information Centre, Toronto, Ontario.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Division of Water Quality Planning and Assessment, Columbus, Ohio.

Rankin, E.T.and C.O. Yoder. 1991. Calculation and uses of the area of degradation value (ADV). Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

Reash R.J. and T.M. Berra. 1989. Incidence of fin erosion and anomalous fishes in a polluted stream and a nearby clean stream. Water, Air, Soil Pollution. 47: 47-63.

Reash R.J. and T.M. Berra. 1987. Comparison of fish communities in a clean-water stream and an adjacent polluted stream. Am. Midl. Nat. 118: 301-322.

Reash R.J. and T.M. Berra. 1986. Fecundity and trace-metal content of creek chubs from a metal contaminated stream. Trans. Am. Fish. Soc. 115: 346-351.

Schuler, T. R. 1994. The importance of imperviousness. Watershed Protection Techniques 1:100-111.

Simpson, K.W. and R.W. Bode. 1980. Common larvae of Chironomidae (Diptera) from New York State streams and rivers. Bull. No. 439, New York State Education Dept., Albany. 105 p.

Steedman, R.J. 1988. Modification of an index of biotic integrity to quantify stream quality in southern Ontario. Canadian Journal of Aquatic Science. 45: 492-501.

Thurston, R. V., R. C. Russo, and K. Emerson. 1979. Aqueous ammonia equilibrium - Tabulation of percent un-ionized ammonia. U.S. EPA Environmental Research Laboratory, Duluth, MN. EPA-600/3-79-091.

U.S. Environmental Protection Agency. 1976. Quality Criteria for Water. Washington, D.C.

Warren, C. E. 1971. Biologyand Water Pollution Control. W. B. Saunders Co., Philadelphia, Pa. 434 pp.

Yoder, C. O. and E. T. Rankin. 1996. Assessing the condition and status of aquatic life designated uses in urban and suburban watersheds. Pages 201-227 *in* Effects of Watershed

Development and Management on Aquatic Ecosystems, L. A Rosner, editor. American Society of Civil Engineers, New York, NY.

Appendix Table 1. Identification and location information for combined sewer outfalls (CSO's) in the City of Akron WPCS sewer service area[1].

Rack Number	NPDES Permit Number	Location	Receiving Stream
2	3PF00000081	9th Ave. at Settlement St.	Little Cuyahoga R.
3	3PF00000046	Kelly Ave.	Little Cuyahoga R.
4	3PF00000047	Mill St. CSO	Ohio Canal
5	3PF00000048	R. St. CSO	Little Cuyahoga R.
6	3PF00000049	Factory St. CSO at R. St.	Little Cuyahoga R.
7	3PF00000050	Case Ave. CSO at South Case Ave.	Little Cuyahoga R.
8	3PF00000051	North Case Ave.- Dublin St. CSO	Little Cuyahoga R.
9	3PF00000052	Williams St. CSO at Kent St.	Little Cuyahoga R.
10	3PF00000053	Case Ave.-Newton St. District CSO at Eastland Ave.	Little Cuyahoga R.
11	3PF00000054	Hazel St. Trunk, district 4 CSO	Little Cuyahoga R.
12	3PF00000055	Home Ave. district CSO	Camp Brook
13	3PF00000056	Madeira St. CSO behind Holland Oil	Little Cuyahoga R.
14	3PF00000057	North Forge St. CSO, north of the railroad tracks	Little Cuyahoga R.
15	3PF00000058	Forest hill District CSO in park ravine	Little Cuyahoga R.
16	3PF00000059	Wolf ledges Trunk CSO	Ohio Canal
17	3PF00000060	Exchange St. CSO	Ohio Canal
18	3PF00000061	Willow Run Trunk CSO	Ohio Canal
19	3PF00000062	West Market St. CSO	Ohio Canal
20	3PF00000063	West North St. CSO	Ohio Canal
21	3PF00000064	North Howard St. CSO	Little Cuyahoga R.
22	3PF00000065	North Hill Trunk CSO at north Howard St.	Little Cuyahoga R.
23	3PF00000066	North Maple St. CSO	Little Cuyahoga R.
24	3PF00000067	West Market St. outlet at Ravine St.	Little Cuyahoga R.
25	3PF00000068	Otto St. District CSO	Little Cuyahoga R.
26	3PF00000069	Aqueduct St. outlet east of Hickory St.	Little Cuyahoga R.
27	3PF00000070	Uhler Ave. CSO at Memorial Pkwy.	Little Cuyahoga R.
28	3PF00000071	Tallmadge Ave. CSO at Memorial Pkwy.	Little Cuyahoga R.
29	3PF00000072	Uhler Ave.-Carpenter St. outlet at Cuyahoga St.	Little Cuyahoga R.
30	3PF00000073	Cuyahoga St./Peck Rd. outlet at Cuyahoga St.	Little Cuyahoga R.
31	3PF00000074	Portage-Sunnyside outfall	Little Cuyahoga R.
32	3PF00000075	Carpenter Hts. District CSO at Cascade Park Rd.	Cuyahoga R.
33	3PF00000076	North side interceptor CSO at Cuyahoga R. and Main St.	Cuyahoga R.
34	3PF00000077	R.side Dr. District CSO along Metroparks easment Rd.	Cuyahoga R.
35	3PF00000078	Gorge Blvd. district CSO at Front St. bridge	Cuyahoga R.
36	3PF00000079	Merriman Rd. outlet along abandoned railroad track bed	Cuyahoga R.
37	3PF00000080	Bowery St. CSO	Ohio Canal
38[2]	3PF00000059		
	3PF00000060	Opportunity Park	Ohio Canal
39[3]	3PF00000082	Bowery St. CSO	Ohio Canal
40[4]			Little Cuyahoga R.

Appendix Table 2. Concentrations of water quality parameters and dissolved metals measured in grab samples collected from the Little Cuyahoga River, 1996.

Little Cuyahoga	River Mile	Date	Time	Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond. (umhos/cm)	Hardness (mg CaCO3/l)	COD (mg/l)
ust. Wingfoot Lake Outlet	11.3	20-Jun-96	0833	23.6	7.57	6.0	342	144	62
	11.3	10-Jul-96	1315	23.0	7.80	6.4	399	183	21
	11.3	30-Jul-96	1231	22.0	8.43	7.2	636	187	18
	11.3	29-Aug-96	0905	21.2	7.15	4.7	379	171	34
	11.3	04-Sep-96	1112	22.6		4.4	420	173	<10
	11.3	12-Sep-96	1000						
@ Gilchrist Rd.	11	20-Jun-96	0904	21.7	7.73	7.2	381	172	30
	11	10-Jul-96	1340	19.1	8.12	9.4	496	250	15
	11	30-Jul-96	1239	19.8	8.51	8.2	751	249	<10
	11	29-Aug-96	0925	17.6	7.89	7.8	489	256	14
	11	04-Sep-96	1125	19.4		7.5	515	236	<10
	11	12-Sep-96	1005						
@ Skelton Rd.	9.7	20-Jun-96	0920	22.2	7.65	6.6	376	163	18
	9.7	10-Jul-96	1255	19.9	8.20	8.8	535	238	15
	9.7	30-Jul-96	1209	20.4	8.61	9.2	771	242	<10
	9.7	29-Aug-96	0940	18.8	8.40	8.3	490	235	11
	9.7	04-Sep-96	1055	22.2		8.7	550	228	<10
	9.7 dup	04-Sep-96	1056	22.2		8.7	550	236	<10
	9.7	12-Sep-96	0950						
dst Rte 91	8.5	20-Jun-96	0952	22.0	7.72	7.2	390	165	21
	8.5	10-Jul-96	1220	19.8	8.20	9.4	535	247	15
	8.5	30-Jul-96	1118	20.8	8.64	9.8	791	240	<10
	8.5	29-Aug-96	1010	19.5	8.49	9.3	580	235	17
	8.5	29-Aug-96	1011	19.5	8.49	9.3	580	226	36
	8.5	04-Sep-96	1025	20.0		8.8	550	235	<10
	8.5	12-Sep-96	0930						

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond. (umhos/cm)	Hardness (mg CaCO3/l)	COD (mg/l)
@ Massilon Rd.	7.3	20-Jun-96	1015	23.7	7.90	7.2	423	172	18
	7.3	10-Jul-96	1130	18.9	8.25	9.6	525	238	21
	7.3	30-Jul-96	1103	21.0	8.67	9.7	814	240	<10
	7.3	29-Aug-96	1050	19.7		9.3	580	221	<10
	7.3	04-Sep-96	1015	20.0		8.2	570	228	<10
	7.3	12-Sep-96	0923						
dst Seiberling Rd.	7.1	20-Jun-96	1505	23.7	8.03	7.5	468	179	21
	7.1	10-Jul-96	1055	18.8	8.32	11.4	574	241	12
	7.1	30-Jul-96	1040	20.8	8.70	9.9	821	240	<10
	7.1	29-Aug-96	1115	20.0		5.3	620	249	12
	7.1	04-Sep-96	0955	20.0		8.2	590	235	<10
	7.1	12-Sep-96	0915						
@ Bank St.	5.1	20-Jun-96	1448	23.7	8.18	8.2	485	187	28
	5.1	10-Jul-96	1040	20.5	8.30	9.2	667	260	27
	5.1	30-Jul-96	1021	22.8	8.73	9.7	1002	273	<10
	5.1	29-Aug-96	1205	23.5		8.0	755	259	18
	5.1	04-Sep-96	940	23.9		8.0	790	292	<10
	5.1	12-Sep-96	0905						
dst Camp Brook	4.2	20-Jun-96	1420	23.2	8.10	8.6	497	189	24
	4.2	10-Jul-96	1015	20.3	8.20	9.3	681	281	<10
	4.2 dup	10-Jul-96	1016	20.3	8.20	9.3	681	276	15
	4.2	30-Jul-96	1004	22.9	8.71	8.8	1024	278	<10
	4.2	29-Aug-96	1225	23.0		8.8	825	280	24
	4.2	04-Sep-96	0930	22.0		7.7	820	330	<10
	4.2	12-Sep-96	0900						

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond. (umhos/cm)	Hardness (mg CaCO3/l)	COD (mg/l)
@ North St.	4.1	20-Jun-96	1341	22.8	8.13	8.1	516	198	18
	4.1 dup	20-Jun-96	1340	22.8	8.13	8.1	516	201	18
	4.1	10-Jul-96	0915	19.8	8.35	9.3	671	281	<10
	4.1	30-Jul-96	0903	22.0	8.72	9.5	1131	292	15
	4.1	29-Aug-96	1305	22.9		8.9	850	271	<10
	4.1	04-Sep-96	0845	21.9		8.2	810	314	<10
	4.1	12-Sep-96	0840						
@ Elizabeth Park	2.9	20-Jun-96	1210	24.7	8.27	7.8	516	198	18
	2.9	10-Jul-96	0900	19.5	8.45	11.2	681	279	<10
	2.9	30-Jul-96	0848	21.7	8.77	9.0	1090	294	<10
	2.9	29-Aug-96	1320	22.2		9.2	840	280	<10
	2.9	04-Sep-96	0838	21.1		8.3	802	316	<10
	2.9	12-Sep-96	0835						
@ Otto St.	1.8	20-Jun-96	1140	23.0	8.25	7.7	656	203	26
	1.8	10-Jul-96	0815	20.4	8.40	9.4	856	265	18
	1.8	30-Jul-96	0820	22.7	8.74	8.8	1529	268	<10
	1.8	29-Aug-96	1345	23.1		8.9	1080	278	21
	1.8	04-Sep-96	0815	23.0		8.1	1300	264	15
	1.8	12-Sep-96	0820						
@ firing range	0.3	20-Jun-96	0855	22.2	7.80	7.5	605	211	15
	0.3	10-Jul-96	0835	20.0	7.50	7.3	858	274	12
	0.3	30-Jul-96	0753	21.8	8.58	8.4	1485	278	<10
	0.3	29-Aug-96	1405	23.8		9.7	1060	264	18
	0.3	04-Sep-96	0750	22.0		7.8	1200	278	<10
	0.3	12-Sep-96	0815						

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	NO3-NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	P (mg/l)	TDS (mg/l)	TSS (mg/l)	Fec. Col. (#/100ml)
ust. Wingfoot	11.3	20-Jun-96	0833	0.1	0.08	0.6	0.05	218	8	230
Lake Outlet	11.3	10-Jul-96	1315	0.1	<0.05	0.4	0.14	274	10	30
	11.3	30-Jul-96	1231	0.1	0.08	0.4	0.15	306	17	43
	11.3	29-Aug-96	0905	0.1	<0.05	0.2	0.05	284	10	15
	11.3	04-Sep-96	1112	0.1	<0.05	0.5	0.05	288	5	32
	11.3	12-Sep-96	1000							390
@ Gilchrist Rd.	11	20-Jun-96	0904	0.21	0.07	0.6	0.07	254	14	170
	11	10-Jul-96	1340	0.45	<0.05	0.2	0.14	358	5	120
	11	30-Jul-96	1239	0.38	0.06	0.2	0.22	386	11	160
	11	29-Aug-96	0925	0.39	<0.05	0.2	0.05	378	9	220
	11	04-Sep-96	1125	0.28	<0.05	0.3	0.05	376	2.5	120
	11	12-Sep-96	1005							3,700
@ Skelton Rd.	9.7	20-Jun-96	0920	0.21	0.09	0.6	0.05	260	17	230
	9.7	10-Jul-96	1255	0.50	<0.05	0.2	0.08	366	2.5	75
	9.7	30-Jul-96	1209	0.48	0.05	<0.2	0.42	366	2.5	850
	9.7	29-Aug-96	0940	0.38	<0.05	0.3	0.05	356	10	230
	9.7	04-Sep-96	1055	0.30	<0.05	0.2	0.05	374	2.5	110
	9.7 dup	04-Sep-96	1056	0.31	<0.05	0.3	0.05	370	2.5	
	9.7	12-Sep-96	0950							3,700
dst Rte 91	8.5	20-Jun-96	0952	0.27	0.08	0.5	0.24	266	22	470
	8.5	10-Jul-96	1220	0.51	<0.05	0.2	0.06	382	11	330
	8.5	30-Jul-96	1118	0.45	0.05	<0.2	0.24	372	8	270
	8.5	29-Aug-96	1010	0.30	<0.05	<0.2	0.05	370	6	230
	8.5	29-Aug-96	1011	0.33	<0.05	0.2	0.05	372	6	
	8.5	04-Sep-96	1025	0.30	<0.05	0.3	0.05	352	2.5	170
	8.5	12-Sep-96	0930							12,000

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	NO3-NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	P (mg/l)	TDS (mg/l)	TSS (mg/l)	Fec. Col. (#/100ml)
@ Massilon Rd.	7.3	20-Jun-96	1015	0.32	0.10	0.5	0.08	270	19	460
	7.3	10-Jul-96	1130	0.54	<0.05	0.3	0.07	392	13	270
	7.3	30-Jul-96	1103	0.48	<0.05	0.3	0.07	380	9	390
	7.3	29-Aug-96	1050	0.34	<0.05	0.2	0.05	370	5	140
	7.3	04-Sep-96	1015	0.27	<0.05	0.3	0.06	358	10	360
	7.3	12-Sep-96	0923							17,000
dst Seiberling Rd.	7.1	20-Jun-96	1505	0.32	0.08	0.6	0.05	308	16	430
	7.1	10-Jul-96	1055	0.46	<0.05	<0.2	0.06	414	2.5	430
	7.1	30-Jul-96	1040	0.50	<0.05	0.2	0.18	400	6	330
	7.1	29-Aug-96	1115	0.30	<0.05	0.4	0.05	388	2.5	260
	7.1	04-Sep-96	0955	0.25	<0.05	0.3	0.05	392	10	400
	7.1	12-Sep-96	0915							24,000
@ Bank St.	5.1	20-Jun-96	1448	0.33	0.09	0.4	0.21	320	17	570
	5.1	10-Jul-96	1040	0.43	<0.05	0.5	0.07	452	5	1,000
	5.1	30-Jul-96	1021	0.47	<0.05	0.2	0.36	480	8	1,400
	5.1	29-Aug-96	1205	0.31	<0.05	0.4	0.06	446	9	1,100
	5.1	04-Sep-96	940	0.21	<0.05	0.3	0.07	500	6	1,800
	5.1	12-Sep-96	0905							24,000
dst Camp Brook	4.2	20-Jun-96	1420	0.36	0.08	0.6	0.05	336	16	570
	4.2	10-Jul-96	1015	0.40	<0.05	0.3	0.05	472	2.5	1,300
	4.2 dup	10-Jul-96	1016	0.40	<0.05	0.3	0.05	464	2.5	
	4.2	30-Jul-96	1004	0.46	<0.05	0.2	0.45	488	7	730
	4.2	29-Aug-96	1225	0.29	<0.05	0.4	0.06	492	2.5	580
	4.2	04-Sep-96	0930	0.18	<0.05	0.3	0.05	542	2.5	850
	4.2	12-Sep-96	0900							28,000

