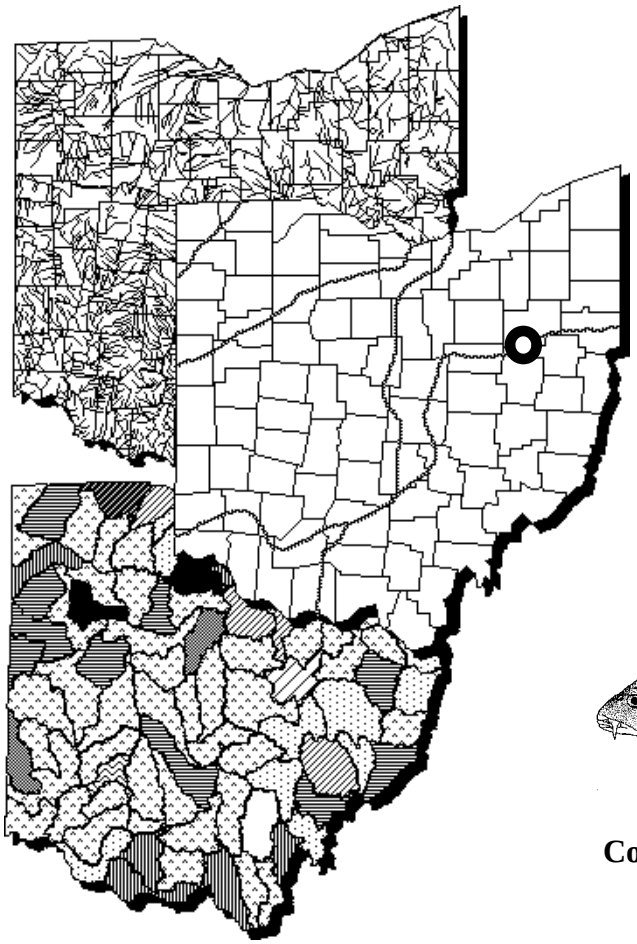
State of Ohio
Environmental Protection Agency

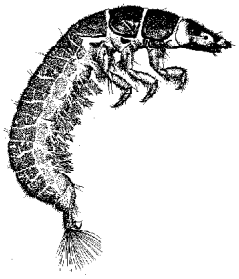
Monitoring and Assessment Section
Division of Surface Water

Biological and Sediment Study of the Tuscarawas River

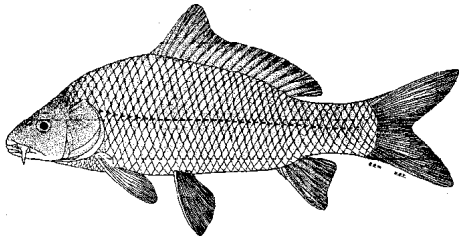
Tuscarawas and Stark Counties, Ohio

Ashland Oil Spill, June 1995





Net-spinning caddisfly (*Ceratopsyche morosa* group)



Common carp (*Cyprinus carpio*)

February 29, 1996

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-1049

Biological and Sediment Quality Study of the Tuscarawas River

Ashland Oil Spill
1995

Stark and Tuscarawas Counties, Ohio

February 29, 1996

OEPA Technical Report MAS/1996-2-1

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
Ecological Assessment Unit
1685 Westbelt Dr.
Columbus, Ohio 43228

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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 I and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in

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

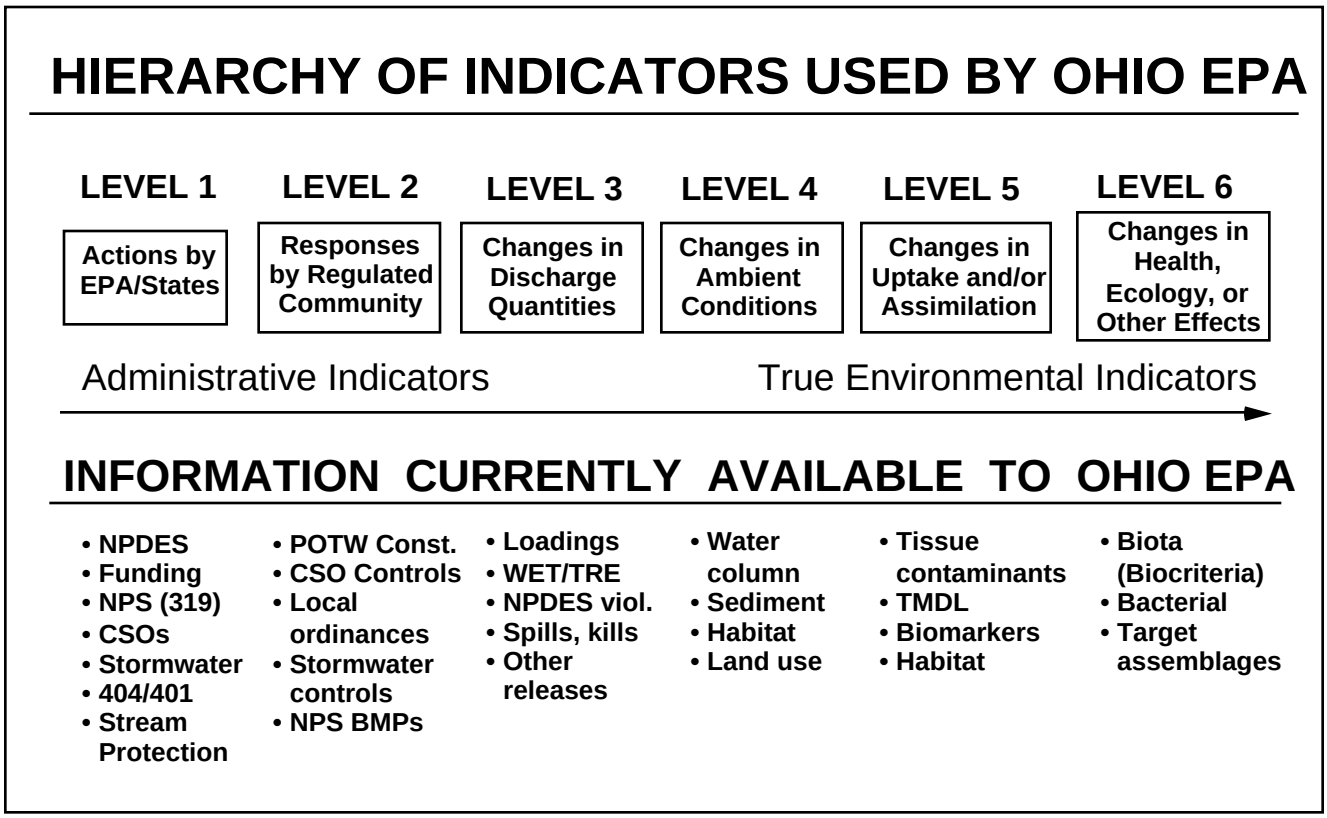

Figure I. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring, assessment, reporting, and evaluating program effectiveness. This is patterned after a model developed by the U.S. EPA, Office of Water.

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

the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

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

Ohio Water Quality Standards: Designated Aquatic Life Uses

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

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

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

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

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

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

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

Ohio Water Quality Standards: Non-Aquatic Life Uses

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

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

ACKNOWLEDGEMENTS

The following Ohio EPA staff are acknowledged for their significant contribution to this report.

Coordinator - David Altfater
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Fish Data Analysis, Sediment - David Altfater
Macroinvertebrate Data Analysis - Bernie Counts
Reviewers - Chris Yoder, Jeff DeShon, and Marc Smith

Support during field collections was provided by Kelly Cappuzi, Jeff Wander, Eric Schultz, Wendy Vorwerk, Mike Pettegrew, Bret Henninger, and Erica Burnett.

Biological and Sediment Quality Study of the Tuscarawas River (Stark and Tuscarawas Counties, Ohio)

Ohio Environmental Protection Agency
Division of Surface Water
Monitoring and Assessment Section
Ecological Assessment Unit
1685 Westbelt Drive
Columbus, Ohio 43228

INTRODUCTION

The Tuscarawas River study area included the mainstem river from Riverland Road (RM 81.4) to near Dover dam (RM 64.1).

Specific objectives of this evaluation were to:

1) measure and determine biological condition and sediment quality in the Tuscarawas River in the vicinity of the Ashland oil spill,

2) determine the potential accumulation of contaminants in river sediments in the vicinity of the Ashland oil spill,

3) determine the attainment status of the current WWH aquatic life use designation for the Tuscarawas River within the study area, and

4) follow-up on conditions documented in the 1989 Ohio EPA survey.

