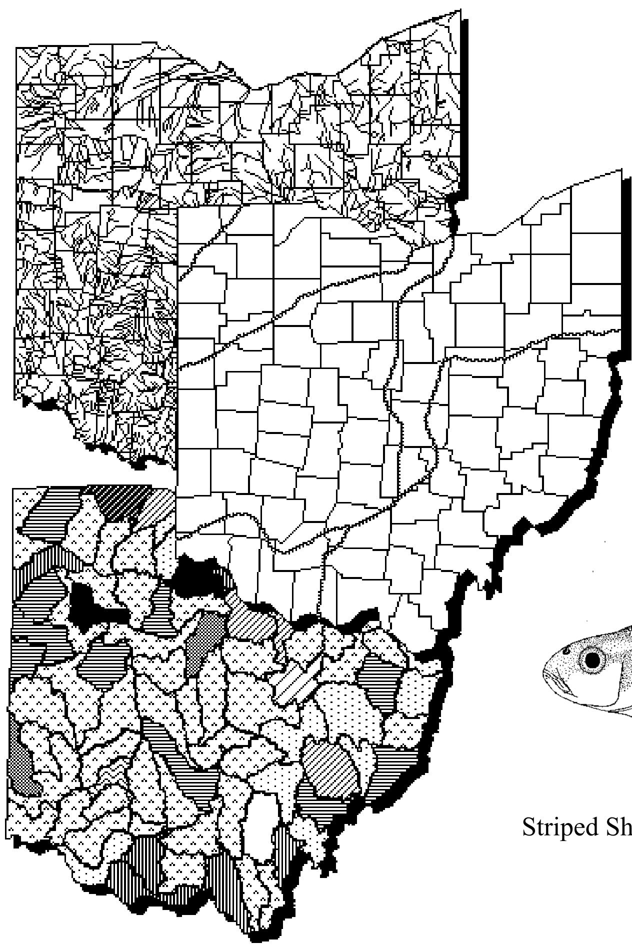
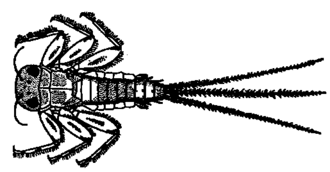
State of Ohio
Environmental Protection Agency

Division of Surface Water

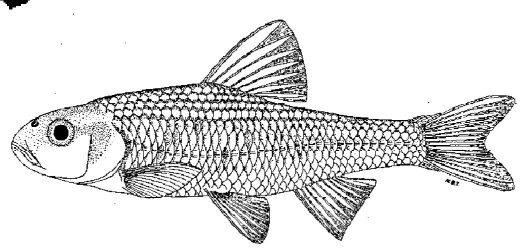
Biological and Water Quality Study of the Rocky River and Selected Tributaries

Summit, Lorain, Medina, and Cuyahoga Counties, Ohio





Mayfly *(Stenonema)*



Striped Shiner *(Notropis chrysocephalus)*

March 15, 1999

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OEPA Technical Report
MAS/1998-12-3

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Ambient Chemical Quality - Steve Tuckerman, Robert Davic
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Reviewer(s) - Chris Yoder, Jeff DeShon, Marc Smith

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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

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

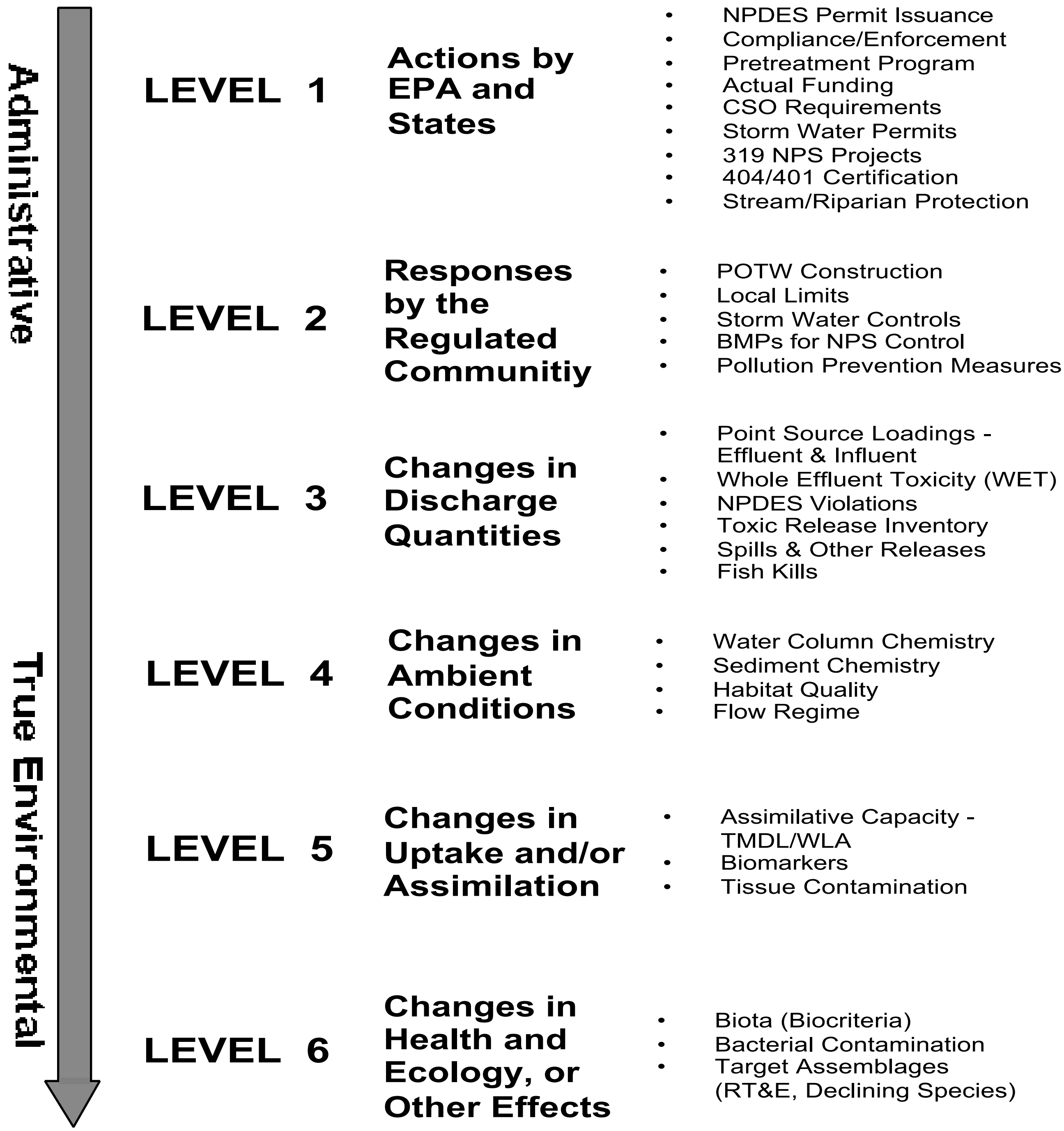

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, 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 coliform, *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.

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INTRODUCTION

As part of the five-year basin approach for ambient monitoring and the NPDES (National Pollution Discharge Elimination System) permitting process, ambient biological, water column chemical and physical sampling was conducted by the Ohio EPA within the Rocky River and selected tributaries. The 1997 study area included the Rocky River mainstem, East Branch, West Branch, Abram Creek, Baldwin Creek, North Royalton "A" WWTP tributary, Plum Creek (tributary to the West Branch), Blodgett Creek, Healey Creek, Cossett Creek, North Branch Rocky River and Plum Creek (tributary to the North Branch). This area was last surveyed by Ohio EPA in 1992 and previous to that in 1981. Nine WWTPs have been eliminated and approximately 10 MGD (15 CFS) of treated WWTP effluent has been removed from the basin since 1992 as a result of tie-ins to the NEORSD Southwest Interceptor. An improvement in the health of instream biological communities might be expected as a result. Conversely, urban runoff and increased development throughout the watershed may exert negative impacts.

This report is limited to evaluating conditions found in 1997 and changes in conditions since 1992 and 1981. Users of this report should reference *Biological and Water Quality Study of the Rocky River and Selected Tributaries* (Ohio EPA, 1993) for more information on conditions encountered in 1992 and for an analysis of trends in conditions prior to that effort .

Specific objectives of this evaluation were to:

1) monitor and assess chemical, physical and biological integrity of the Rocky River study area,

2) determine the attainment status of current aquatic life use and non-aquatic use designations and recommend changes in use where appropriate,

3) evaluate impacts from combined sewer and stormwater overflows (CSOs) and municipal WWTPs on their respective receiving streams, and

4) incorporate previous Ohio EPA studies to evaluate environmental improvements to date and to expand Ohio EPA databases for trends analysis (e.g., 305[b]).

SUMMARY

A total of 92.3 miles of the Rocky River mainstem, its branches and selected tributaries were assessed as part of the 1997 sampling effort. This compares to 84.1 miles assessed in 1992 and 98.1 miles in 1981 Of the total miles assessed in 1997, 44.5 miles were in full attainment of the warmwater habitat (WWH) aquatic life use (48% of the study area); 36.5 miles demonstrated partial attainment (40% of the study area) and 11.3 miles were in non-attainment of the WWH use (12% of the study area). The results demonstrate declines in the percentage of full and nonattainment (down 7% and 13 %, respectively) and an increase in the percentage of partial attainment (up 22%) compared with 1992. Aquatic life use attainment status and biocriteria scores for all sampling locations are presented in Table 1.

Rocky River

Based on the performance of the biological communities compared to ecoregional biocriteria, 8.3 miles of the Rocky River mainstem, including the lacustuary (*i.e.*, the portion influenced by Lake Erie) were in partial attainment of the designated aquatic life use (71% of the surveyed reach). A total of 3.4 miles (29% of the surveyed reach) were in non-attainment. Attainment status, where both organism groups were sampled, was largely determined by the performance of the fish assemblage. While the macroinvertebrates at least marginally achieved ecoregional expectations, one or both fish indices performed at a *fair* to *poor* level throughout the mainstem. A similar pattern was documented in 1992. The ADV statistics for the lotic portion of the Rocky River (Table 2) reflected improved biological communities in 1992 versus 1981 (increased positive ADV statistic values and lower negative ADV statistic values) but little change between 1992 and 1997. A stream that fully met the applicable biocriteria , by comparison, would have negative ADV statistic values of zero. An enrichment effect attributable to the North Olmsted WWTP was moderately decreased in 1997 compared with 1992. Nevertheless, it appeared that the cumulative effects of a high proportion of treated effluent and impacts associated with urban runoff, CSOs, and dry weather sanitary overflows continued to limit full attainment of the WWH aquatic life use. These same sources also contributed to frequent exceedences of the Primary Contact Recreation (PCR) fecal coliform bacteria criteria.

Table 1. Aquatic life use attainment status for the streams sampled in the Rocky River basin, July-October, 1997 (unless otherwise noted). The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities. Fish community sampling was conducted using the wading method.

River Mile Fish/Invertebrate	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Rocky River		*WWH (Existing)*				
11.7/11.5	37^{ns}	6.4*	48	69.0	PARTIAL	
11.3/11.3	*35*	*6.4*	-	-	-	North Olmsted WWTP mixing zone
11.1 /11.1	40	5.8*	36	60.0	**NON**	
- /10.5	-	-	38	-	(FULL)	
10.0 /10.0	37^{ns}	7.2*	G	54.5	PARTIAL	Dst. Abram Creek
8.5/9.0	38	7.3*	30^{ns}	66.0	PARTIAL	
6.1/5.8	28*	5.3*	G	65.0	**NON**	
3.0 /3.0	31*	6.6*	46	73.0	PARTIAL	
1.0/0.7[L]	34*	7.7^{ns}	42	-	PARTIAL	Lacustuary
0.2/0.1[L]	33*	7.7^{ns}	38^{ns}	-	PARTIAL	Lacustuary
Abram Creek		*WWH (Existing)*				
3.2/3.4	16*	NA	18*	42.5	**NON**	
2.8/ -	12*	NA	-	52.5	**(NON)**	
1.9 /1.9	12*	NA	28*	65.5	**NON**	
0.6/0.2	12*	NA	26*	57.5	**NON**	
East Branch Rocky River		*WWH (Existing)*				
29.4 /29.7	44	NA	56	75.0	FULL	
21.9/22.0	44	6.4*	E	67.5	PARTIAL	Reference Site
18.318.3	*42*	*6.3*	-	-	-	Medina 300 WWTP mixing zone
17.5/17.5	43	8.2	50	73.5	FULL	Dst. Medina 300 WWTP
13.0/13.1	41	8.5	50	66.0	FULL	
11.6/11.6	43	7.9	44	69.5	FULL	Dst. North Royalton A WWTP trib.
- /10.8	-	-	42	-	(FULL)	
10.0/10.0	35^{ns}	7.9	42	67.5	FULL	
6.4/6.4	36^{ns}	7.6^{ns}	56	57.5	FULL	
3.0/4.9	34^{ns}	7.0*	42	55.0	PARTIAL	Dst. Baldwin Creek
1.4/1.4	34^{ns}	7.2*	40	66.5	PARTIAL	

Table 1 (continued)

River Mile Fish/Invertebrate	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Baldwin Creek		*WWH (Existing)*				
- /7.5	-	-	MG	-	(FULL)	
7.0/7.0	24*	NA	MG	57.0	PARTIAL	Dst. North Royalton B WWTP
6.1/5.7	20*	NA	42	67.0	PARTIAL	
3.2/3.0	34*	NA	MG	37.0	PARTIAL	
2.6/2.6	24*	NA	34	62.0	PARTIAL	Dst. Strongsville C WWTP
1.4/1.5	22*	NA	38	43.0	PARTIAL	
0.2/ -	24*	NA	-	50.5	(PARTIAL)	
North Royalton "A" WWTP tributary		*WWH (Existing)*				
- /0.6	-	-	F	-	**(NON)**	Ust. North Royalton A WWTP
0.2/0.2	18*	NA	F	72.5	**NON**	Dst. North Royalton A WWTP
West Branch Rocky River		*WWH (Existing)*				
33.5/33.6	32*	NA	46	63.5	PARTIAL	Reference Site
33.3/33.2	43	NA	G	66.5	FULL	Dst. Montville Landfill
27.3/27.3	45	6.8*	36	65.5	PARTIAL	
16.4/16.3	40	7.9	42	66.5	FULL	
13.3/13.3	38	8.0	44	62.0	FULL	Dst. Medina 500 WWTP
4.8/4.8	39	7.8[ns]	44	72.0	FULL	
3.6/3.6	31*	5.9*	44	71.0	PARTIAL	Dst. Blodgett Cr.
1.6/2.1	43	8.0	46	76.0	FULL	Dst. Plum Cr.
0.1/0.4	40	7.4[ns]	E	62.0	FULL	
Plum Creek		*WWH (Existing)*				
2.4/2.9	18*	NA	MG	71.5	**NON**	
0.1/0.2	18*	NA	F	70.5	**NON**	
North Branch Rocky River		*WWH (Existing)*				
5.5/5.6	45	7.6[ns]	54	74.5	FULL	
Blodgett Creek		*WWH (Existing)*				
0.9/ -	31*	NA	-	64.0	**(NON)**	
0.2/ 0.1	40	NA	MG	57.0	FULL	
Healey Creek		*WWH (Existing)*				
0.9	32*	NA	F	65	**NON**	
Cossett Creek		*WWH (Existing)*				
0.2	38[ns]	NA	MG	59.5	FULL	

Table 1 (continued)

River Mile Fish/Invertebrate	**IBI**	**MIwb**	**ICI[a]**	**QHEI**	**Attainment Status[b]**	**Comments**
Plum Creek, tributary to North Branch Rocky River *WWH (Existing)*						
2.5	30*	NA	F	74.5	**NON**	

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)

(OAC Chapter 3745-1-07, Table 8-14)

INDEX-Site Type	WWH	EWH
IBI - Headwaters	40	50
IBI - Wading	38	50
MIwb-Wading	7.9	9.4
ICI	34	46

* - Significant departure from biocriteria (>4 IBI or ICI units; >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
ns - Nonsignificant departure from biocriteria (≤4 IBI or ICI units; ≤0.5 MIwb units).
R - Regional Reference Site.
a - Narrative evaluation used in lieu of ICI numeric score (Exc.=Exceptional; VG=Very Good;G=Good;MG=Marginally Good;P=Poor;VP=Very Poor)).
b - Attainment status based on one organism group is parenthetically expressed.
NA - Headwater site; MIwb is not applicable to streams with drainage areas less than 20 mi^2.

Abram Creek

The entire 3.4 mile sampled segment of Abram Creek was in non-attainment of the WWH aquatic life use designation. Aquatic communities in Abram Creek have been severely impaired since 1981. This is despite the elimination of two WWTPs in the upper watershed by the fall of 1993 and subsequent reductions in loadings of oxygen demanding wastes and ammonia-N. Index of Biotic Integrity (IBI) scores were in the Very Poor range at all sampled locations in 1997. Invertebrate Community Index scores (ICI) were in the Fair range. The ADV statistics (Table 2) demonstrate the severely degraded biological communities in Abram Creek since 1981.

Table 2. Area of Degradation Values (ADV) statistics for the Rocky River, Abram Creek, West Branch Rocky River, Baldwin Creek, and East Branch Rocky River. Values were calculated using Erie Ontario Lake Plain WWH biocriteria as the baseline for community performance.

Stream (Year)			Biological Index Values		ADV Statistics				Attainment Status (miles)		
	Reach				Positive		Negative				
Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	ADV	**ADV/ Mile**	FULL	PARTIAL	**NON**
Rocky River (1997)											
IBI	11.7	1.6	28	40	**146**	**14.5**	223	22.1	0.0	7.9	**2.2**
MIwb			5.3	7.3	0	**0.0**	**512**	50.6			
ICI			30	48	744	73.7	0	0.0			
Rocky River (1992)											
IBI	11.7	1.6	28	42	62	6.1	415	41.1	0.2	9.3	**0.6**
MIwb			6.5	8.8	45	4.4	212	21.0			
ICI			24	30	0	0.0	117	11.5			
Rocky River (1981)											
IBI	11.7	1.6	26	40	62	6.1	627	62.1	0.0	2.5	**7.6**
MIwb			7.3	8.8	350	34.6	1	0.1			
ICI			16	36	161	16.0	432	42.7			
Abram Creek (1997)											
IBI	4.0	0.0	12	16	0	**0.0**	894	**223.5**	0.0	0.0	**3.8**
ICI			18	28	0	**0.0**	240	**60.0**			
Abram Creek (1992)											
IBI	4.0	0.0	12	17	0	**0.0**	905	**226.2**	0.0	0.0	**2.4**
ICI			4	8	0	**0.0**	995	**248.9**			
Abram Creek (1981)											
IBI	4.0	0.0	15	24	0	**0.0**	662	**165.5**	0.0	0.0	**3.8**
ICI			12	24	0	**0.0**	468	**117.0**			

Table 2 (continued)

Stream (Year)			Biological Index Values		ADV Statistics				Attainment Status (miles)		
Index	Reach				Positive		Negative				
	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	ADV	**ADV/ Mile**	FULL	PARTIAL	**NON**
East Branch Rocky River (1997)											
IBI	30.0	0.0	34	44	1747	**58.2**	0.0	**0.0**	14.2	15.8	**0.0**
MIwb			6.4	8.5	417	**13.9**	508	**16.9**			
ICI			40	56	5343	**178.1**	0.0	**0.0**			
East Branch Rocky River (1992)											
IBI	30.0	0.0	22	48	1870	**62.3**	371	**12.3**	22.3	2.6	**5.1**
MIwb			4.5	8.8	1098	**36.6**	682	**22.7**			
ICI			24	54	3065	**102.1**	184	**6.1**			
East Branch Rocky River (1981)											
IBI	30.0	0.0	25	48	2049	**68.3**	607	**20.2**	19.8	5.1	**5.1**
MIwb			5.4	9.1	1621	**54.0**	418	**13.9**			
ICI			22	54	4400	**146.6**	114	**3.8**			
Baldwin Creek (1997)											
IBI	8.0	0.0	20	34	0	**0.0**	885	**110.6**	0.0	1.9	**6.1**
ICI			30	42	429	**53.7**	0.0	**0.0**			
Baldwin Creek (1992)											
IBI	8.0	0.0	17	31	0	**0.0**	1077	**134.7**	0.0	0.6	**7.4**
ICI			28	40	338	**42.2**	8	**1.0**			
Baldwin Creek (1981)											
IBI	8.0	0.0	15	29	0	**0.0**	1216	**152.0**	0.0	0.0	**8.0**
ICI			12	24	0	**0.0**	984	**123.0**			
West Branch Rocky River (1997)											
IBI	28.0	0.0	31	45	1751	**62.5**	14	**0.5**	18.6	9.4	**0.0**
MIwb			5.9	8	389	**13.9**	208	**7.4**			
ICI			36	46	3323	**118.7**	0.0	**0.0**			

Table 2 (continued)

Stream (Year)			Biological Index Values		ADV Statistics				Attainment Status (miles)		
Index	Reach				Positive		Negative				
	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	ADV	**ADV/ Mile**	FULL	PARTIAL	**NON**
West Branch Rocky River (1992)											
IBI	28.0	0.0	28	42	1120	**40.0**	113	**4.0**	21.4	6.6	**0.0**
MIwb			6.6	8.4	906	**32.3**	42	**1.5**			
ICI			30	48	3154	**112.6**	0.0	**0.0**			
West Branch Rocky River (1981)											
IBI	28.0	0.0	17	42	875	**31.2**	322	**11.5**	15.2	10.3	**2.5**
MIwb			4.7	9	923	**32.9**	244	**8.7**			
ICI			8	44	1494	**53.3**	793	**28.3**			

Upstream from Grayton Rd. (RM 1.9), habitat limitations and stormwater runoff from the surrounding urban area were the principle suspected sources of impairment. The primary cause of low biological performance in Abram Creek downstream from Grayton Rd. to the mouth was elevated ammonia-N concentrations originating from deicing operations at Cleveland Hopkins International Airport (CHIA). The ammonia-N enters Abram Creek via a number of stormwater outfalls in concentrations as much as ten times the acute toxicity standard. As a result, the stream was nearly devoid of fish downstream from RM 2.9.

The City of Cleveland has applied for a Section 404 permit to fill in wetlands and culvert or move Abram Creek to allow for the expansion of runways at Cleveland Hopkins International Airport. The area of immediate impact from the proposed runway construction would extend from approximately RM 1.9 to RM 0.9 on Abram Creek. The regulatory agencies and the City are currently discussing and evaluating alternatives for the proposed expansion.

East Branch Rocky River

A total of 29.7 miles of the East Branch Rocky River from upstream from S.R. 303 to the mouth was assessed in 1997. A similar survey was conducted by Ohio EPA in 1992. Full attainment of the existing WWH aquatic life use was indicated for 18.7 miles of the stream. The remainder (11.0 miles) partially met the designated use. Departure from the WWH biocriteria was driven solely by *fair* fish community performance, as the macroinvertebrate community consistently exceeded ecoregional expectations. The partially attaining stream segments were: 1) upstream from the Medina 300 WWTP due to marginal habitat quality in the sampled reach, and 2) downstream from Baldwin Creek. Impairment in the fish community realized in the lower 4.9 miles of the East Branch was reflected in declining in metric scores that began downstream from the Strongsville B tributary (RM 11.1). Similarly, fecal coliform bacteria exceedences were frequently recorded beginning at RM 11.6 and nutrient parameters generally increased in a downstream direction. Elimination of the Berea WWTP in 1992 resulted in a change in attainment status from non-attainment to partially attaining downstream from the former discharge in 1997 (RM 3.2) and was reflected in a decline in the 1997 negative ADV statistics (Table 2).

Baldwin Creek

A total of 7.5 miles of Baldwin Creek from upstream from the North Royalton B WWTP (RM 7.5) to the mouth was assessed in 1997. A similar survey was conducted by Ohio EPA in 1992. Upstream from the North Royalton B WWTP, Baldwin Creek demonstrated attainment of the designated WWH use based on macroinvertebrate sampling alone. The attainment is somewhat suspect in this case since no fish sampling was conducted. Downstream from the North Royalton B WWTP, the WWH aquatic life use was partially attained (RMs 7.0 to 0.1, 93% of the segment). The macroinvertebrates at least marginally attained ecoregional expectations and the fish community performed at a *fair* level. This same reach was in non-attainment of the designated use in 1992, primarily due to the poor condition of the fish assemblage. Consequently, the ADV IBI statistic was only marginally improved in 1997 versus 1992 and 1981. Limited chemical sampling in 1997 yielded exceedences of the PCR criteria for fecal coliform bacteria (2 of 3 samples) at RM 1.4 and RM 3.0. The principal causes of impairment in Baldwin Creek appeared to be nutrient enrichment and habitat alteration.

Blodgett Creek

The lower 0.9 miles of Blodgett Creek was assessed in 1997. A single site at the mouth of the creek was sampled in 1992 (RM 0.1, Lindburgh Rd.) and was replicated in 1997. The upstream site (RM 0.9) failed to attain the WWH aquatic life use, based on fish sampling only. Analysis of the individual fish and macroinvertebrate results from the site at Lindburgh Rd. strongly indicated that an acutely toxic event had impacted the stream prior to sampling even though the WWH criteria were fully met. The macroinvertebrate community at RM 0.1 was in marginally good condition. The first of two fish sampling passes conducted in 1997 at this site yielded young of the year and juvenile representatives of eight species. The second pass produced 14 species including pollution sensitive taxa. The disparity in results suggested that Blodgett Creek had been subjected to an acutely toxic pollution event prior to the initial fish sampling and was recolonized by fishes from the East Branch in the interim between passes. The source of the suspected toxicity is unknown. The fact that, in aggregate, the biocriteria were in full attainment at RM 0.1 shows that elimination of the Strongsville A and Versailles WWTP discharges since the last survey has brought about an improvement in water quality. Additionally, chemical sampling at RM 0.1 demonstrated a significant decline in ammonia-N concentration compared with the 1992 results.

North Royalton A Tributary

The 0.6 mile assessed segment of the tributary failed to attain the WWH aquatic life use. Qualitative macroinvertebrate sampling produced 15 taxa upstream and downstream from the North Royalton A WWTP. The macroinvertebrate community condition at both sites was rated as fair with no readily apparent impact from the WWTP. Habitat impacts brought about by development and construction site runoff appeared to be the primary factor affecting the macroinvertebrates. No fish sampling was conducted upstream from the North Royalton A WWTP in 1997. As in 1981 and 1992, the fish assemblage downstream from the facility in 1997 was apparently severely impacted by stormwater discharges and the WWTP effluent. Only three fish species were collected with pollution tolerant white suckers and creek chubs comprising 92% of the fish community.