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	NO3-NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	P (mg/l)	TDS (mg/l)	TSS (mg/l)	Fec. Col. (#/100ml)
@ North St.	4.1	20-Jun-96	1341	0.36	0.09	0.6	0.13	322	12	530
	4.1 dup	20-Jun-96	1340	0.36	0.07	0.6	0.15	328	12	
	4.1	10-Jul-96	0915	0.40	<0.05	0.5	0.09	486	2.5	870
	4.1	30-Jul-96	0903	0.43	<0.05	0.3	0.16	486	5	820
	4.1	29-Aug-96	1305	0.28	<0.05	0.5	0.05	488	2.5	630
	4.1	04-Sep-96	0845	0.18	<0.05	0.2	0.05	524	6	590
	4.1	12-Sep-96	0840							67,000
@ Elizabeth Park	2.9	20-Jun-96	1210	0.38	0.09	0.6	0.05	342	16	670
	2.9	10-Jul-96	0900	0.41	<0.05	0.5	0.05	480	2.5	1,100
	2.9	30-Jul-96	0848	0.47	<0.05	0.3	0.11	502	6	690
	2.9	29-Aug-96	1320	0.28	<0.05	0.4	0.05	500	2.5	340
	2.9	04-Sep-96	0838	0.21	<0.05	0.2	0.05	520	2.5	410
	2.9	12-Sep-96	0835							60,000
@ Otto St.	1.8	20-Jun-96	1140	0.34	0.09	0.8	0.05	418	16	870
	1.8	10-Jul-96	0815	0.33	0.06	0.7	0.06	556	2.5	1,200
	1.8	30-Jul-96	0820	0.28	0.06	0.4	0.72	664	2.5	500
	1.8	29-Aug-96	1345	0.20	<0.05	0.3	0.05	628	2.5	240
	1.8	04-Sep-96	0815	0.1	<0.05	0.6	0.05	666	5	330
	1.8	12-Sep-96	0820							62,000
@ firing range	0.3	20-Jun-96	0855	0.42	0.17	0.6	0.05	364	18	740
	0.3	10-Jul-96	0835	0.25	0.23	0.7	0.05	556	7	3,100
	0.3	30-Jul-96	0753	0.25	0.16	0.4	0.08	638	14	520
	0.3	29-Aug-96	1405	0.17	0.12	0.3	0.05	608	8	220
	0.3	04-Sep-96	0750	0.1	0.10	0.5	0.05	674	11	480
	0.3	12-Sep-96	0815							53,000

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	Ar (ug/l)	Cd (ug/l)	Ca (mg/l)	Cr (ug/l)	Cu (ug/l)	Pb (ug/l)	Mg (mg/l)	Hg (ug/l)	Zn (ug/l)
ust. Wingfoot	11.3	20-Jun-96	0833	3	<0.2	41	<30	<10	<2	10	<0.2	11
Lake Outlet	11.3	10-Jul-96	1315	4	<0.2	52	<30	<10	<2	13	<0.2	5
	11.3	30-Jul-96	1231	4	<0.2	52	<30	<10	<2	14	<0.2	5
	11.3	29-Aug-96	0905	5	<0.2	47	<30	<10	<2	13	<0.2	5
	11.3	04-Sep-96	1112	4	<0.2	48	<30	<10	<2	13	<0.2	5
	11.3	12-Sep-96	1000									
@ Gilchrist Rd.	11	20-Jun-96	0904	3	<0.2	49	<30	<10	<2	12	<0.2	13
	11	10-Jul-96	1340	3	<0.2	72	<30	<10	<2	17	<0.2	5
	11	30-Jul-96	1239	3	<0.2	70	<30	<10	<2	18	<0.2	5
	11	29-Aug-96	0925	4	<0.2	73	<30	<10	<2	18	<0.2	5
	11	04-Sep-96	1125	2	<0.2	68	<30	<10	<2	16	<0.2	5
	11	12-Sep-96	1005									
@ Skelton Rd.	9.7	20-Jun-96	0920	3	<0.2	47	<30	<10	2	11	<0.2	20
	9.7	10-Jul-96	1255	3	<0.2	69	<30	<10	<2	16	<0.2	5
	9.7	30-Jul-96	1209	3	<0.2	69	<30	<10	<2	17	<0.2	5
	9.7	29-Aug-96	0940	4	<0.2	66	<30	<10	<2	17	<0.2	5
	9.7	04-Sep-96	1055	2	<0.2	65	<30	<10	<2	16	<0.2	5
	9.7 dup	04-Sep-96	1056	2	<0.2	68	<30	<10	<2	16	<0.2	5
	9.7	12-Sep-96	0950									
dst Rte 91	8.5	20-Jun-96	0952	4	<0.2	48	<30	<10	2	11	-	13
	8.5	10-Jul-96	1220	3	<0.2	71	<30	<10	<2	17	<0.2	18
	8.5	30-Jul-96	1118	2	<0.2	68	<30	<10	<2	17	<0.2	5
	8.5	29-Aug-96	1010	2	<0.2	66	<30	<10	<2	17	<0.2	14
	8.5	29-Aug-96	1011	3	<0.2	64	<30	<10	<2	16	<0.2	5
	8.5	04-Sep-96	1025	2	<0.2	66	<30	<10	<2	17	<0.2	10
	8.5	12-Sep-96	0930									

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	Ar (ug/l)	Cd (ug/l)	Ca (mg/l)	Cr (ug/l)	Cu (ug/l)	Pb (ug/l)	Mg (mg/l)	Hg (ug/l)	Zn (ug/l)
@ Massilon Rd.	7.3	20-Jun-96	1015	4	<0.2	49	<30	<10	2	12	<0.2	15
	7.3	10-Jul-96	1130	<2	<0.2	69	<30	<10	3	16	<0.2	5
	7.3	30-Jul-96	1103	2	<0.2	68	<30	<10	2	17	<0.2	11
	7.3	29-Aug-96	1050	3	<0.2	62	<30	<10	<2	16	<0.2	17
	7.3	04-Sep-96	1015	2	<0.2	65	<30	<10	2	16	<0.2	5
	7.3	12-Sep-96	0923									
dst Seiberling Rd.	7.1	20-Jun-96	1505	3	<0.2	52	<30	<10	3	12	<0.2	20
	7.1	10-Jul-96	1055	<2	<0.2	70	<30	<10	<2	16	<0.2	25
	7.1	30-Jul-96	1040	3	<0.2	68	<30	<10	<2	17	<0.2	5
	7.1	29-Aug-96	1115	3	<0.2	70	<30	<10	<2	18	<0.2	5
	7.1	04-Sep-96	0955	2	<0.2	66	<30	<10	<2	17	<0.2	12
	7.1	12-Sep-96	0915									
@ Bank St.	5.1	20-Jun-96	1448	4	<0.2	55	<30	<10	3	12	<0.2	14
	5.1	10-Jul-96	1040	<2	<0.2	76	<30	<10	<2	17	<0.2	5
	5.1	30-Jul-96	1021	<2	<0.2	78	<30	<10	3	19	<0.2	32
	5.1	29-Aug-96	1205	2	<0.2	74	<30	<10	2	18	<0.2	29
	5.1	04-Sep-96	940	2	<0.2	84	<30	<10	3	20	<0.2	34
	5.1	12-Sep-96	0905									
dst Camp Brook	4.2	20-Jun-96	1420	<2	<0.2	56	<30	<10	4	12	<0.2	21
	4.2	10-Jul-96	1015	2	<0.2	83	<30	<10	2	18	<0.2	11
	4.2 dup	10-Jul-96	1016	2	<0.2	81	<30	<10	2	18	<0.2	5
	4.2	30-Jul-96	1004	3	<0.2	80	<30	<10	4	19	<0.2	25
	4.2	29-Aug-96	1225	2	<0.2	81	<30	<10	2	19	<0.2	17
	4.2	04-Sep-96	0930	2	<0.2	96	<30	<10	2	22	<0.2	18
	4.2	12-Sep-96	0900									

Appendix Table 2. Continued.

Little Cuyahoga	River Mile	Date	Time	Ar (ug/l)	Cd (ug/l)	Ca (mg/l)	Cr (ug/l)	Cu (ug/l)	Pb (ug/l)	Mg (mg/l)	Hg (ug/l)	Zn (ug/l)
@ North St.	4.1	20-Jun-96	1341	3	<0.2	58	<30	<10	4	13	<0.2	24
	4.1 dup	20-Jun-96	1340	3	<0.2	59	<30	<10	3	13	<0.2	21
	4.1	10-Jul-96	0915	3	<0.2	83	<30	<10	2	18	<0.2	5
	4.1	30-Jul-96	0903	3	<0.2	84	<30	<10	3	20	<0.2	16
	4.1	29-Aug-96	1305	3	<0.2	79	<30	<10	2	18	<0.2	20
	4.1	04-Sep-96	0845	3	<0.2	91	<30	<10	3	21	<0.2	22
	4.1	12-Sep-96	0840									
@ Elizabeth Park	2.9	20-Jun-96	1210	2	<0.2	58	<30	<10	4	13	<0.2	27
	2.9	10-Jul-96	0900	2	<0.2	82	<30	<10	3	18	<0.2	5
	2.9	30-Jul-96	0848	2	<0.2	83	<30	<10	3	21	<0.2	15
	2.9	29-Aug-96	1320	3	<0.2	81	<30	<10	<2	19	<0.2	14
	2.9	04-Sep-96	0838	3	<0.2	92	<30	<10	<2	21	<0.2	18
	2.9	12-Sep-96	0835									
@ Otto St.	1.8	20-Jun-96	1140	3	<0.2	60	<30	<10	4	13	-	16
	1.8	10-Jul-96	0815	3	<0.2	78	<30	<10	2	17	<0.2	5
	1.8	30-Jul-96	0820	4	0.2	76	<30	<10	3	19	<0.2	11
	1.8	29-Aug-96	1345	3	<0.2	80	<30	<10	<2	19	<0.2	25
	1.8	04-Sep-96	0815	3	<0.2	76	<30	<10	<2	18	<0.2	5
	1.8	12-Sep-96	0820									
@ firing range	0.3	20-Jun-96	0855	<2	<0.2	63	<30	<10	5	13	<0.2	15
	0.3	10-Jul-96	0835	2	<0.2	80	<30	<10	3	18	<0.2	5
	0.3	30-Jul-96	0753	4	<0.2	83	<30	<10	3	19	<0.2	10
	0.3	29-Aug-96	1405	3	<0.2	76	<30	<10	2	18	<0.2	5
	0.3	04-Sep-96	0750	3	<0.2	80	<30	<10	<2	19	<0.2	10
	0.3	12-Sep-96	0815									

Appendix Table 2. Continued.

	River Mile	Date	Time	Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond. (umhos/cm)	Hardness (mg CaCO3/l)	COD (mg/l)
Union Oil Trib. (RM 11.59)									
Union Oil	0.1	30-Jul-96	1301	17.7	8.70	10.3	973	323	12
Trib.	0.1	29-Aug-96	0840	15.5	8.05	9.0	690	341	11
	0.1	04-Sep-96	1140	17.7		9.2	720	341	5
Wingfoot Lake Outlet (RM 11.00)									
Wingfoot	3.2	20-Jun-96	0816	24.0	7.97	6.4	284	128	49
Outlet	3.2	10-Jul-96	1400	16.3	7.80	6.9	438	257	18
	3.2	30-Jul-96	1315	15.7	8.48	8.8	643	266	5
	3.2	29-Aug-96	0805	12.9	7.80	7.6	398	278	14
	3.2	04-Sep-96	1200	15.1		7.7	449	288	5
	0.1	20-Jun-96	0852	19.7	7.90	9.1	413	203	37
	0.1	10-Jul-96	1330	15.5	8.40	11.2	584	300	5
	0.1	30-Jul-96	1243	16.4	8.68	10.7	847	305	5
	0.1	29-Aug-96	0915	14.8	8.10	9.4	605	315	17
	0.1	04-Sep-96	1119	16.9		9.5	620	314	5
	0.1	12-Sep-96	1003						
Roosevelt Ditch (RM 8.70)									
Roosevelt	0.1	20-Jun-96	0934	18.3	7.90	9.8	433	179	12
Ditch	0.1	10-Jul-96	1240	22.9	8.00	7.5	632	245	5
	0.1	30-Jul-96	1200	22.6	8.90	11.1	884	218	15
	0.1	29-Aug-96	0950	18.5	8.55	9.3	675	249	27
	0.1	04-Sep-96	1045	22.0		9.8	705	240	5
	0.1	12-Sep-96	0945						

Appendix Table 2. Continued.

	River Mile	Date	Time	Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond. (umhos/cm)	Hardness (mg CaCO3/l)	COD (mg/l)
Springfield Lake Outlet (RM 7.09)									
Springfield	0.1	20-Jun-96	1005	22.2	7.98	8.4	598	204	15
Lake Outlet	0.1	10-Jul-96	1115	19.3	8.20	8.6	632	211	12
	0.1	30-Jul-96	1056	20.6	8.64	10.6	1117	259	26
	0.1	29-Aug-96	1040	21.1		13.6	875	253	30
	0.1	04-Sep-96	1005	19.9		8.6	870	285	5
	0.1	12-Sep-96	0920						
Camp Brook (RM 4.11)									
Camp Brook	1.6	20-Jun-96	1405	19.1	7.95	8.2	734	276	5
	1.6	10-Jul-96	0940	14.9	8.10	9.2	788	354	21
	1.6	30-Jul-96	0924	16.9	8.59	9.8	1109	343	5
	1.6	29-Aug-96	1250	16.4		9.3	900	328	5
	1.6	04-Sep-96	0900	17.0		8.6	910	370	5
	1.6	12-Sep-96	0850						
	0.1	20-Jun-96	1410	19.1	7.85	8.8	786	312	15
	0.1	10-Jul-96	1005	14.2	7.92	11.3	851	408	5
	0.1	30-Jul-96	0941	16.4	8.55	10.4	1310	400	5
	0.1	29-Aug-96	1220	16.7		9.5	980	385	5
	0.1	04-Sep-96	0922	15.9		8.7	950	434	5
	0.1 dup	30-Jul-96	0942	16.4	8.55	10.4	1310	395	<10
Ohio Canal (RM 2.00)									
Ohio Canal	0.2	12-Sep-96	1159	24.6	8.38	7.5	963	204	18
	0.2	10-Jul-96	0840	23.0	8.40	10.3	1119	225	21
	0.2	30-Jul-96	0832	23.8	8.72	9.4	1871	236	12
	0.2	29-Aug-96	1330	24.2		8.2	1300	222	18
	0.2	04-Sep-96	0825	24.0		8.1	1290	240	12
	0.2	12-Sep-96	0830						

Appendix Table 2. Continued.