A pipeline construction company laying a new high pressure petroleum pipeline in close proximity to an active high pressure crude oil transmission pipeline operated by Ashland Pipeline sheared off a valve within 50 feet of the Tuscarawas River on June 7, 1995. Over 300 barrels of crude oil discharged to the Tuscarawas River approximately seven miles upstream from Bolivar. Containment booms were deployed at several locations downstream with limited success; eventually, the crude oil was contained behind Dover Dam, approximately 16 miles downstream from the spill site. The dam and containment boom stopped the majority of the crude oil with only a sheen passing through the dam.

The Tuscarawas River study area is located in the Erie-Ontario Lake Plain (EOLP) and Western Allegheny Plateau (WAP) ecoregions and is currently assigned the Warmwater Habitat (WWH) aquatic life use.

SUMMARY / CONCLUSIONS

From June to August, 1995 staff from the Ohio EPA Divisions of Surface Water and Emergency and Remedial Response conducted biological community and sediment sampling on the Tuscarawas River in the vicinity of the Ashland oil spill. The results of these sampling events are summarized below.

- Non-attainment of the Warmwater Habitat (WWH) aquatic life use designation occurred at five of the seven biological sampling locations, including the site located upstream from the oil spill (Table 2). Partial attainment of the WWH use was observed at the remaining two sampling locations (RMs 71.6 - 68.7). Biological results from 1995 for the Tuscarawas River study area indicate that 5.7 miles of river were in partial attainment of the WWH use and 11.6 miles of river were not meeting the WWH use designation. The partial and non-attainment status of the biological sampling locations was due primarily to the poor to fair performance of the fish communities.

- The biological results suggest that the fish communities were impaired by residual toxic stresses originating upstream from the oil spill. Macroinvertebrate communities were fully achieving the WWH biocriterion at each sampling location, however the lowest ICI score was observed at RM 78.2 (Dolphin St.). Overall, any biological impairment associated with the oil spill was minor.

- Sediment sampling results revealed slightly elevated concentrations of polycyclic aromatic hydrocarbons (PAHs) at all Tuscarawas River sites. Of particular note was the elevated concentrations of hexachlorobenzene at all sampling locations (excluding RM 79.8 which was influenced by high method detection levels). The levels of hexachlorobenzene were above the Severe Effect Level guideline, a level indicating possible pronounced disturbance of the sediment-dwelling community (Persaud *et al.* 1993). This is due to the effects of upstream sources. Total petroleum hydrocarbons (TPH) were measured in the sediment as an indicator of crude oil contamination. TPH was measured in the Tuscarawas River sediments in the immediate spill area at ten times the upstream concentration. The other downstream sampling locations had TPH levels comparable to the upstream background site, indicating the effect of the spill was localized.

- The physical condition of fish was monitored at each sampling site by recording the incidence of gross DELT (deformities, fin erosions, lesions/ulcers and tumors) external anomalies. An elevated percentage of DELT anomalies was recorded at each sampling location, with results ranging between 8.4% and 26.3%. A majority of the DELT anomalies were deformities on adult common carp, a condition not associated with the spill. Some fish species (rock bass, smallmouth bass, yellow bullhead) collected downstream from the oil spill area had a black material coating the outer edge of the pelvic, anal, caudal and pectoral fins (Plate 1). The black material was associated with the oil spill.

Table 1. Sampling locations (sediment - S, macroinvertebrate - M, fish - F) in the Tuscarawas River, 1995.

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
Tuscarawas River						
81.45	S	40°41’40”	81°30’13”	Riverland Ave.	Stark	Navarre, OH
81.4	M,F	40°41’40”	81°30’13”	Riverland Ave.	Stark	Navarre, OH
79.97	S	40°40’45”	81°29’14”	Pipeline crossing area	Stark	Bolivar, OH
79.8	M,F	40°40’37”	81°29’11”	Pipeline crossing area	Stark	Bolivar, OH
78.2	M,F	40°39’18”	81°29’07”	Dolphin St.	Stark	Bolivar, OH
78.06	S	40°39’11”	81°29’12”	Dolphin St.	Stark	Bolivar, OH
73.64	M,S	40°39’47”	81°26’21”	I-77	Stark/ Tuscarawas	Bolivar, OH
73.4	F	40°39’36”	81°26’06”	I-77	Stark/ Tuscarawas	Bolivar, OH
71.62	S	40°38’29”	81°27’01”	State Route 212	Tuscarawas	Bolivar, OH
71.6	M	40°38’28”	81°27’02”	State Route 212	Tuscarawas	Bolivar, OH
70.8	F	40°38’01”	81°27’09”	Dst. golf course,Bolivar	Tuscarawas	Bolivar, OH
68.72	S	40°36’33”	81°25’43”	Ust. Co. Rd. 82, Zoar	Tuscarawas	Dover, OH
68.7	M,F	40°36’31”	81°25’41”	Co. Rd. 82, Zoar	Tuscarawas	Dover, OH
64.9	M	40°34’11”	81°24’02”	Ust. Dover dam	Tuscarawas	Dover, OH
64.81	S	40°34’08”	81°24’04”	Ust. Dover dam	Tuscarawas	Dover, OH
64.1	F	40°33’40”	81°24’27”	Ust. Dover dam	Tuscarawas	Dover, OH

Table 2. Aquatic life use attainment status for the Tuscarawas River based upon sampling conducted between June and August, 1995. The results for the 1989 survey are also included. Attainment status is based on WWH biocriteria for the Erie-Ontario Lake Plain and Western Allegheny Plateau ecoregions of Ohio (OAC Chapter 3745-1-07, Table 7-17).

RIVER MILE Fish/ Invert.	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comment
***Tuscarawas River* 1995**						
Erie-Ontario Lake Plain ecoregion - WWH use Designation (Existing)						
81.4 / 81.4	26*	5.5*	40	73.0	**NON**	Upstream reference
79.8 / 79.8	23*	5.6*	46	73.5	**NON**	Immediately dst. oil spill
78.2 / 78.2	25*	5.6*	34	74.0	**NON**	Dolphin St.
73.4 / 73.6	20*	4.7*	42	63.0	**NON**	I-77
Western Allegheny Plateau ecoregion - WWH use Designation (Existing)						
70.8 / 71.6	30*	6.6*	42	77.5	PARTIAL	Dst. SR 212, Bolivar
68.7 / 68.7	33*	6.8*	42	80.5	PARTIAL	County Rd.82, Zoar
64.1 / 64.9	18*	4.6*	Very Good	70.5	**NON**	Ust. Dover dam
***Tuscarawas River* 1989**						
Erie-Ontario Lake Plain ecoregion - WWH use Designation (Existing)						
81.6 / 81.4	17*	4.3*	34	45.0	**NON**	Riverland Rd.
78.1 / 78.2	20*	5.0*	40	75.0	**NON**	Dolphin St.
73.4 / 73.6	25*	7.5*	42	51.0	**NON**	I-77
Western Allegheny Plateau ecoregion - WWH use Designation (Existing)						
70.8 / -	23*	4.9*	-	68.0	**(NON)**	Dst. SR 212, Bolivar
68.7 / 68.8	26*	6.0*	42	90.0	**NON**	County Rd. 82, Zoar
- / 64.6	-	-	42	-	(FULL)	Ust. Dover dam

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP)/ Western Allegheny Plateau (WAP)

INDEX	WWH	EWH	MWH[c]
IBI - Boat	40/40	48/48	24/24
MIwb - Boat	8.7/8.6	9.6/9.6	5.8/5.8
ICI	34/36	46/46	22/22

ns Nonsignificant departure from EWH ecoregional biocriterion ($\leq$ 4 IBI or ICI units or $\leq$ 0.5 MIwb units).
* Significant departure from ecoregion biocriterion (>4 IBI units or ICI units or $\leq$ 0.5 MIwb units); poor and very poor results are underlined.
a Narrative evaluation based on qualitative benthic invertebrate sample.
b Attainment status based on one organism group is parenthetically expressed.
c Modified Warmwater Habitat for channel modified areas.