West Branch Rocky River

A total of 33.6 miles of the West Branch Rocky River upstream from S.R. 162 (RM 33.6) to the mouth (RM 0.1) was assessed in 1997. A similar survey was conducted by Ohio EPA in 1992. Full attainment of the existing WWH aquatic life use was indicated for 23.4 miles (70%) of the stream. The remainder (10.2 miles; 30%) partially met the designated use. Departure from the WWH biocriteria was driven solely by *fair* fish community performance, as the macroinvertebrate community consistently exceeded ecoregional expectations. The miles of impairment reflected by MIwb/ADV statistic suggests an uneven distribution of individuals and biomass within the community. The partially attaining stream segments were: 1) at the upstream limit of the survey (RM 33.6), 2) Fenn Rd. (RM 27.3) and 3) downstream from Blodgett Creek (RM 3.6). Fish populations in the upper two partially attaining segments were impacted by habitat modification related to residential construction. These areas fully met the WWH biocriteria in 1992. The stream reach downstream from the Medina 500 WWTP (RM 13.3) to the mouth was improved overall in 1997 compared with 1992. The reach that did not fully attain the designated WWH use was reduced from 8.5 miles in 1992 to 1.0 mile in 1997. This 1.0 mile segment was a partially attaining reach downstream from Blodgett Creek. Biological and chemical water quality sampling of the West Branch demonstrated a shift in impact type from primarily nutrient enrichment due to point sources in 1992 to perturbations associated with an urban land use in 1997.

Plum Creek

The entire 2.9 mile assessed reach of Plum Creek was in non-attainment of the WWH aquatic life use. The fish were in poor condition and the macroinvertebrate community was rated marginally good upstream from the Western Ohio Utility WWTP discharge and fair near the mouth. Both organism groups reflected gross organic enrichment. Similar conditions were encountered in 1992 and demonstrate sustained degradation within the watershed. Chemical sampling demonstrated a significant increase in nutrient parameters and an exceedence of the total lead OMZA criterion near the mouth of Plum Creek. Plum Creek was the only tributary that showed any heavy metals exceedences during the 1997 survey, but the specific source(s) for the lead was unknown. The secondary contact recreation (SCR) criterion for fecal coliform bacteria was exceeded in three of five samples collected at RM 2.7 and in all five samples collected at RM 0.3. Potential sources of impact included the three WWTP discharges (all are now closed), unsewered areas, construction site runoff and polluted stormwater runoff.

North Branch Rocky River

The North Branch Rocky River at Remsen Rd (RM 5.6) has consistently supported diverse biological communities including good numbers of pollution sensitive taxa. The 1997 sampling results were no exception. Full attainment of the WWH aquatic life use was documented. It did not appear that expanding development was significantly affecting the stream at this time. Given the history of lower biological quality associated with increased urban land use exhibited elsewhere in the Rocky River basin and throughout the state, attention needs to be paid to construction practices and storm water quality and retention in this subwatershed in order to protect this stream.

Healey Creek

A district office site survey of Healey Creek indicated that fish and macroinvertebrate communities at RM 0.9 on Healey Creek were in fair condition. The failure of the biological communities to attain the designated WWH aquatic life use was largely due to stream flow becoming intermittent during the summer. Chemical sampling results were below the method detection limits for most parameters analyzed. Development within the basin may be increasing the occurrence of interstitial or intermittent stream flow. A significant portion of the area has become suburbanized since the area was last surveyed in 1981. The addition of a third lane to Interstate 71 is likely to increase development within the basin.

Cossett Creek

A district office site survey of Cossett Creek indicated that the stream at RM 0.2 was marginally attaining the WWH aquatic life use designation, with no obvious signs of significant pollutant loadings. This marginal attainment may be partly explained by the marginal QHEI value of 59.5. The water temperature was 15.2° C which is cool for the August time period; however, no cold water taxa of macroinvertebrates were collected. Numerous adult two-lined salamanders, *Eurycea bislineata,* were observed under rocks along the stream margins. This species is a common inhabitant of constant flowing headwater streams in northeast Ohio. The water chemistry data indicated that the stream was nutrient poor, with total phosphorus below 0.05 mg/l and nitrate-nitrite below 0.10 mg/l. Cadmium was detected at 0.5 ug/l, which is unusual for a small headwater stream.

Plum Creek, tributary to the North Branch Rocky River

A district office site survey of Plum Creek indicated that the stream at RM 2.5 was not in attainment of its aquatic life WWH potential, most likely due to a combination of excessive siltation and nutrient enrichment. Field observations included moderate to heavy siltation with moderate embeddedness of the cobble substrate. Urban runoff from the upstream Brunswick area was a possible source of the in-stream siltation. The stream water was turbid during the collection of samples, even though the stream water stage was low. The summer water temperature was 23.5° C indicating that the stream has no potential to support a cold water fish community. The stream supported a fair macroinvertebrate community with 6 EPT taxa (Ephemroptera, Trichoptera and Plecoptera) and 20 total taxa collected. No cold water taxa of macroinvertebrates were collected. The water chemistry data indicated that the stream was slightly nutrient enriched.

CONCLUSIONS

Urban runoff, CSOs and dry weather sanitary overflows contributed to fecal coliform bacteria exceedences and increased nutrient loads to the East Branch and mainstem of the Rocky River during 1997. Construction site and increased stormwater runoff associated with ongoing development were identified as negatively affecting a number of subwatersheds within the Rocky River basin. These same sources threaten to impact other portions of the watershed.

The impact from the North Olmsted WWTP was less in 1997 compared with results of the study conducted in 1992. However, biological communities in the Rocky River mainstem were not significantly improved overall compared with the previous study. It appears that the cumulative effects of a high proportion of treated effluent and impacts associated with urban runoff, CSOs and dry weather sanitary overflows continued to impact the stream.

The elimination of nine WWTPs and approximately 10 MGD (15 CFS) of treated WWTP effluent from the basin since 1992 has resulted in limited improvement in water quality and health of aquatic communities. The removal of these plants has made impacts from other sources more evident. These sources include deicing operations at the Cleveland Hopkins International Airport on Abram Creek, urban runoff, CSOs, dry weather sanitary overflows and ongoing residential and urban development throughout the watershed.

RECOMMENDATIONS

Status of Aquatic Life Uses

The current Warmwater Habitat aquatic life use that applies to the entire Rocky River watershed should be maintained for all stream segments surveyed as a part of this study. Overall physical habitat conditions were considered to be acceptable, although significant alteration of the flow regime has occurred on the mainstem, branches and larger tributaries due to the discharge of effluents and increasing urbanization. Despite the potential effects they were not sufficient to warrant changes to the WWH use designation of the assessed streams.

The WWH aquatic life use should be considered threatened in those areas that are currently fully or partially attaining due to pollution associated with ongoing development and construction site runoff within the Rocky River watershed.

The State Resource Water (SRW) designation currently applied to the Rocky River mainstem, East Branch, and Baldwin Creek should be retained. All or portions of the streams and their riparian areas are a part of the Cleveland Metropolitan Park system.

Status of Non-Aquatic Life Uses

The existing Primary Contact Recreation (PCR) designation for the surveyed streams should be retained. The streams have pools with average depths of at least 3 feet covering an area exceeding 100 square feet, the requisite habitat feature to qualify for a Primary Contact Recreation use designation.

Exceedances of the primary contact recreation criterion occurred in 57 of 131 samples (44%) collected throughout the Rocky River study area. The pervasiveness of the exceedances suggests CSOs, urban stormwater and polluted runoff as likely sources of the contamination.

Other Recommendations

Efforts to identify and remediate CSOs and dry weather sanitary overflows should be encouraged. Additionally, practices to control urban runoff and protect riparian vegetation in developing areas need to be instituted.

Ammonia-N releases resulting from deicing operations at the CHIA need to be controlled. Meeting the water quality criterion is necessary before recovery of biological communities in Abram Creek can occur.

The good habitat quality of the lower two miles of Abram Creek should be maintained in order to allow recovery of the fish and macroinvertebrate communities once the ammonia-N toxicity problem is controlled.

Future Monitoring Needs

An evaluation is needed of nonpoint source pollution impacts in unmonitored stream segments in the Rocky River Basin.

Possible sources of nutrients and bacteria entering the East Branch from sources in and near the Berea urban area need to be identified.

Possible sources of nutrients and bacteria entering the mainstem from North Olmsted SSOs, and NEORSD and Lakewood CSOs should be investigated.

Monitoring of changes in biota and water quality should follow the needed remediation of the excessive ammonia-N levels in CHIA runoff. Initially, the extent of the instream toxicity due to ammonia-N in Abram Creek downstream from the Cleveland Hopkins Airport 004 and 005 stormwater discharges needs to be defined. Subsequent water quality sampling should include pH, ammonia-N, and flow to document long term loadings to Abram Creek, Rocky River, and Silver Creek. Additionally, chronic bioassay tests need to be conducted to quantify and monitor the toxicity of the various airport outfalls.

A survey is needed to identify source(s) of fecal coliform bacteria, nutrients and lead in Plum Creek.

Fish sampling is needed on the North Royalton A tributary upstream and downstream from the discharge. A poor fish community was encountered near the mouth of the stream. The additional sampling is needed in order to determine the extent that the WWTP was responsible versus upstream land uses. Chronic bioassay testing may also be needed.

Table 3. Existing and recommended beneficial use designations for the Rocky River study area. Recommendations are based on the results from the 1997 Rocky River sampling effort.

River/Stream Affected Segment	**Beneficial Use Designations**												
	Aquatic Life Habitat							**Water Supply**			**Recreation**		
	SRW	**WWH**	**EWH**	**MWH**	**SSH**	**CWH**	**LRW**	**PWS**	**AWS**	**IWS**	**BW**	**PCR**	**SCR**
Rocky River													
confluence of East and West Branches (RM 12.1) to S.R. 10	+	+							+	+		+	
S.R. 10 (RM 6.4) to mouth	+	+							+	+		+	
Abram Creek													
Entire Length		+							+	+		+	
East Branch Rocky River													
Headwaters to Hinckley Reservation	+	+							+	+		+	

Table 3 continued.

River/Stream Affected Segment	**Beneficial Use Designations**												
	Aquatic Life Habitat							**Water Supply**			**Recreation**		
	SRW	**WWH**	**EWH**	**MWH**	**SSH**	**CWH**	**LRW**	**PWS**	**AWS**	**IWS**	**BW**	**PCR**	**SCR**
East Branch Rocky River (continued)													
Within the boundaries of the Hinckley Reservation	+	+							+	+		+	
Upstream boundaries of the Rocky River Res. to confluence with West Br.	+	+							+	+		+	
All other segments		+							+	+		+	
Baldwin Creek													
Entire length	+	+							+	+		+	
North Royalton "A" Tributary													
Entire length		+							+	+		+	
West Branch Rocky River													
Entire length		+							+	+		+	
Plum Creek													
Entire length		+							+	+		+	
Blodgett Creek (a.k.a. Strongsville "A" trib.)													
Entire length		+							+	+		+	
North Branch Rocky River													
Entire length		+							+	+		+	
Healey Creek													
Entire length		*/+							+	+		+	

Table 3 continued.

River/Stream Affected Segment	**Beneficial Use Designations**												
	Aquatic Life Habitat							**Water Supply**			**Recreation**		
	SRW	**WWH**	**EWH**	**MWH**	**SSH**	**CWH**	**LRW**	**PWS**	**AWS**	**IWS**	**BW**	**PCR**	**SCR**
Cossett Creek													
Entire length		*/+							+	+		+	
Plum Creek, tributary to North Branch Rocky River													
Entire length		*/+							+	+		+	

+- Designated use based on the results of an integrated ambient biological assessment performed by Ohio EPA (verified).
*/+- Designated use based on 1978 water quality standards and supported by the 1997 ambient biological field assessment.

STUDY AREA DESCRIPTION

The Rocky River basin, situated between the Cuyahoga River and the Black River basins, drains 293.8 square miles in northeast Ohio (Ohio Dept. of Natural Resources, 1985). The basin headwaters are in Medina and Summit Counties. The river and its tributaries flow in a northerly direction through glaciated topography to drain into Rocky River Harbor and Lake Erie between the cities of Lakewood and Rocky River on the west side of the Cleveland metropolitan area. Specific sampling station locations are presented in Table 4.

Major hydrologic features in the Rocky River Basin include: Rocky River Harbor, the Rocky River mainstem, East Branch, and West Branch. Rocky River Harbor consists of the lower 4,200 feet of Rocky River, an artificial lagoon on the east side near the river mouth with a side channel called the West Channel, and an entrance channel from Lake Erie (U.S. Army Corp of Engineers, 1975). The Rocky River is formed by the confluence of the East and West Branches that join together 12 miles upstream from Lake Erie.

Land use in the northern half of the Rocky River watershed is dominated by urban and suburban communities on the west side of the Cleveland metropolitan area, while in the southern half of the watershed land use varies from smaller urban/suburban areas to agricultural production. Rocky River Harbor and its adjacent communities are a highly urbanized area (Ohio EPA, 1983). Table 5 presents the general characteristics of streams in the study area. Nine WWTPs have been eliminated in the Rocky River watershed, since the watershed was surveyed in 1992. The eliminated discharges and process changes at remaining WWTPs are listed in Table 6.

The Rocky River Basin is located in the Erie-Ontario Lake Plain (EOLP) ecoregion. The EOLP is characterized by glacial plains interspersed with higher remnant beach ridges, drumlins, glacial till ridges, till plains, and outwash terraces. Local relief is greater in the Erie-Ontario Lake Plain ecoregion (northeast Ohio) than in the neighboring Huron-Erie Lake Plain (northwest Ohio) and Eastern Corn Belt Plains (central and western Ohio) ecoregions, but less than the relief found in the Western Allegheny Plateau (southeast Ohio) ecoregion (Omernik, 1988).

Table 4. Sampling locations (effluent sample - E, water chemistry - C, fecal coliform bacteria - FC, macroinvertebrates - M, fish - F, Datasonde - D) in the Rocky River study area, 1997.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Rocky River				
11.7	M	41 24 29 /81 52 59	Valley Parkway	North Olmsted
11.5	F,C,D,FC	41 24 29 /81 52 48	Valley Parkway	North Olmsted
11.3	F,M	41 24 51 /81 52 45	N. Olm. WWTP mix	North Olmsted
11.1	F,M,C,FC	41 24 48 /81 52 36	Adj. Park Blvd.	North Olmsted
10.5	M	41 25 03 /81 52 07	Ust. Brookpark Rd	Lakewood
10.0	F,M,C,FC	41 25 03 /81 51 32	Brookpark Rd.	Lakewood
9.3	D	41 25 33 /81 51 14	Adj. Park Blvd.	Lakewood
9.0	M	41 25 48 /81 51 03	Near picnic area	Lakewood
8.5	F	41 26 00 /81 50 36		Lakewood
8.2	C,FC	41 25 47 /81 51 04	Puritas Rd	Lakewood
6.1	F	41 27 06 /81 49 30		Lakewood
5.8	M	41 27 20 /81 49 17	Dst. SR 10	Lakewood
3.0	F,M,C,FC	41 28 11 /81 49 57	Park Blvd.	Lakewood
1.0	F,M,C,FC	41 28 44 /81 50 02	Estuary	Lakewood
0.2	F	41 29 21 /81 50 08		Lakewood
0.1	M	41 29 27 /81 50 16	Estuary	Lakewood

Table 4 (continued)

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Abram Creek				
3.9	C,FC	41 23 21 /81 50 05	Sheldon Rd.	Lakewood
3.4	M	41 23 31 /81 50 34	Ust.Eastland Rd.	Lakewood
3.2	F	41 23 32 /81 50 38	Eastland Rd.	Lakewood
2.8	F	41 23 34 /81 51 05		Lakewood
1.9	F,M,C,FC	41 23 43 /81 51 57	Grayton Rd.	Lakewood
0.8	C,FC	41 24 27 /81 52 11	Cedar Pt. Rd.	Lakewood
0.6	F	41 24 37 /81 52 10		Lakewood
0.2	M	41 24 57 /81 52 07	Dst. West Area Rd.	Lakewood
West Branch Rocky River				
33.6	M,C,FC	41 06 23 /81 48 22	Copley Rd.	Seville
33.5	F	41 06 23 /81 48 22	SR 162	Seville
33.3	F	41 06 33 /81 48 33	Ridgewood Rd.	Seville
33.2	M	41 16 21 /81 55 20	Dst. Ridgewood Rd.	Seville
27.3	F,M	41 10 17 /81 51 13	Fenn Rd.	Medina
16.4	F,C,FC	41 15 34 /81 55 47	Grafton Rd.	West View
16.3	M	41 15 38 /81 55 48	Dst. Grafton Rd.	West View
14.9	D	41 16 21 /81 55 20	Ust. Medina 500 trib.	West View
14.5	D	41 16 33 /81 55 20	Dst. Medina 500	West View
13.3	F,M,C,FC	41 17 03 /81 55 57	adj. West River Rd.	West View
11.7	D	41 17 41 /8155 05	Columbia Hills CC	West View
4.8	F,M	41 21 21 /81 53 46	I-80	West View
4.7	C,FC	41 21 25 /81 53 45	I-80	West View
3.6	F,M	41 22 19 /81 53 55	Bagley Rd.	West View
3.5	C,FC	41 22 21 /81 52 55	Bagley Road	West View
2.1	M	41 23 21 /81 53 35	adj. Lewis Rd.	West View
1.6	F	41 23 44 /81 53 46		West View
0.4	M,C	41 24 16 /81 53 35	Lewis Rd.	West View
0.1	F	41 24 16 /81 53 19		West View

Table 4 continued.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
East Branch Rocky River				
29.7	M	41 14 28 /81 41 20	Ust S.R. 303	W. Richfield
29.4	F	41 14 18 /81 41 15		W. Richfield
22.0	M	41 14 21 /81 43 40	SR 303	W. Richfield
21.9	F,C,FC	41 14 24 /81 43 40	SR 303	W. Richfield
18.3	D	41 16 23 /81 44 28	Ust Medina 300	Broadview Heights
18.3	F,M	41 16 25 /81 44 29	Medina 300 WWTP Mix	W. Richfield
17.5	F,M	41 16 49 /81 44 28	Private road. nr. SR 3	Broadview Hts.
17.1	C,FC	41 16 59 /81 44 41	SR 3	Broadview Hts.
17.0	D	41 17 03 /81 44 47	Dst. Healey	Broadview Hts.
15.3	D	41 17 38 /81 45 29	Ust. Bennett Rd.	Berea
13.1	M	41 18 16 /81 46 57	Ust. N. Royalton A Trib.	Berea
13.0	F,D	41 18 29 /81 46 58	Ust. N. Royalton A Trib.	Berea
12.5	D	41 18 37 /81 47 20	Dst. N. Royalton A Trib.	Berea
12.2	D	41 18 40 /81 47 37	Mill Stream Run Rd.	Berea
11.6	F,M,C,FC	41 18 45 /81 47 54	SR 82	Berea
10.8	M	41 19 08 /81 48 28	Dst. Strongville B trib.	Berea
10.0	F,M,C,FC	41 19 29 /81 49 05	Mill Stream bridge	Berea
6.5	C,FC	41 21 00 /81 50 45	Park Blvd. ford	Berea
6.4	F,M	41 21 03 /81 51 35	Park Blvd. ford	Berea
4.9	M,C,FC	41 22 00 /81 51 16	Bridge St.	Berea
3.0	F	41 23 10 /81 51 59		Lakewood
1.4	F,M,C,FC	41 23 45 /81 53 04	Spafford Rd.	North Olmsted
0.1	D	41 24 21 /81 53 07	Near Mouth	North Olmsted
Baldwin Creek				
7.5	M	41 20 56 /81 46 23	Ust. N. Royalton B WWTP	Berea
7.0	F,M	41 20 01 /81 46 38	Adj. Abbey Rd.	Berea
6.1	F	41 21 39 /81 46 50		Berea
5.8	D	41 21 47 /81 46 55	Bagley Rd.	Berea
5.7	M	41 21 54 /81 47 02	Dst. Bagley Rd.	Berea

Table 4 (continued)

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Baldwin Creek (continued)				
3.2	F	41 21 11 /81 49 06		Berea
3.0	M	41 21 02 /81 49 14	Sprague Rd.	Berea
2.6	F,M,FC	41 21 01 /81 49 33	Main Rd.	Berea
1.5	M	41 21 27 /81 50 13	Adj. Fowles Rd.	Berea
1.4	F,D,FC	41 21 28 /81 50 21	Eastland Rd.	Berea
0.2	F	41 21 53 /81 51 19		Berea
Blodgett Creek				
0.9	F	41 21 03 /81 53 11		West View
0.1	F,M	41 21 30 /81 53 37	Lindburgh Rd.	West View
North Royalton “A” Tributary				
0.6	M,C	41 18 46 /81 46 29	Ust. N. Royalton A WWTP	Berea
0.2	F,M,C	41 18 30 /81 46 51	Edgerton Rd.	Berea
North Branch Rocky River				
5.6	M	41 11 14 /81 47 08	Remsen Rd.	Medina
5.5	F	41 11 09 /81 46 59	Remsen Rd.	Medina
Plum Creek				
2.9	M,	41 21 31 /81 55 17	Usher Rd.	West View
2.7	C,FC	41 21 31 /81 55 18	Usher Rd.	West View
2.4	F	41 21 35 /81 54 48		West View
0.3	C,FC	41 22 33 /81 54 08	SR 252	North Olmsted
0.2	M	41 22 39 /81 54 08	SR 252	North Olmsted
0.1	F	41 22 40 /81 54 07	Near mouth	North Olmsted
Healey Creek				
0.9	M,F,C	41 16 27/ 81 45 13	Ust Boston Rd	Berea
Cossett Creek				
0.2	M,F,C	41 13 38/ 81 55 14	Ust. S.R. 252	Mallet Creek
Plum Creek, Trib. to North Branch Rocky River				
2.5	M,F,C	41 12 36/ 81 48 23	Ust old Medina 500 WWTP	Medina

Table 5. Stream characteristics and significant identified pollution sources in the Rocky River study area, 1997.

Stream Name	Length (Miles)	Average Fall (Feet/Mile)	Drainage Area (Square Miles)	Nonpoint Source Pollution Categories	Point Sources Evaluated
Rocky River	12.1	13.7	293.8	Urban runoff Sanitary & storm sewers Airport runoff On-site septic systems	North Olmsted WWTP NASA Hopkins Intl. Airport
Abram Creek	7.4	29.4	10.1	Urban runoff Storm sewers Industrial landfills	NASA Hopkins Intl. Airport
West Branch Rocky River	36.3	16.0	188.3	Urban runoff Sanitary landfill Agriculture On-site septic systems	Montville Landfill Medina 500 WWTP
East Branch Rocky River	34.5	16.5	80.4	Urban runoff Sanitary and storm sewers On-site septic systems Agriculture	Medina 300 WWTP Strongsville B WWTP
Baldwin Creek	9.2	53.8	11.9	Urban runoff Storm sewers On-site septic systems	N. Royalton B WWTP Strongsville C WWTP
North Royalton A Tributary	1.4	35.7	2.6	Urban runoff	N. Royalton A WWTP
North Branch Rocky River	5.4	22.4	37.6	Agriculture Urban runoff On-site septic systems	
Plum Creek	14.8	16.4	18.9	On-site septic systems	Brentwood WWTP Western Ohio Utility WWTP (both abandoned 11/97)
Blodgett Creek	5.1	31.4	2.7	Urban runoff	

Table 6. WWTPs abandoned or with process changes in the Rocky River basin between 1992 and 1997.

Facility	Receiving Stream	Change
Brookpark WWTP	Abram Creek	Abandoned (10/04/1993)
Middleburg Heights WWTP	Abram Creek	Abandoned (10/04/1993)
Brentwood WWTP	Plum Creek	Abandoned (11/01/1997)
Western Ohio Utility WWTP	Plum Creek	Abandoned (11/01/1997)
ODOT Park 3-39 WWTP	Plum Creek	Abandoned (late 1997)
NEORSD Strongsville A WWTP	Blodgett Creek	Abandoned (07/28/1994)
Olmsted Falls, Versailles WWTP	Blodgett Creek	Abandoned (02/01/1995)
Lake Erie Girl Scout WWTP	UN Trib. Rocky River	Abandoned (1997?)
Medina 500 WWTP	West Br. Rocky River	De-chlorination (1994)
NEORSD Berea WWTP	East Br. Rocky River	Abandoned (07/28/1994)

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).

Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.,* FULL, PARTIAL, and **NON**) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 8-14). The biological community performance measures that are 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 (1994). 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 1988). 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 at least 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.

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, 1994). 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 in-stream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score that generally ranges from 20 to 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. Scores greater than 75 frequently typify habitat conditions that 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 assessed using a new assessment tool. 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 ICI's 0 to 60 scale. For the qualitative collections in the Rocky River 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. QCTV scores for sampling locations in the study area were used in conjunction with other aspects of the community data to make evaluations and were not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Fish Community Assessment

Fish were sampled using wading or boat method pulsed DC electrofishing gear. The wading method was used at a frequency of one or two samples at each site. The boat method was used at a frequency of two samples at each site.

Area of Degradation Value (ADV)

An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1995) was calculated for the study area based on the longitudinal performance of the biological community indices. The ADV 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 2). 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.

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 the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter 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 1991a; Yoder 1994). 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, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1994) within the biological data itself. Thus the assignment of principal causes and sources of impairment in this report do not represent a true "cause and effect" analysis, but rather represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified. The process is similar to making a medical diagnosis in which a

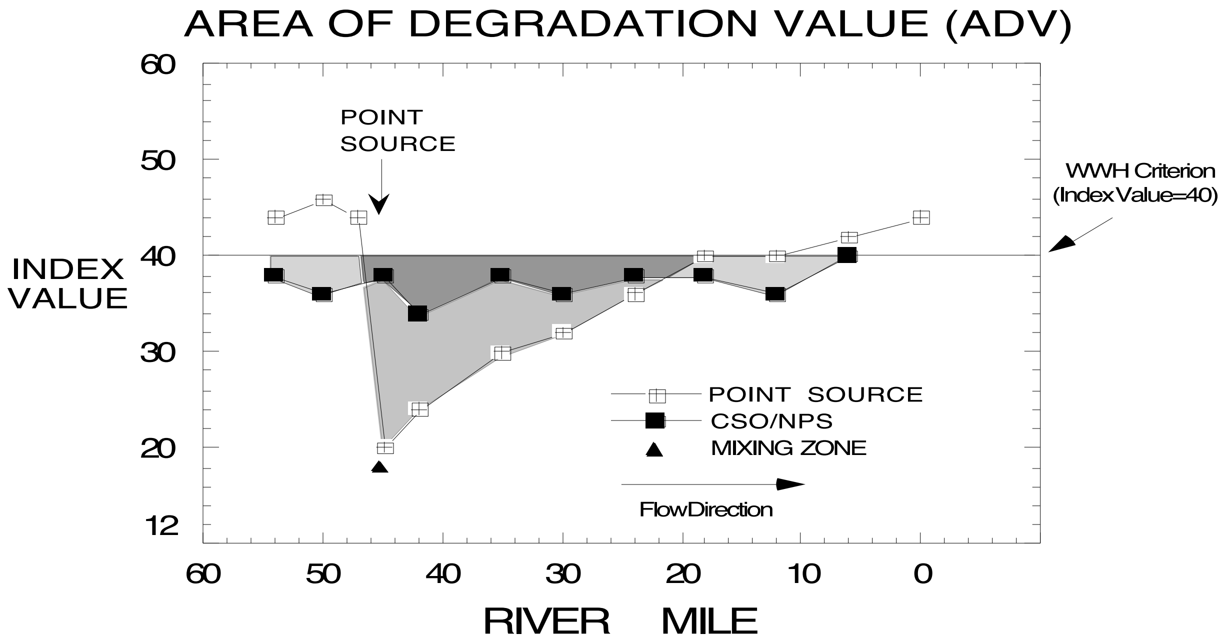


Figure 2 Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears 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.

doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research which experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experience in interpreting symptoms (*i.e.,* multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and the well-being of the patient, the ultimate measure of success in water resource management is 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) here we are referring to the process for identifying biological integrity and causes/sources associated with observed impairment, not whether human health and ecosystem health are analogous concepts.