	River Mile	Date	Time	NO3-NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	P (mg/l)	TDS (mg/l)	TSS (mg/l)	Fec. Col. (#/100ml)
Union Oil Trib. (RM 11.59)										
Union Oil	0.1	30-Jul-96	1301	0.11	0.03	0.4	0.19	482	6	350
Trib.	0.1	29-Aug-96	0840	0.10	0.03	0.1	0.03	470	<5	150
	0.1	04-Sep-96	1140	0.05	0.03	0.1	0.03	478	<5	290
Wingfoot Lake Outlet (RM 11.00)										
Wingfoot	3.2	20-Jun-96	0816	0.05	0.10	0.7	0.18	210	9	67
Outlet	3.2	10-Jul-96	1400	0.15	0.13	0.6	0.03	336	<5	260
	3.2	30-Jul-96	1315	0.16	0.09	0.2	0.09	368	<5	500
	3.2	29-Aug-96	0805	0.20	0.10	0.2	0.03	360	<5	200
	3.2	04-Sep-96	1200	0.18	0.06	0.2	0.03	366	<5	310
	0.1	20-Jun-96	0852	0.39	0.05	0.8	0.03	296	20	170
	0.1	10-Jul-96	1330	0.87	0.03	0.1	0.17	444	<5	210
	0.1	30-Jul-96	1243	0.28	0.03	0.1	0.03	436	<5	220
	0.1	29-Aug-96	0915	0.66	0.03	0.1	0.03	432	<5	180
	0.1	04-Sep-96	1119	0.58	0.03	0.1	0.03	440	<5	200
	0.1	12-Sep-96	1003							7,600
Roosevelt Ditch (RM 8.70)										
Roosevelt	0.1	20-Jun-96	0934	1.11	0.03	0.5	0.14	314	<5	1,000
Ditch	0.1	10-Jul-96	1240	1.01	0.03	0.3	0.22	436	<5	800
	0.1	30-Jul-96	1200	0.80	0.03	0.6	0.15	398	12	6,900
	0.1	29-Aug-96	0950	0.35	0.03	0.1	0.07	416	131	2,100
	0.1	04-Sep-96	1045	0.11	0.03	0.2	0.03	412	7	1,900
	0.1	12-Sep-96	0945							28,000

Appendix Table 2. Continued.

	River Mile	Date	Time	NO3-NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	P (mg/l)	TDS (mg/l)	TSS (mg/l)	Fec. Col. (#/100ml)
Springfield Lake Outlet (RM 7.09)										
Springfield	0.1	20-Jun-96	1005	0.34	0.09	0.7	0.03	392	7	590
Lake Outlet	0.1	10-Jul-96	1115	0.28	0.03	0.6	0.03	452	<5	340
	0.1	30-Jul-96	1056	0.38	0.03	0.7	0.08	516	<5	1,800
	0.1	29-Aug-96	1040	0.26	0.03	0.1	0.03	518	<5	320
	0.1	04-Sep-96	1005	0.05	0.03	0.3	0.03	526	<5	3,900
	0.1	12-Sep-96	0920							11,000
Camp Brook (RM 4.11)										
Camp Brook	1.6	20-Jun-96	1405	0.48	0.10	0.5	0.20	486	<5	1,300
	1.6	10-Jul-96	0940	0.33	0.07	0.4	0.03	624	<5	640
	1.6	30-Jul-96	0924	0.21	0.03	0.2	0.03	632	<5	390
	1.6	29-Aug-96	1250	0.25	0.05	0.2	0.03	606	<5	150
	1.6	04-Sep-96	0900	0.20	0.03	0.1	0.03	606	<5	300
	1.6	12-Sep-96	0850							16,000
	0.1	20-Jun-96	1410	0.41	0.09	0.4	0.03	482	<5	650
	0.1	10-Jul-96	1005	0.24	0.07	0.3	0.03	660	<5	760
	0.1	30-Jul-96	0941	0.16	0.03	0.2	0.07	694	<5	310
	0.1	29-Aug-96	1220	0.20	0.03	0.2	0.03	664	<5	67
	0.1	04-Sep-96	0922	0.12	0.03	0.1	0.03	676	<5	100
	0.1 dup	30-Jul-96	0942	0.15	<0.05	<0.2	0.07	684	<5	
Ohio Canal (RM 2.00)										
Ohio Canal	0.2	12-Sep-96	1159	0.05	0.08	1.1	0.03	560	8	1,600
	0.2	10-Jul-96	0840	0.12	0.08	0.9	0.06	684	<5	1,100
	0.2	30-Jul-96	0832	0.15	0.09	0.7	0.09	778	<5	670
	0.2	29-Aug-96	1330	0.15	0.06	0.4	0.03	708	<5	620
	0.2	04-Sep-96	0825	0.05	0.03	0.6	0.03	726	6	300
	0.2	12-Sep-96	0830							65,000

Appendix Table 2. Continued.

	River Mile	Date	Time	Ar (ug/l)	Cd (ug/l)	Ca (mg/l)	Cr (ug/l)	Cu (ug/l)	Pb (ug/l)	Mg (mg/l)	Hg (ug/l)	Zn (ug/l)
Union Oil Trib. (RM 11.59)												
Union Oil	0.1	30-Jul-96	1301	1	0.1	88	<30	<10	3	25	<0.2	5
Trib.	0.1	29-Aug-96	0840	1	0.1	97	<30	<10	1	24	<0.2	5
	0.1	04-Sep-96	1140	1	0.1	97	<30	<10	1	24	<0.2	5
Wingfoot Lake Outlet (RM 11.00)												
Wingfoot	3.2	20-Jun-96	0816	4	0.1	38	<30	<10	2	8	<0.2	5
Outlet	3.2	10-Jul-96	1400	3	0.1	75	<30	<10	1	17	<0.2	5
	3.2	30-Jul-96	1315	2	0.1	75	<30	<10	1	19	<0.2	5
	3.2	29-Aug-96	0805	1	0.1	80	<30	<10	1	19	<0.2	5
	3.2	04-Sep-96	1200	1	0.1	84	<30	<10	1	19	<0.2	5
	0.1	20-Jun-96	0852	4	0.1	60	<30	<10	2	13	<0.2	11
	0.1	10-Jul-96	1330	1	0.1	87	<30	<10	1	20	<0.2	5
	0.1	30-Jul-96	1243	1	0.1	86	<30	<10	1	22	<0.2	5
	0.1	29-Aug-96	0915	3	0.1	90	<30	<10	1	22	<0.2	5
	0.1	04-Sep-96	1119	1	0.1	91	<30	<10	1	21	<0.2	11
	0.1	12-Sep-96	1003									
Roosevelt Ditch (RM 8.70)												
Roosevelt	0.1	20-Jun-96	0934	1	0.1	52	<30	<10	1	12	-	5
Ditch	0.1	10-Jul-96	1240	1	0.1	70	<30	<10	1	17	<0.2	10
	0.1	30-Jul-96	1200	2	0.3	61	<30	<10	5	16	<0.2	40
	0.1	29-Aug-96	0950	1	0.1	70	<30	<10	13	18	<0.2	47
	0.1	04-Sep-96	1045	1	0.1	68	<30	<10	1	17	<0.2	5
	0.1	12-Sep-96	0945									

Appendix Table 2. Continued.

	River Mile	Date	Time	Ar (ug/l)	Cd (ug/l)	Ca (mg/l)	Cr (ug/l)	Cu (ug/l)	Pb (ug/l)	Mg (mg/l)	Hg (ug/l)	Zn (ug/l)
Springfield Lake Outlet (RM 7.09)												
Springfield	0.1	20-Jun-96	1005	1	0.1	62	<30	<10	2	12	<0.2	10
Lake Outlet	0.1	10-Jul-96	1115	1	0.1	63	<30	<10	1	13	<0.2	19
	0.1	30-Jul-96	1056	2	0.1	74	<30	<10	1	18	<0.2	5
	0.1	29-Aug-96	1040	2	0.2	75	<30	<10	1	16	<0.2	33
	0.1	04-Sep-96	1005	1	0.1	86	<30	<10	1	17	<0.2	5
	0.1	12-Sep-96	0920									
Camp Brook (RM 4.11)												
Camp Brook	1.6	20-Jun-96	1405	1	0.1	81	<30	<10	1	18	<0.2	10
	1.6	10-Jul-96	0940	1	0.1	102	<30	<10	1	24	<0.2	5
	1.6	30-Jul-96	0924	1	0.1	96	<30	<10	1	25	<0.2	5
	1.6	29-Aug-96	1250	1	0.1	95	<30	<10	1	22	<0.2	5
	1.6	04-Sep-96	0900	1	0.1	107	<30	<10	1	25	<0.2	5
	1.6	12-Sep-96	0850									
	0.1	20-Jun-96	1410	1	0.1	92	<30	<10	1	20	<0.2	5
	0.1	10-Jul-96	1005	1	0.1	119	<30	<10	1	27	<0.2	17
	0.1	30-Jul-96	0941	1	0.1	114	<30	<10	1	28	<0.2	5
	0.1	29-Aug-96	1220	1	0.1	113	<30	<10	1	25	<0.2	5
	0.1	04-Sep-96	0922	1	0.1	126	<30	<10	1	29	<0.2	5
	0.1 dup	30-Jul-96	0942	1	<0.2	112	<30	<10	<2	28	<0.2	<10
Ohio Canal (RM 2.00)												
Ohio Canal	0.2	12-Sep-96	1159	4	0.1	62	<30	<10	4	12	-	11
	0.2	10-Jul-96	0840	4	0.1	67	<30	<10	2	14	<0.2	15
	0.2	30-Jul-96	0832	4	0.1	68	<30	<10	1	16	<0.2	10
	0.2	29-Aug-96	1330	4	0.1	64	<30	<10	1	15	<0.2	5
	0.2	04-Sep-96	0825	4	0.1	68	<30	<10	1	17	<0.2	10
	0.2	12-Sep-96	0830	4	0.1	68	<30	<10	1	16	<0.2	10

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-030 River: Little Cuyahoga River RM: 11.20

Taxa Code	Taxa	Quant/Qual
01320	Hydra sp	4
01801	Turbellaria	1529 +
03121	Paludicella articulata	1 +
03360	Plumatella sp	1 +
03600	Oligochaeta	151 +
04901	Erpobdellidae	6 +
06201	Hyalella azteca	2 +
06700	Crangonyx sp	3 +
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
11120	Baetis flavistriga	3
11130	Baetis intercalaris	10
22001	Coenagrionidae	+
43570	Neoplea sp	+
47600	Sialis sp	+
52200	Cheumatopsyche sp	98 +
52530	Hydropsyche depravata group	249 +
60900	Peltodytes sp	+
68700	Dubiraphia sp	1
69400	Stenelmis sp	38 +
74100	Simulium sp	11 +
74501	Ceratopogonidae	+
77500	Conchapelopia sp	127
77750	Hayesomyia senata or Thienemannimyia norena	42
77800	Helopelopia sp	42 +
78600	Pentaneura inconspicua	635 +
82820	Cryptochironomus sp	42 +
83158	Endochironomus nigricans	85 +
83300	Glyptotendipes (G.) sp	85
84450	Polypedilum (P.) convictum	2412 +
84470	Polypedilum (P.) illinoense	85 +
84540	Polypedilum (Tripodura) scalaenum group	254 +
85625	Rheotanytarsus exiguus group	+
87540	Hemerodromia sp	31 +
93200	Hydrobiidae	51
95100	Physella sp	1
96930	Laevapex fuscus	24 +
98200	Pisidium sp	6
98600	Sphaerium sp	73 +

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 31 Total Taxa: 38

No. Qualitative Taxa: 28 ICI: **24**

Number of Organisms: 6102 Qual EPT: 2

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-030 River: Little Cuyahoga River RM: 11.00

Taxa Code	Taxa	Quant/Qual
00556	Ephydatia fluviatilis	+
01801	Turbellaria	14 +
03600	Oligochaeta	6
05800	Caecidotea sp	1 +
06700	Crangonyx sp	+
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
11120	Baetis flavistriga	24 +
11130	Baetis intercalaris	52 +
13400	Stenacron sp	+
13530	Stenonema ithaca	45
21300	Hetaerina sp	+
23909	Boyeria vinosa	+
50804	Lype diversa	1
52200	Cheumatopsyche sp	770 +
52440	Ceratopsyche slossonae	119 +
52530	Hydropsyche depravata group	1853 +
69200	Optioservus sp	1 +
69400	Stenelmis sp	25 +
70600	Antocha sp	1
74100	Simulium sp	11 +
77800	Helopelopia sp	60
78600	Pentaneura inconspicua	+
79720	Diamesa sp	+
81270	Nanocladius (N.) spiniplenus	21
81825	Rheocricotopus (Psilocricotopus) robacki	21
82141	Thienemanniella xena	21
82220	Tvetenia discoloripes group	123
82730	Chironomus (C.) decorus group	+
84210	Paratendipes albimanus or P. duplicatus	+
84450	Polypedilum (P.) convictum	1924 +
84470	Polypedilum (P.) illinoense	39
84480	Polypedilum (P.) laetum group	+
84540	Polypedilum (Tripodura) scalaenum group	21
84888	Xenochironomus xenolabis	21 +
85625	Rheotanytarsus exiguus group	60
87540	Hemerodromia sp	25
96930	Laevapex fuscus	1 +
98600	Sphaerium sp	+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 26 Total Taxa: 38

No. Qualitative Taxa: 25 ICI: **36**

Number of Organisms: 5260 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-030 River: Little Cuyahoga River RM: 9.70

Taxa Code	Taxa	Quant/Qual
00556	Ephydatia fluviatilis	+
01801	Turbellaria	+
03600	Oligochaeta	53 +
04685	Placobdella ornata	+
04901	Erpobdellidae	+
05800	Caecidotea sp	2 +
06700	Crangonyx sp	+
07820	Cambarus (Cambarus) bartonii cavatus	+
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
08601	Hydracarina	8 +
11118	Baetis dubius	4 +
11120	Baetis flavistriga	456 +
11130	Baetis intercalaris	123 +
13400	Stenacron sp	+
13530	Stenonema ithaca	+
21200	Calopteryx sp	+
21300	Hetaerina sp	+
24900	Gomphus sp	+
47600	Sialis sp	+
50301	Chimarra aterrima	22
50804	Lype diversa	1
52200	Cheumatopsyche sp	44 +
52430	Ceratopsyche morosa group	2
52440	Ceratopsyche slossonae	8
52530	Hydropsyche depravata group	530 +
53800	Hydroptila sp	26 +
60900	Peltodytes sp	+
66500	Enochrus sp	+
67700	Paracymus sp	+
68025	Ectopria sp	+
68075	Psephenus herricki	+
68901	Macronychus glabratus	3
69200	Optioservus sp	+
69400	Stenelmis sp	40 +
70600	Antocha sp	27 +
74100	Simulium sp	13
77355	Clinotanypus pinguis	+
77500	Conchapelopia sp	132 +
77800	Helopelopia sp	60 +
78450	Nilotanypus fimbriatus	8
78600	Pentaneura inconspicua	+
78650	Procladius sp	+
80410	Cricotopus (C.) sp	58 +
80420	Cricotopus (C.) bicinctus	200 +
80430	Cricotopus (C.) tremulus group	92 +
80440	Cricotopus (C.) trifascia group	50 +
81650	Parametriocnemus sp	25
82141	Thienemanniella xena	8
82200	Tvetenia bavarica group	8
84300	Phaenopsectra obediens group	+
84460	Polypedilum (P.) fallax group	33
84540	Polypedilum (Tripodura) scalaenum group	83 +
85625	Rheotanytarsus exiguus group	33
87540	Hemerodromia sp	18
92516	Campeloma decisum	+
93200	Hydrobiidae	+
93900	Elimia sp	4 +
95100	Physella sp	+
96900	Ferrissia sp	28 +
98200	Pisidium sp	+
98600	Sphaerium sp	+