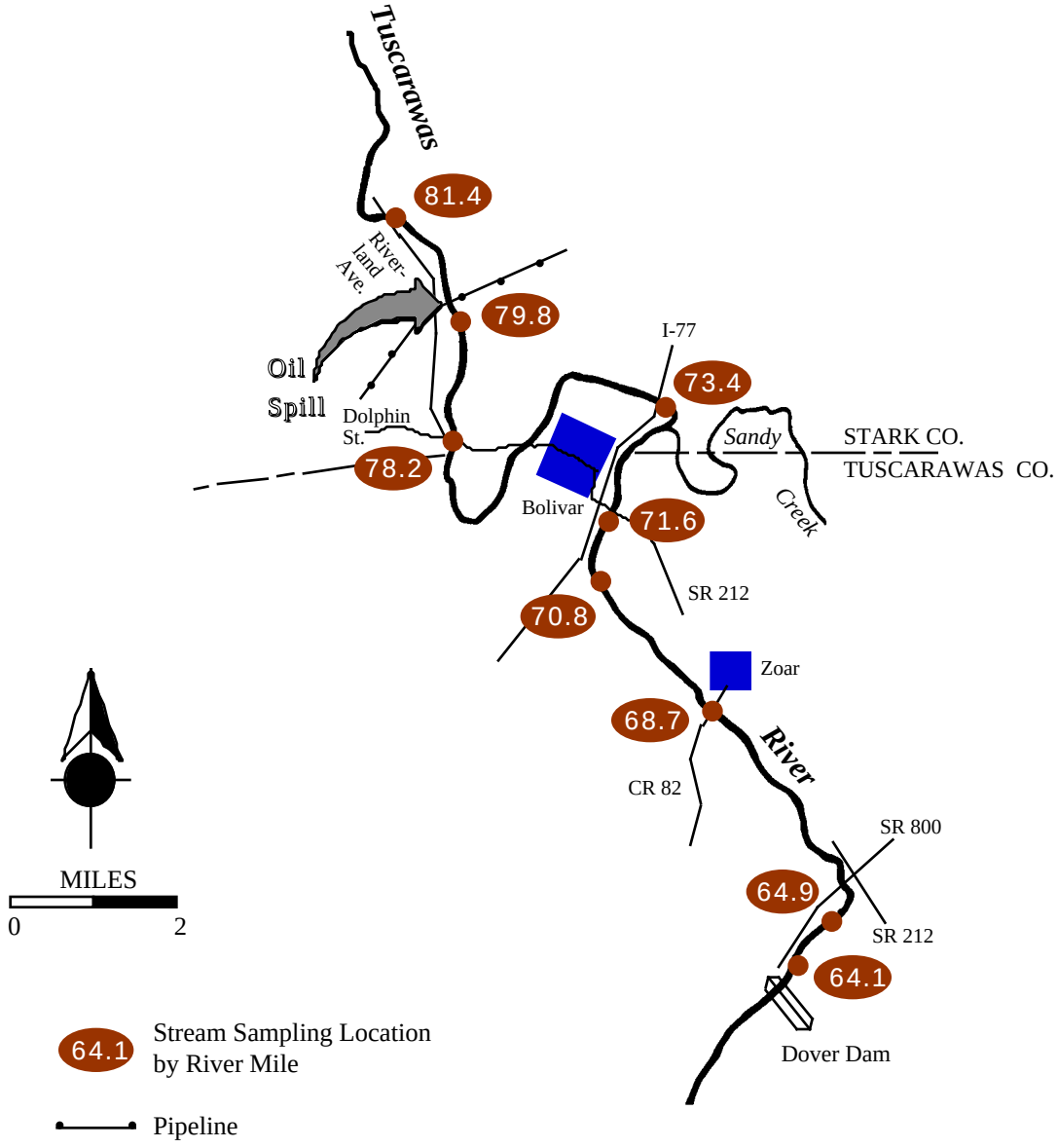

Figure 1. Map of the Tuscarawas River study area showing principal streams, landmarks, the oil spill location and Ohio EPA biological sampling locations, 1995.

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) for aquatic habitat assessment. Fish communities, macroinvertebrate communities, and sediment were sampled during the summer of 1995 at seven locations on the Tuscarawas River from river miles (RM) 81.4 to 64.1 (Table 1, Figure 1). Sampling was conducted to assess fish and macroinvertebrate communities, and sediment in the vicinity of the Ashland oil spill.

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 7-17). The biological community performance measures which 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 (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is full if all three indices (or those available) meet the applicable biocriteria, partial if at least one of the indices does not attain and performance is 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, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which 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 which have the ability to support exceptional warmwater faunas.

Sediment Assessment
Fine grained sediment samples were collected in the upper six inches of bottom material at each location using decontaminated stainless steel scoop samplers (decontamination followed the procedures outlined in FSOP 10.01, DERR Sampling Guidance, Vol. III, Ohio EPA 1992). Collected sediment was placed into decontaminated clear glass jars with teflon lined lids, placed on ice (to maintain 4˚C) and shipped to an Ohio EPA contract lab. Sediment data is reported on a dry weight basis. Sediment evaluations were conducted using guidelines established by the Ontario Ministry of the Environment (Persaud *et al.* 1993), reference conditions and published literature.

Macroinvertebrate Community Assessment
Macroinvertebrates were sampled quantitatively for a six-week period from June 19 to August 2, 1995 using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. During the present study, macroinvertebrates collected from the natural substrates were also evaluated using an assessment tool currently in the testing and refinement phase. This method relies on tolerance values derived for each taxon, based upon the abundance data for that taxon from artificial substrate (quantitative) samples collected throughout Ohio. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected are weighted by its abundance on the artificial substrates. The mean of the weighted ICI scores for the taxon results in a value which represents its relative level of tolerance on the ICI's 0 to 60 scale. For the qualitative collections in the Tuscarawas 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. Use of the QCTV in evaluating sites in the Tuscarawas River study area was restricted to relative comparisons between sites and was not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Fish Community Assessment
Fish were sampled using the boat method pulsed DC electrofishing gear, used at a frequency of two samples at each site. Fish collections were made at each site from June to August using pulsed DC electrofishing gear, with a sampling distance of 500 meters.

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 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1995) 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 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

Sediment Chemistry

Sediment samples were collected at seven locations in the Tuscarawas River by the Ohio EPA during June 1995. All sampling locations are indicated by river mile in Figure 1. Samples were analyzed for semivolatile organic compounds, volatile organic compounds, total organic carbon, and petroleum hydrocarbons. Specific chemical parameters tested and results are listed in Appendix Table 1.

- Sediment samples were evaluated in part using guidelines established by the Ontario Ministry of the Environment (Persaud *et al.* 1993). The guidelines define two levels of ecotoxic effects and are based on the chronic, long term effects of contaminants on benthic organisms. A *Lowest Effect Level* is a level of sediment contamination that can be tolerated by the majority of benthic organisms, and a *Severe Effect Level* indicates a level at which pronounced disturbance of the sediment-dwelling community can be expected. The Severe Effect Level is the sediment concentration of a compound that would be detrimental to the majority of benthic species. When any parameters are at or above the Severe Effect Level guideline, the material tested is considered highly contaminated and will likely have a significant effect on benthic biological resources. Based on the guidelines noted above, six sediment samples exceeded the Lowest Effect Level based on PAH contaminants (Table 3). The highest levels of PAH compounds were found upstream from the oil spill area. Eleven of the PAH chemicals tested were reported at levels above the Lowest Effect Level. Hexachlorobenzene was documented at the Severe Effect Level both upstream and downstream from the spill location. The guidelines detailed in Persaud *et al.* (1993) do not include evaluations of volatile organic compounds, several PAHs and metals, and most non-PAH semivolatile organic compounds.

- Benzene was detected in Tuscarawas River sediment immediately downstream from the spill site; however, the concentration appeared to be low.

- Diesel range heavy total petroleum hydrocarbons (TPH) were detected at substantially higher levels in the sediment of the Tuscarawas River immediately downstream from the oil spill location. Upstream from the spill area (at RM 81.45), petroleum hydrocarbons were documented at 300 mg/kg. A ten-fold increase in petroleum hydrocarbons occurred in the Tuscarawas River sediments at RM 79.97, where a concentration of 3100 mg/kg was measured. Other downstream sampling locations had TPH levels comparable to the upstream background site. It appears that the elevated TPH level at RM 79.97 contributed to interference with the other organics, resulting in the high sample detection levels.

Table 3. Summary of select organic chemical parameters measured in the sediment of the Tuscarawas River, June 1995. The oil spill occurred in the Tuscarawas River at river mile 79.98. Measurements in **bold** exceed the Lowest Effect Level as detailed in Persaud *et al.* 1993. Parameters exceeding the Severe Effect Level are indicated by underlined **bold** numbers. Parameters in *italics* do not have review guidelines established in Persaud *et al.* 1993.