RESULTS AND DISCUSSION

Pollutant Loadings

Medina 300 WWTP (East Branch: RM 18.2)

The Medina 300 WWTP is a recently expanded 4.0 MGD extended aeration plant with filters, phosphorus removal and de-chlorination. Only total suspended solids (TSS) loadings have increased at this WWTP. All other loadings have remained constant. Figure 3 shows graphs of average flow and TSS loading trends for the Medina 300 WWTP from 1981 to 1997. The Medina 300 WWTP diverts a portion of its flow for irrigation at a nearby golf course.

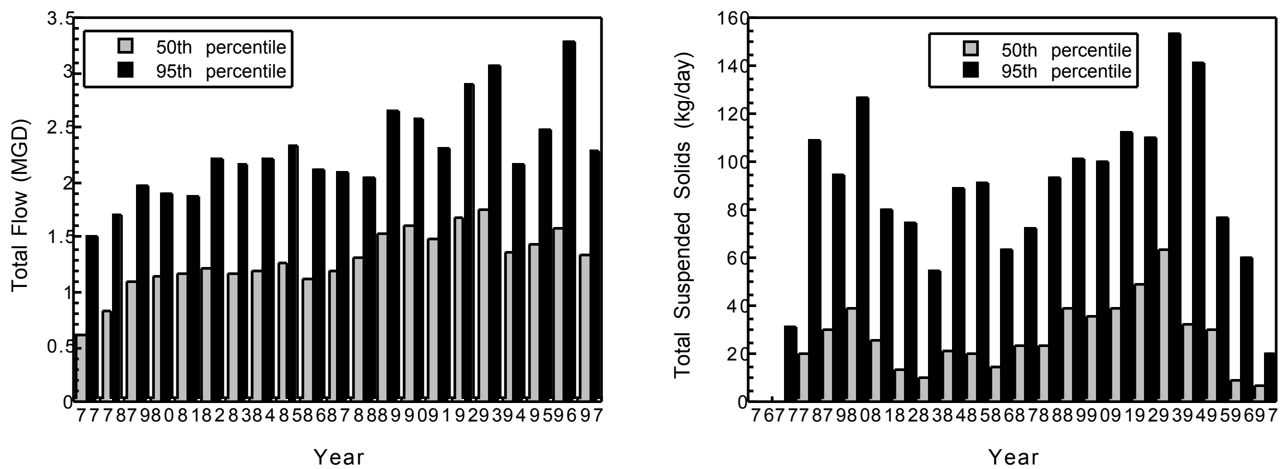


Figure 3 Median and 95th percentile flow and annual total suspended solids loadings to the East Branch Rocky River by the Medina 300 WWTP, 1977-1997.

Strongsville B WWTP (East Branch: RM 11.1, 0.4)

Treatment at this WWTP includes rotating biological contactors, filters and phosphorus removal. There has been no apparent trend in flows or loadings from the Strongsville B WWTP from 1981 to 1997. A recently constructed regional mall and subsequent development may change the loadings from this facility.

Medina 9 WWTP (East Branch: RM 22.5, 0.9)

The Medina 9 WWTP is an extended aeration plant. There has been no apparent trend in flows or loadings from the Medina 9 WWTP from 1981 to 1997. A significant increase in the 95th percentile loadings for ammonia–N did occur in 1996. This high loading was isolated.

North Olmsted WWTP (Rocky River: RM 11.4)

Treatment at this WWTP is advanced secondary with phosphorus removal. Total phosphorus and copper loadings appear to be increasing at the facility (Figure 4). TKN and ammonia loads have decreased since 1992 indicating better operation of the treatment facility (Figure 4).

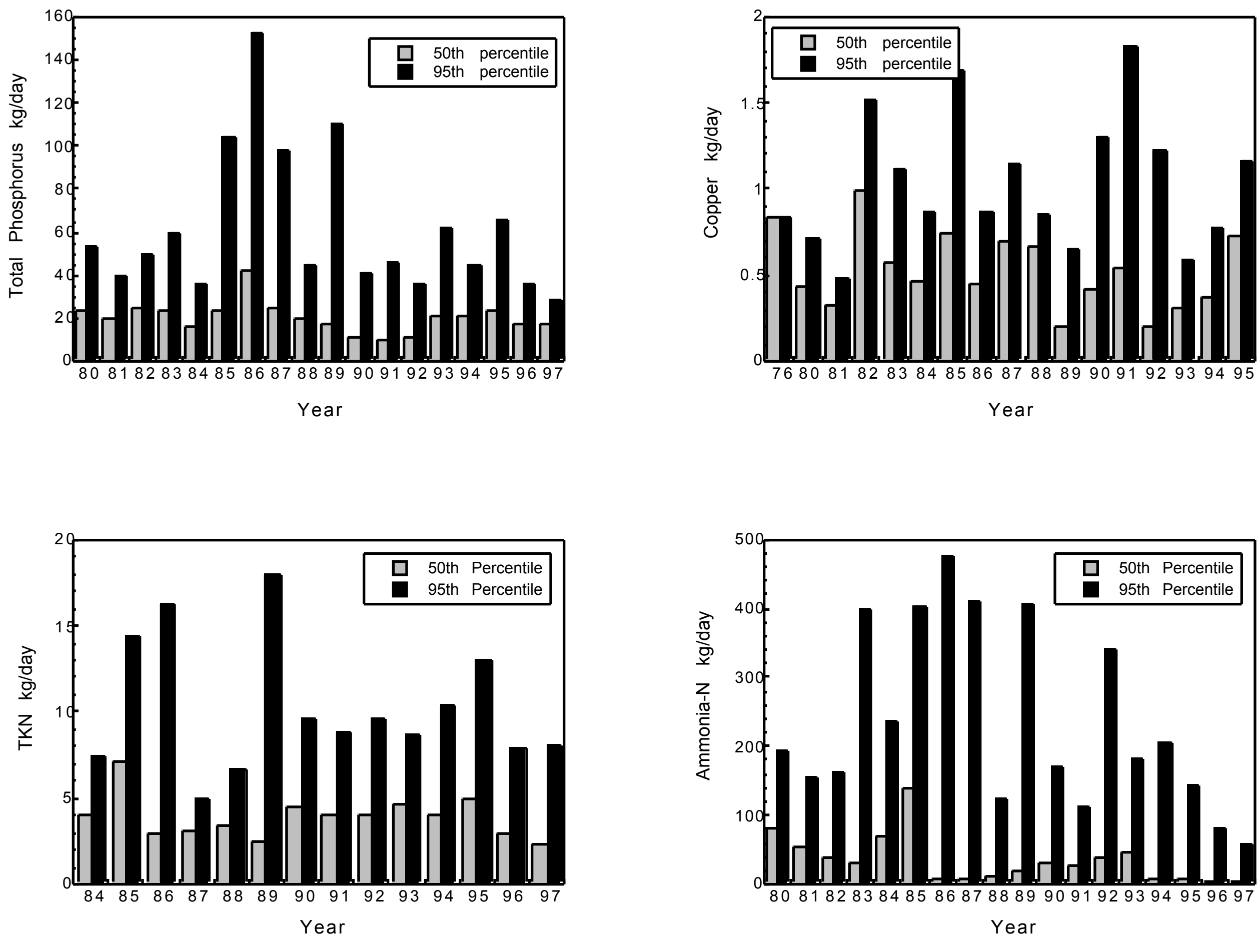


Figure 4 Median and 95th percentile annual phosphorus, copper, TKN, and ammonia-N loadings to the Rocky River by the North Olmsted WWTP, 1976-1997.

North Royalton A WWTP (East Branch: RM 12.9, 0.5)

This 3.3 MGD WWTP is an extended aeration plant with phosphorus removal and filtration. Flows have steadily decreased since 1992 with a concurrent reduction of conventional pollutant loadings. Figure 5 illustrates the flow and TSS loading reductions at this facility.

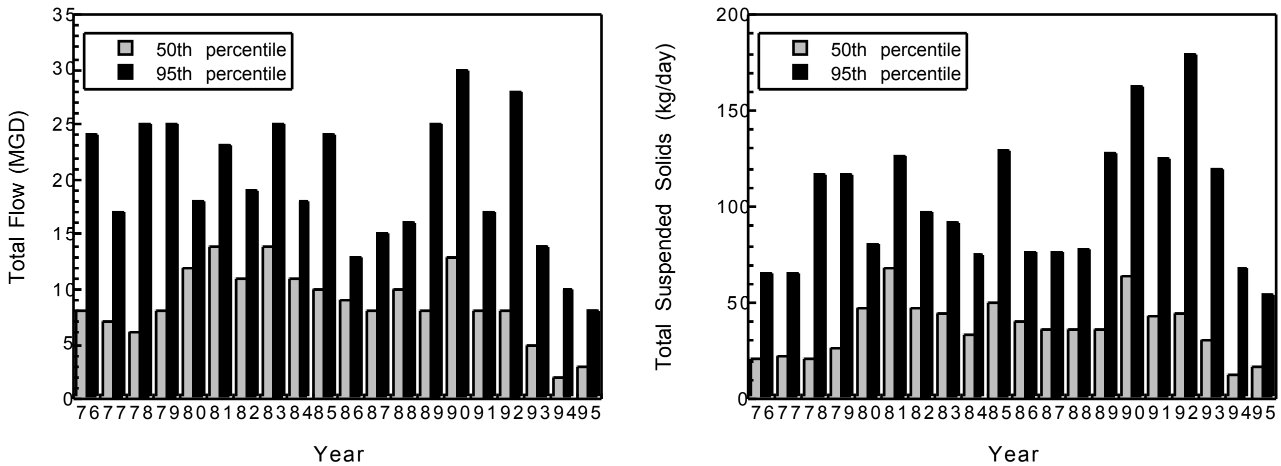


Figure 5 Median and 95th percentile flow and annual total suspended solids loadings to the East Branch Rocky River by the North Royalton A WWTP, 1977-1995.

Medina 500 WWTP (West Branch: RM 14.8)

This facility is a powdered activated carbon (PAC) plant with tertiary treatment and phosphorus removal. Their current permit became effective on May 1, 1994 and expires on April 30, 1999. Treatment processes include bar screen, aerated grit chamber, primary clarification, extended aeration, secondary treatment, secondary clarification, sand filters, chlorination, and dechlorination. The dry weather design flow is 10.0 MGD. Effluent flow has been maintained at about 80% design capacity during dry weather over the previous five years, and continues to exceed the 10 MGD design flow during wet weather conditions (Figure 6). $CBOD_5$, ammonia-N, and TSS loadings have remained relatively constant since the previous 1992 survey, but total residual chlorine has been substantially reduced since 1996 due to implementation of dechlorination treatment, removing a potentially toxic source of pollutant loading to the West Branch Rocky River mainstem.

Medina County Sewer District requested in 1995 that Ohio EPA evaluate a request to expand design flow to 15.0 MGD. In December, 1996 the Ohio EPA evaluated the 15.0 MGD expansion option in a wasteload allocation (WLA) model and determined that the current loading of $CBOD_5$ of 378.5 kg/day would have to be maintained in order to maintain the dissolved oxygen water quality standards in the West Branch Rocky River. The WLA model results determined that Medina 500 WWTP could maintain this loading discharge at 15.0 MGD flow if the concentration of $CBOD_5$ was reduced from 10 mg/l to 6.7 mg/l as an average permit limit, and

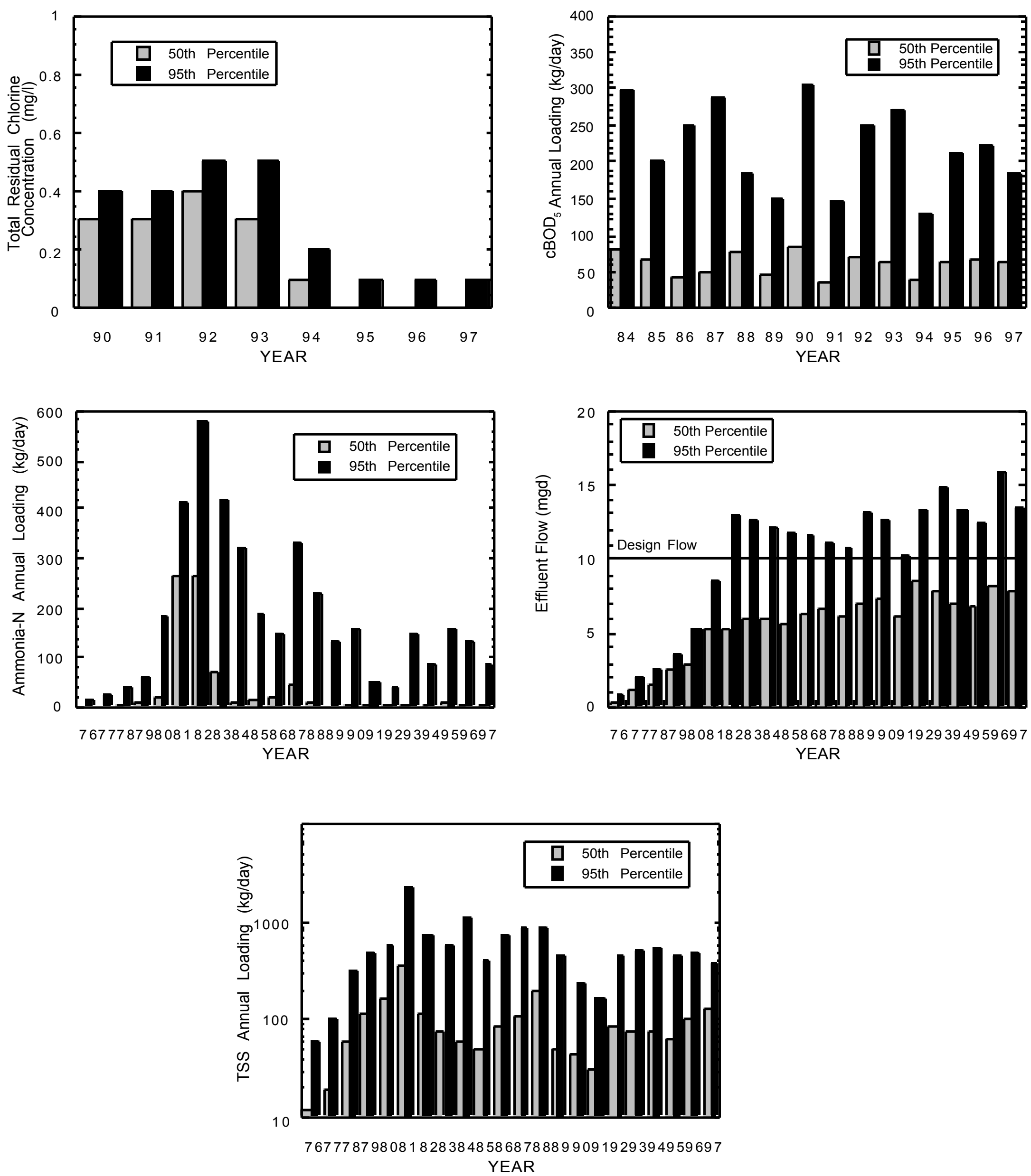


Figure 6 Median and 95th percentile flow (MGD) and annual loadings (kg/day) of $CBOD_5$, ammonia-N, total suspended solids, and residual chlorine from the Medina 500 WWTP 1976-1997. (Note: Not all years are available)

if ammonia-N was reduced from 1.5 mg/l to 1.0 mg/l. In October, 1997 the new OAC antidegradation rule went into effect, with the potential to modify the results of the 1996 WLA for the Medina 500 expansion request. This antidegradation review is presently in progress.

A review of monthly operating reports for Medina 500 WWTP from 1995 to 1997 indicated a few exceedences of NPDES limits for ammonia-N in May 1995, pH in October 1995, pH in May and July of 1996, TSS in March of 1997, and fecal coliform bacteria in May of 1997. The nature and extent of these exceedences indicated that chronic toxic effects should not have been present in the West Branch Rocky River below this discharge during the 1997 Ohio EPA survey.

NASA-Lewis Research Center

The Lewis Research Center is one of NASA's primary research and development centers for power and propulsion systems for air and space. Their main work is centered on research and development on advanced propulsion and power generation systems. NASA is listed on the Ohio EPA Master Sites List (MSL) because of mercury and other chemicals related to fuel that were detected in samples collected on NASA property. NASA is currently (April, 1998) under Ohio EPA Findings and Orders through the Division of Emergency and Remedial Response (DERR) to conduct a Remedial Investigation and Feasibility Study (RIFS) for their entire property, including the south area that contains three landfills, the central area with research buildings and underground storage tanks, and the west area that has a history of mercury contamination.

NASA has an NPDES permit that became effective February 1, 1994 and expires January 31, 1999. The entity has one major process water discharge (001), with numerous additional non contact cooling water outfalls with no treatment (Table 7). Flows are summarized below in Table 7. In addition to the permitted outfalls, NASA has about 10 non permitted stormwater discharges to the Rocky River and/or Abram Creek along their property. These stormwater outfalls will need to be identified and added to the NPDES permit renewal for this entity when the current NPDES permit expires in 1999.

NASA maintains three separate sewer systems: sanitary, storm, and industrial wastes. Sanitary waste is conveyed to the NEORSD Southerly WWTP. Stormwater is collected and

Table 7. NASA NPDES permitted discharges, 1997.

Number	Flow (MGD)	Wastewater Type[a]	Treatment System	Lat/Long
001	0.934	Process (industrial); NCCW	Settling, internal Oil/water separation	412500/815155 (Rocky River)
003	0.054	NCCW	None	412500/815142 (Rocky River)
004	0.0295	NCCW	None	412500/815142 (Rocky River)
006	0.029	NCCW	None	412442/815206 (Abram Creek)
007	0.168	NCCW	None	412452/815219 (Abram Creek)
008	0.169	NCCW	None	412438/815201 (Abram Creek)
009	<0.010	Stormwater	None	412424/815210 (Abram Creek)
010	0.150*	Coal Storage Runoff	Settling	412418/815157 (Abram Creek)
059	0.120	Rocket Test Cooling Water	None	412417/815203 (Abram Creek)
060	0.120	Rocket Test Cooling Water	None	412417/815203 (Abram Creek)

* Only when discharging
[a] NCCW= Noncontact cooling water

conveyed untreated to numerous outfalls that discharge to Rocky River or Abram Creek.

Long term monitoring of conductivity at NASA from seven outfalls showed that discharge from outfalls 003 and 004 (Rocky River discharge), and outfall 007 (Abram Creek discharge) have exceeded the 2500 umhos/lm water quality criterion from 1995 to 1997 at the 95th percentile of the data collected. However, median values over the same time period did not exceed the criterion. All three of these outfalls contain non-contact cooling water (NCCW), a likely source of the conductivity. The highest conductivity discharge has been consistently the NASA outfall 007. The average annual flow from this outfall has been measured at less than 0.02 MGD since 1995 (Figure 7).

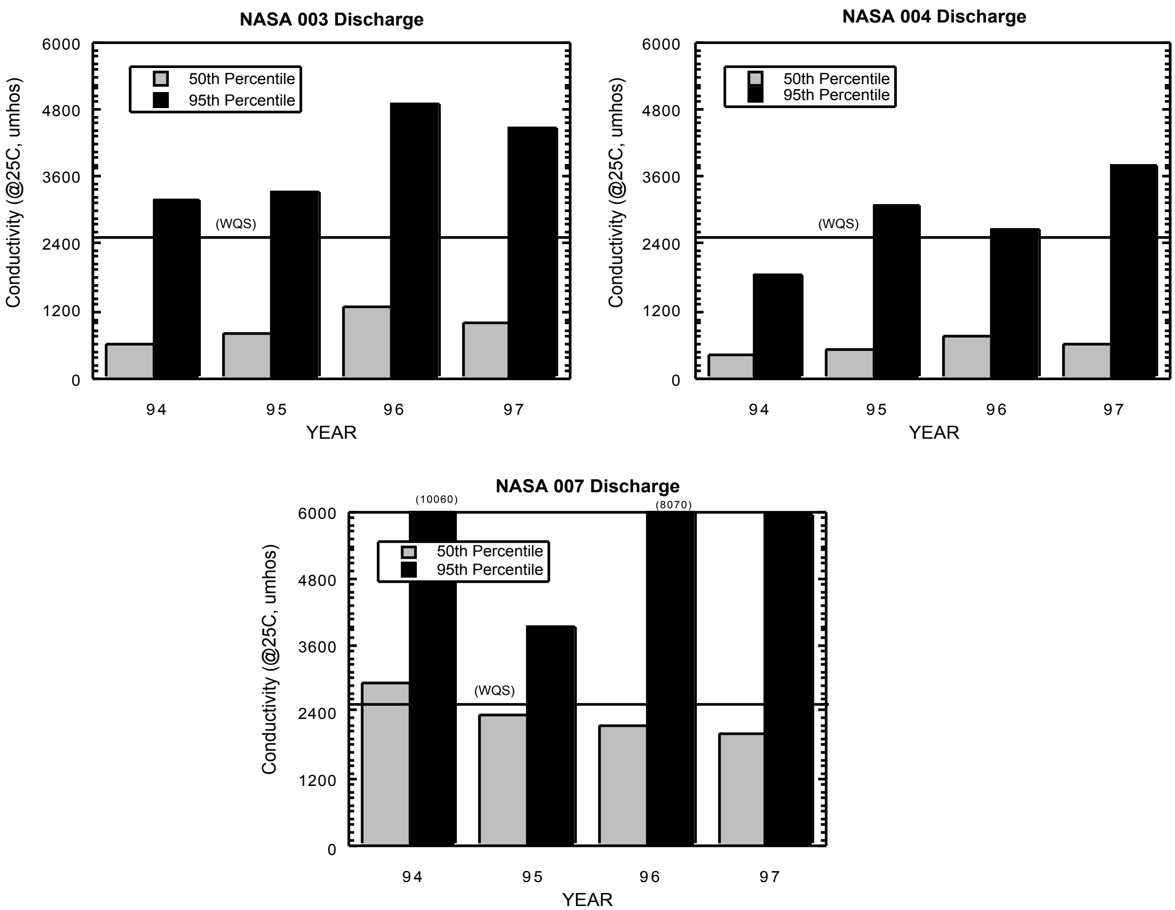


Figure 7 Median and 95th percentile conductivity values from the NASA 003, 004 and 007 outfalls, 1994-1997.

The discharge from several NASA outfalls is influenced by upstream contributions from the Cleveland Hopkins International Airport. Cleveland Hopkins outfall 006 discharges to NASA 008 outfall, which enters Abram Creek. Cleveland Hopkins 007 and 008 outfalls enter NASA 017 and 015 outfalls, respectively, both of which discharge directly to the Rocky River. Recently, the Ohio EPA discovered that drainage from either/or outfall areas 006 and/or 007 empties into NASA outfall 031, which enters Abram Creek upstream from Cedar Point Road.

The industrial waste stream at NASA is protected by 25 oil separator pits (US EPA inspection report, February 12, 1992) . The industrial waste stream goes into two waste retention basins for settling before being discharged from outfall 001 directly to Rocky River, at a location just downstream from where Abram Creek empties into Rocky River.

Cleveland Hopkins International Airport

Cleveland Hopkins International Airport, located at Riverside Drive in Cleveland, is owned and operated by the city of Cleveland,. In early 1987, the Ohio EPA first became aware of potential illegal discharges of sanitary waste, jet fuel, degreasing solvents, and deicing chemicals from the Hopkins Airport that were being discharged to storm sewers that entered the Rocky River mainstem, Abram Creek and Silver Creek in violation of Ohio Revised Code (ORC) 6111.04 and Section 402 of the Federal Water Pollution Control Act.

On August 6, 1987, the U.S. EPA, Region V, issued Findings of Violation and Order of Compliance against the City of Cleveland to investigate the discharge of stormwater from the airport property. One of the major chemicals of concern was urea that has been used as a deicing agent on runways. Urea readily decomposes into ammonia-N when dissolved in water.

On August 11, 1992 a Consent Order was issued by the Cuyahoga County Court of Common Pleas against the City of Cleveland and Executive Hangers, Inc. for activities conducted at the Cleveland Hopkins International Airport in violation of ORC 6111. On June 16, 1995 Ohio EPA gave approval of the Stormwater Pollution Prevention Study that was conducted in 1994 in fulfillment of the Consent Order. At the request of Ohio EPA, the Cleveland Hopkins Airport submitted an NPDES permit application to the Ohio EPA on August 17, 1995 to address stormwater runoff from eight outfalls that drain from the Cleveland Hopkins Airport. As of April 1998 the draft NPDES permit has not been issued. On October 2, 1996 the Ohio EPA received a report conducted by the City of Cleveland consultants, Malcolm Pirnie, Inc., on the biological use attainment and attainability of Abram Creek. The Ohio EPA, Division of Emergency and Remedial Response (DERR) is working with Cleveland Hopkins Airport on six sites as part of the Voluntary Action Program (VAP) initiative, that are proposed to be transferred to the City of Brookpark. The Hopkins Airport also has some old foundry sand solid waste sites on their property near Abram Creek that fall under Rule 13 of the Ohio EPA solid waste regulations.

Sampling of various storm sewer outfalls (see Table 8) since 1987 by Ohio EPA, U.S. EPA, and consultants for the Cleveland Hopkins Airport indicated a long history of discharges with highly elevated ammonia-N levels (concentrations above 100 mg/l) and pH values above 9.5 S.U. No long term NPDES sampling data from the Cleveland Hopkins storm sewers are available since the NPDES permit has not been issued. On March 10, 1998 a sample collected by Ohio EPA from the manhole on the Cleveland Hopkins sewer that discharges to NASA outfall 031 showed an ammonia-N concentration of 28 mg/l. An ammonia-N concentration of 43 mg/l was detected at the Cleveland Hopkins 005 discharge on the same day.