No. Quantitative Taxa: 33 Total Taxa: 61

No. Qualitative Taxa: 48 ICI: **42**

Number of Organisms: 2202 Qual EPT: 8

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 8.40

Taxa Code	Taxa	Quant	Qual
00653	Eunapius fragilis		+
01801	Turbellaria		+
03121	Paludicella articulata		+
03600	Oligochaeta	19	+
04685	Placobdella ornata		+
04960	Mooreobdella sp		+
05800	Caecidotea sp	12	+
06700	Crangonyx sp	4	+
08260	Orconectes (Crokerinus) sanbornii sanbornii		+
08601	Hydracarina	2	+
11118	Baetis dubius	6	
11120	Baetis flavistriga	66	+
11130	Baetis intercalaris	31	+
13400	Stenacron sp	66	+
13590	Stenonema vicarium	9	
21200	Calopteryx sp		+
21300	Hetaerina sp		+
22300	Argia sp	2	
23909	Boyeria vinosa	1	
50804	Lype diversa	1	
52200	Cheumatopsyche sp	44	+
52430	Ceratopsyche morosa group	5	+
52440	Ceratopsyche slossonae		+
52530	Hydropsyche depravata group	98	+
57900	Pycnopsyche sp		+
68025	Ectopria sp	1	
68702	Dubiraphia bivittata		+
68708	Dubiraphia vittata group		+
68901	Macronychus glabratus	5	
69400	Stenelmis sp	23	+
70600	Antocha sp	2	
74100	Simulium sp		+
77500	Conchapelopia sp	20	
77800	Helopelopia sp	20	
78401	Natarsia species A (sensu Roback, 1978)		+
80370	Corynoneura lobata	2	
80410	Cricotopus (C.) sp	8	
80420	Cricotopus (C.) bicinctus	16	
80430	Cricotopus (C.) tremulus group	8	
81270	Nanocladius (N.) spiniplenus	3	
81650	Parametriocnemus sp	5	
81825	Rheocricotopus (Psilocricotopus) robacki	5	
82220	Tvetenia discoloripes group	3	
84300	Phaenopsectra obediens group	8	
84450	Polypedilum (P.) convictum	18	
84460	Polypedilum (P.) fallax group	88	
84540	Polypedilum (Tripodura) scalaenum group	36	
84700	Stenochironomus sp	3	
84888	Xenochironomus xenolabis		+
85625	Rheotanytarsus exiguus group	16	
85814	Tanytarsus glabrescens group	3	
87540	Hemerodromia sp	10	+
93900	Elimia sp	1	+
95100	Physella sp		+
96900	Ferrissia sp	31	+

No. Quantitative Taxa: 39 Total Taxa: 55

No. Qualitative Taxa: 30 ICI: **40**

Number of Organisms: 701 Qual EPT: 8

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 7.10

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	11 +
03600	Oligochaeta	178 +
05800	Caecidotea sp	1 +
06201	Hyalella azteca	+
06700	Crangonyx sp	+
08250	Orconectes (Procericambarus) rusticus	1 +
08601	Hydracarina	41 +
11118	Baetis dubius	+
11120	Baetis flavistriga	320 +
11130	Baetis intercalaris	173 +
13400	Stenacron sp	2 +
21300	Hetaerina sp	+
52200	Cheumatopsyche sp	15 +
52430	Ceratopsyche morosa group	19 +
52530	Hydropsyche depravata group	184 +
53800	Hydroptila sp	85 +
60800	Haliplus sp	+
66500	Enochrus sp	+
69400	Stenelmis sp	17 +
70600	Antocha sp	19 +
77500	Conchapelopia sp	102 +
77800	Helopelopia sp	34
80310	Cardiocladius obscurus	34 +
80410	Cricotopus (C.) sp	136 +
80420	Cricotopus (C.) bicinctus	425 +
80430	Cricotopus (C.) tremulus group	323 +
80440	Cricotopus (C.) trifascia group	136 +
81250	Nanocladius (N.) minimus	34
81270	Nanocladius (N.) spiniplenus	17
81825	Rheocricotopus (Psilocricotopus) robacki	17
82220	Tvetenia discoloripes group	17 +
84450	Polypedilum (P.) convictum	51
84460	Polypedilum (P.) fallax group	68
84470	Polypedilum (P.) illinoense	+
84540	Polypedilum (Tripodura) scalaenum group	17 +
85500	Paratanytarsus sp	17
85625	Rheotanytarsus exiguus group	85 +
87540	Hemerodromia sp	66 +
93900	Elimia sp	1
95100	Physella sp	+
96900	Ferrissia sp	7 +
98600	Sphaerium sp	+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 33 Total Taxa: 42

No. Qualitative Taxa: 34 ICI: **32**

Number of Organisms: 2653 Qual EPT: 8

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 7.00

Taxa Code	Taxa	Quant/Qual
03600	Oligochaeta	117
04685	Placobdella ornata	+
04964	Mooreobdella microstoma	1 +
05800	Caecidotea sp	+
06700	Crangonyx sp	2 +
08255	Orconectes rusticus x sanbornii	+
08260	Orconectes (Crokerinus) sanbornii sanbornii	1
11120	Baetis flavistriga	139 +
11130	Baetis intercalaris	25 +
13400	Stenacron sp	8 +
21200	Calopteryx sp	+
21300	Hetaerina sp	1
23600	Aeshna sp	+
52200	Cheumatopsyche sp	10
52430	Ceratopsyche morosa group	19 +
52440	Ceratopsyche slossonae	2
52530	Hydropsyche depravata group	36 +
53800	Hydroptila sp	78 +
60501	Haliplidae	+
68025	Ectopria sp	+
69400	Stenelmis sp	4 +
70600	Antocha sp	20
77500	Conchapelopia sp	146
77750	Hayesomyia senata or Thienemannimyia norena	59
77800	Helopelopia sp	234 +
80410	Cricotopus (C.) sp	183 +
80420	Cricotopus (C.) bicinctus	256 +
80430	Cricotopus (C.) tremulus group	256 +
80440	Cricotopus (C.) trifascia group	18 +
81270	Nanocladius (N.) spiniplenus	37
82820	Cryptochironomus sp	18 +
83040	Dicrotendipes neomodestus	37
84300	Phaenopsectra obediens group	18
84460	Polypedilum (P.) fallax group	439
84470	Polypedilum (P.) illinoense	18 +
84540	Polypedilum (Tripodura) scalaenum group	73 +
84700	Stenochironomus sp	18
85500	Paratanytarsus sp	18
85625	Rheotanytarsus exiguus group	18
85800	Tanytarsus sp	18
85814	Tanytarsus glabrescens group	37
87540	Hemerodromia sp	35 +
96900	Ferrissia sp	92 +

No. Quantitative Taxa: 36 Total Taxa: 43

No. Qualitative Taxa: 26 ICI: **28**

Number of Organisms: 2491 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 5.10

Taxa Code	Taxa	Quant/Qual
03600	Oligochaeta	26
05800	Caecidotea sp	+
06700	Crangonyx sp	2 +
06810	Gammarus fasciatus	+
08601	Hydracarina	2 +
11120	Baetis flavistriga	+
11130	Baetis intercalaris	1 +
13400	Stenacron sp	4 +
13590	Stenonema vicarium	1
22001	Coenagrionidae	+
22300	Argia sp	+
52200	Cheumatopsyche sp	17 +
52530	Hydropsyche depravata group	91 +
53800	Hydroptila sp	+
69400	Stenelmis sp	2 +
77500	Conchapelopia sp	117
77800	Helopelopia sp	39
80310	Cardiocladius obscurus	+
80430	Cricotopus (C.) tremulus group	25
81270	Nanocladius (N.) spiniplenus	6
81650	Parametriocnemus sp	3
81825	Rheocricotopus (Psilocricotopus) robacki	3 +
82820	Cryptochironomus sp	3
83040	Dicrotendipes neomodestus	3
84300	Phaenopsectra obediens group	13 +
84450	Polypedilum (P.) convictum	32
84460	Polypedilum (P.) fallax group	86 +
84470	Polypedilum (P.) illinoense	10
84540	Polypedilum (Tripodura) scalaenum group	16
85625	Rheotanytarsus exiguus group	16 +
87540	Hemerodromia sp	6
96900	Ferrissia sp	15 +

No. Quantitative Taxa: 25 Total Taxa: 32

No. Qualitative Taxa: 19 ICI: **26**

Number of Organisms: 539 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 4.20

Taxa Code	Taxa	Quant/Qual
01900	Nemertea	4
03600	Oligochaeta	245 +
05800	Caecidotea sp	3 +
06700	Crangonyx sp	11 +
08250	Orconectes (Procericambarus) rusticus	+
08601	Hydracarina	4
11120	Baetis flavistriga	39 +
11130	Baetis intercalaris	4 +
13400	Stenacron sp	17 +
21300	Hetaerina sp	+
43570	Neoplea sp	+
52530	Hydropsyche depravata group	210 +
53800	Hydroptila sp	+
68708	Dubiraphia vittata group	+
69400	Stenelmis sp	2 +
77500	Conchapelopia sp	167 +
77800	Helopelopia sp	21
80310	Cardiocladius obscurus	+
80420	Cricotopus (C.) bicinctus	7
80430	Cricotopus (C.) tremulus group	7 +
80440	Cricotopus (C.) trifascia group	+
81270	Nanocladius (N.) spiniplenus	14
82730	Chironomus (C.) decorus group	+
84450	Polypedilum (P.) convictum	+
84460	Polypedilum (P.) fallax group	234 +
84540	Polypedilum (Tripodura) scalaenum group	90
85625	Rheotanytarsus exiguus group	35 +
87540	Hemerodromia sp	16 +
93900	Elimia sp	+
96900	Ferrissia sp	3 +

No. Quantitative Taxa: 20 Total Taxa: 30

No. Qualitative Taxa: 24 ICI: **20**

Number of Organisms: 1133 Qual EPT: 5

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 19-030 River: Little Cuyahoga River RM: 3.80

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	+
05800	Caecidotea sp	+
06700	Crangonyx sp	+
08255	Orconectes rusticus x sanbornii	+
11120	Baetis flavistriga	+
13400	Stenacron sp	+
52530	Hydropsyche depravata group	+
74100	Simulium sp	+
77800	Helopelopia sp	+
84470	Polypedilum (P.) illinoense	+
95100	Physella sp	+
96900	Ferrissia sp	+

No. Quantitative Taxa: 0 Total Taxa: 12

No. Qualitative Taxa: 12 ICI:

Number of Organisms: 0 Qual EPT: 3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 19-030 River: Little Cuyahoga River RM: 2.20

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	+
03600	Oligochaeta	+
04901	Erpobdellidae	+
05800	Caecidotea sp	+
06700	Crangonyx sp	+
08255	Orconectes rusticus x sanbornii	+
11120	Baetis flavistriga	+
11130	Baetis intercalaris	+
13400	Stenacron sp	+
21200	Calopteryx sp	+
23909	Boyeria vinosa	+
52530	Hydropsyche depravata group	+
53800	Hydroptila sp	+
69400	Stenelmis sp	+
77500	Conchapelopia sp	+
80310	Cardiocladius obscurus	+
80420	Cricotopus (C.) bicinctus	+
80440	Cricotopus (C.) trifascia group	+
85625	Rheotanytarsus exiguus group	+
87540	Hemerodromia sp	+
96900	Ferrissia sp	+

No. Quantitative Taxa: 0 Total Taxa: 21

No. Qualitative Taxa: 21 ICI:

Number of Organisms: 0 Qual EPT: 5

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 19-030 River: Little Cuyahoga River RM: 1.80

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	2
03600	Oligochaeta	212 +
04962	Mooreobdella fervida	+
05800	Caecidotea sp	+
06810	Gammarus fasciatus	4 +
11120	Baetis flavistriga	2 +
11130	Baetis intercalaris	+
17200	Caenis sp	2
52530	Hydropsyche depravata group	34 +
53800	Hydroptila sp	5 +
68708	Dubiraphia vittata group	+
71900	Tipula sp	+
71910	Tipula abdominalis	+
74100	Simulium sp	+
77120	Ablabesmyia mallochi	2
77500	Conchapelopia sp	21 +
77800	Helopelopia sp	+
78401	Natarsia species A (sensu Roback, 1978)	5
80310	Cardiocladius obscurus	+
80420	Cricotopus (C.) bicinctus	2 +
80430	Cricotopus (C.) tremulus group	+
81240	Nanocladius (N.) distinctus	2
83300	Glyptotendipes (G.) sp	12 +
84300	Phaenopsectra obediens group	6
84450	Polypedilum (P.) convictum	27 +
84460	Polypedilum (P.) fallax group	50 +
84540	Polypedilum (Tripodura) scalaenum group	3 +
85625	Rheotanytarsus exiguus group	8 +
87540	Hemerodromia sp	2 +
95100	Physella sp	10
96900	Ferrissia sp	3

No. Quantitative Taxa: 21 Total Taxa: 31

No. Qualitative Taxa: 23 ICI: **16**

Number of Organisms: 414 Qual EPT: 4

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 19-030 River: Little Cuyahoga River RM: 0.20

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	7 +
03360	Plumatella sp	1
03600	Oligochaeta	355 +
04666	Helobdella triserialis	+
04964	Mooreobdella microstoma	1 +
05800	Caecidotea sp	+
06810	Gammarus fasciatus	3 +
11120	Baetis flavistriga	6 +
11130	Baetis intercalaris	21
21200	Calopteryx sp	+
21300	Hetaerina sp	+
43300	Ranatra sp	+
48410	Corydalus cornutus	1
52200	Cheumatopsyche sp	36 +
52450	Ceratopsyche sparna	3
52530	Hydropsyche depravata group	112 +
52540	Hydropsyche dicantha	1
53501	Hydroptilidae	1
63900	Laccophilus sp	+
68601	Ancyronyx variegata	+
68707	Dubiraphia quadrinotata	+
72101	Psychodidae	1
74100	Simulium sp	+
77500	Conchapelopia sp	202 +
77800	Helopelopia sp	30
78200	Larsia sp	7
81270	Nanocladius (N.) spiniplenus	7
82141	Thienemanniella xena	7
82730	Chironomus (C.) decorus group	+
83300	Glyptotendipes (G.) sp	15 +
84040	Parachironomus frequens	+
84300	Phaenopsectra obediens group	7
84450	Polypedilum (P.) convictum	209
84460	Polypedilum (P.) fallax group	82
84470	Polypedilum (P.) illinoense	+
84540	Polypedilum (Tripodura) scalaenum group	45
84612	Saetheria tylus	7
85625	Rheotanytarsus exiguus group	187
86100	Chrysops sp	+
87540	Hemerodromia sp	34 +
95100	Physella sp	14 +
96900	Ferrissia sp	20

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 29 Total Taxa: 42
No. Qualitative Taxa: 24 ICI: **22**
Number of Organisms: 1422 Qual EPT: 3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-031 River: Springfield Lake Outlet RM: 0.10

Taxa Code	Taxa	Quant/Qual
03360	Plumatella sp	+
03600	Oligochaeta	+
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
11120	Baetis flavistriga	+
13400	Stenacron sp	+
22001	Coenagrionidae	+
22300	Argia sp	+
23600	Aeshna sp	+
52530	Hydropsyche depravata group	+
71900	Tipula sp	+
74100	Simulium sp	+
77120	Ablabesmyia mallochi	+
77500	Conchapelopia sp	+
77800	Helopelopia sp	+
80420	Cricotopus (C.) bicinctus	+
80430	Cricotopus (C.) tremulus group	+
80440	Cricotopus (C.) trifascia group	+
82730	Chironomus (C.) decorus group	+
82820	Cryptochironomus sp	+
84460	Polypedilum (P.) fallax group	+
84470	Polypedilum (P.) illinoense	+
87540	Hemerodromia sp	+
95100	Physella sp	+
96900	Ferrissia sp	+

No. Quantitative Taxa: 0 Total Taxa: 24

No. Qualitative Taxa: 24 ICI:

Number of Organisms: 0 Qual EPT: 3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/19/96 River Code: 19-032 River: Wingfoot Lake Outlet RM: 3.20

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	+
05800	Caecidotea sp	+
06201	Hyalella azteca	+
06700	Crangonyx sp	+
23600	Aeshna sp	+
45300	Sigara sp	+
52200	Cheumatopsyche sp	+
52530	Hydropsyche depravata group	+
53800	Hydroptila sp	+
57900	Pycnopsyche sp	+
65700	Anacaena sp	+
69225	Optioservus fastiditus	+
71900	Tipula sp	+
77500	Conchapelopia sp	+
81650	Parametriocnemus sp	+
84315	Phaenopsectra flavipes	+
84415	Polypedilum (P.) sp	+
86100	Chrysops sp	+
87540	Hemerodromia sp	+