	Sampling Location (River Mile)						
Parameter	81.45	**79.97**	78.06	73.64	71.62	68.72	68.81
(ug/kg)							
Benzene	<17	25J	<15	<25	16J	<29	3J
Chorobenzene	<17	250	<15	<25	<19	<29	<19
1,4-Dichlorobenzene	<2600	2000J	<900	<2000	<820	<730	<590
Hexachlorobenzene	**15,000**	<22,000	**5400**	**7900**	**3000**	**4500**	**1400**
3,3-Dichlorobenzidine	1700J	<22,000	300J	320J	300J	1000	300J
Naphthalene	180J	<22,000	36J	<2000	<820	290J	55J
2-Methylnaphthalene	250J	<22,000	42J	65J	45J	250J	66J
Acenaphthylene	55J	<22,000	<900	<2000	<820	<730	<590
Acenaphthene	160J	<22,000	37J	<2000	<820	120J	<590
Dibenzofuran	180J	<22,000	39J	<2000	<820	100J	24J
Fluorene	**210J**	<22,000	44J	<2000	<820	**240J**	<590
Phenanthrene	**2000J**	530J	510J	270J	270J	**1800**	310J
Anthracene	**590J**	<22,000	76J	33J	22J	**330J**	43J
Carbazole	270J	<22,000	130J	<2000	<820	<730	<590
Fluoranthene	**3600**	<22,000	720J	680J	550J	**2300**	530J
Pyrene	**2500J**	<22,000	**540J**	**520J**	**500J**	**2100**	460J
Chrysene	**2000J**	<22,000	320J	**400J**	310J	**970**	330J
Benzo(b)fluoranthene	1600J	<22,000	300J	540J	360J	<730	410J
Benzo(k)fluoranthene	**1300J**	<22,000	**250J**	**350J**	<820	**800**	**390J**
Benzo(a)pyrene	**1600J**	<22,000	200J	300J	160J	**590J**	230J
Indeno(1,2,3-cd)pyrene	**800J**	<22,000	94J	120J	63J	**230J**	74J
Dibenzo(a,h)anthracene	**150J**	<22,000	27J	<2000	<820	<730	<590
Benzo(g,h,i)perylene	**640J**	<22,000	96J	100J	58J	**260J**	59J
Total PAHs	**17,635J**	530J	3292J	3378J	2338J	**10,280J**	2957J
(mg/kg)							
Petroleum hydrocarbons	300	3100	63	160	320	650	180
Total Organic Carbon	7510	7390	21,300	19,900	26,400	25,000	4720

J - Value is estimated. The value is less than the Contract Required Quantitation Limit but greater than zero.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in the Tuscarawas River at each 1995 biological sampling location. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 4.

- Stream morphology in the Tuscarawas River within the study area is primarily free-flowing and consists of pools interspersed with well developed riffle and run habitats. Two sections of river are impounded; one by a low-head dam in Zoar and one by a flow controlled dry dam (Dover dam). Bottom substrates are predominated by cobble, gravel, and sand. Qualitative Habitat Evaluation Index (QHEI) scores for the Tuscarawas River within the study area ranged between 63.0 and 80.5, with a mean value of 73.1. These scores are indicative of good stream and riparian habitat and reflect conditions which are easily capable of supporting WWH stream fish communities.

- The fish sampling site at RM 73.4 had the lowest QHEI score (63) within the study area. This lower score was due in part to the lack of riffle and run habitats within the sampling zone. The other fish sampling sites within the study area were composed of pool, riffle and run habitats.

- River flow conditions were different between the first and second sampling pass at RM 64.1. This sampling location is influenced by the flow control structures in the Dover dam. During the first sampling pass in June, river flow was being impounded by the control structures during the oil spill recovery phase. Flow controls were not evident during the second fish sampling pass in August. The QHEI score for RM 64.1 reflects the conditions of the river during the August sampling event.

Table 4. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Tuscarawas River study area, 1995.

			WWH Attributes									MWH Attributes																					
												High Influence					*Moderate Influence*																	
Key QHEI Components			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.L 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.L MWH Attributes**	**MWH HL/WWH Ratio**	**MWH ML/WWH Ratio**
River Mile	QHEI	Gradient (ft/mile)																															
(17-500) Tuscarawas River																																	
Year: 95																																	
81.4	**73.0**	1.28	■■		■		■		■	■■■			7		●				1	▲		▲		▲▲						4	0.25	0.75
79.8	**73.5**	2.89	■■		■		■		■	■■■			7		●				1	▲		▲		▲▲						4	0.25	0.75
78.2	**74.0**	2.89	■■		■		■		■	■■■			7						0	▲		▲		▲▲						4	0.13	0.63
73.4	**63.0**	1.23	■■		■		■			■			5		●				1	▲		▲▲		▲▲			▲			6	0.33	1.33
70.8	**77.5**	1.23	■■		■		■		■	■■■			7						0	▲		▲		▲▲						4	0.13	0.63
68.7	**80.5**	1.23	■■		■	■	■		■	■■			8						0	▲				▲▲▲						4	0.11	0.56
64.1	**70.5**	1.23	■■		■					■			5		●				1	▲		▲▲		▲▲▲						6	0.33	1.33

Macroinvertebrate Community

Macroinvertebrate communities were sampled during the summer of 1995 at seven locations in the Tuscarawas River from Riverland Rd. (RM 81.4) to upstream from Dover dam (RM 64.9) (Table 1). Two qualitative samples were collected, the first in June when the artificial substrates were set and the usual sample when the artificial substrates were retrieved in August. Summarized results from the 1995 macroinvertebrate sampling are compiled in Tables 5 and 6. ICI metrics, scores, and raw data tables sampled by river mile are attached as Appendix Tables 2 and 3. Also included in Table 5 are data collected in 1989 by the Ohio EPA.

- The upstream site (RM 81.4) in the study area had a light oily film on the water surface but no oil along the margins or on woody debris and rocks. The site just downstream from the spill (RM 79.8) had an oily sheen on the water surface with some oil along the margins. The sites further downstream (RMs 78.2 - 64.9) had a heavy coating of oil along the stream margins and on woody debris.

- The upstream site at Riverland Rd. (RM 81.4) supported a macroinvertebrate community in the marginally good range in June with 23 taxa including 3 EPT taxa collected. The artificial substrates were washed downstream by high water and were lying on their side. In spite of the sampler disturbance, the community had improved in August into the very good range with an ICI score of 40 with 46 total taxa and 39 qualitative taxa including 9 EPT taxa collected. There were 1316 organisms collected from the artificial substrates with the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprising 89.4% of the sample; only 0.8 % of the sample was classified as pollution tolerant organisms.

- The site just downstream from the spill (RM 79.8) was approximately 150 meters downstream from the pipeline. The macroinvertebrate community was in the marginally good range in June with 21 taxa including 3 EPT taxa collected. There was an oily sheen on the water and some along the stream margins but good current velocity seemed to prevent the oil from settling out. The macroinvertebrate community had improved by August into the exceptional range with an ICI score of 46, exceeding the WWH ecoregional biocriterion and meeting the EWH biocriterion. There were 41 total taxa and 31 qualitative taxa collected including 12 EPT taxa. There were 1765 organisms collected from the artificial substrates with the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprising 87.7% of the sample; only 1.5% of the sample was classified as pollution tolerant organisms.

- The site at Dolphin Rd. (RM 78.2) was approximately 1.7 miles downstream from the oil spill and had a macroinvertebrate community in June in the marginally good range with 24 taxa including 4 EPT taxa collected. Of all the locations sampled in the Tuscarawas River study area in 1995, this site showed the least improvement in the macroinvertebrate community between June and August. The macroinvertebrates, in August, indicated a community in the good range with an ICI score of 34, attaining the ecoregional biocriterion for the WWH use designation. There were 42 total taxa and 25 qualitative taxa collected including 9 EPT taxa. Of the 974 organisms collected from the artificial substrates the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprised only 57.7 % of the sample; 16.6% of the organisms were classified as pollution tolerant. These results indicated a lasting, though minor, impact on the macroinvertebrate

community at this site relative to the other locations in the study area.

- Upstream from Bolivar at I-77 (RM 73.6) the macroinvertebrate community, in June, was in the poor range with 15 taxa and no EPT taxa collected. By August the macroinvertebrate community performance had improved into the very good range with an ICI score of 42, exceeding the ecoregional WWH biocriterion. There were 46 total taxa and 29 qualitative taxa collected including 10 EPT taxa. There were 737 organisms collected from the artificial substrates with the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprising 76.6% of the sample; 3.0% of the sample was classified as pollution tolerant organisms.