Table 8. Cleveland Hopkins International Airport stormwater outfalls, 1997.

Number	Flow (MGD)	Wastewater	Treatment System	Lat/Long
001	0.072	Stormwater	None	412518 /815034 (Silver Creek)
002	0.05	Stormwater	None	412518 /815028 (Silver Creek)
003	0.239	Stormwater	None	412331 /815035 (Abram Creek)
004 (48")	0.148	Stormwater	None	412507 /815200 (Abram Creek)
005 (72")	0.55	Stormwater	None	412409 /815156 (Abram Creek)
006 (to NASA 008, 031?)	0.24	Stormwater	None	412438 /815201 (Abram Creek)
007 (to NASA 017, 031?)	0.084	Stormwater	None	412500 /815132 (Rocky River)
008 (to NASA 015)	0.10	Stormwater	None	412507 /815127 (Rocky River)

Chemical Water Quality

Rocky River Mainstem

The 1997 flow hydrograph for the Rocky River at Cedar Point Road (RM 12.07) is shown in Figure 8. The average discharge in the Rocky River for the period of record at Cedar Point Road is 284 cfs. The maximum measured flow was 21,400 cfs in 1959 and the minimum flow was 0.2 cfs in 1932. The average flow for the period July through October 1997 was 484 cfs. The natural Q7,10 for the Rocky River mainstem near the confluence of the East and West branches is estimated by U.S.G.S. at 1.4 cfs. However, wastewater discharges and water supply removal in the basin result in an effective Q7,10 of 15.3 cfs (derived from the NEORSD Southwest Interceptor Environmental Impact Statement/Facilities Plan and I/I Analysis, 1982, John David Jones and Associates, Cleveland, Ohio). Only one of the five Ohio EPA water quality sampling dates in 1997 was near the effective Q7,10 flow (Figure 8). Approximately 10 MGD (15 CFS) of treated WWTP effluent has been removed from the basin since 1992 as a result of tie-ins to the NEORSD Southwest Interceptor.

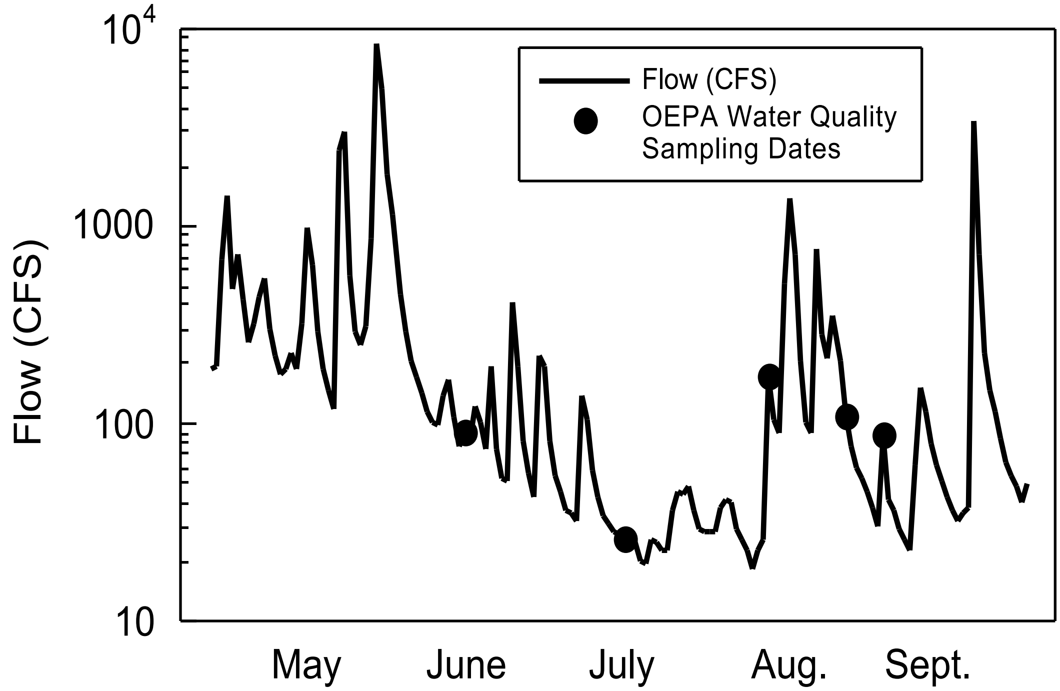


Figure 8 Flow hydrograph in cubic feet per second (CFS) for the Rocky River at Cedar Point Rd. (RM 12.07), May through September, 1997 (USGS 1998).

Significant discharges to the mainstem include the North Olmsted WWTP, NASA and the Cleveland Hopkins International Airport (CHIA). NASA and CHIA discharges also flow into Abram Creek. The City of Lakewood has had a history of dry weather sanitary sewer overflows. A total of 17 combined sewer overflows (CSOs) from the NEORSD (7) and Lakewood (10) sewer systems enter the Rocky River from approximately RM 7.5 to RM 1.5. The Lakewood combined sewers overflow with a 0.1 inch rainfall.

Fecal coliform bacteria and nutrients are the primary chemical/physical water quality concerns in the mainstem of the Rocky River. Fecal coliform bacteria counts in the mainstem exceeded the Primary Contact Recreation (PCR) criterion of 1000 colonies/100 ml in most sections of the river (Table 9). Median fecal coliform bacteria counts were elevated near Cedar Point Road, declined, then increased again in the area of CSOs (Figure 9). No other exceedences of the WWH chemical/physical criteria were documented in the Rocky River mainstem during the 1997 survey.

Median dissolved oxygen concentrations increased downstream from Abram Creek and the NASA and CHIA discharges and then declined towards the mouth (Figure 9). The highest ammonia–N concentrations were at Rockcliff Ford (RM 3.0) downstream from Lakewood and NEORSD CSOs (Figure 9). None of the concentrations exceeded the ammonia–N criterion at the associated temperature and pH. Median COD concentrations increased immediately downstream from the North Olmsted WWTP, Abram Creek, and NASA and CHIA discharges, declined slightly and then increased again downstream from the CSOs (Figure 9). Heavy metal concentrations in the mainstem were generally at or near method detection limits. Of those parameters that were greater than the method detection limits, the highest concentrations were generally highest downstream from the North Olmsted WWTP.

East Branch Rocky River

Significant discharges to the East Branch include the Medina 300 WWTP, the North Royalton A WWTP via an unnamed tributary at RM 12.92, the Strongsville B WWTP via an unnamed tributary at RM 11.1, and the Strongsville C and North Royalton B WWTPs via Baldwin Creek. Barriers to fish migration include dams (three located on the East Branch at RMs 0.7, 5.23 [Baldwin Lake], and 23.16 [Hinckley Lake]) and a natural waterfall (RM 3.8).

Nutrients and fecal coliform bacteria are the primary chemical/physical water quality concerns in the East Branch Rocky River. Fecal coliform bacteria counts were generally below the PRC criterion of 1000 colonies/100 ml upstream from the urban centers in the watershed (Figure 10). Exceedences of the criteria (10 of 35 samples) began downstream (RM 11.6) from the North Royalton A WWTP and extended throughout the urban areas of the East Branch to the mouth (Table 9). There were no other exceedences of the WWH chemical/physical

Table 9. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Rocky River study area, 1997. (Units are ug/l for metals, # colonies/100 ml for fecal bacteria, and mg/l for all other parameters).

Stream Name	River Mile	Violation: Parameter (value)
Rocky River		
	11.5	fecal coliform bacteria (2700 ◊; 5600 ◊◊; 19000 ◊◊)
	11.1	fecal coliform bacteria (6900 ◊◊; 24000 ◊◊)
	10.0	fecal coliform bacteria (9000 ◊◊; 15000 ◊◊)
	8.19	fecal coliform bacteria (3100 ◊; 13000 ◊◊; 28000 ◊◊)
	3.0	fecal coliform bacteria (2800 ◊; 7900 ◊◊)
	1.0	fecal coliform bacteria (8800 ◊◊; 13000 ◊◊)
East Branch		
	11.6	fecal coliform bacteria (5900 ◊◊; 16000 ◊◊)
	10.0	fecal coliform bacteria (14000 ◊◊)
	6.5	fecal coliform bacteria (4600 ◊; 4700 ◊;14000 ◊◊)
	4.9	fecal coliform bacteria (7600 ◊◊; 27000 ◊◊)
	1.4	fecal coliform bacteria (6000 ◊◊; 37000 ◊◊)
Unnamed Tributary to the East Branch (North Royalton A Trib)		
	12.92/0.2	fecal coliform bacteria (6000 ◊◊)
	12.92/0.6	fecal coliform bacteria (3600 ◊; 25000 ◊◊; 36000 ◊◊)
Healey Creek		
	0.9	No Exceedences
West Branch		
	33.55	fecal coliform bacteria (2300 ◊; 2700 ◊)
	16.35	fecal coliform bacteria (93000 ◊◊)
	13.30	fecal coliform bacteria (56000 ◊◊)
	4.70	fecal coliform bacteria (2800 ◊; 15000 ◊◊)
	3.50	fecal coliform bacteria (3100 ◊; 13000 ◊◊)
	0.40	fecal coliform bacteria (5400 ◊◊; 15000 ◊◊)
Blodgett Creek		
	0.17	fecal coliform bacteria (11000 ◊◊; 13000 ◊◊; 18000 ◊◊)

Table 9. (continued)

Stream Name	River Mile	Violation: Parameter (value)
Plum Creek		
	2.70	fecal coliform (2100 ◊; 2200 ◊; 9000 ◊◊)
	0.25	fecal coliform bacteria (5200 ◊◊; 6500 ◊◊; 6700 ◊◊; 11000 ◊◊, 18000 ◊◊) T-Pb (38*)
Abram Creek		
	3.91	fecal coliform (3500 ◊; 18000 ◊◊) D.O. (4.41 ‡)
	1.90	fecal coliform (4200 ◊; 5300 ◊◊; 15000 ◊◊)
	0.84	fecal coliform (3200 ◊; 4900 ◊; 5900 ◊◊) NH3-N (1.71*; 2.39*; 2.49*; 4.20*; 5.49*)

* indicates an exceedence of numerical criteria for prevention of chronic toxicity (OMZA)
** indicates an exceedence of numerical criteria for prevention of acute toxicity (OMZM)
*** indicates an exceedence of numerical criteria for prevention of lethality (IMZM)
‡ violation of the average WWH dissolved oxygen (D.O.) criterion
‡‡ violation of the minimum WWH dissolved oxygen (D.O.) criterion
‡‡‡ violation of the LRW dissolved oxygen (D.O) criterion
◊ exceedence of the Primary Contact Recreation criterion
◊◊ exceedence of the Secondary Contact Recreation criterion

criteria for the East Branch of the Rocky River. Nitrate+nitrite, total Kjeldahl nitrogen (TKN) and total dissolved solids concentrations increased from the upstream reaches of the East Branch to the mouth (Figure 10). Ammonia–N concentrations were highest in Berea downstream from Baldwin Creek (Figure 10).

Water quality investigations by NEORSD as part of their evaluation of the southwest interceptor project revealed sources of dry weather sanitary discharges to the East Branch Rocky River. As a result of these investigations, the City of Berea has established a three year program to further identify the problem sewers and to remediate them. These sanitary discharges are likely sources of fecal coliform bacteria and nutrients in this reach of the river.

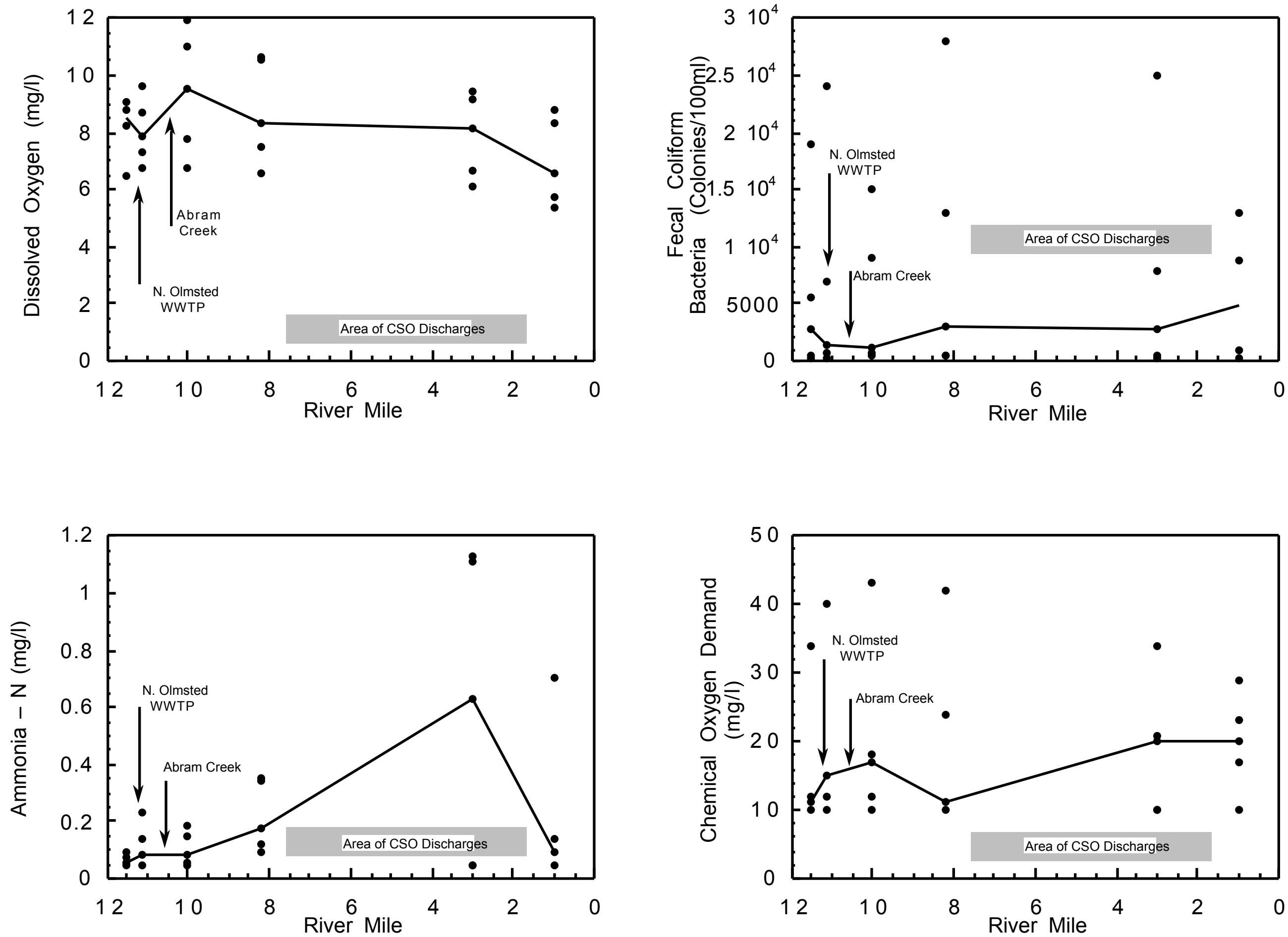


Figure 9 Concentrations of dissolved oxygen, fecal coliform bacteria, ammonia-N and chemical oxygen demand from Rocky River, 1997.

West Branch Rocky River

The most significant point source to the West Branch Rocky River during the 1997 survey was the Medina 500 WWTP. Grab water samples collected from RMs 16.4 to 0.4 showed a measurable increase in phosphorus and nitrate-nitrite enrichment downstream from the discharge of the WWTP (Figure 11). Nutrient enrichment is believed to cause negative effects on the trophic dynamic attributes of the Index of Biotic Integrity (IBI). However, the results from the 1997 survey showed only a slight decline of 2 IBI points (40 to 38) downstream from the Medina 500 WWTP and reflected that nutrient enrichment downstream from the WWTP was not sufficient to result in a significant change in the overall integrity of the fish community. The highest ammonia-N concentration recorded in the West Branch mainstem was at RM 13.3 (0.36 mg/l), also downstream from the Medina 500 WWTP discharge; however, this value is well below

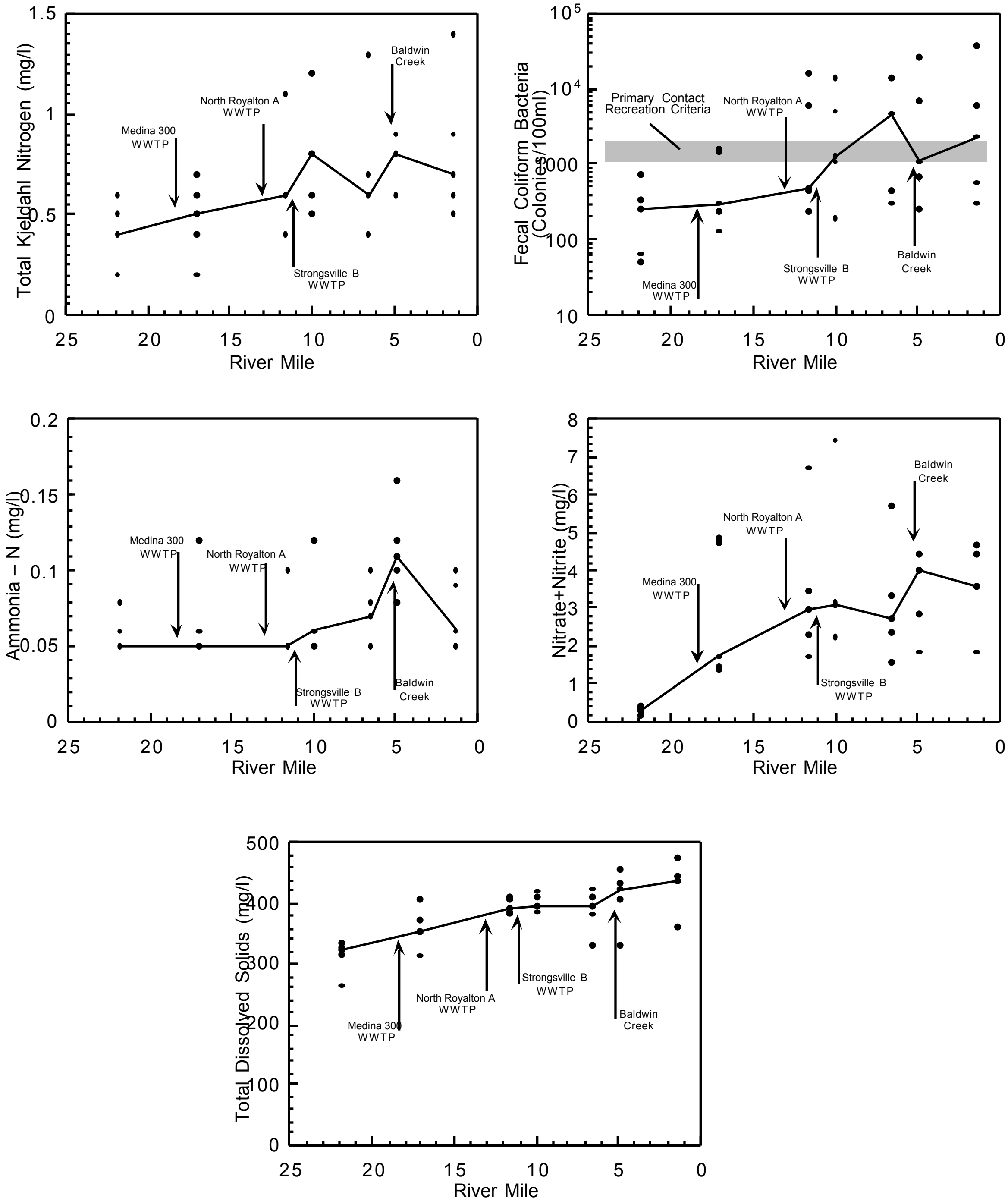
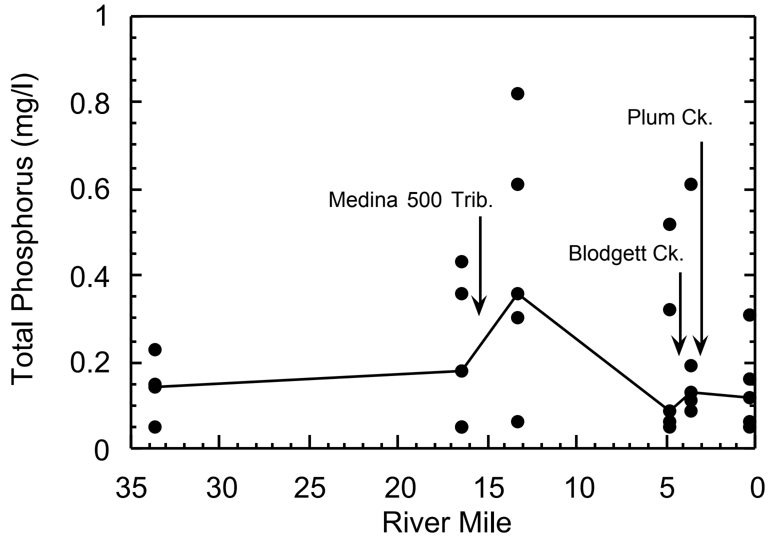


Figure 10 Concentrations of total Kjeldahl nitrogen, fecal coliform bacteria, dissolved oxygen, ammonia-N, nitrite-nitrate, and total dissolved solids from the East Branch Rocky River, 1997.



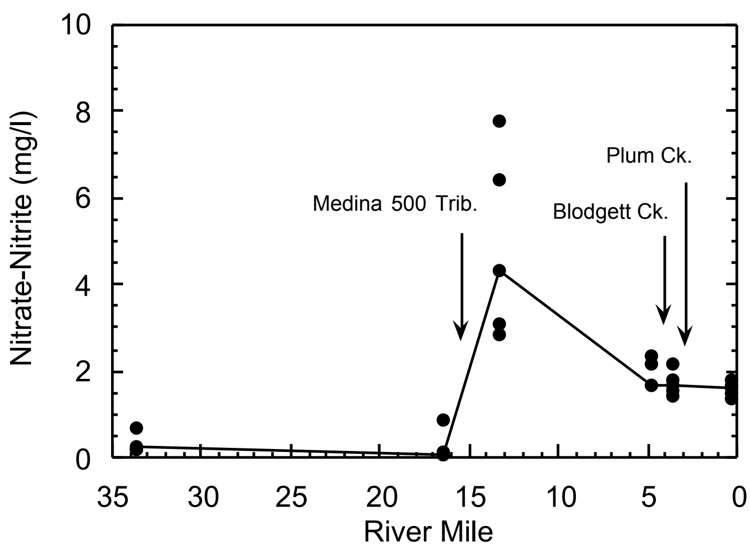


Figure 11 Concentrations of total phosphorus and nitrite+nitrate -nitrogen from West Branch Rocky River, 1997.

chronic toxicity value at the measured temperature and pH.

The geometric mean number of fecal coliform bacteria was above the 1000/100 ml PCR criterion at four of five sample locations downstream from RM 16.4, and at a regional reference site further upstream at RM 33.6, indicating nonpoint sources of bacteria are widespread in the watershed (Table 9). Sampling for toxic pollutants including ammonia-N and heavy metals showed no exceedences of standards, with most total metal concentrations at less than detection limits. Results of 24-hour monitoring for dissolved oxygen (8/12-13/97) showed a slight oxygen sag below the Medina 500 WWTP, but all stations were well above the 5.0 mg/l 24-hour average criterion (Figure 12).

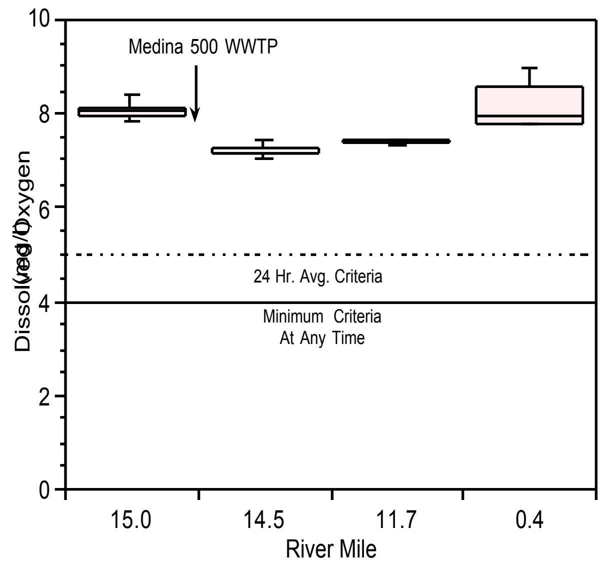


Figure 12 Box plot distributions of hourly dissolved oxygen measurements recorded over a 24-hour period August 12 - 13, 1997 in the West Branch Rocky River

Abram Creek

Abram Creek is a headwater tributary of the Rocky River mainstem with a drainage area of 10.1 square miles. The watershed is largely urbanized. The upper segments of Abram Creek have been channelized resulting in significant habitat modification; however, from near Grayton Road (RM 1.9) and extending downstream, Abram Creek maintains sufficient habitat quality to support WWH biological communities.

The headwaters of Abram Creek have a long history of impact from two wastewater treatment plants, the Brookpark and Middleburg Heights WWTPs. By the fall of 1993 these two WWTPs were tied into the NEORSD system. The results from the 1997 survey indicated that the elimination of these two discharges has resulted in significantly improved chemical water quality at a downstream monitoring station location at RM 1.9 (Grayton Road). During the previous 1992 Ohio EPA survey of Abram Creek, ammonia-N as high as 3.0 mg/l was found at RM 1.9, whereas the highest ammonia-N recorded at this location during the summer of 1997 was 0.47 mg/l (Figure 13). Thus, a major source of in-stream toxicity has been eliminated from the headwaters of Abram Creek.

Follow-up winter sampling in Abram Creek by Ohio EPA district staff on January 26, 1998 at RM 1.9 showed elevated ammonia-N (1.48 mg/l) during baseflow conditions. Possible sources of this ammonia-N is seepage of deicing chemicals from Cleveland Hopkins Airport via storm sewer outfall 003, which enters Abram Creek upstream from RM 1.9, and old solid waste landfills located near Abram Creek upstream from RM 1.9.

Samples for dissolved oxygen from the 1997 survey of Abram Creek showed an improvement in dissolved oxygen between 1992 and 1997 at RM 1.9, with about a 1.5 mg/l increase in minimum oxygen concentration. The lowest dissolved oxygen at RM 1.9 in 1997 was 6.0 mg/l, which is well above the minimum dissolved oxygen criterion for a WWH stream (Figure 13). During the 1997 survey, low dissolved oxygen (4.4 mg/l) was found at the most upstream station at RM 3.9 (Sheldon Road), which is most likely due to the low reareation potential from the channelized stream habitat. Also during the 1997 survey, exceedences of Ohio WQS for fecal coliform bacteria were found at all stations on Abram Creek especially after rain runoff. This suggested nonpoint sources of bacteria remain in the urban watershed (Table 9).