No. Quantitative Taxa: 0 Total Taxa: 19

No. Qualitative Taxa: 19 ICI:

Number of Organisms: 0 Qual EPT: 4

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/19/96 River Code: 19-032 River: Wingfoot Lake Outlet RM: 0.10

Taxa Code	Taxa	Quant/Qual
03600	Oligochaeta	+
05800	Caecidotea sp	+
06700	Crangonyx sp	+
11120	Baetis flavistriga	+
11125	Labiobaetis frondalis	+
21200	Calopteryx sp	+
21300	Hetaerina sp	+
23909	Boyeria vinosa	+
52200	Cheumatopsyche sp	+
52440	Ceratopsyche slossonae	+
52530	Hydropsyche depravata group	+
57900	Pycnopsyche sp	+
60900	Peltodytes sp	+
67800	Tropisternus sp	+
69225	Optioservus fastiditus	+
74100	Simulium sp	+
77800	Helopelopia sp	+
79761	Pagastia species A (sensu Oliver & Roussel, 1982)	+
79880	Prodiamesa olivacea	+
80310	Cardiocladius obscurus	+
80420	Cricotopus (C.) bicinctus	+
80430	Cricotopus (C.) tremulus group	+
80750	Eukiefferiella devonica group	+
82820	Cryptochironomus sp	+
84300	Phaenopsectra obediens group	+
84450	Polypedilum (P.) convictum	+
84480	Polypedilum (P.) laetum group	+
84540	Polypedilum (Tripodura) scalaenum group	+
84750	Stictochironomus sp	+
95100	Physella sp	+
96900	Ferrissia sp	+
98200	Pisidium sp	+

No. Quantitative Taxa: 0 Total Taxa: 32

No. Qualitative Taxa: 32 ICI:

Number of Organisms: 0 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 19-049 River: Ohio Canal RM: 0.20

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	78 +
03600	Oligochaeta	49 +
04666	Helobdella triserialis	9 +
04964	Mooreobdella microstoma	+
06810	Gammarus fasciatus	111 +
08601	Hydracarina	4
11120	Baetis flavistriga	248 +
11130	Baetis intercalaris	308 +
52530	Hydropsyche depravata group	739 +
53800	Hydroptila sp	80
71300	Limonia sp	+
74100	Simulium sp	30 +
77500	Conchapelopia sp	160 +
77800	Helopelopia sp	+
80310	Cardiocladius obscurus	+
80410	Cricotopus (C.) sp	69
80420	Cricotopus (C.) bicinctus	205 +
83300	Glyptotendipes (G.) sp	228 +
84450	Polypedilum (P.) convictum	1073 +
84470	Polypedilum (P.) illinoense	160 +
85625	Rheotanytarsus exiguus group	776
87540	Hemerodromia sp	84
95100	Physella sp	6 +
96264	Planorbella (Pierosoma) pilsbryi	1

No. Quantitative Taxa: 20 Total Taxa: 24

No. Qualitative Taxa: 18 ICI: **20**

Number of Organisms: 4418 Qual EPT: 3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-050 River: Trib. to L. Cuyahoga R. (RM 11.59) RM: 0.50

Taxa Code	Taxa	Quant/Qual
01801	Turbellaria	+
03600	Oligochaeta	+
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
11120	Baetis flavistriga	+
11130	Baetis intercalaris	+
21200	Calopteryx sp	+
22300	Argia sp	+
23600	Aeshna sp	+
23909	Boyeria vinosa	+
47600	Sialis sp	+
52200	Cheumatopsyche sp	+
52440	Ceratopsyche slossonae	+
67100	Hydrobius sp	+
68707	Dubiraphia quadrinotata	+
68708	Dubiraphia vittata group	+
69200	Optioservus sp	+
69400	Stenelmis sp	+
71900	Tipula sp	+
71910	Tipula abdominalis	+
77500	Conchapelopia sp	+
77800	Helopelopia sp	+
78401	Natarsia species A (sensu Roback, 1978)	+
79880	Prodiamesa olivacea	+
80430	Cricotopus (C.) tremulus group	+
82820	Cryptochironomus sp	+
84300	Phaenopsectra obediens group	+
84460	Polypedilum (P.) fallax group	+
84470	Polypedilum (P.) illinoense	+
84480	Polypedilum (P.) laetum group	+
84540	Polypedilum (Tripodura) scalaenum group	+
84750	Stictochironomus sp	+
85400	Micropsectra sp	+
95100	Physella sp	+
98600	Sphaerium sp	+

No. Quantitative Taxa: 0 Total Taxa: 34
No. Qualitative Taxa: 34 ICI:
Number of Organisms: 0 Qual EPT: 4

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-051 River: Camp Brook RM: 1.60

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
06700	Crangonyx sp	+			
11120	Baetis flavistriga	+			
11130	Baetis intercalaris	+			
23600	Aeshna sp	+			
23909	Boyeria vinosa	+			
52530	Hydropsyche depravata group	+			
68707	Dubiraphia quadrinotata	+			
78401	Natarsia species A (sensu Roback, 1978)	+			
84540	Polypedilum (Tripodura) scalaenum group	+			
95100	Physella sp	+			

No. Quantitative Taxa:	0	Total Taxa:	10
No. Qualitative Taxa:	10	ICI:	
Number of Organisms:	0	Qual EPT:	3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-051 River: Camp Brook RM: 0.10

Taxa Code	Taxa	Quant/Qual
11120	Baetis flavistriga	+
21200	Calopteryx sp	+
23600	Aeshna sp	+
69400	Stenelmis sp	+
71900	Tipula sp	+
84470	Polypedilum (P.) illinoense	+
95100	Physella sp	+

No. Quantitative Taxa: 0 Total Taxa: 7

No. Qualitative Taxa: 7 ICI:

Number of Organisms: 0 Qual EPT: 1

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/20/96 River Code: 19-075 River: Roosevelt Ditch RM: 0.10

Taxa Code	Taxa	Quant/Qual
08260	Orconectes (Crokerinus) sanbornii sanbornii	+
08601	Hydracarina	+
13400	Stenacron sp	+
13590	Stenonema vicarium	+
22001	Coenagrionidae	+
68707	Dubiraphia quadrinotata	+
69400	Stenelmis sp	+
77500	Conchapelopia sp	+
77800	Helopelopia sp	+
78401	Natarsia species A (sensu Roback, 1978)	+
80420	Cricotopus (C.) bicinctus	+
80430	Cricotopus (C.) tremulus group	+
82730	Chironomus (C.) decorus group	+
83040	Dicrotendipes neomodestus	+
84300	Phaenopsectra obediens group	+
84450	Polypedilum (P.) convictum	+
84470	Polypedilum (P.) illinoense	+
85500	Paratanytarsus sp	+
87540	Hemerodromia sp	+

No. Quantitative Taxa: 0 Total Taxa: 19

No. Qualitative Taxa: 19 ICI:

Number of Organisms: 0 Qual EPT: 2

ICI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
(19-030)													
Year: 96													
11.20 2	18.6	31(4)	2(0)	2(4)	12(2)	0.2(2)	5.7(6)	0.0(0)	93.5(0)	3.9(6)	2(0)	3	24
11.00 6	25.8	26(4)	3(2)	4(6)	13(2)	2.3(2)	52.1(6)	1.1(2)	43.9(4)	0.9(6)	6(2)	3	36
9.70 8	26.3	33(4)	3(2)	7(6)	16(4)	26.5(6)	28.7(6)	1.5(2)	41.3(4)	14.3(4)	8(4)	3	42
8.40 8	27.2	39(6)	5(4)	4(6)	19(4)	25.4(4)	21.1(6)	2.7(2)	46.2(2)	22.0(2)	8(4)	3	40
7.10 8	31.0	33(4)	3(2)	4(6)	18(4)	18.7(4)	11.4(6)	3.8(2)	65.4(0)	25.6(0)	8(4)	3	32
7.00 6	44.0	36(4)	3(2)	5(6)	21(6)	6.9(2)	5.8(4)	3.7(2)	83.4(0)	37.0(0)	6(2)	3	28
5.10 6	51.0	25(4)	3(2)	2(4)	15(4)	1.1(2)	20.0(6)	3.0(2)	75.5(0)	25.4(0)	6(2)	3	26
4.20 5	61.0	20(2)	3(2)	1(2)	9(2)	5.3(2)	18.5(6)	3.1(2)	72.9(0)	43.2(0)	5(2)	3	20
3.80 3	61.0	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	3(0)	3	0
2.20 5	63.0	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	5(0)	3	0
1.80 4	65.0	21(2)	2(0)	2(4)	12(2)	1.0(2)	9.4(4)	1.9(2)	87.7(0)	67.4(0)	4(0)	3	16
0.20 3	68.0	29(4)	2(0)	5(6)	14(4)	1.9(2)	10.8(4)	13.2(2)	74.1(0)	33.1(0)	3(0)	3	22
Year: 91													
11.00 7	25.8	42(6)	6(4)	4(6)	24(6)	8.2(2)	54.2(6)	2.2(2)	35.2(4)	6.7(6)	7(2)	3	44
3.80 3	61.0	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	3(0)	3	0
0.30 4	68.0	28(4)	2(0)	3(4)	13(2)	0.4(2)	5.4(2)	3.9(2)	90.1(0)	42.3(0)	4(0)	3	16
Year: 86													
12.60 3	14.3	15(2)	0(0)	2(4)	7(2)	0.0(0)	4.9(6)	0.0(0)	94.3(0)	43.6(0)	3(0)	3	14
11.70 1	15.1	20(2)	1(0)	1(2)	6(0)	0.3(2)	0.3(2)	0.8(2)	98.3(0)	54.1(0)	1(0)	3	10
11.20 4	18.6	19(2)	1(0)	2(4)	10(2)	0.5(2)	10.1(6)	4.4(2)	83.4(0)	14.4(4)	4(2)	3	24
11.00 6	25.8	23(2)	2(0)	4(6)	12(2)	0.4(2)	9.1(6)	60.7(6)	28.7(6)	2.1(6)	6(2)	3	38
9.60 6	26.3	28(4)	4(2)	2(4)	12(2)	21.4(4)	1.6(2)	4.4(2)	72.2(0)	28.8(0)	6(2)	3	22

ICI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
8.60 8	27.2	31(4)	5(4)	2(4)	14(4)	9.2(2)	0.4(2)	1.1(2)	89.0(0)	42.0(0)	8(4)	3	26
7.10 6	31.0	26(4)	3(2)	3(6)	15(4)	2.5(2)	1.2(2)	4.0(2)	92.2(0)	65.0(0)	6(2)	3	24
6.40 2	44.0	26(4)	1(0)	1(2)	14(4)	2.0(2)	1.1(2)	0.0(0)	95.7(0)	71.0(0)	2(0)	3	14
5.10 4	51.0	20(2)	2(0)	0(0)	15(4)	0.8(2)	0.0(0)	0.0(0)	99.2(0)	55.8(0)	4(0)	3	8
3.80 5	61.0	25(4)	3(2)	1(2)	14(4)	2.2(2)	0.2(2)	0.0(0)	97.4(0)	49.8(0)	5(2)	3	18
2.10 3	63.0	33(4)	3(2)	2(4)	16(4)	9.7(2)	3.0(2)	0.0(0)	86.9(0)	56.0(0)	3(0)	3	18
1.80 5	65.0	28(4)	2(0)	3(4)	15(4)	7.3(2)	4.3(2)	0.0(0)	88.4(0)	58.8(0)	5(2)	3	18
0.30 5	68.0	33(4)	2(0)	3(4)	18(4)	5.1(2)	3.8(2)	3.3(2)	87.5(0)	34.2(0)	5(2)	3	20
Year: 84													
1.80 3	65.0	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	3(0)	3	0
(19-031)													
Year: 96													
0.10 3	10.1	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	3(0)	3	0
Year: 86													
3.50 0	6.3	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0(0)	3	0
0.50 2	9.5	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	2(0)	3	0
0.10 1	10.1	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	1(0)	3	0
(19-032)													
Year: 96													
3.20 4	4.3	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	4(0)	3	0
0.10 6	7.2	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	6(0)	3	0
Year: 86													
3.20 8	4.3	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	8(0)	3	0
0.50 6	7.0	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	6(0)	3	0

ICI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
0.10 5	7.2	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	5(0)	3	0
(19-049)													
Year: 96													
0.20 3	200.0	20(2)	2(0)	2(2)	9(2)	12.6(2)	18.5(4)	17.6(4)	51.3(2)	9.5(2)	3(0)	3	20
Year: 86													
0.20 3	200.0	22(2)	2(0)	1(2)	10(2)	0.3(2)	2.5(2)	0.0(0)	96.9(0)	62.4(0)	3(0)	3	10
(19-050)													
Year: 96													
0.50 4	3.3	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	4(0)	3	0
Year: 86													
1.60 6	1.5	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	6(0)	3	0
0.50 8	3.3	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	8(0)	3	0
(19-051)													
Year: 96													
1.60 3	3.6	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	3(0)	3	0
0.10 1	5.2	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	1(0)	3	0
Year: 86													
1.60 2	3.6	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	2(0)	3	0
0.10 2	5.2	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	2(0)	3	0
(19-075)													
Year: 96													
0.10 2	1.6	0(0)	0(0)	0(0)	0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	2(0)	3	0

Species List

River Code: 19-030 River Mile: 11.30	Stream: Little Cuyahoga River Basin: Cuyahoga River Time Fished: 5380 sec Drain Area: 18.6 sq mi Dist Fished: 0.30 km No of Passes: 2	Sample Date: 1996 Date Range: 07/02/96 Thru: 08/13/96 Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	120	120.00	35.93	15.02	65.14	125.18
COMMON SHINER	N	I	S		56	56.00	16.77	0.20	0.87	3.57
LARGEMOUTH BASS	F	C	C		33	33.00	9.88	3.10	13.46	94.07
YELLOW BULLHEAD		I	C	T	25	25.00	7.49	2.28	9.89	91.24
BLUEGILL SUNFISH	S	I	C	P	22	22.00	6.59	0.73	3.17	33.23
CREEK CHUB	N	G	N	T	19	19.00	5.69	0.07	0.30	3.68
BLUNTNOSE MINNOW	N	O	C	T	14	14.00	4.19	0.05	0.23	3.79
PUMPKINSEED SUNFISH	S	I	C	P	11	11.00	3.29	0.45	1.95	40.91
GOLDEN SHINER	N	I	M	T	10	10.00	2.99	0.05	0.20	4.60
GREEN SUNFISH	S	I	C	T	7	7.00	2.10	0.14	0.61	20.00
GRASS PICKEREL		P	M	P	6	6.00	1.80	0.32	1.38	53.00
HYBRID X SUNFISH					6	6.00	1.80	0.33	1.41	54.17
WARMOUTH SF	S	C	C		5	5.00	1.50	0.32	1.39	64.20
	Mile Total				334	334.00		23.06		
	Number of Species				12					
	Number of Hybrids				1					

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 11.00	Basin: Cuyahoga River	Date Range: 07/11/96
	Time Fished: 4800 sec Drain Area: 25.8 sq mi	Thru: 08/13/96
	Dist Fished: 0.36 km No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	111	92.50	50.23	16.86	66.18	182.23
CREEK CHUB	N	G	N	T	32	26.67	14.48	0.85	3.35	32.03
YELLOW BULLHEAD		I	C	T	27	22.50	12.22	2.15	8.43	95.37
COMMON SHINER	N	I	S		20	16.67	9.05	0.67	2.63	40.26
BLUNTNOSE MINNOW	N	O	C	T	10	8.33	4.52	0.03	0.11	3.50
LARGEMOUTH BASS	F	C	C		8	6.67	3.62	0.03	0.10	3.75
BLACKNOSE DACE	N	G	S	T	4	3.33	1.81	0.00	0.01	0.67
WARMOUTH SF	S	C	C		3	2.50	1.36	0.19	0.74	75.00
GRASS PICKEREL		P	M	P	2	1.67	0.91	0.07	0.28	43.50
COMMON CARP	G	O	M	T	2	1.67	0.90	4.63	18.16	2,775.00
BLUEGILL SUNFISH	S	I	C	P	2	1.67	0.90	0.00	0.01	1.00
Mile Total					221	184.17		25.47		
Number of Species					11					
Number of Hybrids					0					