- Downstream from Bolivar at State Route 212 (RM 71.6) the results from the June qualitative sample indicated fair conditions in the macroinvertebrate community with 18 taxa including 3 EPT taxa collected. In August, the macroinvertebrate community condition had improved into the very good range with an ICI score of 42, exceeding the ecoregional WWH biocriterion. There were 58 total taxa and 37 qualitative taxa collected, including 13 EPT taxa. There were 1515 organisms collected from the artificial substrates with the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprising 75.9% of the sample; 3.5% of the sample was classified as pollution tolerant organisms. This site consisted of an extended run with woody debris serving functionally as riffle habitat. During the June sampling the woody debris was coated in oil holding very few organisms; however, during the August sampling the woody debris was much cleaner and held large numbers of organisms, including an abundance of caddisflies and mayflies.

- The site at Zoar (RM 68.7) was located approximately one mile downstream from the Wilkshire Hills WWTP discharge. The June qualitative sample indicated a macroinvertebrate community in the poor range with 10 taxa and no EPT taxa collected. In August the results indicated the community had improved into the very good range with an ICI score of 42 with 46 total taxa and 27 qualitative taxa collected including 8 EPT taxa. Of the 1696 organisms collected from the artificial substrates, the abundances of relatively pollution sensitive caddisflies, mayflies, and tanytarsini midges comprised 80.5% of the sample; 1.8% of the sample was classified as pollution tolerant organisms.

- The most downstream site in the study area was just over one mile upstream from the Dover dam (RM 64.9). The June results indicated the macroinvertebrate community was in the poor range with 9 taxa including 1 EPT taxon collected. The artificial substrates were washed out by high water and, therefore, an ICI score was not available. The August results for qualitative sampling indicated the macroinvertebrate community had improved into the very good range with 33 taxa collected including 9 EPT taxa.

Table 5. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and from natural substrates (qualitative sampling) in the Tuscarawas River in 1989 and 1995. The Tuscarawas River within the study area has a WWH aquatic life use designation in the Ohio Water Quality Standards.

Stream/ River Mile	Relative Density	Total Taxa	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	ICI	Evaluation[b]
Tuscarawas River - 1995							
	Erie-Ontario Lake Plain Ecoregion - WWH Use Designation						
81.4	263	46	25	39	9	40	Very Good
79.8	353	41	28	31	12	46	Exceptional
78.2	195	42	35	25	9	34	Good
	Western Allegheny Plateau Ecoregion - WWH Use Designation						
73.6	147	46	32	29	10	42	Very Good
71.6	303	58	41	37	13	42	Very Good
68.7	339	46	36	27	8	42	Very Good
64.9	-	-	-	33	9	-	Very Good
Tuscarawas River- 1989							
	Erie-Ontario Lake Plain Ecoregion - WWH Use Designation						
81.4	785	62	39	51	14	34	Good
78.2	966	66	43	51	9	40	Very Good
	Western Allegheny Plateau Ecoregion - WWH Use Designation						
73.6	1150	52	34	38	8	42	Very Good
68.8	3070	52	29	42	9	42	Very Good

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)/ Western Allegheny Plateau (WAP) (from Ohio Administrative Code 3745-1-07, Table 7-17)

INDEX	**WWH**	**EWH**	**MWH**[c]
ICI	34/36	46/46	22/22

* Significant departure from ecoregional biocriterion (>4 ICI units); poor and very poor results are underlined.

ns Nonsignificant departure from ecoregional biocriterion ($\leq$4 ICI units).

a EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.

b The narrative evaluation using the qualitative sample is based on best professional judgment utilizing sample attributes such as taxa richness, EPT taxa richness, and community composition and is used in lieu of the ICI when artificial substrates are not collected or retrieved.

c Modified Warmwater Habitat for channel modified areas.

Table 6. Summary of macroinvertebrate data collected from natural substrates (qualitative sampling) in the Tuscarawas River, 1995.

Stream/ River Mile[a]	Qualitative Taxa	EPT Taxa	QCTV	Evaluation
Tuscarawas River - 1995				
Erie-Ontario Lake Plain Ecoregion - WWH Use Designation				
81.4A	23	3	35.6	Marginally Good
81.4B	39	9	38.6	Very Good
79.8A	21	3	34.2	Marginally Good
79.8B	31	12	38.9	Exceptional
78.2A	24	4	32.9	Marginally Good
78.2B	25	9	38.9	Good
Western Allegheny Plateau Ecoregion - WWH Use Designation				
73.6A	15	0	30.1	Poor
73.6B	29	10	38.2	Very Good
71.6A	18	3	32.6	Fair
71.6B	37	13	39.2	Very Good
68.7A	10	0	32.9	Poor
68.7B	27	8	34.6	Very Good
64.9A	9	1	31.3	Poor
64.9B	33	9	38.9	Very Good

[a] - A denotes the June macroinvertebrate collection, B denotes the August macroinvertebrate collection.

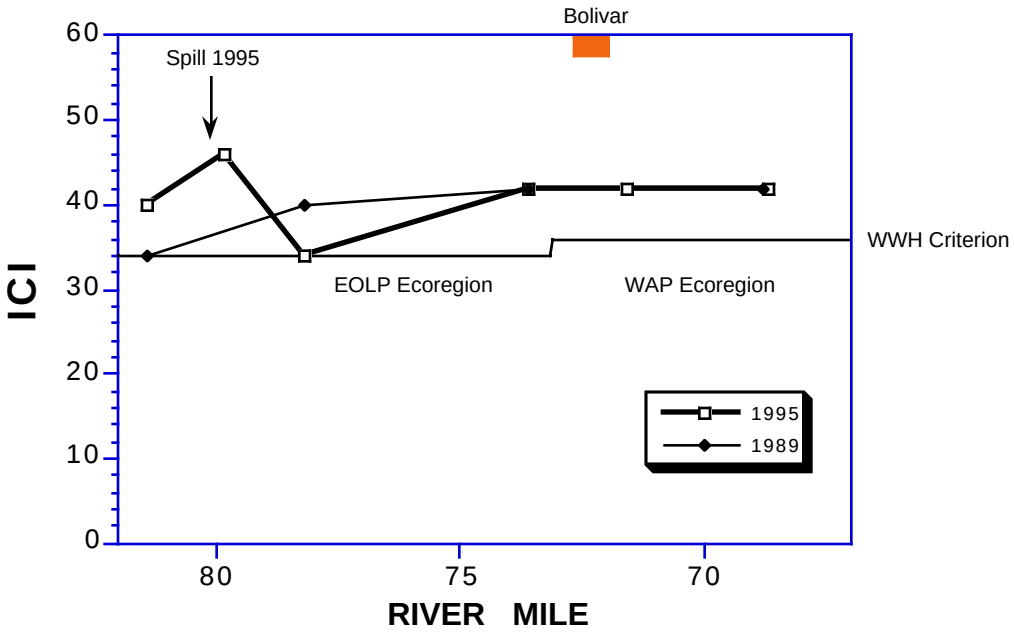

Figure 2. Longitudinal performance of the Invertebrate Community Index (ICI) in the Tuscarawas River for 1989 and 1995.

Fish Community

A total of 1,055 fish representing 34 species and three hybrids were collected from the Tuscarawas River between June and August, 1995. The sampling effort included a cumulative distance electrofished of 7.10 km at seven locations. (Table 7, Figure 1). Relative numbers and species collected per location are presented in Appendix Table 4. Sampling locations were evaluated using Warmwater Habitat biocriteria.

- Common carp (33.7%) and northern hog sucker (25.9%) predominated the catch numerically, while common carp dominated by weight (84.8%). Top carnivores (rock bass, smallmouth bass, largemouth bass, northern pike, bowfin, and warmouth sunfish) comprised 7.5% of the fish community.

- The fish communities from the four most upstream sampling locations (RMs 81.4 - 73.4; Riverland Rd. to I-77) exhibited substantial biological degradation. The IBI (20 - 26) and MIwb (4.7 - 5.6) scores were reflective of very poor to fair conditions and the entire stream reach was not achieving the applicable biocriteria. These conditions were observed upstream and downstream from the oil spill location.

- Improved fish community results were noted between RMs 70.8 and 68.7 (Bolivar golf course to Zoar). IBI (30 - 33) and MIwb (6.6 - 6.8) scores were in the fair range, with increased numbers of fish and species richness observed in comparison to upstream sites. Although an improvement in the fish community was documented, these two sites were not fully achieving the appropriate biocriteria.

- The most downstream fish sampling location (RM 64.1) occurred within 0.5 miles of the Dover dam. This site was influenced by flow regulation during the June sampling event. As a result, a substantial decline in IBI and MIwb scores were reported in June (IBI= 14, MIwb= 3.8) in comparison to the August (IBI= 22, MIwb= 5.5) sampling event. Overall sampling results at RM 64.1 reflected very poor to poor conditions.