Abram Creek from Grayton Road (RM 1.9) to Cedar Point Road (RM 0.85) receives storm water runoff and continuous ground water discharge from two large storm sewer outlets, one 48" and one 72", that drain Cleveland Hopkins Airport (CHIA outfall 005 and 004) and storm water from NASA property (NASA outfall 031 and 030) . In January 1998, Ohio EPA NEDO staff discovered that storm water from either drainage areas for outfall 006 and/or outfall 007 also enter NASA outfall 031, which is located above the RM 0.85 station at Cedar Point Road.

During the 1997 survey, five samples collected at RM 0.85 immediately downstream from these sewer discharges showed highly elevated ammonia-N concentrations ranging from 1.71 to 5.49 mg/l; all values exceeded the ambient Ohio WQS water quality standards for chronic toxicity (Table 9). Of significance is the fact that four of the five samples were collected during dry periods with Abram Creek at normal baseflow conditions, indicating chronic discharges of ammonia-N upstream from the RM 0.85 sample station. These Cleveland Hopkins storm sewers have previously been sampled by Ohio EPA, US EPA, and consultants for Cleveland Hopkins

Airport and have been documented to have ammonia-N concentrations well above 100 mg/l, with the source of the ammonia-N believed to be seepage of deicing urea based chemicals that have been used for runway deicing for an extended period of time. These compounds readily

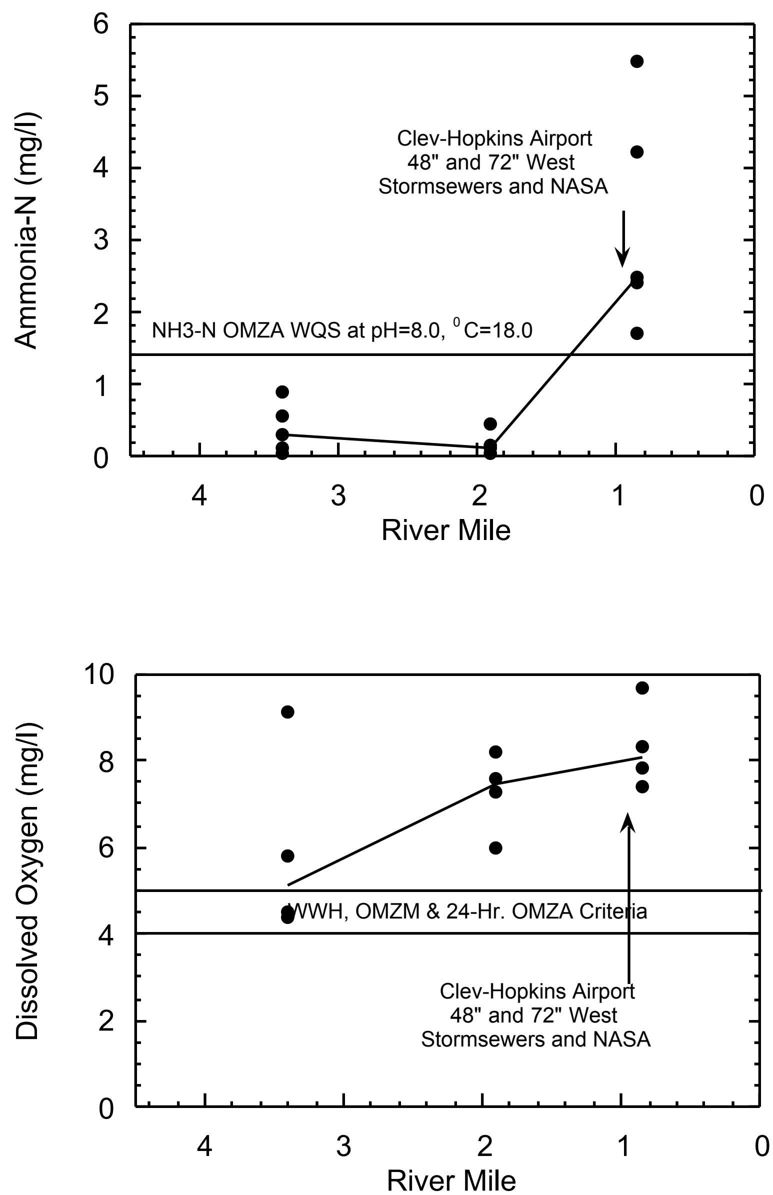


Figure 13 Concentrations of ammonia-N and dissolved oxygen from Abram Creek, 1997.

decompose into ammonia-N when dissolved in water.

An Ohio EPA district office sample from the tributary that receives discharge from the Cleveland Hopkins 004 and 005 outfall showed an ammonia-N concentration of 149 mg/l on 1/26/98, a value more than 10 times the acute toxicity WQS criterion. In April, 1998 a fish kill of about 20 white suckers, that had entered the stream to spawn, was reported from Abram Creek at five locations between Cedar Point Road (RM 0.85) and West Avenue Road near the mouth.

Malcolm Pirnie (1996), in their study of Abram Creek for the city of Cleveland, documented elevated ammonia-N in samples collected on January 19, 1996 near Sheldon Road (2.75 and 2.28 mg/l), at the same time that elevated ammonia-N was found at Koltoff Road at RM 2.85 (2.10 and 2.17 mg/l). However, this winter sample was collected when TSS levels were extremely elevated (range of values from 73 to 103 mg/l), suggesting that they were taken after a significant rain event and would not represent normal baseflow conditions in Abram Creek. Thus, the upstream “source” of ammonia-N reported by Malcolm Pirnie was most likely ammonia-N attached to sediment organic particles, and not ammonia-N that would be dissolved in the water under baseflow conditions. Any potential seepage of ammonia-N from the Cleveland Hopkins Airport storm sewers located above Koltoff Road would have been diluted by the high stream flow. A second sample collected during normal baseflow conditions on July 24, 1995 showed relatively low levels of ammonia-N at Koltoff Road (0.56 mg/l), and further upstream (0.46 and 0.39 mg/l), indicating that chronic sources of ammonia-N do not exist in Abram Creek at locations upstream from the Cleveland Hopkins Airport storm sewers near RM 2.85. Data collected by Ohio EPA at the upstream stations during the 1997 survey also indicated low levels of ammonia-N in Abram Creek above the Cleveland Hopkins 004 and 005 outfall during normal baseflow stream conditions.

In 1995, Ohio EPA district staff discovered a discharge to a storm sewer from the boiler room of the IX Center. This sewer is located just upstream from Klothoff Road at RM 2.85. The discharge was from a leaky closed looped boiler cooling water system that contained a biocide with potential toxic effects on biological communities. The discharge was eliminated within one month of discovery in 1995. Other potential sources of pollutants to Abram Creek between Kolthoff Road (RM 2.85) and Grayton Road (RM 1.9) are disposal sites for foundry sand, fly ash, and construction landfill wastes, and runoff from the Cleveland Hopkins Airport, the IX Center, and other urbanized areas.

Blodgett Creek

Since the previous Ohio EPA survey in 1992, two WWTPs have discontinued discharge to Blodgett Creek. The NEORSD Strongsville A WWTP stopped discharging in 1994 and the Olmsted Falls Versailles WWTP stopped discharging in 1995. Thus, it would be expected that reduced loadings of pollutants would allow for recovery of downstream biological communities from the non-attainment status found in the 1992 survey. Results from the 1997 biological survey did indicate full attainment of the WWH aquatic life use in Blodgett Creek near the mouth.

Chemical results from the 1997 survey showed relatively good chemical water quality in Blodgett Creek near the mouth at RM 0.2. Three of five samples for ammonia-N were below the laboratory detection limit of 0.05 mg/l and the minimum dissolved oxygen recorded was 6.7 mg/l. In the 1992 survey, ammonia-N ranged from 6.5 to 9.8 mg/l at RM 0.2 in Blodgett Creek. This was evidence of a significant pollutant reduction over time as a result of the elimination of the two upstream WWTP discharges. In 1997, the only exceedence of Ohio WQS criteria was for fecal coliform bacteria, with a geometric mean of 5 samples of 5002/100 ml (Table 9). These data indicated a continued nonpoint source of bacteria from the upstream watershed. Visual observation of the stream at RM 0.2 indicated extremely clear water with little clay-silt turbidity, making Blodgett Creek one of the least turbid tributaries sampled in the West Branch Rocky River basin.

Plum Creek

Chemical sampling in Plum Creek at RM 2.7 (Usher Road) and near the mouth at RM 0.3 showed a significant increase in nutrient enrichment for nitrate-nitrite and total phosphorus, increased ammonia-N, and an exceedence of the total lead ambient criterion at RM 0.3, with a value of 38 ug/l at a hardness of 158 mg/l (Table 9). Total lead was higher at RM 0.3 than at RM 2.7 on two other sample dates, and below detection limit at both sites in two samples. Plum Creek was the only tributary that showed any exceedences for any heavy metals during the 1997 survey, but the specific source(s) for the lead was unknown.

Samples for fecal coliform bacteria clearly indicated that untreated sewage was being discharged to Plum Creek between RM 2.8 and RM 0.3, the lowest fecal coliform count in five samples collected at RM 0.3 was 5,200/100 ml, a number exceeding both the PCR and SCR criteria. The geometric mean number of fecal coliform bacteria in Plum Creek at RM 0.3 was 8,518/100 ml, the highest average value of any site sampled in the West Branch Rocky River basin. Potential sources of impact included three WWTP discharges (all are now closed), unsewered areas and polluted stormwater runoff.

Spills and Fish Kills

Reported spills from 1993 to 1997 were primarily hydrocarbons released in the Cleveland metropolitan area with the largest numbers occurring on or near the Cleveland Hopkins International Airport. Of the 46 reported spills, 30 were hydrocarbons, 7 were sewage and 3 were acids. Most of the incidents reported unknown quantities of materials spilled, but at least four hydrocarbon spills exceeded 3000 gallons each.

Chemical Water Quality Changes: 1992-1997.

Rocky River

Previous sampling in the Rocky River watershed was conducted by the Ohio EPA in 1981 and 1992, the results of which are summarized in the August 16, 1993 Ohio EPA report, "Biological and Water Quality Study of the Rocky River and Selected Tributaries". A review of chemical data from 1992 and 1997 indicated an increase in the median total phosphorus concentration (Figure 14). This apparent increase occurred despite the elimination

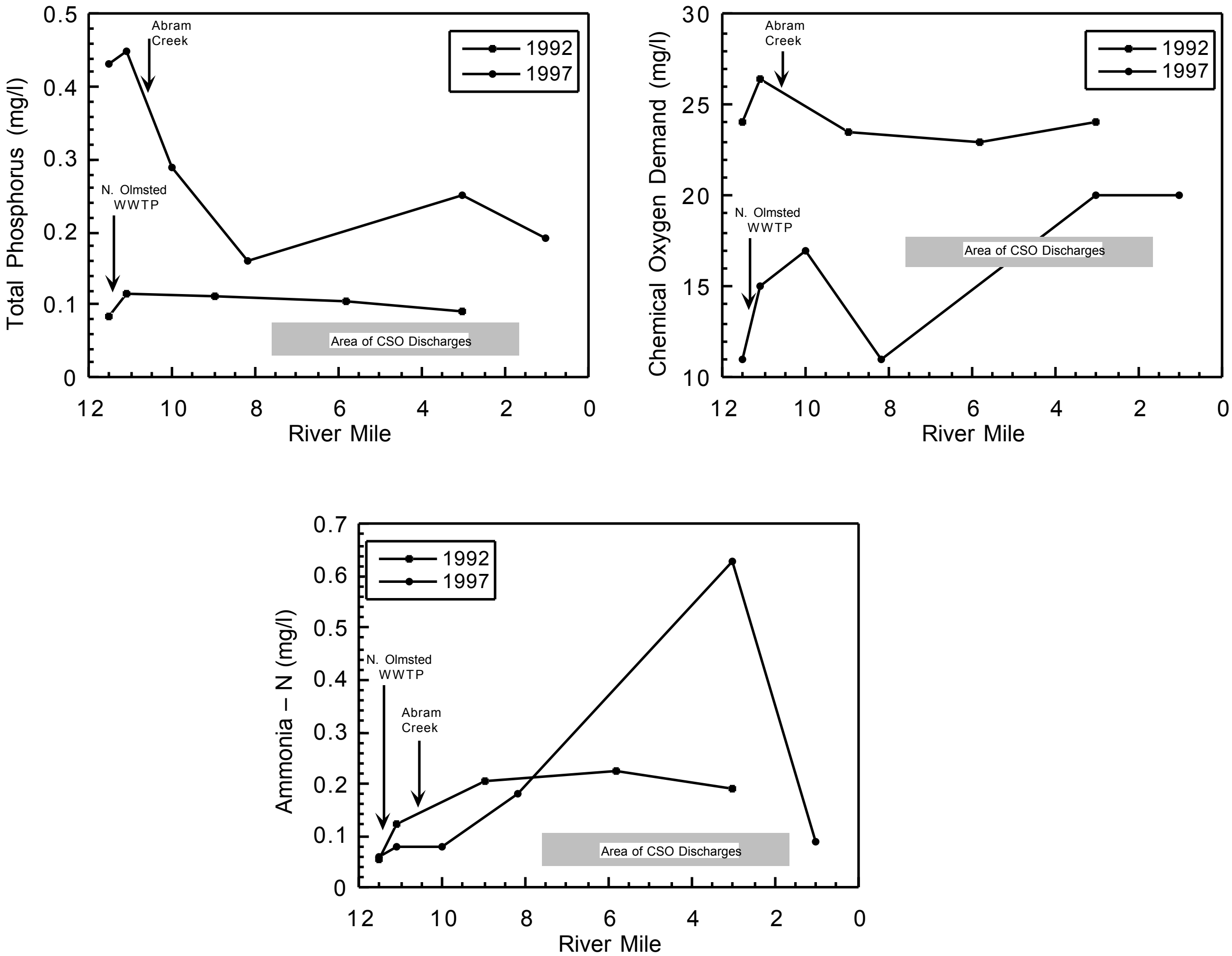


Figure 14 Longitudinal median concentrations of phosphorus, chemical oxygen demand and ammonia-N from the Rocky River, 1992-1997.

of the Berea (East Branch), the Strongsville A (Blodgett Creek to the West Branch), and the Middleburg Heights (Abram Creek) and Brookpark (Abram Creek) WWTPs in 1993. It appeared that removal of these discharges did result in a decrease in COD levels. The median ammonia–N concentration at Rockcliff Ford (RM 3.0) was much higher in 1997 compared to 1992 while the ammonia–N concentrations at other locations in the mainstem were essentially unchanged (Figure 14). The Rockcliff Ford site is downstream from Lakewood and NEORSD CSOs which may account for the increased ammonia–N concentrations. There were no other apparent differences in the chemical/physical water quality of the mainstem of the Rocky River from 1992 to 1997.

East Branch Rocky River

The elimination of the Berea WWTP has resulted in the decrease of median concentrations for total phosphorus and ammonia–N and an increase in dissolved oxygen downstream from the former discharge (Figure 15). There has been an increase in COD concentrations in the East Branch at all stations sampled in 1997 compared to 1992. There has been an apparent increase from 1992 to 1997 in total zinc concentrations (Figure 15) in the East Branch beginning in the Strongsville/Berea area. Most nutrient parameters also increased in this reach with the largest increase occurring in Berea downstream from Baldwin Creek. These increases may be a result of the dry weather overflows occurring in Berea as mentioned earlier in this report.

West Branch Rocky River

Previous sampling in the West Branch Rocky River watershed was conducted by the Ohio EPA in 1981 and 1992, the results of which are summarized in the August 16, 1993 Ohio EPA report, "Biological and Water Quality Study of the Rocky River and Selected Tributaries". The 1992 survey indicated improved chemical water quality in the West Branch Rocky River compared to the 1981 survey for heavy metals, chemical oxygen demand, total phosphorus, ammonia-N, and dissolved oxygen. These improvements were believed to be mostly due to the elimination of small WWTPs, improved operation and maintenance at the Medina 500 WWTP, and remedial measures at the Montville solid waste landfill.

A review of chemical data from 1992 to 1997 indicated no significant difference in the chemical quality of the West Branch for the parameters measured, with the exception of a significant decline in average ammonia-N immediately downstream from Blodgett Creek. This site specific improvement in chemical water quality was likely the result of the elimination of two WWTP discharges to Blodgett Creek between 1994 and 1995. During the 1992 Ohio EPA survey, ammonia-N levels between 6.5 and 9.9 mg/l were found at the mouth of Blodgett Creek, whereas follow-up sampling in 1997 showed ammonia-N in the range of <0.05 to 0.20 mg/l, a very significant reduction in concentration.

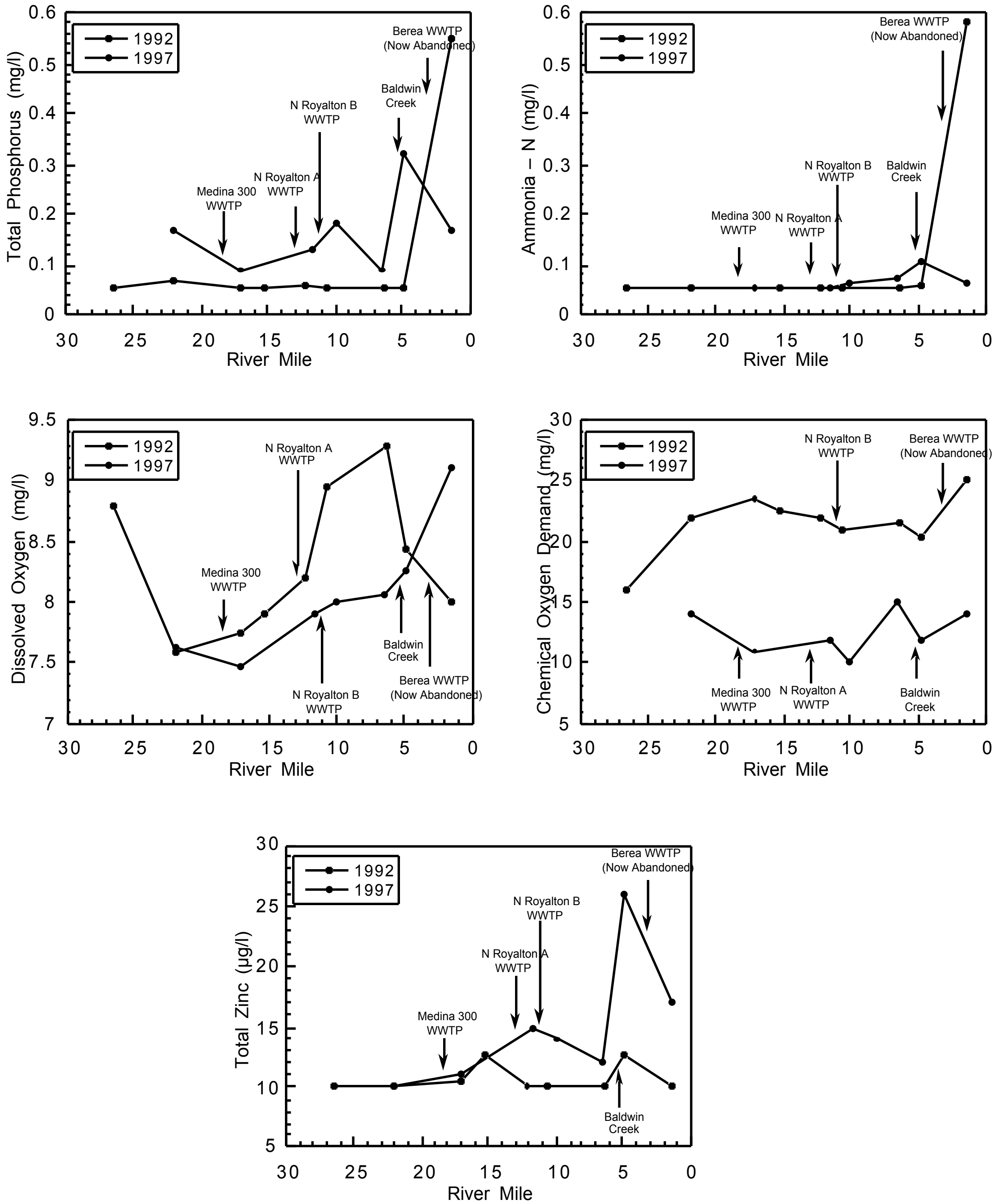


Figure 15 Longitudinal median concentrations of phosphorus, ammonia-N, dissolved oxygen, chemical oxygen demand and zinc from the East Branch Rocky River, 1992-1997.

Abram Creek

The headwaters of Abram Creek have a long history of impact from two WWTPs, the Brookpark and Middleburg Heights WWTPs. By the fall of 1993 these two WWTPs were tied into the NEORSD Southwest Interceptor. The results from the 1997 survey indicated that the elimination of their discharges has resulted in significantly improved chemical water quality at a downstream monitoring station location at RM 1.9 (Grayton Road). During the previous 1992 Ohio EPA survey of Abram Creek, ammonia-N as high as 3.0 mg/l was found at RM 1.9, whereas the highest ammonia-N recorded at this location during the summer of 1997 was 0.47 mg/l. Data from the 1997 survey of Abram Creek also showed an improvement in dissolved oxygen between 1992 and 1997 at RM 1.9, with about a 1.5 mg/l increase in minimum oxygen concentration.

Plum Creek

There has been little change in the chemical water quality near the mouth of Plum Creek between 1992 and 1997. Exceptions included spikes of total lead found in 1997 that were not observed in 1992. Potential sources of pollutants to Plum Creek in 1997 were the Brentwood WWTP, Western Ohio Utility WWTP, and the ODOT Park 3-39 WWTP, all of which discontinued discharge in late 1997, after the Ohio EPA 1997 survey had been completed. Future sampling is recommended to document changes in water quality resulting from the elimination of these upstream discharges.

Blodgett Creek

Since the previous Ohio EPA survey in 1992, two WWTPs have discontinued discharge to Blodgett Creek. The NEORSD Strongsville A WWTP stopped discharging in 1994 and the Olmsted Falls Versailles WWTP stopped discharging in 1995. Chemical results from the 1997 survey showed relatively good chemical water quality in Blodgett Creek near the mouth at RM 0.2. Three of five samples for ammonia-N were below the laboratory detection limit of 0.05 mg/l and the minimal dissolved oxygen recorded was 6.7 mg/l. In the 1992 survey, ammonia-N ranged from 6.5 to 9.8 mg/l at RM 0.2 in Blodgett Creek, indicating a significant reduction due to the elimination of the two upstream WWTPs.

Physical Habitat for Aquatic Life

Rocky River

The Rocky River downstream from the confluence with the East and West Branches is free flowing and generally lacks channel modifications, the harbor mouth withstanding. Consequently, the habitat, given by a mean QHEI score of 64.6, is capable of supporting a community assemblage expected under the Warmwater Habitat Aquatic Life use designation. Despite this, a relatively high proportion of modified habitat attributes characterize the instream habitat. The ratio of modified to natural habitat attributes approached or exceeded 1.0 in three of six sampling locations (Table 10). Modified habitat attributes common to all sites included little or no instream cover and high riffle embeddedness. Other modified attributes commonly observed were moderate to heavy siltation and fair channel development. Sediment loads and scouring stream flows from urban runoff are the principal factors acting to reduce habitat quality. These impacts are facilitated by the erodible nature of the shale bedrock over which the Rocky River flows.

Abram Creek

The physical habitats in Abram Creek, as a whole, were marginally suited to supporting warmwater biological communities due to habitat modifications and habitat degradation arising from urban runoff (QHEI = 54.5). Modified attributes imparted by urban runoff were primarily embedded substrates and little instream cover. The most upstream site was a channelized drainage ditch nearly devoid of positive habitat attributes. The site at Grayton Road (RM 1.9) had the best habitat (QHEI = 65.5), yet scouring flows and past channel modifications appeared to have widened and straightened the channel.

East Branch Rocky River

Similar to the Rocky River mainstem, instream cover was sparse in the lower ten miles of the East Branch owing to shale bedrock and urban runoff (Table 10). Modified attributes common to most locations in the upper suburbanized reach were high to moderate riffle and overall embeddedness, and to a lesser extent, siltation. The relatively high degree of embeddedness and siltation was caused, in part, by eroding banks. The suburbs of Strongsville, Brunswick and North Royalton are developing rapidly, and likely contribute to sedimentation and flashy stream flows. Overall habitat quality was sufficient to support a warmwater stream assemblage given a mean QHEI of 66.7.

Table 10 QHEI matrix for sites sampled in the Rocky River basin, 1997.

Key QHEI Components: WWH Attributes (■); MWH Attributes — High Influence (●), 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 Overall Embeddedness	Max. Depth > 40 cm	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
(13-001) Rocky River																																		
Year: 97																																		
11.5	69.0	7.25	■	■		■	■	■	■	■	■		9				●		1											▲		1	0.20	0.30
11.1	60.0	7.25	■			■	■			■	■		6				●		1					▲	▲	▲		▲		▲		5	0.29	1.00
10.0	54.5	8.55	■			■	■			■	■		5				●		1		▲			▲	▲	▲		▲	▲	▲		7	0.33	1.50
8.5	66.0	6.13	■	■		■	■	■	■	■	■		8				●		1											▲		1	0.22	0.33
6.1	65.0	7.63	■	■		■	■	■		■	■		7				●		1		▲			▲				▲	▲	▲		5	0.25	0.88
3.0	73.0	8.85	■	■		■	■	■	■	■	■		9				●		1		▲									▲		2	0.20	0.40
(13-002) Abram Creek																																		
Year: 97																																		
3.2	42.0	6.85		■							■		2	●		●	●		3	▲	▲			▲	▲			▲	▲		▲	7	1.33	3.67
2.8	52.5	17.54	■	■			■	■					4				●	●	2		▲			▲				▲	▲	▲		5	0.60	1.60
1.9	65.5	40.00	■	■		■	■	■			■		6			●			1						▲			▲	▲	▲		4	0.29	0.86
0.6	57.5	40.00	■	■		■	■	■	■		■		7						0					▲					▲	▲		3	0.13	0.50
(13-100) East Branch Rocky River																																		
Year: 97																																		
29.4	75.0	26.32	■	■		■	■	■		■	■		8						0									▲		▲		2	0.11	0.33
21.9	67.5	12.19	■	■			■	■			■		5						0					▲				▲	▲	▲	▲	5	0.17	1.00
13.1	73.5	6.54	■	■		■	■	■		■	■		8						0									▲	▲	▲		3	0.11	0.44
13.0	66.0	6.54	■	■		■	■	■			■		6						0		▲							▲	▲	▲		4	0.14	0.71
11.6	69.5	32.26	■	■		■	■	■			■		6						0		▲			▲				▲	▲	▲		5	0.14	0.86
10.0	67.5	6.33	■			■	■	■	■		■		6				●		1		▲								▲	▲		3	0.29	0.71
6.4	57.5	4.29	■			■	■	■			■		5				●		1		▲							▲	▲	▲		4	0.33	1.00
3.0	55.0	43.48	■			■	■			■	■	■	6				●		1					▲		▲		▲				3	0.29	0.71
1.4	66.5	8.47	■			■	■	■	■	■	■		7				●		1		▲			▲						▲		3	0.25	0.63
(13-101) Baldwin Creek																																		
Year: 97																																		
7.0	57.0	23.81	■	■			■	■			■		5						0					▲				▲	▲	▲		4	0.17	0.83
6.1	67.0	11.76	■	■		■	■	■			■		6						0									▲	▲	▲		3	0.14	0.57
3.2	37.0	6.25	■					■			■		3			●	●		2	▲				▲	▲			▲	▲	▲		6	0.75	2.25

Table 10 QHEI matrix for sites sampled in the Rocky River basin, 1997.