Species List

River Code: 19-030	Stream: Little Cuyahoga River		Sample Date: 1996
River Mile: 9.70	Basin: Cuyahoga River		Date Range: 07/02/96
	Time Fished: 4500 sec	Drain Area: 26.3 sq mi	Thru: 08/13/96
	Dist Fished: 0.40 km	No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	173	129.75	27.03	6.37	60.54	49.07
BLUNTNOSE MINNOW	N	O	C	T	169	126.75	26.41	0.55	5.25	4.36
CREEK CHUB	N	G	N	T	117	87.75	18.28	2.44	23.18	27.78
BLACKNOSE DACE	N	G	S	T	102	76.50	15.94	0.37	3.54	4.86
FATHEAD MINNOW	N	O	C	T	25	18.75	3.91	0.05	0.49	2.76
JOHNNY DARTER	D	I	C		24	18.00	3.75	0.02	0.17	0.99
COMMON SHINER	N	I	S		19	14.25	2.97	0.31	2.92	21.58
YELLOW BULLHEAD		I	C	T	8	6.00	1.25	0.28	2.70	47.25
LARGEMOUTH BASS	F	C	C		3	2.25	0.47	0.13	1.21	56.67
	Mile Total				640	480.00		10.52		
	Number of Species				9					
	Number of Hybrids				0					

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 8.50	Basin: Cuyahoga River	Date Range: 07/02/96
	Time Fished: 3540 sec Drain Area: 27.2 sq mi	Thru: 08/13/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACKNOSE DACE	N	G	S	T	324	324.00	62.43	1.19	16.76	3.69
CREEK CHUB	N	G	N	T	78	78.00	15.03	2.50	35.08	32.05
WHITE SUCKER	W	O	S	T	63	63.00	12.14	3.02	42.34	47.90
JOHNNY DARTER	D	I	C		19	19.00	3.66	0.04	0.50	1.86
BLUNTNOSE MINNOW	N	O	C	T	17	17.00	3.28	0.09	1.32	5.53
COMMON SHINER	N	I	S		11	11.00	2.12	0.27	3.72	24.09
LARGEMOUTH BASS	F	C	C		5	5.00	0.96	0.02	0.27	3.80
FATHEAD MINNOW	N	O	C	T	2	2.00	0.39	0.00	0.03	1.00
Mile Total					519	519.00		7.13		
Number of Species					8					
Number of Hybrids					0					

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 7.30	Basin: Cuyahoga River	Date Range: 07/03/96
	Time Fished: 4020 sec Drain Area: 31.0 sq mi	Thru: 08/13/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACKNOSE DACE	N	G	S	T	104	104.00	32.50	0.54	3.88	5.22
CREEK CHUB	N	G	N	T	94	94.00	29.38	3.76	26.87	40.01
WHITE SUCKER	W	O	S	T	84	84.00	26.25	7.27	51.92	86.51
COMMON SHINER	N	I	S		11	11.00	3.44	0.21	1.46	18.61
BLUEGILL SUNFISH	S	I	C	P	8	8.00	2.50	0.32	2.31	40.38
BLUNTNOSE MINNOW	N	O	C	T	6	6.00	1.88	0.03	0.22	5.17
YELLOW BULLHEAD		I	C	T	6	6.00	1.88	1.04	7.40	172.67
LARGEMOUTH BASS	F	C	C		3	3.00	0.94	0.66	4.72	220.33
BLACK CRAPPIE	S	I	C		2	2.00	0.63	0.15	1.07	75.00
PUMPKINSEED SUNFISH	S	I	C	P	1	1.00	0.31	0.02	0.13	18.00
JOHNNY DARTER	D	I	C		1	1.00	0.31	0.00	0.01	2.00
Mile Total					320	320.00		14.00		
Number of Species					11					
Number of Hybrids					0					

River Code: 19-030	Stream: Little Cuyahoga River		Sample Date: 1996
River Mile: 7.10	Basin: Cuyahoga River		Date Range: 07/03/96
	Time Fished: 4560 sec	Drain Area: 31.0 sq mi	Thru: 08/13/96
	Dist Fished: 0.40 km	No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	115	86.25	28.47	8.39	59.04	97.32
CREEK CHUB	N	G	N	T	83	62.25	20.54	2.51	17.67	40.36
BLACKNOSE DACE	N	G	S	T	80	60.00	19.80	0.38	2.64	6.25
BLUNTNOSE MINNOW	N	O	C	T	61	45.75	15.10	0.23	1.60	4.96
COMMON SHINER	N	I	S		33	24.75	8.17	0.51	3.59	20.61
YELLOW BULLHEAD		I	C	T	18	13.50	4.46	2.16	15.17	159.72
JOHNNY DARTER	D	I	C		8	6.00	1.98	0.01	0.05	1.25
LARGEMOUTH BASS	F	C	C		3	2.25	0.74	0.01	0.09	5.33
BLUEGILL SUNFISH	S	I	C	P	2	1.50	0.50	0.02	0.11	10.00
PUMPKINSEED SUNFISH	S	I	C	P	1	0.75	0.25	0.01	0.05	10.00
	Mile Total				404	303.00		14.22		
	Number of Species				10					
	Number of Hybrids				0					

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 5.10	Basin: Cuyahoga River	Date Range: 07/09/96
	Time Fished: 3300 sec Drain Area: 51.0 sq mi	Thru: 08/13/96
	Dist Fished: 0.33 km No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CREEK CHUB	N	G	N	T	95	87.17	25.71	2.78	7.56	31.87
BLUNTNOSE MINNOW	N	O	C	T	86	82.00	24.19	0.25	0.67	3.00
WHITE SUCKER	W	O	S	T	63	59.83	17.65	2.28	6.21	38.67
BLACKNOSE DACE	N	G	S	T	50	46.00	13.57	0.16	0.43	3.46
YELLOW BULLHEAD		I	C	T	19	17.00	5.01	1.82	4.94	106.14
COMMON SHINER	N	I	S		17	16.33	4.82	0.44	1.21	27.18
COMMON CARP	G	O	M	T	10	9.17	2.70	27.98	76.16	3,080.00
PUMPKINSEED SUNFISH	S	I	C	P	8	7.33	2.16	0.06	0.17	8.38
HYBRID X SUNFISH					4	3.67	1.08	0.15	0.41	41.00
GOLDFISH	G	O	M	T	3	2.67	0.79	0.56	1.53	216.33
LARGEMOUTH BASS	F	C	C		3	2.67	0.79	0.01	0.02	2.67
BLUEGILL SUNFISH	S	I	C	P	3	2.50	0.74	0.21	0.57	84.00
GREEN SUNFISH	S	I	C	T	2	1.83	0.54	0.04	0.12	24.00
FATHEAD MINNOW	N	O	C	T	1	0.83	0.25	0.00	0.00	1.00
Mile Total					364	339.00		36.74		
Number of Species					13					
Number of Hybrids					1					

Species List

River Code: 19-030	Stream: Little Cuyahoga River		Sample Date: 1996
River Mile: 4.20	Basin: Cuyahoga River		Date Range: 07/09/96
	Time Fished: 4200 sec	Drain Area: 61.0 sq mi	Thru: 08/14/96
	Dist Fished: 0.40 km	No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	303	227.25	45.98	5.27	63.81	23.18
CREEK CHUB	N	G	N	T	164	123.00	24.89	2.30	27.91	18.73
BLUNTNOSE MINNOW	N	O	C	T	105	78.75	15.93	0.28	3.42	3.58
BLACKNOSE DACE	N	G	S	T	69	51.75	10.47	0.28	3.45	5.49
FATHEAD MINNOW	N	O	C	T	10	7.50	1.52	0.03	0.30	3.30
PUMPKINSEED SUNFISH	S	I	C	P	3	2.25	0.46	0.02	0.25	9.00
COMMON SHINER	N	I	S		2	1.50	0.30	0.05	0.59	32.50
YELLOW BULLHEAD		I	C	T	2	1.50	0.30	0.02	0.21	11.00
LARGEMOUTH BASS	F	C	C		1	0.75	0.15	0.01	0.09	10.00
Mile Total					659	494.25		8.26		
Number of Species					9					
Number of Hybrids					0					

Species List

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 4.10	Basin: Cuyahoga River	Date Range: 07/09/96
	Time Fished: 3600 sec Drain Area: 61.0 sq mi	Thru: 08/14/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CREEK CHUB	N	G	N	T	110	110.00	39.57	3.57	35.26	32.45
WHITE SUCKER	W	O	S	T	101	101.00	36.33	4.35	42.98	43.07
BLACKNOSE DACE	N	G	S	T	56	56.00	20.14	0.27	2.64	4.77
BLUNTNOSE MINNOW	N	O	C	T	7	7.00	2.52	0.03	0.28	4.05
FATHEAD MINNOW	N	O	C	T	2	2.00	0.72	0.01	0.05	2.50
COMMON CARP	G	O	M	T	1	1.00	0.36	1.90	18.77	1,900.00
YELLOW BULLHEAD		I	C	T	1	1.00	0.36	0.00	0.02	2.00
	Mile Total				278	278.00		10.12		
	Number of Species				7					
	Number of Hybrids				0					

River Code: 19-030	Stream: Little Cuyahoga River		Sample Date: 1996
River Mile: 2.90	Basin: Cuyahoga River		Date Range: 07/10/96
	Time Fished: 4200 sec	Drain Area: 62.0 sq mi	Thru: 08/14/96
	Dist Fished: 0.34 km	No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CENTRAL STONEROLLER	N	H	N		114	98.63	34.54	1.51	22.12	15.11
CREEK CHUB	N	G	N	T	64	55.79	19.54	1.23	18.01	21.88
BLACKNOSE DACE	N	G	S	T	45	38.68	13.55	0.24	3.49	6.18
WHITE SUCKER	W	O	S	T	32	28.21	9.88	1.19	17.37	41.41
COMMON SHINER	N	I	S		32	27.16	9.51	0.74	10.78	27.16
BLUNTNOSE MINNOW	N	O	C	T	27	22.37	7.83	0.13	1.89	5.79
YELLOW BULLHEAD		I	C	T	9	8.37	2.93	1.34	19.53	158.33
NORTHERN HOG SUCKER	R	I	S	M	6	5.58	1.95	0.45	6.55	78.17
HYBRID X SUNFISH					1	0.79	0.28	0.02	0.26	23.00
	Mile Total				330	285.58		6.84		
	Number of Species				8					
	Number of Hybrids				1					

River Code: 19-030	Stream: Little Cuyahoga River	Sample Date: 1996
River Mile: 1.80	Basin: Cuyahoga River	Date Range: 07/10/96
	Time Fished: 4200 sec Drain Area: 65.0 sq mi	Thru: 08/14/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
YELLOW BULLHEAD		I	C	T	37	37.00	22.29	2.55	16.54	68.92
GIZZARD SHAD		O	M		26	26.00	15.66	0.43	2.76	16.35
BLUNTNOSE MINNOW	N	O	C	T	19	19.00	11.45	0.08	0.53	4.26
CENTRAL STONEROLLER	N	H	N		19	19.00	11.45	0.11	0.74	6.00
BLUEGILL SUNFISH	S	I	C	P	11	11.00	6.63	0.29	1.87	26.18
GREEN SUNFISH	S	I	C	T	7	7.00	4.22	0.08	0.52	11.51
WHITE SUCKER	W	O	S	T	6	6.00	3.61	0.58	3.77	96.83
COMMON SHINER	N	I	S		6	6.00	3.61	0.08	0.49	12.50
PUMPKINSEED SUNFISH	S	I	C	P	6	6.00	3.61	0.07	0.43	11.00
HYBRID X SUNFISH					6	6.00	3.61	0.05	0.35	9.00
NORTHERN HOG SUCKER	R	I	S	M	4	4.00	2.41	0.25	1.60	61.75
COMMON CARP	G	O	M	T	4	4.00	2.41	10.60	68.74	2,650.00
BLACKNOSE DACE	N	G	S	T	4	4.00	2.41	0.03	0.18	6.75
CREEK CHUB	N	G	N	T	3	3.00	1.81	0.04	0.26	13.33
WARMOUTH SF	S	C	C		3	3.00	1.81	0.07	0.47	24.00
GREENSIDE DARTER	D	I	S	M	2	2.00	1.20	0.01	0.07	5.50
CHANNEL CATFISH	F		C		1	1.00	0.60	0.05	0.35	54.00
BLACK CRAPPIE	S	I	C		1	1.00	0.60	0.05	0.30	46.00
LARGEMOUTH BASS	F	C	C		1	1.00	0.60	0.01	0.06	10.00
Mile Total					166	166.00		15.42		
Number of Species					18					
Number of Hybrids					1					

River Code: 19-030	Stream: Little Cuyahoga River		Sample Date: 1996
River Mile: 0.30	Basin: Cuyahoga River		Date Range: 07/09/96
	Time Fished: 4200 sec	Drain Area: 68.0 sq mi	Thru: 08/13/96
	Dist Fished: 0.35 km	No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
YELLOW BULLHEAD		I	C	T	103	87.65	22.41	5.39	49.09	61.19
CENTRAL STONEROLLER	N	H	N		71	61.03	15.60	0.37	3.37	6.06
CREEK CHUB	N	G	N	T	71	60.64	15.50	1.10	10.01	17.96
WHITE SUCKER	W	O	S	T	60	51.57	13.18	1.77	16.17	34.44
COMMON SHINER	N	I	S		34	29.31	7.49	0.34	3.11	11.58
BLUNTNOSE MINNOW	N	O	C	T	27	23.33	5.96	0.11	0.98	4.63
GIZZARD SHAD		O	M		25	22.06	5.64	0.22	2.01	10.00
BLACKNOSE DACE	N	G	S	T	22	18.73	4.79	0.10	0.94	5.45
GREENSIDE DARTER	D	I	S	M	14	11.86	3.03	0.07	0.62	5.71
NORTHERN HOG SUCKER	R	I	S	M	13	11.42	2.92	1.37	12.47	119.86
SILVERJAW MINNOW	N	I	M		4	3.33	0.85	0.03	0.23	7.50
SPOTFIN SHINER	N	I	M		3	2.60	0.66	0.03	0.25	10.33
GREEN SUNFISH	S	I	C	T	3	2.55	0.65	0.03	0.25	10.67
PUMPKINSEED SUNFISH	S	I	C	P	2	1.67	0.43	0.02	0.21	13.50
FATHEAD MINNOW	N	O	C	T	1	0.88	0.23	0.00	0.03	4.00
JOHNNY DARTER	D	I	C		1	0.88	0.23	0.00	0.02	3.00
BLUEGILL SUNFISH	S	I	C	P	1	0.83	0.21	0.01	0.05	6.00
HYBRID X SUNFISH					1	0.83	0.21	0.02	0.21	27.00
Mile Total					456	391.18		10.97		
Number of Species					17					
Number of Hybrids					1					

River Code: 19-031	Stream: Springfield Lake Outlet	Sample Date: 1996
River Mile: 0.10	Basin: Cuyahoga River	Date Range: 07/03/96
	Time Fished: 2580 sec Drain Area: 10.1 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACKNOSE DACE	N	G	S	T	109	218.00	57.67	1.13	19.12	5.20
CREEK CHUB	N	G	N	T	39	78.00	20.63	2.00	33.74	25.64
WHITE SUCKER	W	O	S	T	16	32.00	8.47	1.60	27.00	50.00
COMMON SHINER	N	I	S		16	32.00	8.47	0.47	7.93	14.69
BLUNTNOSE MINNOW	N	O	C	T	5	10.00	2.65	0.03	0.51	3.00
YELLOW BULLHEAD		I	C	T	4	8.00	2.12	0.69	11.71	86.75
Mile Total					189	378.00		5.93		
Number of Species					6					
Number of Hybrids					0					