- The physical condition of fish was monitored at each sampling site by recording the incidence of gross DELT (deformities, fin erosions lesions/ulcers and tumors) external anomalies. Biosurvey results collected by Ohio EPA from throughout the state show a high frequency of DELT anomalies to be an accurate indication of pollution stress usually caused by multiple sublethal stresses as the result of degraded water quality (*i.e.* often a combination of toxic impacts combined with marginal D.O. concentrations). Within Ohio, there are ample coincidences between sites containing chemically contaminated sediments (*e.g.* metals, PAHs) and very high percent occurrence of DELT anomalies (>10-20%) in combination with very low Index of Biotic Integrity and Modified Index of Well-Being scores (Yoder 1991). A high percentage of DELT anomalies were recorded at each sampling location, with site results ranging between 8.4 and 26.3%. A majority of the DELT anomalies were deformities on adult common carp. Some fish species (rock bass, smallmouth bass, yellow bullhead) collected downstream from the oil spill area had black material coating the outer edge of pelvic, anal, caudal and pectoral fins (Plate 1).

Table 7. Fish community indices from the Tuscarawas River, 1989 and 1995 based on pulsed D.C. boat electrofishing at sites sampled by Ohio EPA. Relative number and weight are per 1.0 km.

Stream/ River Mile	Mean Number of Species	Cumulative Species	Mean Relative Number	Mean Relative Weight	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Tuscarawas River - 1995								
81.4	12.5	17	144	113.0	73.0	5.5*	26*	Poor/Fair
79.8	12.5	19	131	78.3	73.5	5.6*	23*	Poor
78.2	10.5	14	130	75.9	74.0	5.6*	25*	Poor
73.4	11.0	15	109	80.0	63.0	4.7*	20*	Very Poor/Poor
70.8	14.5	21	157	105.6	77.5	6.6*	30*	Fair
68.7	16.5	24	238	140.8	80.5	6.8*	33*	Fair
64.1	9.5	13	133	201.2	70.5	4.6*	18*	Very Poor/Poor
Tuscarawas River - 1989								
81.6	9.7	14	180	87.7	45.0	4.3*	17*	Very Poor/Poor
78.1	15.3	21	264	39.2	75.0	5.0*	20*	Poor
73.4	18.7	24	256	91.9	51.0	7.5*	25*	Fair/Poor
70.8	14.3	22	208	70.2	68.0	4.9*	23*	Very Poor/Poor
68.7	18.7	27	204	72.5	90.0	6.0*	26*	Poor/Fair

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP)/Western Allegheny Plateau (WAP) (from Ohio Administrative Code 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH[b]
IBI - Boat	40/40	48/48	24/24
MIwb - Boat	8.7/8.6	9.6/9.6	5.8/5.8

* Significant departure from ecoregional biocriteria (>4 IBI units, >0.5 MIwb units); poor and very poor results are underlined.

ns Nonsignificant departure from EWH biocriteria (≤4 IBI units, ≤0.5 MIwb units).

a Narrative evaluation is based on MIwb and IBI scores, when available.

b Modified Warmwater Habitat for channel modified areas.

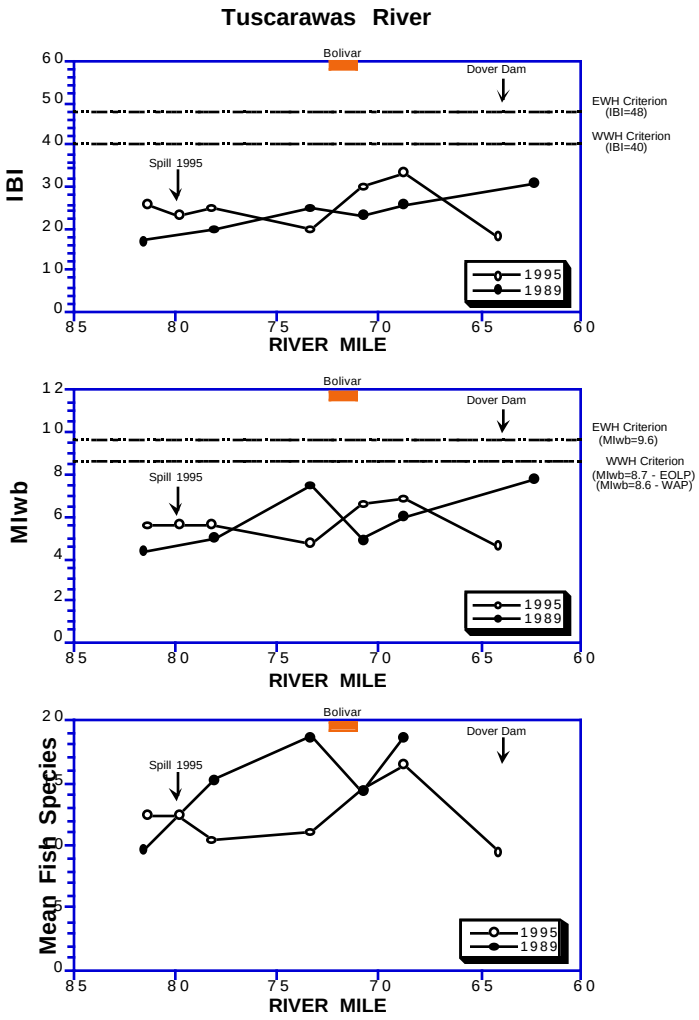

Figure 3. Longitudinal performance of the Index of Biotic Integrity (IBI), the Modified Index of Well-being (MIwb), and mean number of fish species in the Tuscarawas River, 1989 and 1995.

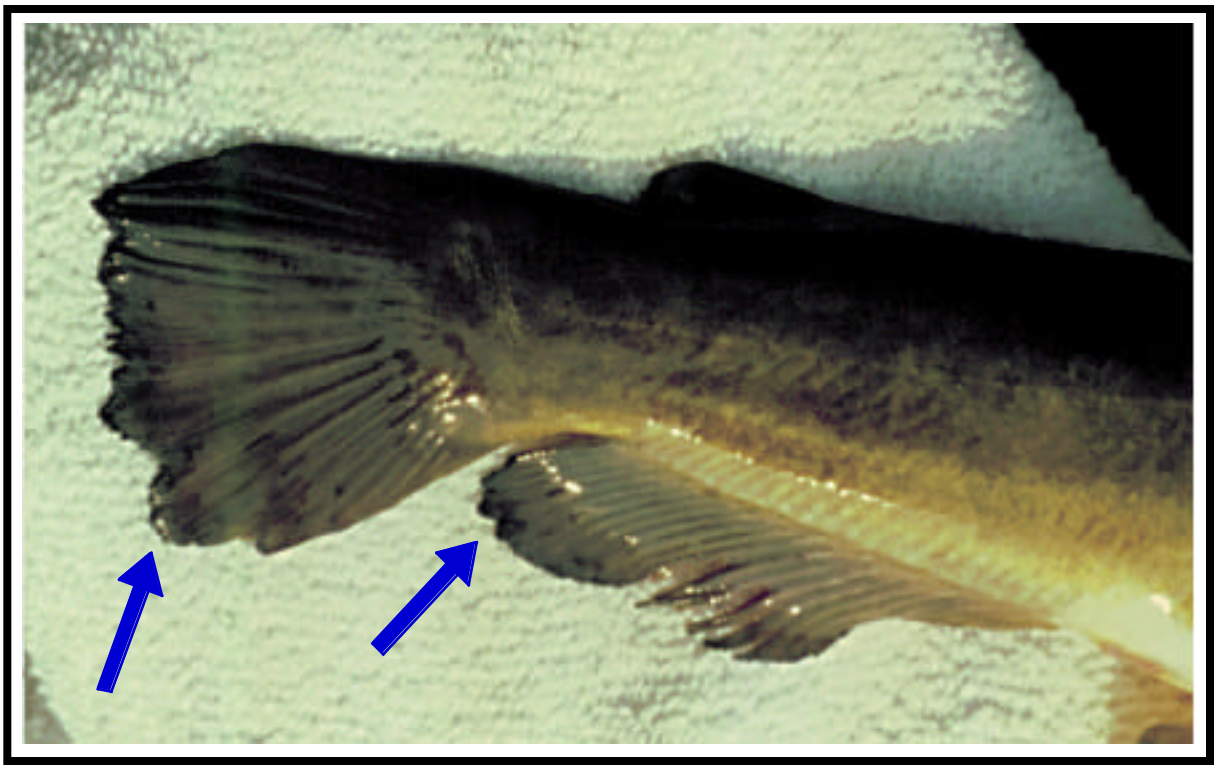

Plate 1.Photo of a yellow bullhead showing blackened fin margins; collected from the Tuscarawas River at RM 79.8, June 19, 1995.