Key QHEI Components: ■ = WWH attribute; ● = MWH attribute (high influence); ▲ = MWH attribute (moderate influence)

			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 Overall Embeddedness	Max. Depth > 40 cm	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**
(13-101) Baldwin Creek																																		
Year: 97																																		
2.6	62.0	6.25	■	■			■	■			■		5			●	●		2	▲			▲	▲	▲			▲	▲	▲		7	0.50	1.67
1.4	42.5	7.52						■			■		2		●	●	●		3	▲	▲			▲	▲			▲	▲	▲	▲	8	1.33	4.00
0.2	50.0	7.52		■							■		2			●	●		2	▲	▲			▲	▲			▲	▲	▲		7	1.00	3.33
(13-103) Trib. to E. Br. Rocky R. (N. Royal. "A")																																		
Year: 97																																		
0.2	72.5	26.30	■	■		■	■	■			■		6						0									▲	▲	▲		3	0.14	0.57
(13-200) West Branch Rocky River																																		
Year: 97																																		
33.5	63.5	13.33	■	■		■	■	■		■	■		7						0		▲			▲				▲	▲	▲		5	0.13	0.75
33.3	66.5	14.71	■	■		■	■	■		■	■		8						0		▲							▲	▲	▲		4	0.11	0.56
27.3	65.5	3.48	■	■		■	■	■	■		■		7						0		▲			▲					▲	▲		4	0.13	0.63
17.5	69.0	5.71	■			■	■	■			■		5						0									▲	▲	▲		3	0.17	0.67
16.4	66.0	5.71	■			■	■	■		■	■		6						0									▲		▲		2	0.14	0.43
13.3	61.5	2.65	■	■			■	■			■		5				●		1		▲			▲				▲	▲	▲		5	0.33	1.17
4.8	72.0	8.77	■			■	■	■	■	■	■	■	8						0													0	0.11	0.11
3.6	71.0	14.49	■			■	■	■	■	■	■	■	8				●		1													0	0.22	0.22
1.6	76.0	20.00	■	■		■	■	■	■	■	■		9						0											▲		1	0.10	0.20
0.1	62.0	11.63	■			■	■		■	■	■	■	7				●		1					▲	▲	▲						3	0.25	0.63
(13-201) Plum Creek																																		
Year: 97																																		
2.9	70.5	12.05	■	■		■	■	■		■	■		8						0					▲				▲		▲		3	0.11	0.44
0.1	70.5	200.0	■	■		■	■	■	■	■	■		8						0		▲									▲		2	0.11	0.33
(13-203) Cossett Creek																																		
Year: 97																																		
0.2	59.5	23.33	■	■			■	■		■	■	■	7			●	●		2		▲			▲	▲			▲				4	0.38	0.88
(13-205) North Branch Rocky River																																		
Year: 97																																		
5.5	74.5	12.05	■	■		■	■	■		■	■		8						0									▲	▲	▲		3	0.11	0.44

Table 10 QHEI matrix for sites sampled in the Rocky River basin, 1997.

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: 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 Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total **WWH** Attributes	MWH Attributes, *High Influence*: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total **H.I. MWH** Attributes	MWH Attributes, *Moderate Influence*: 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**
(13-206) Plum Creek																																		
Year: 97																																		
2.5	**74.5**	10.00	■	■		■		■	■		■		6			●			1	▲	▲			▲	▲			▲	▲	▲		7	0.29	1.29
(13-209) Blodgett Creek																																		
Year: 97																																		
0.9	**63.5**	28.57	■	■		■	■	■		■	■		7						0					▲				▲		▲		3	0.13	0.50
0.2	**57.0**	39.53	■				■			■	■		5				●		1					▲				▲				2	0.33	0.67

Baldwin Creek

Like Abram Creek, Baldwin Creek drains primarily urban and high density residential areas, consequently the habitat is degraded by scouring flows and sedimentation. The number of ratio of modified to warmwater habitat attributes generally increased going downstream (Table 10), reflecting the cumulative impact of urban drainage. Embedded substrates and riffles were observed at all sites, while channel modifications, heavy siltation and limited instream cover characterized the downstream reaches. On average, the physical habitat in Baldwin Creek is marginally suited to supporting normal warmwater stream communities.

North Royalton A Tributary.

The North Royalton A tributary flows through a wooded flood plain before entering the East Branch, and the habitat quality is augmented accordingly by woody debris. Scouring under and around the woody debris imparted sinuosity and development to a channel that would otherwise be straighter and smoother owing to effects from urban and suburban runoff. The catchment immediately upstream from the sampling location is highly developed, so the habitat score (QHEI = 72.5) may be anomously high. Suburban impacts were evident primarily in embedded substrates and unstable riffles.

West Branch Rocky River

Sandstone bedrock in the lower reaches of the West Branch minimized effects of flashy urban runoff on habitat, consequently the ratio of modified habitat to warmwater habitat attributes were less than 0.5 in three of the four lower sites. The one exception being at the mouth where the river cuts through shale bedrock. In the upper reach (RM$\geq$ 13.3), modified attributes imparted by habitat impacts associated with agriculture (though mimicking those noted for suburbanization in the East Branch) included moderate to high substrate and riffle embeddedness, and siltation. The absence of wide-spread direct habitat alterations was evident in the mean QHEI score of 67.4, reflecting habitats generally capable of supporting warmwater biological assemblages.

Plum Creek

Warmwater habitat attributes comprised the majority of habitat characteristics in Plumb Creek (Table 10). The ratio of modified to warmwater attributes was less than 0.5 at both sites, reflecting the lack of channel modifications, moderate instream cover, good channel development and heterogeneous substrates.

Blodgett Creek

Blodgett Creek contained habitat suitable for warmwater stream faunas; however, the suburbanized nature of the catchment imparted modified characteristics. Specifically, there was very little cover, low channel stability and marginal development, and embedded riffles.

North Branch Rocky River

Very good habitat quality was noted in the North Branch, being characterized by a sinuous and developed channel, instream cover, and heterogeneous substrates (Table 10). Some impact from agriculture was evident in embedded riffles and moderate siltation in depositional areas.

Biological Assessment: Macroinvertebrate Community

Rocky River

Macroinvertebrate sampling in 1997 was conducted at eight locations in the free flowing portion of the Rocky River mainstem from upstream from the North Olmsted WWTP (RM 11.5) to Park Blvd. (RM 3.0). A total of 108 taxa were collected with an average of 35 taxa in the quantitative samples and 33 taxa from the natural substrates. Invertebrate Community Index scores ranged from 30 at RM 9.0 to 48 at RM 11.5 (Figure 16, Table 11). These scores and statistics generally meet or exceed the expectations for WWH streams in the Erie-Ontario Lake Plain.

The benthic assemblage present in the mixing zone of the North Olmsted WWTP (RM 11.3) was primarily limited by marginal habitat (shallow flat bedrock) rather than the discharge of treated effluent. Qualitative sampling was conducted twice in the North Olmsted WWTP mixing zone, when the quantitative samples were set and again when they were retrieved. The number of taxa was relatively low, however, the collection of 6 to 8 EPT taxa indicated that the effluent was not acutely toxic.

Mainstem ICI scores from 1981 and 1997 demonstrate significant improvement in the macroinvertebrate community (Figure 16) in the interim. One of five sampled sites (RM 2.9) attained the WWH ICI criteria in 1981. In 1997, all five sites were within the range of insignificant departure or higher. ICI scores from RMs 11.5 and 3.0 met the expectations for an EWH (Exceptional Warmwater Habitat) Aquatic Life Use. The ICI score averaged 40 in 1997 compared with 24 in 1981.

Improvement following the completion of the southwest interceptor is more difficult to discern due to a lack of comparable quantitative data from the 1992 survey. There was an observed decrease in the prominence of blackflies on the natural substrates in 1997 and Qualitative Community Tolerance Values (QCTV) suggest some improvement since 1992. The average QCTV score, excluding mixing zones, increased from 35.4 in 1992 to 36.9 in 1997. By comparison, sites in the Erie-Ontario Lake Plain (ELOP) ecoregion that achieve the ICI biocriterion generally have QCTV scores that exceed 37.2 (the 25th percentile of the QCTV scores of attaining WWH ELOP sites). It appeared that macroinvertebrate community in the Rocky River remained somewhat depressed compared with similarly effluent dominated streams in Ohio but which are not affected by other pollutant sources such as CSOs and urban runoff (*i.e.,* the Scioto River downstream from Columbus, and the Licking River downstream from Newark).

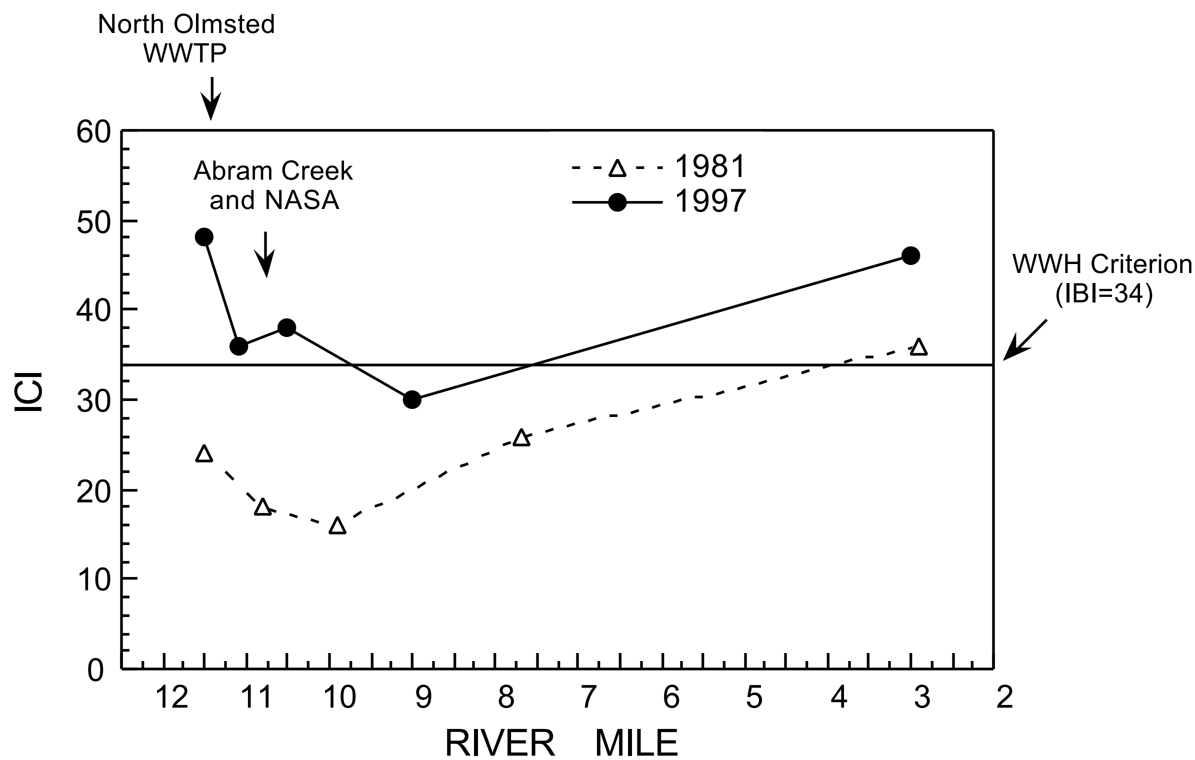


Figure 16 Longitudinal trends in the Invertebrate Community Index in the Rocky River study area, 1981 and 1997.

Macroinvertebrate sampling was conducted in the Rocky River lacustuary in 1997 and 1995. A Lacustuary ICI (LICI) is being developed by Ohio EPA for use in evaluating stream reaches that are affected by Lake Erie. LICI scores reflected fair to marginally good conditions in 1997 and were somewhat higher than in 1995 (Table 11). The difference in scores may be a reflection of the variability inherent in disturbed habitats. The organisms that were present do not suggest any severe water quality problems in the lacustuary, however, siltation and habitat loss limit community diversity.

Table 11. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in Rocky River basin, July - October, 1997. Aquatic life uses listed are those currently designated in the Ohio Water Quality Standards or are proposed use designation changes.

Stream River Mile[f]	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Qual. EPT[a]	Predominate Organisms	QCTV[c]	ICI[e]	Narrative Evaluation[b]
					Rocky River (existing WWH)			
11.5	1498	33	39	11	Hydropsychid caddis, midges, mayflies	37.7	48	Exceptional
11.3	-	-	21	8	Hydropsychid caddis, midges, mayflies	35.9	-	
11.3	-	-	14	6	Hydropsychid caddis, baetid mayflies	38.7	-	
11.1	1177	31	37	9	Hydropsychid caddis, midges	38.4	36	Good
10.5	1293	35	33	9	Hydropsychid caddis, midges	38.6	38	Good
10.0	-	-	35	9	Hydropsychid caddis, midges, mayflies	38.4	-	Good
9.0	404	32	33	11	Midges, hydropsychid caddis	32.9	30[ns]	Marginally Good
5.8	-	-	31	8	Midges, hydropsychid caddis	34.9	-	Good
3.0	739	43	23	7	Tanytarsini midges, hydropsychid caddis	37.7	46	Exceptional
0.7L	940	32	35	6	Tanytarsini midges, caenis mayflies	-	42[ns]	Very Good
0.1L	1065	21	7	2	Scuds,zebra mussels	-	38[ns]	Marginally Good
					Abram Creek (existing WWH)			
3.4	496	28	12	1	Aquatic worms, fingernail clams	31.8	18*	Fair
1.9	264	28	20	4	Hydropsychid caddis, aquatic worms	35.3	28*	Fair
0.2	123	25	19	4	Aquatic worms, midges	34.3	26*	Fair
					East Branch Rocky River (existing WWH)			
29.7	367	34	40	11	Mayflies, hydropsychid caddis	40.9	56	Exceptional
22.0	-	-	41	15	Caddisflies, mayflies, midges	39.8	-	Exceptional
18.3	-	-	17	4	River snails, midges	40.9	-	
18.3	-	-	11	2	Heptageniid mayflies, midges	34.3	-	
17.5	435	42	32	11	Hydropsychid caddis, water penny, midges	40.9	50	Exceptional
13.1	322	49	40	12	Hydropsychid caddis, mayflies	40.9	50	Exceptional
11.6	574	45	31	11	Hydropsychid caddis, midges, mayflies	40.3	44	Very Good
10.8	600	32	33	10	Hydropsychid caddis, midges, mayflies	40.3	42	Very Good

Table 11 continued.

Stream River Mile[f]	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Qual. EPT[a]	Predominate Organisms	QCTV[c]	ICI[e]	Narrative Evaluation[b]
10.0	889	41	43	9	Heptageniid mayflies, midges	39.8	42	Very Good
6.4	223	44	44	14	Hydropsychid caddis, midges, mayflies	41.5	56	Exceptional
4.9	429	31	30	10	Hydropsychid caddis, baetid mayflies, midges	39.5	42	Very Good
1.4	413	23	35	8	Hydropsychid caddis, tanytarsini midges	38.4	40	Very Good
					Baldwin Creek (existing WWH)			
7.5	-	-	21	1	Midges, water penny	35.2	-	Marginally Good
7.0	-	-	33	4	Blackflies, midges, baetid mayflies	34.9	-	Marginally Good
5.7	355	27	25	6	Hydropsychid caddis, tanytarsini midges	38.4	42	Very Good
3.0	-	-	17	5	Hydropsychid caddis	38.4	-	Marginally Good
2.6	520	30	22	4	Midges, hydropsychid caddis	38.4	34	Good
1.5	816	30	19	6	Tanytarsini midges, hydropsychid caddis	38.4	38	Good
					North Royalton "A" WWTP tributary			
0.6	-	-	18	3	Midges	36.8	-	Fair
0.2	-	-	18	3	Craneflies, midges	36.4	-	Fair
					West Branch Rocky River (existing WWH)			
33.6	372	37	41	9	Midges, hydropsychid caddis	36.4	46	Exceptional
33.2	-	-	45	7	Hydropsychid caddis, riffle beetles	36.4	-	Very Good
27.3	90	37	37	11	Hydropsychid caddis, riffle beetles	41.5	36	Good
16.3	320	38	40	9	Hydropsychid caddis, riffle beetles, mayflies	38.4	42	Very Good
13.3	622	45	40	8	Midges, hydropsychid caddis, riffle beetles,	39.5	44	Very Good
4.8	754	35	44	11	Midges, hydropsychid caddis,mayflies	38.7	44	Very Good
3.6	2402	32	37	11	Hydropsychid caddis, midges	38.7	44	Very Good
2.1	1895	39	38	10	Hydropsychid caddis, midges	39.5	46	Exceptional
0.4	-	-	35	12	Baetid mayflies, midges	39.5	-	Exceptional
					Plum Creek (existing WWH)			
2.9	-	-	32	6	Mayflies, riffle beetles, fingernail clams	31.8	-	Marginally good
0.2	-	-	23	2	Midges, blackflies, isopods	33.4	-	Fair

Table 11 continued.

Stream River Mile[f]	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Qual. EPT[a]	Predominate Organisms	QCTV[c]	ICI[e]	Narrative Evaluation[b]
					North Branch Rocky River (existing WWH)			
5.6	1168	39	47	12	Midges, mayflies	39.5	54	Exceptional
					Blodgett Creek (existing WWH)			
0.1	-	-	17	8	Baetid mayflies	39.5	-	Marginally good
					Healey Creek (existing WWH)			
0.9	-	-	17	2	Mayflies, dragonflies	37.7	-	Fair
					Cossett Creek (existing WWH)			
0.2	-	-	27	7	Mayflies, hydropsychid caddisflies	39.2	-	Marginally good
					Plum Creek, tributary to North Branch Rocky River (existing WWH)			
2.5	-	-	20	6	Mayflies, amphipods, blackflies	36.8	-	Fair

Ecoregion Biocriteria: Erie-0ntario Lake Plain (EOLP)

INDEX	WWH	EWH
ICI	34	46

a- EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), & Trichoptera (caddisflies) taxa richness.
b- Qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate an Invertebrate Community Index (ICI) score.
c- Qualitative Community Tolerance Value (QCTV) is derived as the median of the tolerance values calculated for each qualitative taxon present (see discussion in Methods Section).
d- Qualitative assessment used in lieu of quantitative score due to lack of flow and/or vandalism of H.-D.'s.
e- Lacustuary ICI (LICI) used at sampling locations affected by Lake Erie.
f- L after river mile denotes lacustuary sampling location.
*- Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.
ns- Nonsignificant departure from ecoregion biocriterion ($\leq$4 ICI units).

Abram Creek

Macroinvertebrate sampling in 1997 was conducted at three locations in Abram Creek from Eastland Rd. (RM 3.4) to near the mouth (RM 0.2). A total of 55 taxa were collected with an average of 27 taxa in the quantitative samples and 17 taxa from the natural substrates. Invertebrate Community Index scores ranged from 28 at RM 1.9 (ust. Grayton Rd.) to 18 at RM 3.4 (ust. Eastland Rd.). The stream was last sampled in 1992 and, at that time, was severely degraded by discharges from the Middleburg Heights (RM 4.0) and Brookpark WWTPs (RM 3.7). Elimination of these discharges has resulted in limited improvement in the condition of the macroinvertebrate community. ICI scores that were in the poor range in 1992 improved to the fair range in 1997 (Figure 17). The urban nature of the watershed was the principal impact source at the Grayton Rd. site and was evident by large amounts of construction debris in the

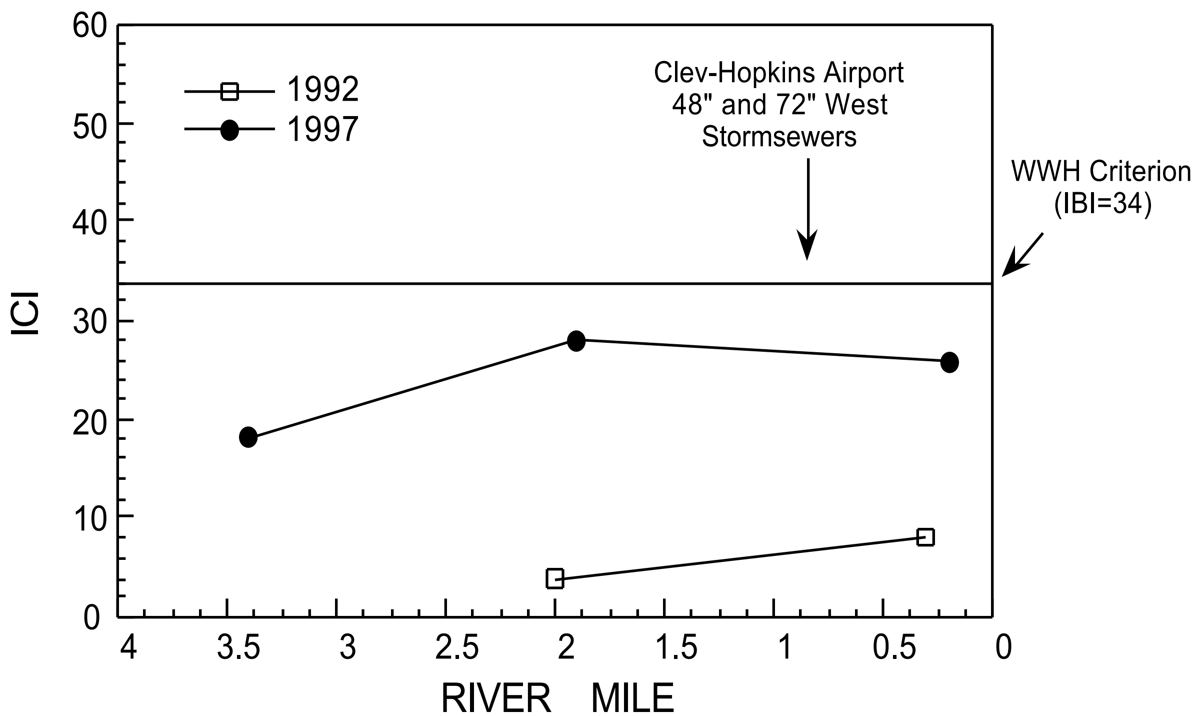


Figure 17 Longitudinal trends in the Invertebrate Community Index in the Abram Creek study area, 1992 and 1997.

stream. Good numbers of hydropsychid caddisflies and baetid mayflies present at Eastland Rd. contributed to a modestly improved ICI score. Conditions near the mouth of Abram Creek were similar to the Eastland Rd. site. Habitat at all three sampling locations was sufficient to support a typical warmwater fauna of macroinvertebrates. It appears that water quality impacts from the surrounding watershed described earlier in this report, were limiting the development of a more diverse benthic fauna.

East Branch Rocky River

Macroinvertebrate sampling in 1997 was conducted at eleven locations in East Branch Rocky River from SR 303 (RM 29.7 to Eastland Rd. (RM 1.4) (Figure 18). A total of 144 taxa were collected with an average of 38 taxa in the quantitative samples and 37 taxa from the natural substrates. The macroinvertebrate community was in good to exceptional condition throughout the study area (ICI values ranged from 56 to 42). Similar conclusions were drawn based on previous studies in 1981 and 1992; except for an improvement demonstrated in 1997 at RM 1.4. The elimination of the Berea WWTP discharge in 1994 coincides with the improved macroinvertebrate results at this site.

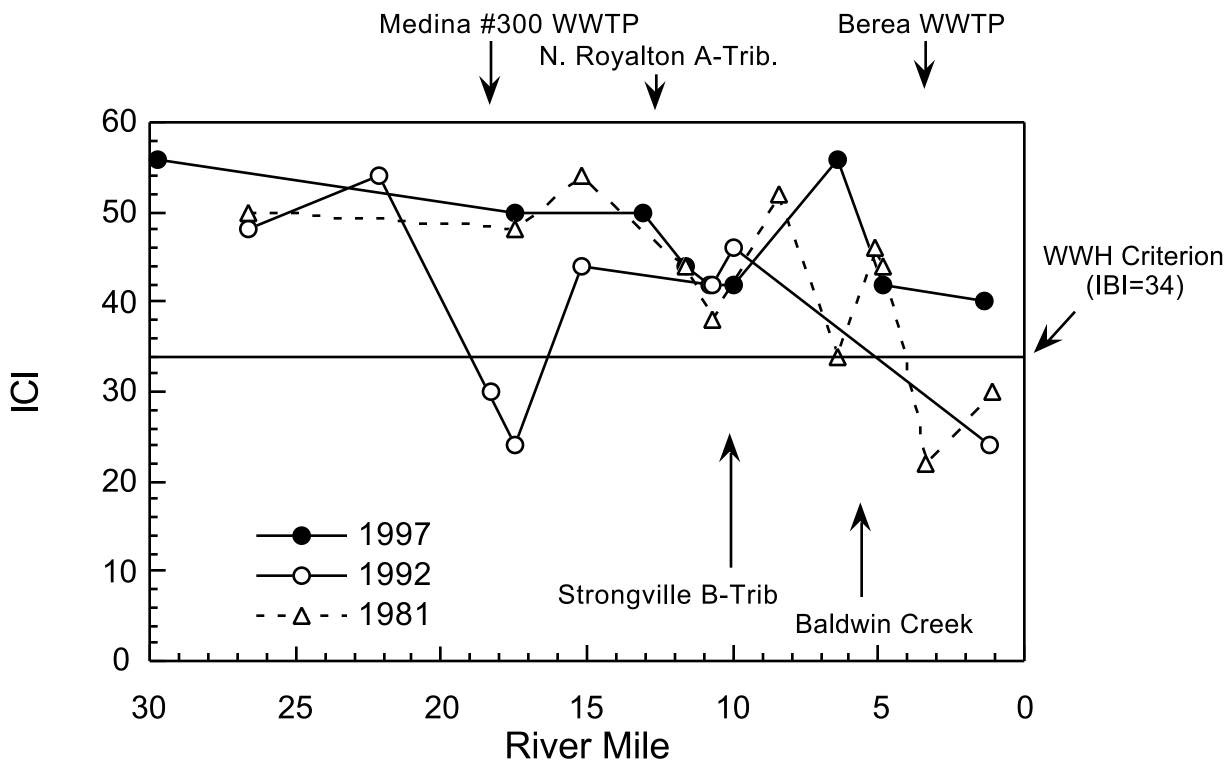


Figure 18 Longitudinal trends in the Invertebrate Community Index in the East Branch Rocky River study area, 1981 to 1997.