River Code: 19-032	Stream: Wingfoot Lake Outlet	Sample Date: 1996
River Mile: 1.30	Basin: Cuyahoga River	Date Range: 08/27/96
	Time Fished: 1800 sec Drain Area: 6.4 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	246	492.00	52.68	18.11	76.65	36.81
CREEK CHUB	N	G	N	T	71	142.00	15.20	4.11	17.41	28.96
BLACKNOSE DACE	N	G	S	T	70	140.00	14.99	0.92	3.89	6.57
JOHNNY DARTER	D	I	C		45	90.00	9.64	0.20	0.86	2.27
BROOK STICKLEBACK		I	C		27	54.00	5.78	0.08	0.33	1.42
LARGEMOUTH BASS	F	C	C		4	8.00	0.86	0.07	0.28	8.25
BLUEGILL SUNFISH	S	I	C	P	2	4.00	0.43	0.08	0.33	19.50
PUMPKINSEED SUNFISH	S	I	C	P	2	4.00	0.43	0.06	0.25	15.00
Mile Total					467	934.00		23.63		
Number of Species					8					
Number of Hybrids					0					

Species List

River Code: 19-032	Stream: Wingfoot Lake Outlet	Sample Date: 1996
River Mile: 0.10	Basin: Cuyahoga River	Date Range: 07/02/96
	Time Fished: 2700 sec Drain Area: 7.2 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CREEK CHUB	N	G	N	T	38	76.00	40.00	1.80	27.90	23.68
BLACKNOSE DACE	N	G	S	T	26	52.00	27.37	0.07	1.02	1.27
WHITE SUCKER	W	O	S	T	17	34.00	17.89	4.35	67.42	127.94
COMMON SHINER	N	I	S		6	12.00	6.32	0.08	1.21	6.50
WARMOUTH SF	S	C	C		2	4.00	2.11	0.06	0.87	14.00
GOLDEN SHINER	N	I	M	T	1	2.00	1.05	0.01	0.15	5.00
FATHEAD MINNOW	N	O	C	T	1	2.00	1.05	0.00	0.03	1.00
LARGEMOUTH BASS	F	C	C		1	2.00	1.05	0.00	0.03	1.00
GREEN SUNFISH	S	I	C	T	1	2.00	1.05	0.04	0.62	20.00
BLUEGILL SUNFISH	S	I	C	P	1	2.00	1.05	0.01	0.19	6.00
HYBRID X SUNFISH					1	2.00	1.05	0.04	0.56	18.00
Mile Total					95	190.00		6.45		
Number of Species					10					
Number of Hybrids					1					

Species List

River Code: 19-050	Stream: Trib. to L. Cuyahoga R. (RM 11.59)		Sample Date: 1996
River Mile: 1.20	Basin: Cuyahoga River		Date Range: 08/27/96
	Time Fished: 1200 sec	Drain Area: 1.5 sq mi	
	Dist Fished: 0.15 km	No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACKNOSE DACE	N	G	S	T	147	294.00	46.67	1.40	11.90	4.76
GREEN SUNFISH	S	I	C	T	52	104.00	16.51	0.84	7.11	8.04
CREEK CHUB	N	G	N	T	46	92.00	14.60	1.52	12.92	16.52
WHITE SUCKER	W	O	S	T	43	86.00	13.65	7.80	66.30	90.70
LARGEMOUTH BASS	F	C	C		12	24.00	3.81	0.04	0.36	1.75
FATHEAD MINNOW	N	O	C	T	4	8.00	1.27	0.03	0.22	3.25
BLUEGILL SUNFISH	S	I	C	P	4	8.00	1.27	0.02	0.17	2.50
YELLOW BULLHEAD		I	C	T	3	6.00	0.95	0.08	0.66	13.00
HYBRID X SUNFISH					2	4.00	0.63	0.02	0.19	5.50
CENTRAL MUDMINNOW		I	C	T	1	2.00	0.32	0.02	0.14	8.00
BLUNTNOSE MINNOW	N	O	C	T	1	2.00	0.32	0.00	0.03	2.00
Mile Total					315	630.00		11.76		
Number of Species					10					
Number of Hybrids					1					

River Code: 19-051 River Mile: 1.00	Stream: Camp Brook Basin: Cuyahoga River Time Fished: 2100 sec Drain Area: 3.8 sq mi Dist Fished: 0.15 km No of Passes: 1	Sample Date: 1996 Date Range: 07/09/96 Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACKNOSE DACE	N	G	S	T	86	172.00	54.78	0.56	23.59	3.26
CREEK CHUB	N	G	N	T	58	116.00	36.94	1.45	61.08	12.50
WHITE SUCKER	W	O	S	T	10	20.00	6.37	0.36	15.16	18.00
BROOK STICKLEBACK		I	C		2	4.00	1.27	0.00	0.08	0.50
BLUEGILL SUNFISH	S	I	C	P	1	2.00	0.64	0.00	0.08	1.00
Mile Total					157	314.00		2.37		
Number of Species					5					
Number of Hybrids					0					

River Code: 19-051	Stream: Camp Brook	Sample Date: 1996
River Mile: 0.10	Basin: Cuyahoga River	Date Range: 07/03/96
	Time Fished: Drain Area: 5.2 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	55	110.00	41.35	1.60	51.78	14.55
BLACKNOSE DACE	N	G	S	T	52	104.00	39.10	0.65	21.04	6.25
CREEK CHUB	N	G	N	T	26	52.00	19.55	0.84	27.18	16.15
	Mile Total				133	266.00		3.09		
	Number of Species				3					
	Number of Hybrids				0					

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
L. Cuyahoga River - (19-030)																
Year: 96																
11.30	D	07/02/96	18.6	9(3)	2(1)	0(1)	0(1)	0(1)	2(1)	55(1)	47(1)	10(5)	27(3)	1.8(3)	102(1)	22
11.30	D	08/13/96	18.6	12(3)	4(3)	0(1)	0(1)	0(1)	2(1)	60(1)	37(1)	13(5)	45(3)	2.4(1)	176(1)	22
Year: 86																
11.20	E	07/01/86	15.0	6(1)	1(1)	0(1)	0(1)	0(1)	1(1)	80(1)	20(3)	20(3)	47(3)	3.3(5)	9(1)* *	22
11.20	E	07/29/86	15.0	8(3)	3(1)	0(1)	0(1)	0(1)	1(1)	89(1)	25(3)	25(5)	50(5)	0.0(5)	14(1)*	28
11.20	E	08/25/86	15.0	7(1)	3(1)	0(1)	0(1)	0(1)	1(1)	93(1)	23(3)	37(3)	41(3)	2.2(1)	11(1)*	18
Springfield Lk Outlt - (19-031)																
Year: 96																
0.10	E	07/03/96	10.1	6(1)	4(3)	1(1)	0(1)	0(1)	3(3)	92(1)	11(5)	23(5)	11(1)	1.1(3)	32(1)	26
Year: 86																
2.90	E	07/10/86	6.0	9(3)	3(3)	1(1)	0(1)	1(1)	2(1)	96(1)	78(1)	20(5)	13(1)	1.0(3)	9(1)	22
2.90	F	08/05/86	6.0	8(3)	3(3)	1(1)	0(1)	1(1)	2(1)	98(1)	51(1)	31(3)	9(1)	1.1(3)	4(1)*	20
2.90	F	08/27/86	6.0	6(1)	3(3)	1(1)	0(1)	1(1)	2(1)	99(1)	30(1)	52(3)	2(1)	0.0(5)	2(1)	20
0.80	E	07/10/86	9.0	4(1)	3(1)	1(1)	0(1)	0(1)	2(1)	100(1)	45(1)	63(1)	0(1)	0.0(5)	0(1)	16
0.10	E	07/07/86	10.0	5(1)	4(3)	1(1)	0(1)	0(1)	2(1)	100(1)	8(5)	51(3)	1(1)	0.0(5)	2(1)	24
0.10	E	07/29/86	10.0	7(1)	4(3)	1(1)	0(1)	0(1)	3(3)	99(1)	13(5)	60(1)	1(1)	0.0(5)	8(1)	24
0.10	E	08/25/86	10.0	6(1)	4(3)	1(1)	0(1)	0(1)	3(3)	99(1)	5(5)	59(1)	2(1)	0.0(5)	8(1)	24
Wingfoot Lake Outlet - (19-032)																
Year: 96																
1.30	E	08/27/96	6.4	8(3)	2(1)	2(3)	0(1)	1(1)	2(1)	83(1)	53(1)	25(5)	16(1)	0.0(5)	160(3)	26
0.10	E	07/02/96	7.2	10(3)	5(3)	1(1)	0(1)	0(1)	3(3)	88(1)	19(3)	42(3)	10(1)	0.0(5)	22(1)*	26

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

				Number of						Percent of Individuals							
River Mile	Type	Date	Drainage area (sq mi)	Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	
Year: 86																	
3.10	F	07/09/86	4.0	7(3)	2(1)	2(3)	0(1)	1(1)	2(1)	89(1)	7(5)	13(5)	26(3)	0.0(5)	21(1)*	30	
3.10	F	08/05/86	4.0	5(1)	2(1)	1(1)	0(1)	1(1)	2(1)	89(1)	6(5)	21(5)	21(3)	0.0(5)	24(1)	26	
3.10	F	08/27/86	4.0	7(3)	2(1)	2(3)	0(1)	1(1)	2(1)	84(1)	9(5)	27(5)	22(3)	0.0(5)	72(1)	30	
0.50	E	07/09/86	7.0	3(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	30(1)	20(5)	0(1)	0.0(1)	0(1)**	16	▲
0.50	E	08/05/86	7.0	4(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	15(3)	27(5)	4(1)	0.0(5)	0(1)*	22	
0.50	E	08/26/86	7.0	6(1)	4(3)	1(1)	0(1)	0(1)	2(1)	98(1)	42(1)	42(3)	4(1)	7.5(1)	2(1)*	16	
0.10	E	07/10/86	7.0	9(3)	4(3)	1(1)	0(1)	1(1)	2(1)	88(1)	21(3)	63(1)	10(1)	8.0(1)	40(1)	18	
0.10	E	08/05/86	7.0	11(3)	5(3)	1(1)	0(1)	1(1)	2(1)	88(1)	18(3)	67(1)	14(1)	1.2(3)	83(1)	20	
0.10	E	09/04/86	7.0	8(3)	3(3)	1(1)	0(1)	1(1)	2(1)	90(1)	19(3)	67(1)	9(1)	0.8(5)	40(1)	22	
Union Oil Trib. - (19-050)																	
Year: 96																	
1.20	E	08/27/96	1.5	10(5)	4(3)	1(1)	0(1)	0(1)	2(3)	94(1)	15(3)	33(3)	19(3)	0.0(5)	36(1)	30	
Year: 86																	
1.50	E	07/09/86	1.5	2(1)	2(1)	1(1)	0(1)	0(1)	1(1)	100(1)	0(5)	8(5)	0(1)	0.0(5)	0(1)	24	
1.50	E	08/05/86	1.5	5(3)	2(1)	2(3)	0(1)	0(1)	2(3)	99(1)	3(5)	23(5)	0(1)	0.0(5)	16(1)	30	
1.50	F	09/02/86	1.5	3(1)	2(1)	1(1)	0(1)	0(1)	2(3)	100(1)	4(5)	10(5)	0(1)	0.0(5)	0(1)	26	
0.30	E	07/09/86	3.3	6(3)	4(3)	1(1)	0(1)	1(1)	2(1)	99(1)	5(5)	21(5)	1(1)	0.0(5)	18(1)	28	
0.30	E	08/05/86	3.3	9(3)	5(5)	1(1)	0(1)	1(1)	2(1)	98(1)	8(5)	27(5)	2(1)	1.3(1)	72(1)	26	
0.30	E	09/08/86	3.3	8(3)	5(5)	1(1)	0(1)	1(1)	2(1)	97(1)	9(5)	21(5)	3(1)	0.0(5)	60(1)	30	
Camp Creek - (19-051)																	
Year: 96																	
1.00	E	07/09/96	3.8	5(1)	2(1)	2(3)	0(1)	0(1)	2(1)	98(1)	6(5)	37(3)	2(1)	0.0(5)	6(1)	24	

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Minnow species	Number of: Headwater species	Number of: Sensitive species	Number of: Darter & Sculpin species	Number of: Simple Lithophils	Percent of Individuals: Tolerant fishes	Percent of Individuals: Omni-vores	Percent of Individuals: Pioneering fishes	Percent of Individuals: Insect-ivores	Percent of Individuals: DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	
0.10	E	07/03/96	5.2	3(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	41(1)	20(5)	0(1)	0.0(5)	0(1)	20	
Year: 94																	
0.50	D	07/12/94	3.9	3(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	10(5)	38(3)	0(1)	0.0(5)	0(1)*	22	
0.50	D	09/18/94	3.9	3(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	4(5)	70(1)	0(1)	0.0(5)	0(1)*	20	
0.10	D	07/11/94	5.2	5(1)	3(3)	1(1)	0(1)	0(1)	2(1)	99(1)	15(3)	37(3)	1(1)	0.6(3)	3(1)	20	
0.10	D	09/18/94	5.2	5(1)	4(3)	1(1)	0(1)	0(1)	2(1)	100(1)	36(1)	45(3)	0(1)	0.0(5)	0(1)	20	
Year: 86																	
1.50	E	07/09/86	3.6	3(1)	2(1)	1(1)	0(1)	0(1)	2(1)	100(1)	8(1)	46(3)	0(1)	0.0(1)	0(1)**	14	▲
1.50	F	08/05/86	3.6	2(1)	2(1)	1(1)	0(1)	0(1)	1(1)	100(1)	0(5)	79(1)	0(1)	0.0(5)	0(1)*	20	
1.50	F	08/27/86	3.6	3(1)	2(1)	0(1)	0(1)	0(1)	1(1)	62(1)	6(5)	56(1)	0(1)	2.0(5)	38(1)*	20	
0.10	E	07/09/86	5.2	2(1)	2(1)	1(1)	0(1)	0(1)	1(1)	100(1)	0(1)	50(1)	0(1)	0.0(1)	0(1)**	12	
0.10	E	08/04/86	5.2	2(1)	2(1)	1(1)	0(1)	0(1)	1(1)	100(1)	0(5)	36(3)	0(1)	0.0(5)	0(1)*	22	
0.10	F	08/27/86	5.2	2(1)	2(1)	0(1)	0(1)	0(1)	0(1)	73(1)	0(5)	73(1)	0(1)	1.8(3)	56(1)	18	