TREND ASSESSMENT

Changes in Macroinvertebrate Performance: 1989 - 1995

- The macroinvertebrate communities between RMs 81.4 and 64.6 were sampled during 1989 as part of a larger survey of the Tuscarawas River. Historical results (Ohio EPA 1990) have indicated macroinvertebrate communities in the good to very good range , with ICI values ranging from 34 to 42. The site at RM 81.4 improved from an ICI score of 34 in 1989 to 40 in 1995. The site at RM 78.2 declined from an ICI score of 40 in 1989 to 34 in 1995. The two sites at RMs 73.6 and 68.8/68.7 were consistent with ICI scores of 42 in both 1989 and 1995. The site at RM 64.6 had an ICI score of 42 (very good) in 1989; in 1995 at RM 64.9, the narrative evaluation was also in the very good range. With the exception of the slight decline below the oil spill at RM 78.2 the macroinvertebrate communities throughout this reach of the Tuscarawas River were stable and relatively unchanged between 1989 and 1995.

Changes in Fish Community Performance: 1989 - 1995

- The fish communities between RMs 81.6 and 68.7 were sampled during 1989 as part of a larger survey of the Tuscarawas River. Historical results have indicated fish communities in the very poor to fair range , with IBI values ranging from 17 to 26 and MIwb scores ranging between 4.3 and 7.5. Four of the five 1989 sampling locations showed improvement in IBI and MIwb scores during 1995; however, 1995 results were still within the very poor to fair range and not achieving the biocriteria.

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Appendix Table 1. Sediment Chemistry.

Appendix Table 1. Tuscarawas River sediment results from samples collected in June, 1995.

SAMPLE NUMBERS		TR-01	TR-02	TR-03	TR-04	TR-05	TR-06	TR-07
DATE SAMPLE COLLECTED		6/19/95	6/19/95	6/19/95	6/19/95	6/20/95	6/20/95	6/20/95
RIVER MILE		81.45	79.97	78.06	73.64	71.62	68.72	64.81
LATITUDE		4004140	4004045	4003911	4003947	4003829	4003633	4003408
LONGITUDE		8103013	8102914	8102912	8102621	8102701	8102543	8102404
VOLATILE ORGANIC COMPOUNDS								
	CRQL							
chloromethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
bromomethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
vinyl chloride	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
chloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
methylene chloride	10 ug/kg	2JB	200JB	7JB	21JB	19U	10JB	17JB
acetone	10 ug/kg	17U	480	14J	25U	19U	29U	19U
carbon disulfide	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,1-dichloroethene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,1-dichloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,2-dichloroethene (total)	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
chloroform	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,2-dichloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
2-butanone	10 ug/kg	17U	160J	15U	25U	19U	29U	19U
1,1,1-trichloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
carbon tetrachloride	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
bromodichloromethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,2-dichloropropane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
cis-1,3-dichloropropene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
trichloroethene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
dibromochloromethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,1,2-trichloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
benzene	10 ug/kg	17U	25J	15U	25U	16J	29U	3J
trans-1,3-dichloropropene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
bromoform	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
4-methyl-2-pentanone	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
2-hexanone	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
tetrachloroethene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
1,1,2,2-tetrachloroethane	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
toluene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
chlorobenzene	10 ug/kg	17U	250	15U	25U	19U	29U	19U
ethyl benzene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
styrene	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
xylenes (total)	10 ug/kg	17U	200U	15U	25U	19U	29U	19U
SEMI-VOLATILE ORGANIC COMPOUNDS								
	CRQL							
phenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
bis(2-chloroethyl)ether	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2-chlorophenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
1,3-dichlorobenzene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
1,4-dichlorobenzene	330 ug/kg	2600U	2000J	900U	2000U	820U	730U	590U
1,2-dichlorobenzene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U

Appendix Table 1. Continued.

SAMPLE NUMBERS		TR-01	TR-02	TR-03	TR-04	TR-05	TR-06	TR-07
DATE SAMPLE COLLECTED		6/19/95	6/19/95	6/19/95	6/19/95	6/20/95	6/20/95	6/20/95
RIVER MILE		81.45	79.97	78.06	73.64	71.62	68.72	64.81
LATITUDE		4004140	4004045	4003911	4003947	4003829	4003633	4003408
LONGITUDE		8103013	8102914	8102912	8102621	8102701	8102543	8102404
SEMI-VOLATILE ORGANIC COMPOUNDS								
	CRQL							
2-methylphenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2,2-oxybis(1-chloropropane)	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
4-methylphenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
n-nitroso-di-n-dipropylamine	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
hexachloroethane	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
nitrobenzene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
isophorone	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2-nitrophenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2,4-dimethylphenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
bis(2-chloroethoxy)methane	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2,4-dichlorophenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
1,2,4-trichlorobenzene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
naphthalene	330 ug/kg	180J	22000U	36J	2000U	820U	290J	55J
4-chloroaniline	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
hexachlorobutadiene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
4-chloro-3-methylphenol	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2-methylnaphthalene	330 ug/kg	250J	22000U	42J	65J	45J	250J	66J
hexachlorocyclopentadiene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2,4,6-trichlorophenol	330 ug/kg	2600U	22000U	900U	2000U	2000U	1800U	1500U
2,4,5-trichlorophenol	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
2-chloronaphthalene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
2-nitroaniline	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
dimethylphthalate	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
acenaphthylene	330 ug/kg	55J	22000U	900U	2000U	820U	730U	590U
2,6-dinitrotoluene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
3-nitroaniline	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
acenaphthene	330 ug/kg	160J	22000U	37J	2000U	820U	120J	590U
2,4-dinitrophenol	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
4-nitrophenol	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
dibenzofuran	330 ug/kg	180J	22000U	39J	2000U	820U	100J	24J
2,4-dinitrotoluene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
diethylphthalate	330 ug/kg	2600U	22000U	51J	2000U	820U	730U	590U
4-chlorophenyl-phenyl ether	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
fluorene	330 ug/kg	210J	22000U	44J	2000U	820U	240J	590U
4-nitroaniline	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
4,6-dinitro-2-methylphenol	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
n-nitrosodiphenylamine	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
4-bromophenyl-phenyl ether	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
hexachlorobenzene	330 ug/kg	15000	22000U	5400	7900	3000	4500	1400
pentachlorophenol	800 ug/kg	6400U	54000U	2300U	5100U	2000U	1800U	1500U
phenanthrene	330 ug/kg	2000J	530J	510J	270J	270J	1800	310J
anthracene	330 ug/kg	590J	22000U	76J	33J	22J	330J	43J

Appendix Table 1. Continued.

SAMPLE NUMBERS		TR-01	TR-02	TR-03	TR-04	TR-05	TR-06	TR-07
DATE SAMPLE COLLECTED		6/19/95	6/19/95	6/19/95	6/19/95	6/20/95	6/20/95	6/20/95
RIVER MILE		81.45	79.97	78.06	73.64	71.62	68.72	64.81
LATITUDE		4004140	4004045	4003911	4003947	4003829	4003633	4003408
LONGITUDE		8103013	8102914	8102912	8102621	8102701	8102543	8102404
SEMI-VOLATILE ORGANIC COMPOUNDS								
	CRQL							
carbazole	330 ug/kg	270J	22000U	130J	2000U	820U	730U	590U
di-n-butylphthalate	330 ug/kg	460BJ	22000U	410JB	590JB	570JB	390JB	360JB
fluoranthene	330 ug/kg	3600	22000U	720J	680J	550J	2300	530J
pyrene	330 ug/kg	2500J	22000U	540J	520J	500J	2100	460J
butylbenzylphthalate	330 ug/kg	2600U	22000U	85JB	2000U	40JB	730U	590U
3,3-dichlorobenzidine	330 ug/kg	1700J	22000U	300J	320J	300J	1000	300J
benzo(a)anthracene	330 ug/kg	2600U	22000U	900U	2000U	820U	730U	590U
chrysene	330 ug/kg	2000J	22000U	320J	400J	310J	970	330J
bis(2-ethylhexyl)phthalate	330 ug/kg	440BJ	22000U	520JB	1400JB	460JB	750B	190JB
di-n-octylphthalate	330 ug/kg	2600U	22000U	900U	2000U	750J	730U	590U
benzo(b)fluoranthene	330 ug/kg	1600J	22000U	300J	540J	360J	730U	410J
benzo(k)fluoranthene	330 ug/kg	1300J	22000U	250J	350J	820U	800	390J
benzo(a)pyrene	330 ug/kg	1600J	22000U	200J	300J	160J	590J	230J
indeno(1,2,3-cd)pyrene	330 ug/kg	800J	22000U	94J	120J	63J	230J	74J
dibenzo(a,h)anthracene	330 ug/kg	150J	22000U	27J	2000U	820U	730U	590U
benzo(g,h,i)perylene	330 ug/kg	640J	22000U	96J	100J	58J	260J	59J
OTHER ANALYSIS								
	EQL							
total organic carbon	100 mg/kg	7510	7390	21300	19900	26400	25000	4720
petroleum hydrocarbons	20 mg/kg	300	3100	63	160	320	650	180

J - Value is estimated. The value is less than the CRQL but greater than zero.
U- Compound was analyzed for but not detected.
B- Analyte found in associated blank as well as in the sample. Indicates probable blank contamination.
CRQL- Contract Required Quantitation Limit.
EQL- Estimated Quantitation Limit.