The benthic assemblage present in the mixing zone of the Medina 300 WWTP (RM 11.3) was primarily limited by habitat (deep pool) rather than the discharge of treated effluent. Qualitative sampling was conducted twice during the summer and produced seventeen and eleven taxa. The number of taxa was relatively low due to the limited sampling area. However, collection of relatively pollution sensitive organisms indicated that the effluent was not acutely toxic. No significant impact was observed in the East Branch downstream from the WWTP.

Baldwin Creek

Macroinvertebrate sampling in 1997 was conducted at six locations in Baldwin Creek from upstream from the North Royalton B WWTP (RM 7.5) to adjacent Fowles Rd. (RM 1.5). A total of 77 taxa were collected with an average of 29 taxa in the quantitative samples and 23 taxa from the natural substrates. Invertebrate Community Index scores ranged from 42 at RM 5.7 (dst. Bagley Rd.) to 34 at RM 2.6 (ust. Main St.) (Figure 19). An excess of nutrients and particulate organic material was evidenced by high numbers of blackflies on the natural substrates downstream from the North Royalton B WWTP. No significant impact was observed due to the discharge of treated effluent from the Strongsville C WWTP. Baldwin Creek macroinvertebrate assemblages were in marginally good to good condition which is slightly improved compared with results from 1992. However, development within the watershed is ongoing and attention to the impact land use changes will have on both flow regime and water quality is needed to prevent deterioration in macroinvertebrate community condition.

North Royalton A WWTP tributary

Qualitative macroinvertebrate sampling was conducted upstream and downstream from the North Royalton A WWTP. Fifteen taxa were collected at each site and a reflected fair macroinvertebrate community. The most noticeable difference between the two sites was increased flow volume contributed by the WWTP. Habitat impacts brought about by

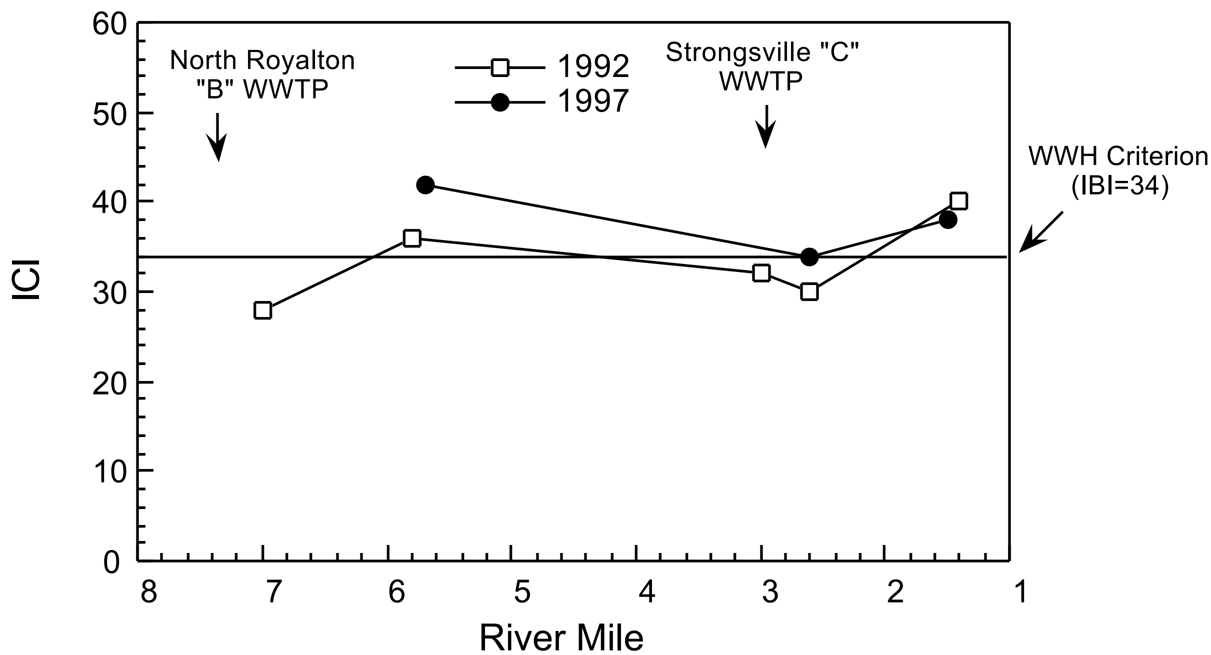


Figure 19 Longitudinal trends in the Invertebrate Community Index in the Baldwin Creek study area, 1992 and 1997.

development in the watershed appeared to be the primary factor affecting the macroinvertebrates. Both sites were significantly affected by siltation and substrate embeddedness that resulted in low taxa diversity and low numbers of organisms.

West Branch Rocky River
Macroinvertebrate sampling in 1997 was conducted at nine locations in West Branch Rocky River from SR 162 (RM 33.6) to Lewis Rd. (RM 0.3). A total of 151 taxa were collected with an average of 38 taxa in the quantitative samples and 40 taxa from the natural substrates. The macroinvertebrate community was in very good to exceptional condition throughout the study area (Table 11). An improvement in the macroinvertebrate community in the lower four miles of the West Branch since 1992 is best represented by the QCTV due to a lack of 1992 ICI data. The average QCTV score increased from 36.5 in 1992 to 39.2 in 1997. In 1992, this stream segment was affected by nutrient enrichment and the macroinvertebrate community was in marginally good condition. The elimination the Strongsville A WWTP discharge to Blodgett Creek and the attendant nutrient load likely resulted in the changes exhibited by benthic biota in the lower four miles of West Branch (Figure 20).

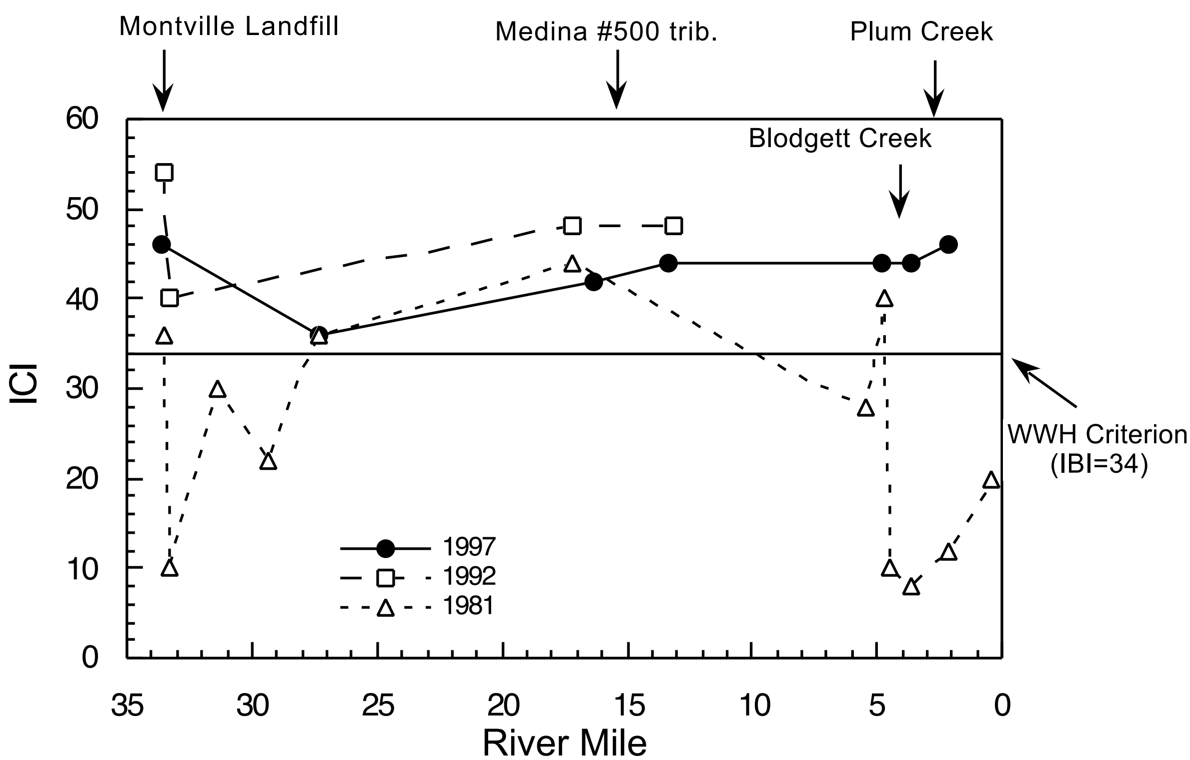


Figure 20 Longitudinal trends in the Invertebrate Community Index in the West Branch Rocky River study area, 1992 and 1997.

Blodgett Creek

Qualitative sampling at RM 0.1 yielded only seventeen taxa, however, mayfly or caddisfly taxa were well represented (8 taxa). This site was considered to be in poor condition in 1992, prior to the elimination of the Strongsville A and Olmsted Falls Versailles WWTP discharges. At that time, the community was predominated by pollution tolerant midge taxa and no EPT taxa were collected. A reduction in nutrient enrichment was indicated in 1997 compared with 1992, however, macroinvertebrate community condition remained somewhat depressed by a combination of limited habitat (bedrock) and impacts associated with the surrounding urban area.

Plum Creek

Qualitative sampling was conducted at two locations on Plum Creek, upstream and downstream from Olmsted Falls (RMs 2.9 and 0.2, respectively). Thirty two taxa were collected at RM 2.9 including six EPT taxa. The macroinvertebrate community was in marginally good condition. It appeared that ongoing development was impacting the stream. Sediment from construction site runoff in the near term and subsequent changes in flow regime and storm water runoff will present ongoing threats to the biota of the stream.

The macroinvertebrate community of Plum Creek at RM 0.2 was predominated by pollution tolerant midges, isopods, and blackflies. Twenty three taxa were collected. Similar conditions were encountered in 1992 and demonstrate sustained degradation within the watershed. Potential sources of impact included three WWTP discharges (all are now closed), unsewered areas and polluted stormwater runoff.

North Branch Rocky River

The North Branch Rocky River at RM 5.6 has consistently supported a diverse macroinvertebrate fauna including good numbers of pollution sensitive organisms. The 1997 sampling results were no exception. The site yielded an ICI score of 54. Forty seven taxa were collected from the natural substrates including twelve EPT taxa.

Biological Assessment: Fish Communities 1981 - 1997

Rocky River

Fish communities in the Rocky River mainstem (downstream from the confluence of the East and West Branches) appear suppressed by degraded water quality. Community structure is relatively intact, given that three of six IBI scores met the Warmwater Habitat Biological Criterion, most scores are in the Marginally Good to Fair range (Table 12, Figure 21), and the community is not dominated by tolerant and omnivorous fishes. However, the relative abundance of nontolerant species is low, and pollution intolerant species are virtually absent. Consequently, MIwb scores are in the Poor and Fair ranges. The marginal performance of the IBI suggests that degraded water quality is impairing the fish community. The difference between the IBI performance and the MIwb further suggests that episodic toxicity is also a factor.

Specific stressors impairing the fish community were detected. Organic or nutrient enrichment was affecting the fish community, at least on a local basis at RM 6.1, given the high relative abundance of tolerant and omnivorous fishes found there. Habitat as a limiting factor, particularly the lack of cover (woody debris), is evident in the low numbers of sunfish species present. Moderately to highly embedded riffles also appear to suppress the abundance of darters.

Compared to 1992 and 1981, the fish community sampled in 1997 had slightly higher IBI scores in the mainstem reach between RM 8.0 and the confluence of the East and West Branches (Table 12), owing to a decrease in the relative abundance of tolerant and omnivorous fishes in 1997. The improvement likely reflects upgrades to the North Olmsted WWTP and elimination of the Berea WWTP discharge to the East Branch. Downstream from RM 8.0, IBI scores were similar between all years. MIwb scores were slightly higher in 1981 and 1992 compared to 1997 (Figure x), especially in the reach immediately downstream from the confluence of the two branches to downstream from the North Olmsted WWTP. The higher MIwb scores in 1992 and 1981 may be due to enriching effects of nutrients and poorly treated organic wastes on a fauna comprised largely of tolerant and intermediately tolerant species. Also, the low MIwb scores in 1997 may reflect episodic toxicity (See *Blodgett Creek* below) or the collective assault on water quality from upstream (see *Blodgett Creek, Plum Creek, Baldwin Creek, and the East Branch* below). The abundance of bluntnose minnows and spotfin shiners, both of which are favored by enriched conditions (especially bluntnose minnows), was higher in 1992 than 1997 (Figure 22). Although stoneroller abundance was similar between years, the relative abundance was more normally distributed among sites than in 1992, suggesting a more uniform distribution of favored algal species (Figure 22). Substrates in both branches became increasingly slippery moving downstream, coinciding with increasing wastewater loadings, and were most slippery due to a slimy algal coating between RMs 11.5 (immediately downstream from the confluence) and RM

Table 12. Fish community indices from samples collected in the Rocky River basin study area 1981 - 1997.

River Mile	Number Species	Mean Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean MIwb[a]	Mean IBI	Narrative Evaluation
				Erie-Ontario Lake Plain WWH				
Rocky River (13-001) 1997								
11.7	14.0	18	152	29.5	69.0	6.4*	33*	Fair
11.3	*9.0*	*13*	*420*	*4.6*		*6.4**	*35[ns]*	*Fair/M.Good*
11.1	13.5	18	202	8.6	60.0	<u>5.8</u>*	37[ns]	Poor/M.Good
10.0	14.0	17	281	6.9	54.5	7.2*	37[ns]	Fair/M.Good
8.5	12.5	15	506	4.1	66.0	7.3*	38	Fair/Good
6.1	9.5	12	194	1.9	65.0	<u>5.3</u>*	28*	Poor/Fair
3.0	11.0	14	216	3.3	73.0	6.6*	31*	Fair
1.0[L]	22.0	29	705	204.9		7.7[ns]	34*	Fair
0.2[L]	11.0	11	236	106.6		7.7[ns]	33*	Fair
Rocky River (13-001) 1995								
1.0[L]	15.0	2	295	167.5		6.8*	23*	Fair
0.2[L]	15.0	22	283	170.2		6.2*	23*	Fair
Rocky River (13-001) 1992								
11.5	22.5	8	496	13.8	64.0	8.2	43	Good
11.3	*13.5*	*15*	*2568*	*14.0*	*61.5*	*8.6*	*33**	*Good/Fair*
11.1	18.5	21	518	29.4	70.0	7.3*	30*	Fair
10.0	18.5	22	345	10.3	67.0	7.2*	33*	Fair
9.5	23.0	23	1473	7.9	68.0	8.2	32*	Good/Fair
9.0	13.5	15	349	6.5	70.5	7.0*	27*	Fair
5.8	13.0	15	494	4.0	68.0	7.1*	32*	Fair
3.0	18.0	21	306	14.7	80.5	6.9*	28*	Fair
1.0[L]	18.3	29	386	111.1	63.0	7.5	29*	Good/Fair
0.1[L]	16.0	27	335	94.5	34.0	7.2*	27*	Fair
Rocky River (13-001) 1986								
11.5	18.0	2	2075	20.7		8.3	40	Good
10.4	20.0	7	732	23.8		8.0	40	Good
Rocky River (13-001) 1982								
11.5	16.5	10	1714	6.1	65.5	7.8[ns]	34[ns]	M.Good
10.4	13.5	8	3074	7.0	69.0	7.1*	30*	Fair
8.9	14.5	9	3062	20.0	76.5	6.5*	24*	Fair

Table 12. 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
Rocky River (13-001) 1982 continued.								
2.9	21.0	26	4613	24.2	79.0	9.2	28*	V.Good/Fair
2.8	12.0	12	387	212.8		5.3*	22*	Fair
1.3[L]	7.0	7	142	40.0		6.0*	26*	Fair
0.1[L]	7.0	7	157	100.9		4.6*	20*	Fair
Abram Creek (13-002) 1997								
3.2	5.0	6	84	0.0	42.5	NA	12*	Very Poor
2.8	3.0	3	16	0.0	52.5	NA	12*	Very Poor
1.9	3.0	4	15	0.0	65.5	NA	12*	Very Poor
0.6	2.0	4	17	0.0	57.5	NA	12*	Very Poor
Abram Creek (13-002) 1995 (Malcom-Pirnie)								
3.5	--	--	--	--	39.5	NA	16*	Very Poor
3.0	--	--	--	--	36.5	NA	12*	Very Poor
0.5	--	--	--	--	59.5	NA	20*	Poor
Abram Creek (13-002) 1992								
1.9	2.0	3	10	0.0	73.0	NA	12*	Very Poor
0.4	7.5	9	142	8.5	59.0	NA	17*	Very Poor
Abram Creek (13-002) 1981								
4.6	4.5	5	510	1.0	43.0	NA	16*	Very Poor
3.7	3.0	4	109	1.0	52.5	NA	17*	Very Poor
2.8	2.0	3	25	0.4	51.5	NA	15*	Very Poor
0.9	12.5	16	757	94.3	67.0	NA	24*	Poor
East Branch Rocky River (13-100) 1997								
29.4	14.0	14	739	0.0	75.0	NA	44	Good
21.6	14.5	17	141	2.4	67.5	6.4*	36	Fair/Good
17.8	12.0	16	285	1.2		6.3*	42	Fair/Good
17.5	19.0	21	597	8.2	73.5	8.2	43	Good
13.0	18.0	20	1043	13.1	66.0	8.5	41	Good
11.6	21.5	26	383	9.1	69.5	7.9	43	Good
10.0	18.0	21	844	8.9	67.5	7.9	35[ns]	Good/M.Good
6.4	16.5	19	947	11.6	57.5	7.6[ns]	36[ns]	M.Good

Table 12. 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
East Branch Rocky River (13-100) 1997 continued.								
3.0	15.0	19	518	18.2	55.0	7.0*	34[ns]	Fair/M.Good
1.4	13.5	15	512	12.4	66.5	7.2*	34[ns]	Fair/M.Good
East Branch Rocky River (13-100) 1992								
26.7	13.5	1	694	6.3	68.0	7.5[ns]	45	M.Good/Good
21.9	20.0	2	646	13.9	79.0	8.8	48	Good/V.Good
18.2	*16.0*	*20*	*1112*	*10.7*	*67.0*	*8.4*	*43*	*Good*
17.5	20.0	3	367	15.5	70.0	7.3*	39	Fair/Good
15.3	21.5	25	617	14.4	63.5	8.0	45	Good
11.6	17.5	6	1169	17.2	83.5	8.2	39	Good
10.0	16.0	1	2204	24.7	62.0	8.6	36[ns]	Good/M.Good
6.5	19.0	2	527	18.9	63.5	7.8[ns]	36[ns]	M.Good
4.9	13.5	17	87	9.1	67.5	5.5*	34[ns]	Poor/M.Good
1.4	12.5	4	358	35.4	72.0	4.4*	22*	Very Poor/Poor
East Branch Rocky River (13-100) 1981								
26.7	16.5	18	1185	16.6	77.0	8.0	48	Good/V.Good
21.9	22.5	24	713	8.0	83.0	9.1	46	V.Good
17.5	21.0	24	1247	13.6	73.0	8.9	47	V.Good
15.2	20.0	23	851	7.3	57.0	8.7	42	Good
11.6	16.5	18	914	13.1	71.5	8.1	40	Good
10.0	20.5	24	4111	17.9	61.0	8.9	33*	V.Good/Fair
6.5	20.5	24	2642	13.4	59.5	7.2*	28*	Fair
4.7	10.5	14	88	4.4	70.5	5.4*	26*	Poor/Fair
4.1	16.5	22	508	6.8	58.5	6.8*	30*	Fair
3.3	16.5	20	997	17.1	63.0	6.6*	25*	Fair
1.4	11.0	16	216	1.0	63.0	4.6*	21*	Poor/Fair
Baldwin Creek (13-101) 1997								
7.0	6.5	7	1074	0.0	57.0	NA	24*	Poor
6.1	6.0	7	643	0.0	67.0	NA	20*	Poor
3.2	9.0	11	1423	0.0	37.0	NA	34*	Fair

Table 12. 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
Baldwin Creek (13-101) 1997 continued.								
2.6	9.0	9	488	0.0	62.0	NA	24*	Poor
1.4	9.5	11	253	0.0	43.0	NA	22*	Poor
0.2	10.0	10	77	2.1	50.5	NA	24*	Poor
Baldwin Creek (13-101) 1992								
7.4	8.0	9	922	12.5	54.5	NA	31*	Fair
5.8	7.5	4	633	18.1	80.5	NA	<u>17</u>*	Very Poor
3.0	11.5	14	2033	16.0	42.5	NA	27*	Poor
2.6	9.5	12	724	23.3	67.0	NA	22*	Poor
1.4	6.5	0	906	8.0	58.5	NA	19*	Poor
Baldwin Creek (13-101) 1981								
5.8	5.0	7	239	3.4	69.0	NA	<u>15</u>*	Very Poor
3.1	9.5	10	660	12.2	60.0	NA	23*	Poor
2.5	7.5	10	483	7.1	62.5	NA	24*	Poor
1.4	6.5	9	584	3.9	64.0	NA	28*	Fair
0.2	9.5	12	184	5.4	64.0	NA	29*	Fair
North Royalton "A" Trib. (13-103) 1997								
0.2	3.0	3	142	0.0	72.5	NA	<u>18</u>*	Poor
North Royalton "A" Trib. (13-103) 1992								
0.6	7.5	8	839	5.0	44.5	NA	35*	Fair
0.2	2.5	2	473	3.3	70.5	NA	20*	Poor
North Royalton "A" Trib. (13-103) 1981								
0.6	6.5	8	489	3.5	71.0	NA	26*	Poor
0.2	2.0	2	24	0.0	64.5	NA	<u>12</u>*	Very Poor
West Branch Rocky River (13-200) 1997								
33.5	17.5	22	669	0.0	63.5	NA	32*	Fair
33.3	16.0	19	951	0.0	66.5	NA	43	Good
27.3	19.0	21	356	11.0	65.5	6.8*	45	Fair/Good
16.4	19.5	22	385	4.1	66.5	7.9	40	Good
13.3	20.5	21	430	6.4	62.0	8.0	38	Good
4.8	15.0	18	506	14.1	72.0	7.8[ns]	39	M.Good/Good
3.6	8.0	10	112	10.8	71.0	5.9*	31*	Fair

Table 12. 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
West Branch Rocky River (13-200) 1997 continued.								
1.6	16.0	18	599	8.2	76.0	8.0	43	Good
0.1	13.5	16	526	3.1	62.0	7.4[ns]	40	M.Good
West Branch Rocky River (13-200) 1992								
33.5	20.5	23	884	28.5	68.5	NA	43	Good
33.3	19.0	5	2547	15.5	70.0	NA	49	V.Good
27.3	20.5	4	1256	13.3	72.5	8.3	42	Good
17.2	22.0	3	728	4.0	61.5	8.4	39	Good
13.3	22.0	24	772	4.7	75.0	8.0	32*	Good/Fair
4.8	15.0	18	479	16.7	81.0	7.6[ns]	42	M.Good/Good
West Branch Rocky River (13-200) 1992 - Continued								
3.6	11.0	14	276	11.4	68.0	6.6*	34[ns]	Fair/M.Good
2.1	12.5	14	517	8.1	62.5	7.2*	30*	Fair
0.4	15.0	20	929	10.7	76.5	7.8[ns]	33*	M.Good/Fair
West Branch Rocky River (13-200) 1981								
33.6	20.5	23	1261	8.9	73.5	NA	38	Good
33.3	20.5	23	1171	35.1	68.5	NA	42	Good
30.8	18.0	21	564	16.5	57.0	NA	33*	Fair
29.5	20.5	24	1267	7.6	70.0	8.5	43	Good
27.3	20.5	24	801	5.3	59.0	7.6[ns]	42	M.Good/Good
21.8	19.0	22	3199	12.8	58.5	8.7	41	Good
17.2	19.0	21	2344	11.1	67.0	8.8	38	Good
11.8	16.0	18	448	3.9	56.0	6.5*	31*	Fair
5.3	20.5	23	2124	14.2	65.5	9.0	36[ns]	V.Good/M.Good

Table 12. 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
West Branch Rocky River (13-200) 1981 continued.								
4.6	19.0		2765	23.5	74.0	8.3	34^{ns}	Good/M.Good
4.4	15.0		9	332	1.6	72.5	6.3*	25*Fair/Poor
3.7	7.0		11	60	0.1	55.5	4.7*	17*Poor/V.Poor
2.0	13.0		9	946	4.4	55.0	6.9*	27*Fair/Poor
0.3	19.0		25	3715	21.8	59.0	8.5	38Good
Plum Creek (13-201) 1997								
2.4	9.0		10	612	1.9	71.5	NA	18*Poor
0.1	4.5		7	123	2.7	70.5	NA	18*Poor
Plum Creek (13-201) 1992								
0.3	7.5		5	608	9.5	42.5	NA	18*Poor
Plum Creek (13-201) 1981								
8.5	11.5		13	1257	21.1	50.0	NA	21*Poor
0.3	4.5		6	138	5.0	55.5	NA	19*Poor
North Branch Rocky River (13-205) 1997								
5.5	18.5		23	394	7.6	74.5	7.6^{ns}	45Good
North Branch Rocky River (13-205) 1992								
5.5	21.0		26	629	11.6	73.5	8.2	47V.Good
North Branch Rocky River (13-205) 1981								
5.5	21.0		24	952	30.3	80.0	8.3	43Good
0.4	22.0		23	1109	15.0	71.0	9.0	49V.Good
Blodgett Creek (13-209) 1997								
0.9	7.0		7	521	0.0	64.0	NA	31*Fair
0.2	11.0		15	742	0.0	57.0	NA	40Good
Blodgett Creek (13-209) 1992								
0.1	10.0		13	725	2.7	63.5	NA	38Good
Blodgett Creek (13-209) 1981								
1.9	2.0		2	358	5.6	59.5	NA	20*Poor

Table 12. continued.