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
L. Cuyahoga River - (19030)																		
Year: 96																		
11.00	D	07/11/96	25	8(1)	1(1)	1(1)	0(1)	0(1)	57(5)	87(1)	57(1)	6.6(5)	18(1)	3.8(1)	23(1)	*	20	3.8
11.00	D	08/13/96	25	10(3)	2(3)	1(1)	0(1)	0(1)	65(5)	82(1)	55(1)	5.2(5)	26(3)	0.0(5)	35(1)	*	30	4.7
9.70	D	07/02/96	26	9(3)	0(1)	1(1)	0(1)	1(1)	54(5)	91(1)	53(1)	0.3(1)	10(1)	0.6(3)	41(1)		20	4.6
9.70	D	08/13/96	26	8(1)	0(1)	1(1)	0(1)	1(1)	38(5)	94(1)	62(1)	0.6(1)	6(1)	0.0(5)	29(1)		20	4.7
8.50	E	07/02/96	27	8(1)	0(1)	1(1)	0(1)	1(1)	83(5)	91(1)	18(5)	0.9(1)	8(1)	0.9(3)	42(1)		22	4.3
8.50	E	08/13/96	27	7(1)	0(1)	1(1)	0(1)	1(1)	71(5)	95(1)	14(5)	1.1(3)	4(1)	0.4(5)	28(1)		26	3.9
7.30	D	07/03/96	31	10(3)	2(3)	1(1)	0(1)	1(1)	60(5)	91(1)	31(3)	1.0(3)	10(1)	3.9(1)	36(1)		24	5.4
7.30	D	08/13/96	31	7(1)	1(1)	1(1)	0(1)	0(1)	66(5)	94(1)	24(3)	0.8(1)	7(1)	2.0(1)	16(1)		18	3.8
7.10	D	07/03/96	31	8(1)	1(1)	1(1)	0(1)	0(1)	52(5)	92(1)	47(1)	0.4(1)	14(1)	1.8(1)	30(1)		16	4.6
7.10	D	08/13/96	31	10(3)	2(3)	1(1)	0(1)	1(1)	63(5)	84(1)	39(1)	1.2(3)	17(1)	0.6(5)	41(1)		26	4.8
5.10	D	07/09/96	51	11(3)	3(3)	1(1)	0(1)	0(1)	31(3)	90(1)	34(3)	1.3(3)	16(1)	6.7(1)	25(1)		22	4.4
5.10	D	08/13/96	51	9(1)	2(3)	1(1)	0(1)	0(1)	39(5)	91(1)	52(1)	0.5(1)	12(1)	3.3(1)	40(1)		18	4.6
4.20	D	07/09/96	61	8(1)	1(1)	1(1)	0(1)	0(1)	68(5)	99(1)	68(1)	0.0(1)	1(1)	0.6(3)	6(1)		18	2.8
4.20	D	08/14/96	61	8(1)	1(1)	1(1)	0(1)	0(1)	43(5)	99(1)	58(1)	0.4(1)	1(1)	0.0(5)	3(1)		20	3.1
4.10	D	07/09/96	61	4(1)	0(1)	1(1)	0(1)	0(1)	53(5)	100(1)	30(3)	0.0(1)	0(1)	0.6(5)	0(1)		22	2.4
4.10	D	08/14/96	61	6(1)	0(1)	1(1)	0(1)	0(1)	61(5)	100(1)	54(1)	0.0(1)	1(1)	0.0(5)	0(1)		20	2.0
2.90	E	07/10/96	62	8(1)	0(1)	2(3)	0(1)	0(1)	35(3)	53(1)	19(3)	0.0(1)	13(1)	0.5(5)	156(1)		22	6.6
2.90	E	08/14/96	62	8(1)	0(1)	2(3)	0(1)	0(1)	35(3)	55(1)	16(5)	0.0(1)	16(1)	0.8(5)	108(1)		24	6.4
1.80	E	07/10/96	65	14(3)	5(5)	2(3)	0(1)	1(1)	11(1)	59(1)	21(3)	2.5(3)	52(3)	3.4(1)	96(1)		26	6.1
1.80	E	08/14/96	65	10(1)	2(3)	1(1)	0(1)	0(1)	19(3)	21(5)	63(1)	2.1(3)	27(3)	6.3(1)	76(1)	*	24	4.4
0.30	E	07/09/96	68	14(3)	3(3)	2(3)	0(1)	1(1)	29(3)	71(1)	17(5)	0.0(1)	44(3)	1.8(1)	112(1)		26	5.7

na - Qualitative data, Modified Iwb not applicable.

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
0.30	E	08/13/96	68	14(3)	1(1)	2(3)	0(1)	2(1)	33(3)	55(1)	33(3)	0.0(1)	34(3)	3.3(1)	180(1)	22	7.2
Year: 94																	
9.80	D	07/12/94	26	10(3)	2(3)	1(1)	0(1)	0(1)	56(5)	86(1)	34(3)	4.8(3)	11(1)	0.0(5)	23(1)	* 28	5.0
9.80	D	09/20/94	26	12(3)	2(3)	1(1)	0(1)	1(1)	67(5)	97(1)	35(1)	1.0(3)	3(1)	0.5(3)	36(1)	24	4.3
6.80	D	07/12/94	44	10(3)	3(3)	1(1)	0(1)	1(1)	44(5)	82(1)	29(3)	3.9(3)	16(1)	1.3(5)	21(1)	* 28	4.6
6.80	D	09/20/94	44	8(1)	2(3)	1(1)	0(1)	0(1)	37(5)	90(1)	34(3)	0.0(1)	11(1)	0.5(5)	30(1)	24	4.6
5.20	D	07/13/94	51	11(3)	2(3)	1(1)	0(1)	1(1)	26(3)	84(1)	59(1)	0.0(1)	15(1)	6.9(1)	24(1)	* 18	3.7
5.20	D	09/18/94	51	10(1)	3(3)	1(1)	0(1)	0(1)	28(3)	88(1)	62(1)	4.9(3)	15(1)	1.0(3)	36(1)	20	5.0
4.70	D	07/13/94	52	8(1)	3(3)	1(1)	0(1)	0(1)	59(5)	92(1)	62(1)	1.3(3)	8(1)	2.5(3)	9(1)	* 22	3.3
4.70	D	09/18/94	52	9(1)	3(3)	1(1)	0(1)	0(1)	40(5)	91(1)	56(1)	0.0(1)	10(1)	0.0(5)	21(1)	22	4.0
4.30	D	07/12/94	55	6(1)	2(3)	1(1)	0(1)	0(1)	53(5)	92(1)	40(1)	0.0(1)	8(1)	0.0(5)	13(1)	* 22	3.8
4.30	D	09/18/94	55	7(1)	0(1)	1(1)	0(1)	0(1)	51(5)	99(1)	30(3)	0.0(1)	0(1)	0.0(5)	3(1)	22	3.1
4.20	D	07/12/94	61	4(1)	0(1)	1(1)	0(1)	0(1)	37(5)	100(1)	26(3)	0.0(1)	0(1)	0.0(5)	0(1)	* 22	1.9
4.20	D	09/18/94	61	5(1)	0(1)	1(1)	0(1)	0(1)	49(5)	100(1)	32(3)	0.0(1)	1(1)	0.7(5)	0(1)	22	1.9
2.80	D	07/13/94	62	8(1)	2(3)	1(1)	0(1)	0(1)	62(5)	76(1)	51(1)	0.0(1)	8(1)	0.0(5)	66(1)	22	4.8
2.80	D	09/19/94	62	12(3)	3(3)	2(3)	0(1)	0(1)	17(1)	35(3)	11(5)	0.0(1)	3(1)	0.0(5)	1282(5)	32	7.5
2.10	D	07/13/94	63	10(1)	4(5)	2(3)	0(1)	0(1)	33(3)	58(1)	34(3)	1.4(3)	10(1)	5.5(1)	47(1)	* 24	5.3
2.10	D	09/20/94	63	10(1)	1(1)	2(3)	0(1)	1(1)	47(5)	56(1)	44(1)	0.0(1)	7(1)	0.9(3)	245(3)	22	6.5
1.90	D	07/14/94	65	5(1)	0(1)	1(1)	0(1)	0(1)	23(3)	41(3)	31(3)	0.8(1)	0(1)	3.1(1)	150(1)	18	4.6
1.90	D	09/19/94	65	11(3)	2(3)	2(3)	0(1)	0(1)	27(3)	36(3)	27(3)	0.6(1)	3(1)	1.2(3)	686(3)	28	7.2
1.80	D	07/14/94	65	17(3)	4(5)	2(3)	0(1)	0(1)	27(3)	74(1)	51(1)	11.4(5)	7(1)	0.3(3)	302(3)	30	7.5
1.80	D	09/19/94	65	13(3)	2(3)	2(3)	0(1)	1(1)	26(3)	48(1)	24(3)	1.4(3)	29(3)	0.5(3)	345(3)	30	7.6
0.10	D	07/14/94	68	13(3)	2(3)	2(3)	0(1)	0(1)	28(3)	45(1)	18(5)	0.0(1)	32(3)	1.4(1)	179(1)	26	6.6

na - Qualitative data, Modified Iwb not applicable.

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

				Number of					Percent of Individuals						Rel.No. minus tolerants			
River Mile	Type	Date	Drainage area (sq mi)	Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	/(0.3km)		IBI	Modified Iwb
0.10	D	09/22/94	68	11(3)	2(3)	2(3)	0(1)	0(1)	23(3)	50(1)	18(5)	1.0(1)	21(1)	0.0(5)	80(1)	*	28	5.6
Year: 91																		
11.00	E	07/24/91	22	8(1)	3(3)	1(1)	0(1)	0(1)	54(5)	71(1)	48(1)	8.1(5)	36(3)	1.0(5)	87(1)		28	5.8
11.00	E	08/29/91	22	10(3)	3(3)	1(1)	0(1)	0(1)	47(5)	75(1)	42(1)	2.3(3)	36(3)	0.0(5)	96(1)		28	5.8
2.20	E	07/24/91	63	8(1)	0(1)	2(3)	0(1)	1(1)	34(3)	58(1)	26(3)	0.0(1)	5(1)	0.0(5)	248(3)		24	5.9
2.20	E	08/29/91	63	8(1)	0(1)	2(3)	0(1)	1(1)	35(3)	38(3)	23(3)	1.0(3)	9(1)	0.0(5)	246(3)		28	5.9
0.30	D	07/24/91	68	12(3)	1(1)	2(3)	0(1)	1(1)	13(1)	28(3)	11(5)	0.6(1)	11(1)	1.7(1)	516(3)		24	5.9
0.30	D	08/29/91	68	13(3)	1(1)	1(1)	0(1)	2(1)	26(3)	71(1)	28(3)	0.9(1)	16(1)	0.9(3)	190(1)		20	6.0
Year: 86																		
11.00	E	07/01/86	22	7(1)	2(3)	1(1)	0(1)	0(1)	34(3)	83(1)	31(3)	8.6(5)	20(1)	2.9(3)	10(1)	*	24	4.0
11.00	E	07/29/86	22	9(3)	3(3)	1(1)	0(1)	1(1)	33(3)	86(1)	24(3)	6.3(5)	11(1)	0.0(5)	18(1)	*	28	3.5
11.00	E	08/25/86	22	7(1)	2(3)	1(1)	0(1)	0(1)	48(5)	67(1)	48(1)	12.5(5)	29(3)	2.1(3)	27(1)	*	26	3.9
9.80	E	07/01/86	26	6(1)	1(1)	1(1)	0(1)	1(1)	37(5)	87(1)	68(1)	0.0(1)	14(1)	1.4(3)	14(1)	*	18	3.5
9.80	D	07/29/86	26	8(1)	1(1)	1(1)	0(1)	1(1)	21(3)	75(1)	55(1)	19.9(5)	9(1)	0.0(5)	102(1)		22	5.1
9.80	D	08/25/86	26	12(3)	1(1)	1(1)	0(1)	2(3)	41(5)	78(1)	52(1)	6.8(5)	30(3)	0.0(5)	59(1)		30	5.0
8.40	D	07/01/86	28	7(1)	0(1)	1(1)	0(1)	1(1)	75(5)	97(1)	20(3)	1.0(3)	3(1)	1.0(3)	9(1)		22	3.6
8.40	D	07/29/86	28	10(3)	0(1)	1(1)	0(1)	1(1)	57(5)	98(1)	19(3)	1.3(3)	1(1)	0.0(5)	25(1)		26	3.7
8.40	D	08/25/86	28	8(1)	0(1)	1(1)	0(1)	1(1)	68(5)	98(1)	15(5)	0.3(1)	2(1)	0.9(3)	19(1)		22	3.7
7.10	D	07/07/86	31	9(1)	4(5)	1(1)	0(1)	0(1)	44(5)	98(1)	15(5)	0.0(1)	2(1)	0.4(3)	11(1)		26	3.4
7.10	D	07/29/86	31	8(1)	1(1)	1(1)	0(1)	0(1)	63(5)	100(1)	9(5)	0.3(1)	0(1)	0.1(3)	5(1)		22	3.1
7.10	D	08/27/86	31	7(1)	1(1)	1(1)	0(1)	0(1)	52(5)	99(1)	13(5)	0.3(1)	0(1)	0.1(3)	7(1)		22	3.3
6.70	D	07/08/86	44	7(1)	0(1)	1(1)	0(1)	0(1)	17(1)	99(1)	53(1)	0.3(1)	1(1)	0.9(3)	6(1)		14	3.4
6.70	D	07/30/86	44	7(1)	0(1)	1(1)	0(1)	0(1)	34(3)	99(1)	61(1)	0.9(1)	1(1)	0.0(5)	21(1)		18	4.1

na - Qualitative data, Modified Iwb not applicable.

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

IBI metrics values and scores for sites sampled in the Little Cuyahoga River survey, 1996.

				Number of					Percent of Individuals								
River Mile	Type	Date	Drainage area (sq mi)	Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
6.70	D	08/27/86	44	8(1)	1(1)	1(1)	0(1)	0(1)	45(5)	96(1)	61(1)	3.5(3)	1(1)	0.0(5)	28(1)	22	4.7
5.00	E	07/08/86	51	4(1)	0(1)	1(1)	0(1)	0(1)	24(3)	100(1)	33(3)	0.0(1)	0(1)	5.5(1)	0(1) *	16	1.8
5.00	D	07/30/86	51	7(1)	0(1)	1(1)	0(1)	0(1)	20(3)	100(1)	77(1)	0.4(1)	0(1)	1.5(1)	6(1)	14	3.2
5.00	E	09/02/86	51	7(1)	0(1)	1(1)	0(1)	0(1)	29(3)	98(1)	33(3)	0.4(1)	2(1)	2.9(1)	7(1)	16	3.5
4.10	D	09/02/86	61	4(1)	0(1)	1(1)	0(1)	0(1)	42(5)	100(1)	10(5)	0.5(1)	0(1)	0.5(3)	2(1)	22	2.3
3.80	E	07/08/86	61	3(1)	0(1)	1(1)	0(1)	0(1)	80(1)	100(1)	40(1)	0.0(1)	0(1)	20.0(1)	0(1) **	12	▲ 1.2
3.80	E	08/04/86	61	4(1)	0(1)	1(1)	0(1)	0(1)	32(3)	97(1)	10(1)	3.2(3)	0(1)	0.0(1)	2(1) *	16	▲ 1.9
3.80	E	08/26/86	61	3(1)	0(1)	1(1)	0(1)	0(1)	55(1)	100(1)	23(1)	0.0(1)	0(1)	9.1(1)	0(1) **	12	▲ 1.3
2.20	E	07/08/86	63	9(1)	2(3)	1(1)	0(1)	0(1)	10(1)	34(3)	9(5)	0.0(1)	5(1)	0.6(3)	159(1)	22	5.2
2.20	E	08/04/86	63	5(1)	1(1)	1(1)	0(1)	0(1)	16(1)	39(3)	17(5)	0.0(1)	2(1)	1.2(3)	79(1) *	20	4.4
2.20	E	08/26/86	63	4(1)	0(1)	1(1)	0(1)	0(1)	22(3)	41(3)	22(3)	2.0(3)	0(1)	3.0(1)	93(1) *	20	4.7
1.80	D	07/08/86	65	14(3)	3(3)	1(1)	0(1)	0(1)	18(1)	20(5)	13(5)	0.3(1)	50(3)	1.3(1)	478(3)	28	7.3
1.80	D	08/04/86	65	17(3)	4(5)	1(1)	0(1)	1(1)	23(3)	19(5)	31(3)	2.7(3)	32(3)	1.0(3)	1384(5)	36	8.3
1.80	D	08/26/86	65	13(3)	3(3)	1(1)	0(1)	1(1)	31(3)	56(1)	24(3)	7.3(5)	41(3)	0.6(3)	240(3)	30	6.3
0.20	D	07/09/86	68	12(3)	2(3)	1(1)	0(1)	1(1)	30(3)	68(1)	43(1)	0.8(1)	18(1)	0.8(3)	146(1)	20	6.3
0.20	D	08/04/86	68	15(3)	2(3)	1(1)	0(1)	1(1)	33(3)	49(1)	30(3)	1.4(3)	21(1)	0.0(5)	467(3)	28	6.9
0.20	D	08/26/86	68	13(3)	3(3)	1(1)	0(1)	1(1)	31(3)	51(1)	17(5)	0.8(1)	25(1)	2.2(1)	219(3)	24	5.9
Ohio Canal - (19049)																	
Year: 94																	
0.10	D	07/13/94	200	5(1)	3(3)	1(1)	0(1)	0(1)	52(5)	70(1)	57(1)	0.0(1)	35(3)	4.3(5)	21(1) *	24	4.0
0.10	D	09/21/94	200	5(1)	0(1)	1(1)	0(1)	0(1)	49(5)	59(1)	54(1)	0.0(1)	2(1)	2.4(5)	51(1) *	20	3.7

na - Qualitative data, Modified Iwb not applicable.

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.