Ecoregion Biological Criteria: Erie-Ontario Lake Plain				
	IBI		MIwb	
Site Type	WWH	EWH	WWH	EWH
Headwaters	40	50	NA	NA
Wading	38	50	7.9	9.3
Boat	40	48	8.7	9.5
Lacustuary	42	50	8.6	9.6

a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.
* - Indicates significant departure from applicable biological criteria (>4 IBI units or > 0.5 MIwb units). Underlined scores are in the Poor to Very Poor range.
ns - Nonsignificant departure from applicable biological criteria (≤ 4 IBI units or ≤ 0.5 MIwb units).
W - Wading criteria apply
L - Lake influenced, lacustuary criteria apply.
H - Headwaters criterion apply

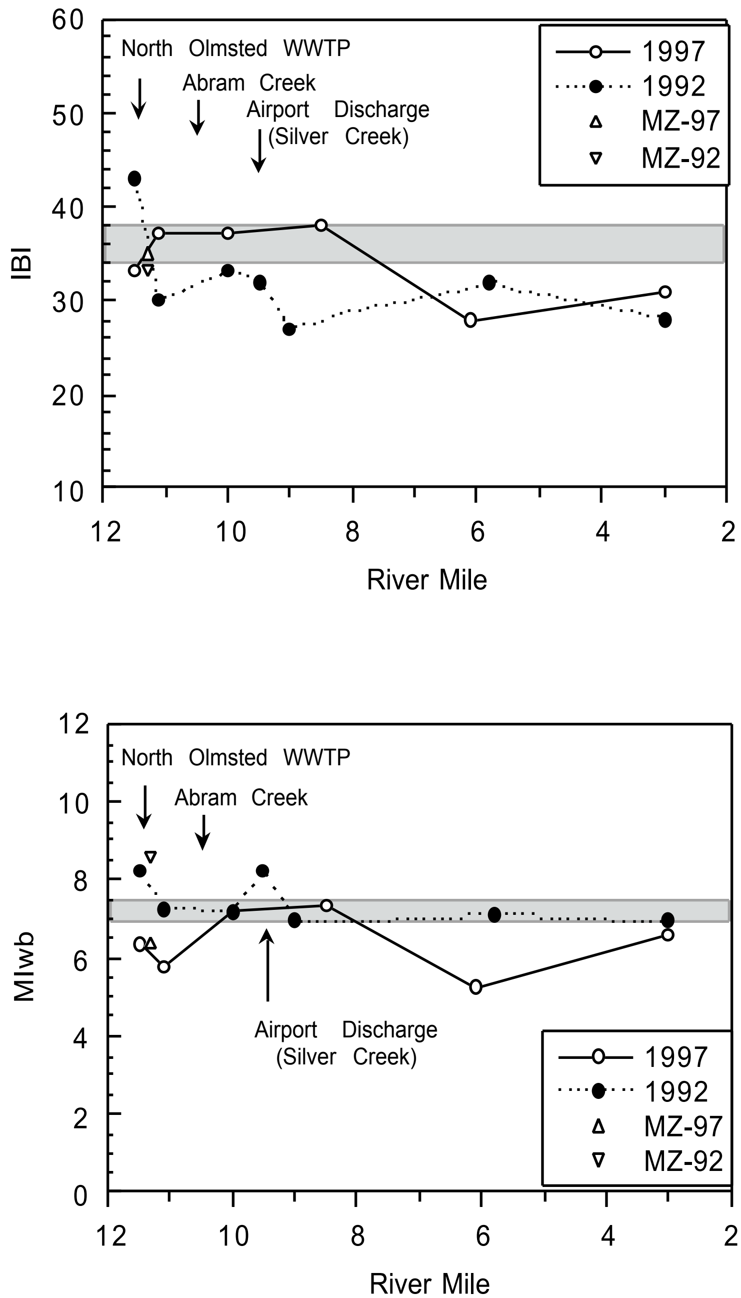


Figure 21 Longitudinal trend of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) in Rocky River, 1981-1997. The shaded box shows the area of nonsignificant departure from the applicable WWH biological criterion.

10.0. Curiously, abundance of stonerollers was lowest where the substrates were most slippery, suggesting that the algal community was not palatable to the stonerollers. High levels of nutrients favor a shift in assemblage away from diatoms toward one dominated by bluegreen and filamentous green algae, both of which are less palatable to fishes than are diatoms (Dodd et al. 1998).

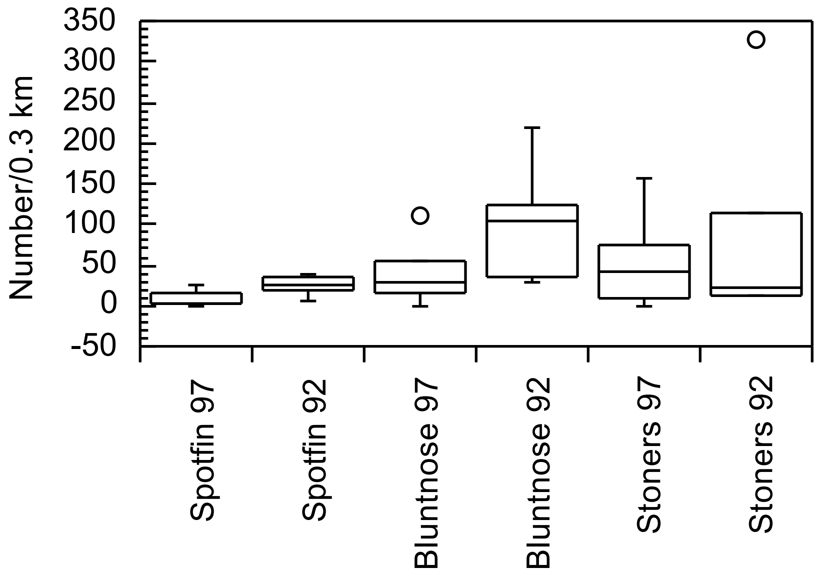


Figure 22 Box plots showing distributions of relative abundance for spotfin shiners, bluntnose minnows and stonerollers collected in the Rocky River mainstem, 1997 and 1992.

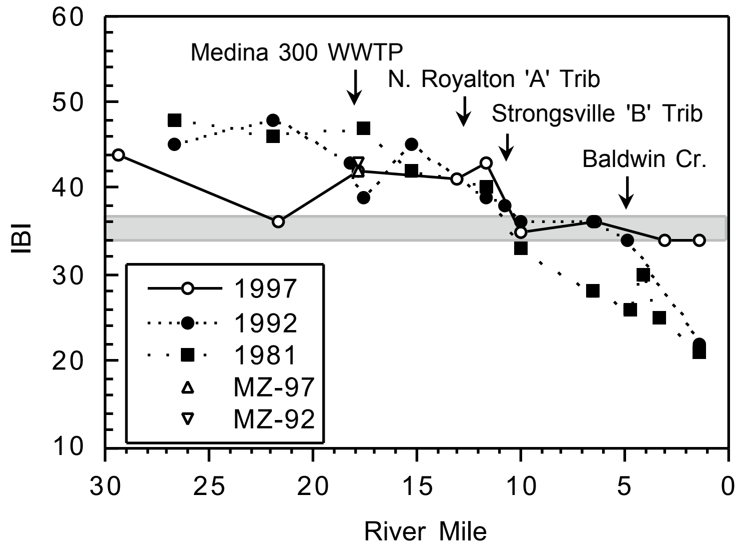
Abram Creek

Abram Creek was nearly devoid of fish life at all three sampling locations downstream from Koltoff Road (RM 2.9). As few as 1 juvenile green sunfish and 3 young-of-the-year white suckers were collected from RM 0.6 on one pass, and fewer than 17 fish were collected on all other passes at each location. The near complete absence of fish in Abram Creek demonstrates frequent acute water column toxicity. The very poor conditions at RM 2.8, presumably upstream from Cleveland Hopkins International Airport stormwater outfalls, suggests polluted stormwater runoff from adjacent commercial and industrial facilities severely impact water quality in Abram Creek. However, a storm sewer draining the IX center and part of Hopkins Airport enters the creek upstream from RM 2.8 at Koltoff Road. The fish community at the most upstream site (RM 3.2) was also in very poor condition, but it did support adult fish. Numerous young-of-the-year fathead minnows were observed in the electrofishing field at RM 3.2 and not elsewhere, suggesting that water quality was not as severely degraded, or episodic toxicity as frequent, as downstream. The fish communities observed in 1997 were as equally degraded as those observed in 1995 by Malcom-Pirnie, and in 1992 and 1981 by the Ohio EPA (Table 12).

East Branch Rocky River

Evident in 1981 and 1992 was a striking decline in IBI and MIwb scores starting downstream from the Strongsville B tributary (confluence at RM 11.1) with additional declines downstream from Baldwin Creek (Figure 23). IBI scores in 1997 also declined downstream from the Strongsville B tributary, but not downstream from Baldwin Creek, suggesting a lessening of impacts associated with Baldwin Creek. In the reach downstream from the Strongsville B tributary, the proportion of insectivores decreased by about one-third, tolerant and omnivorous fishes increased slightly, the total number of species declined, the pollution intolerant river chub and sensitive golden redhorse were lost or very rare, and rainbow darters were supplanted by greenside darters. Greenside darters feed on a wider range of prey sizes than rainbow darters (Van Snik-Gray et al. 1997), which may favor greenside darters under enriched conditions. Coincidentally, RM 11.0 approximately marks a transition where the East Branch flows out of predominately lacustrine and till deposits, and starts cutting through shale bedrock. The transition in geomorphic type does account for the loss of some species, specifically brook stickleback and central mudminnow, and to a lesser extent, sunfish species. However, while the transition between parent substrates may affect species composition and some individual IBI metrics (*i.e.*, number of sunfish species), it should not cause a decline in IBI scores (see the Grand and Ashtabula River TSD, OEPA 1997). Therefore, the observed shift in the fish community, although subtle on the basis of component metrics, argues for degraded water quality and enrichment.

The wide contrast in MIwb scores at RM 21.6 in 1997 and RM 21.9 in 1992 is attributable to differences in habitat between the two locations. The QHEI score was 67.5 at RM 21.6 versus 79.0 at RM 21.9. The habitat at RM 21.6 (downstream from SR 303) was modified by road construction, the gradient was lower, and the substrate composed of sand and gravel.



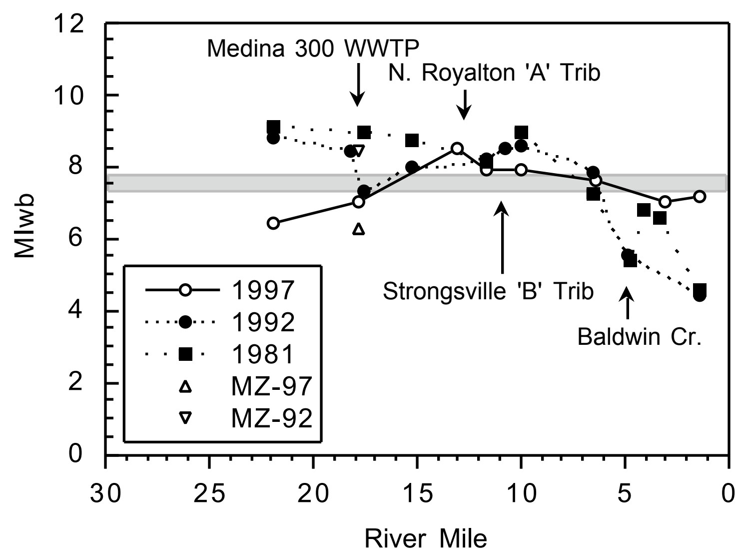


Figure 23 Longitudinal trend of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) in East Branch Rocky River, 1981-1997. The shaded box shows the area of nonsignificant departure from the applicable WWH biological criterion.

Baldwin Creek

The fish communities sampled in Baldwin Creek were degraded in response to marginal habitat quality, suburban runoff, and nutrient enrichment. Recent and historical residential development, and historical habitat modifications have resulted in moderately to highly embedded substrates. Stormwater surges have denuded the channel of woody debris, especially in the lower reach. Wastewater treatment at the North Royalton B and Strongsville C WWTPs prior to plant upgrades in the mid 1980s did not adequately remove ammonia from the final effluent. Consequently, darters and headwater species are absent from the creek, sensitive species are rare (several sand shiners were collected at RM 1.4), and the number of simple lithophilic species is below that expected. Two dams likely prevent recolonization from the East Branch of darters and other species.

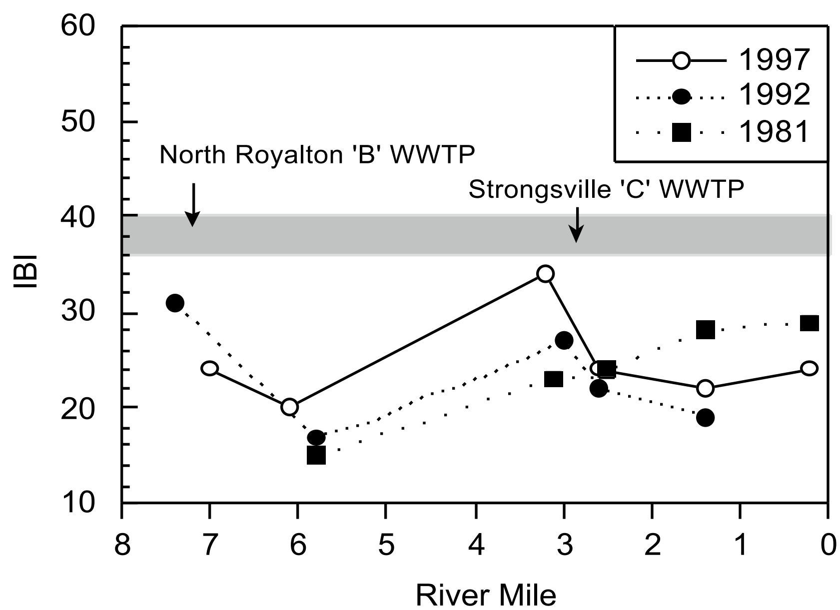


Figure 24 Longitudinal trend of the Index of Biotic Integrity (IBI) in Baldwin Creek, 1981-1997. The shaded box shows the area of nonsignificant departure from the applicable WWH biological criterion.

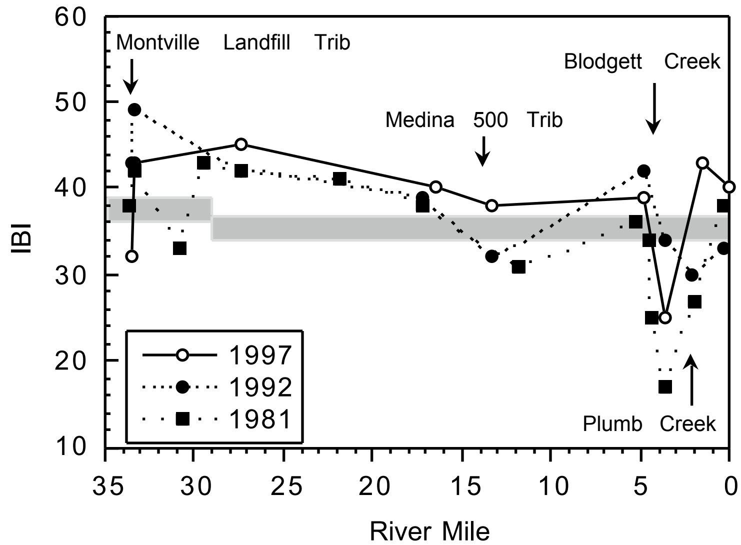
Although a pattern of impact, recovery, impact is apparent in Figure 24, the IBI score at RM 3.2 may reflect a unique ecological condition as much as recovery. The habitat at RM 3.2 is the most degraded in the stream. The stream is channelized, has a grassy riparian area, receives direct sunlight, and the substrates are sand and gravel. These conditions appear to favor the two species dominating the community at RM 3.2, bigmouth shiners, a prairie relict species, and stonerollers, a herbivore. However, despite the historical disturbances and existing marginal habitat quality, the high proportion of tolerant individuals at all stations except RM 3.2, coupled with the abrupt shift downstream from the Strongsville C WWTP, and the complete lack of response by the IBI to habitat quality suggest that the fish community is impaired by degraded water quality.

North Royalton A Tributary
The fish community in the North Royalton A tributary was badly degraded in response to the North Royalton A WWTP and stormwater discharges. White suckers and creek chubs, both tolerant of pollution, made up 92% of the fish community. The only other species collected were common shiners. These results are similar to those obtained in 1992 and 1981 (Table 12); however, in both 1992 and 1981 the two species dominating the community at RM 0.2 were creek chubs and blacknose dace. The loss of blacknose dace and replacement by white sucker suggests severe disturbance, possibly toxicity associated with the WWTP effluent or increasing volume and frequency of stormwater discharges.

West Branch Rocky River
Plots of IBI and MIwb scores for the West Branch show two readily apparent impacts, one downstream from Blodgett Creek, and the other at the two upstream most sites (Figure 25). Blodgett Creek receives wastewater discharge from the Strongsville "A" WWTP, and the fish community in Blodgett Creek had apparently experienced a toxic event (see *Blodgett Creek* below). Similar to Blodgett, the IBI scores at RM 3.6 in the West Branch differed considerably between passes, suggesting that poor biological performance in both streams was related to a common cause. The pattern of impact and recovery downstream from Blodgett Creek was similar in all three sampling years, but the footprint appears successively less over time. This suggests less of the assimilative capacity is taxed from sources other than Blodgett Creek (e.g., Plumb Creek, the Medina 500 WWTP).

The impact at the two most upstream sites was caused by residential construction. At RM 33.5, the 10-50 m wide mature woody riparian buffer that bordered the stream river right in 1992 was lost to a driveway prior to 1997. Similarly at RM 33.3, improvements to a driveway bridge (or a new one) crossing the stream and loss of riparian vegetation destabilized the banks and added clay and silt to the stream. Consequently habitat sensitive species were reduced in abundance or absent; darters and hog suckers were severely reduced in abundance, and golden redhorse, rock bass and sand shiners were lost. The relative abundance of creek chubs, however, doubled at both sites. Collectively, the changes to the fish community imparted by habitat degradation reduced the mean IBI scores at RMs 33.5 and 33.3 by 11 and 6 points, respectively (Table 12). These results illustrate the sensitivity of headwater streams to perturbations within the riparian zone.

A significant improvement in IBI scores was noted downstream from the Medina 500 Tributary (Figure 25). Tolerant and omnivorous fishes were less abundant while relative abundance of insectivores increased in 1997 compared to 1992.



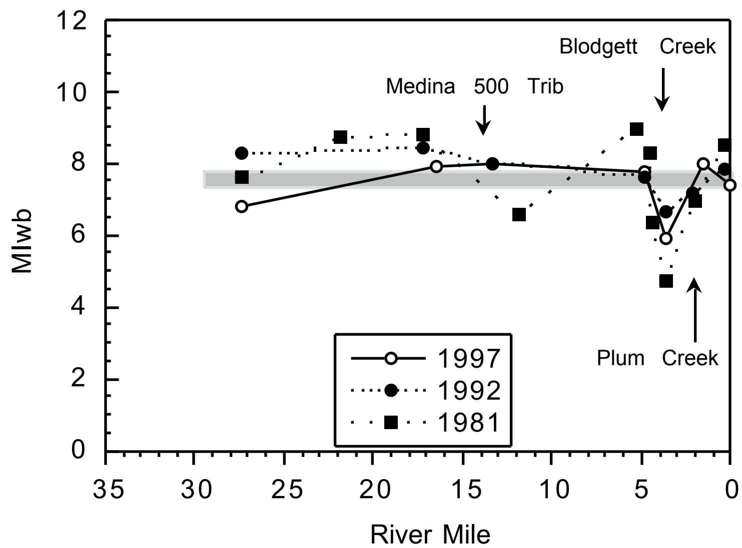


Figure 25 Longitudinal trend of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) in West Branch Rocky River, 1981-1997. The shaded box shows the area of nonsignificant departure from the applicable WWH biological criterion.

Plum Creek
The fish community sampled in Plum Creek indicates severe water quality impacts. Nearly the entire community at RM 0.1 was composed of two tolerant species, creek chubs and white suckers. The complete absence of all species but tolerants (except for two incidental stonerollers) suggests toxicity or chronically low dissolved oxygen from pollutant loadings by either the small WWTPs discharging upstream, septic discharge, or both. Upstream at RM 2.4, tolerant species comprised greater than 85% of the community and sensitive species were completely absent. The fish community performance indicates that RM 2.4 is badly polluted by organic enrichment. The high proportion of pioneering species further suggests periodic disturbance, likely from chronically low dissolved oxygen. A stormwater or sewer pipe with an obvious septic odor and visible sewage matter discharged into the creek within the sampling zone.

Blodgett Creek
Badly degraded water quality with toxic conditions is inferred from the fish community in Blodgett Creek. At the upstream site, tolerant fishes made up greater than 95% of the community, and sensitive species and darters were absent. Pioneering fishes were only moderately elevated, though, suggesting that toxicity may have been chronic. However, at the downstream site (RM 0.2), the fish community changed radically from a fair to exceptional community between sampling passes. Eight species were collected on the first pass, and as noted on the field QHEI sheet, all of the fish collected appeared to be young-of-the-year (YOY) or juvenile. During the second pass, 14 species were collected, relative abundance was high and spread across species, and two sensitive species were present. The disparity in results suggests that Blodgett Creek was recolonized by fishes from the West Branch between sampling passes, and implies that the reach downstream from the Strongsville “A” WWTP had experienced an acutely toxic event. This toxic event also apparently impacted the fish community in the West Branch at RM 3.6 (see *West Branch* above).

North Branch Rocky River
The North Branch Rocky River fish community at RM 5.5 was in good condition. Acceptable habitat and water quality conditions supported an assemblage with relatively high species richness including lithophilic, insectivorous and pollution sensitive species. Similar results have been achieved at this site since 1981.

District Site Surveys

Cossett Creek, Tributary to West Branch Rocky River

A district site survey was conducted on August 7, 1997 on Cossett Creek at RM 0.2, just upstream from the Rt. 252 bridge. Cossett Creek is a tributary of the West Branch Rocky River.

It has a length of 5.2 miles and a drainage area of 4.18 sq. mi. Cossett Creek is designated a WWH stream for protection of aquatic life in Ohio water quality standards, OAC 3745-1. The survey was conducted to determine if the stream was attaining its designated aquatic life use. Samples were collected for fish (IBI electrofishing survey), benthic macroinvertebrates (qualitative sample), habitat (QHEI), and water chemistry.

The fish community attained an IBI of 38, indicating full attainment but nonsignificant departure from the headwater habitat criteria of 40 IBI. This marginal attainment may be partly explained by the marginal QHEI value of 59.5, which is at the lower range of a potential WWH stream. Eleven species of fish were collected, with 68% of the numbers represented by creek chub and blacknose dace. A spot fin shiner x mimic shiner hybrid was collected, a rare shiner hybrid type. A single cold water species, the redside dace was collected. The water temperature was 15.2 C which is cool for the August time period. A marginally good macroinvertebrate community was observed with 7 EPT taxa and 27 total qualitative species collected. No cold water taxa of macroinvertebrates were collected. No single taxa appeared to dominate the invertebrate community, but mayflies and caddisflies were the most dominant types collected. Numerous adults of the two-lined salamander, *Eurycea bislineata,* were observed under rocks along the stream margins. This species is a common inhabitant of constant flowing headwater streams in northeast Ohio. The water chemistry data indicated that the stream was nutrient poor, with total phosphorus below 0.05 mg/l and nitrate-nitrite below 0.10 mg/l. Cadmium was detected at 0.5 ug/l, which is unusual for a small headwater stream.

In summary, the site survey of Cossett Creek indicated that the stream at RM 0.2 was marginally attaining it WWH aquatic life use designation, with no obvious signs of significant pollutant loadings.

Plum Creek, Tributary to North Branch of the West Branch Rocky River

A district site survey was conducted on June 30, 1997 on Plum Creek at RM 2.5, just upstream from the previous discharge of the old Medina 500 WWTP. Plum Creek is a tributary of the North Branch of the West Branch Rocky River. It has a length of 7.1 miles and a drainage area of 12.79 sq. mi. Plum Creek is designated a WWH stream for protection of aquatic life in Ohio water quality standards, OAC 3745-1. This Plum Creek is a different watershed than the Plum Creek (West Branch Rocky River tributary) that was sampled at SR 252 near North Olmsted for the 1992 Rocky River survey. The present survey was conducted to determine if the stream was attaining its designated aquatic life use. Samples were collected for fish (IBI electrofishing survey), benthic macroinvertebrates (qualitative sample), habitat (QHEI), and water chemistry.

The fish community attained an IBI of 30, indicating non-attainment of the headwater habitat criteria of 40 IBI. This non-attainment may be partly explained by field observations of moderate to heavy siltation with moderate embeddedness of the cobble substrate that was present. Urban runoff from the upstream Brunswick area is a possible source of the in stream siltation. The stream water was turbid during the collection of samples, even though the water stage was low, an indication that turbidity is a problem in this stream. Thirteen species of fish were collected, with 63% of the numbers represented by creek chub and stoneroller minnow. Three species of darters were collected, but their total numbers were only about 5% of the fish community.

The water temperature was 23.5 C suggesting that the stream has no potential to support a cold water fish community. A fair macroinvertebrate community was observed with 6 EPT taxa and 20 total qualitative species collected. No cold water taxa of macroinvertebrates were collected. No single taxa appeared to dominate the invertebrate community, but mayflies, scuds, and blackfly larvae were the most common types collected. The water chemistry data indicated that the stream was slightly nutrient enriched, with total phosphorus at 0.07 mg/l and nitrate-nitrite at 0.51 mg/l.

In summary, the site survey of Plum Creek indicated that the stream at RM 2.5 was not meeting the WWH aquatic life use, most likely due to a combination of excessive siltation from urban runoff and nutrient enrichment.

Healey Creek

A total of 1359 fish comprised of 7 species were collected from Healey Creek at RM 0.9 on June 19, 1997. The fish species that numerically predominated were: creek chub (36%), blacknose dace (32%), spotfin shiner (10.0%), central stoneroller (19%) and rainbow darter (11%). Species that predominated in terms of biomass were: creek chub (51%) and blacknose dace (32%). The second of two sampling events was conducted after the stream flow had become interstitial and the fish population had retreated further downstream or were confined into bedrock pools. In terms of relative abundance, the community primarily consisted of tolerant insectivorous and omnivorous cyprinid species. Overall, the fish community performance can be characterized as fair (IBI = 32) and reflected an influence of suburbanization on the flow regime of Healey Creek.

Qualitative macroinvertebrate sampling produced 17 taxa. The site was predominated by mayfly, *Stenonema femoratum* and dragonflies were common. Total organism density was considered low. The macroinvertebrate community was in fair condition and the sampling results indicated that low flow was limiting the establishment of a more diverse benthic fauna.

A previous water quality/biological survey of Healey Creek was conducted in 1981. The 1997 fish sampling results contained fewer species compared to 1981, yet there were more individuals collected. The species that were not found during the 1997 sampling effort included the more sensitive hogsucker and pool dwelling centrarchids such as largemouth bass, bluegill and pumpkinseed sunfish. The loss of these species and the increased number of individuals during the 1997 sampling indicate possible perturbations of the flow regime and nutrient enrichment since the 1981 survey. The City of Brunswick and several other communities that are all or partly within the Healey Creek watershed have experienced some of the largest population increases in northeastern Ohio, since 1981. The addition of a third lane to Interstate 71 is likely to exacerbate the growth in the area.

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