Appendix Table 2. Raw macroinvertebrate data by river mile for the Tuscarawas River, 1995.

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/19/95 River Code: 17-500 River: Tuscarawas River RM: 81.40 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03360	*Plumatella sp*	0	+			
03600	*Oligochaeta*	0	+			
05800	*Caecidotea sp*	0	+			
06800	*Gammarus sp*	0	+			
08250	*Orconectes (Procericambarus) rusticus*	0	+			
22001	*Coenagrionidae*	0	+			
22300	*Argia sp*	0	+			
52200	*Cheumatopsyche sp*	0	+			
52430	*Ceratopsyche morosa group*	0	+			
52530	*Hydropsyche depravata group*	0	+			
63300	*Hydroporus sp*	0	+			
68708	*Dubiraphia vittata group*	0	+			
69400	*Stenelmis sp*	0	+			
74100	*Simulium sp*	0	+			
79085	*Telopelopia okoboji*	0	+			
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
84540	*Polypedilum (Tripodura) scalaenum group*	0	+			
97601	*Corbicula fluminea*	0	+			
98600	*Sphaerium sp*	0	+			
99240	*Lasmigona complanata*	0	+			
99540	*Elliptio dilatata*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 23

No. Qualitative Taxa: 23 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/09/95 River Code: 17-500 River: Tuscarawas River RM: 81.40 **B**

Taxa Code	Taxa	Quan/Qual	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	0	+
06810	*Gammarus fasciatus*	1	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	16	+
13000	*Leucrocuta sp*	1	
13550	*Stenonema mexicanum integrum*	44	+
13570	*Stenonema terminatum*	47	+
16700	*Tricorythodes sp*	32	+
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
25620	*Stylurus spiniceps*	0	+
43300	*Ranatra sp*	0	+
52200	*Cheumatopsyche sp*	445	+
52430	*Ceratopsyche morosa group*	36	+
52530	*Hydropsyche depravata group*	78	+
52540	*Hydropsyche dicantha*	206	+
52560	*Hydropsyche orris*	3	
52570	*Hydropsyche simulans*	198	+
62800	*Dytiscus sp*	0	+
64400	*Oreodytes sp*	0	+
65800	*Berosus sp*	0	+
67700	*Paracymus sp*	0	+
68901	*Macronychus glabratus*	0	+
69400	*Stenelmis sp*	2	+
74100	*Simulium sp*	0	+
77500	*Conchapelopia sp*	5	
77750	*Hayesomyia senata or Thienemannimyia norena*	18	+
79085	*Telopelopia okoboji*	0	+
80410	*Cricotopus (C.) sp*	0	+
80420	*Cricotopus (C.) bicinctus*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	0	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	10	+
82141	*Thienemanniella xena*	0	+
82220	*Tvetenia discoloripes group*	3	
84450	*Polypedilum (P.) convictum*	66	+
84460	*Polypedilum (P.) fallax group*	0	+
84470	*Polypedilum (P.) illinoense*	5	+
84540	*Polypedilum (Tripodura) scalaenum group*	5	+
84700	*Stenochironomus sp*	10	
85625	*Rheotanytarsus exiguus group*	71	+
86401	*Atherix lantha*	0	+
87540	*Hemerodromia sp*	7	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	6	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 25 Total Taxa: 46

No. Qualitative Taxa: 39 ICI: **40**

Number of Organisms: 1316 Qual EPT: **9**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/19/95 River Code: 17-500 River: Tuscarawas River RM: 79.80 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03360	*Plumatella sp*	0	+			
03600	*Oligochaeta*	0	+			
04901	*Erpobdellidae*	0	+			
05800	*Caecidotea sp*	0	+			
06800	*Gammarus sp*	0	+			
10000	*Ephemeroptera*	0	+			
22001	*Coenagrionidae*	0	+			
22300	*Argia sp*	0	+			
52200	*Cheumatopsyche sp*	0	+			
52430	*Ceratopsyche morosa group*	0	+			
68601	*Ancyronyx variegata*	0	+			
69400	*Stenelmis sp*	0	+			
77500	*Conchapelopia sp*	0	+			
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+			
79100	*Thienemannimyia group*	0	+			
81650	*Parametriocnemus sp*	0	+			
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+			
82730	*Chironomus (C.) decorus group*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84540	*Polypedilum (Tripodura) scalaenum group*	0	+			
84700	*Stenochironomus sp*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 21

No. Qualitative Taxa: 21 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/01/95 River Code: 17-500 River: Tuscarawas River RM: 79.80 **B**

Taxa Code	Taxa	Quan/Qual	
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	8	+
06810	*Gammarus fasciatus*	5	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	8	+
13400	*Stenacron sp*	7	+
13510	*Stenonema exiguum*	1	
13550	*Stenonema mexicanum integrum*	298	+
13570	*Stenonema terminatum*	261	+
16700	*Tricorythodes sp*	65	+
17200	*Caenis sp*	0	+
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	1	+
24900	*Gomphus sp*	0	+
25610	*Stylurus notatus*	0	+
48410	*Corydalus cornutus*	2	
52200	*Cheumatopsyche sp*	710	+
52430	*Ceratopsyche morosa group*	78	+
52530	*Hydropsyche depravata group*	44	+
52540	*Hydropsyche dicantha*	24	+
52570	*Hydropsyche simulans*	45	+
52580	*Hydropsyche valanis*	1	
59100	*Ceraclea sp*	0	+
63300	*Hydroporus sp*	0	+
68601	*Ancyronyx variegata*	3	+
68901	*Macronychus glabratus*	1	
69400	*Stenelmis sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	92	+
77800	*Helopelopia sp*	0	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	25	
82141	*Thienemanniella xena*	3	
82820	*Cryptochironomus sp*	0	+
84300	*Phaenopsectra obediens group*	3	
84450	*Polypedilum (P.) convictum*	18	
84470	*Polypedilum (P.) illinoense*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	34	
84700	*Stenochironomus sp*	3	+
85625	*Rheotanytarsus exiguus group*	6	
96900	*Ferrissia sp*	18	+

No. Quantitative Taxa:	28	Total Taxa:	41
No. Qualitative Taxa:	31	ICI:	**46**
Number of Organisms:	1765	Qual EPT:	**12**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/19/95 River Code: 17-500 River: Tuscarawas River RM: 78.20 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03360	*Plumatella sp*	0	+			
03600	*Oligochaeta*	0	+			
06001	*Amphipoda*	0	+			
06810	*Gammarus fasciatus*	0	+			
08200	*Orconectes sp*	0	+			
21200	*Calopteryx sp*	0	+			
22300	*Argia sp*	0	+			
34500	*Perlesta placida complex*	0	+			
52200	*Cheumatopsyche sp*	0	+			
52430	*Ceratopsyche morosa group*	0	+			
52540	*Hydropsyche dicantha*	0	+			
69400	*Stenelmis sp*	0	+			
74100	*Simulium sp*	0	+			
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+			
79085	*Telopelopia okoboji*	0	+			
80410	*Cricotopus (C.) sp*	0	+			
80420	*Cricotopus (C.) bicinctus*	0	+			
80430	*Cricotopus (C.) tremulus group*	0	+			
80440	*Cricotopus (C.) trifascia group*	0	+			
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84460	*Polypedilum (P.) fallax group*	0	+			
84540	*Polypedilum (Tripodura) scalaenum group*	0	+			
98600	*Sphaerium sp*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 24

No. Qualitative Taxa: 24 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/01/95 River Code: 17-500 River: Tuscarawas River RM: 78.20 **B**

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	1	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	121	+
05800	*Caecidotea sp*	1	
06810	*Gammarus fasciatus*	8	+
08250	*Orconectes (Procericambarus) rusticus*	1	+
08601	*Hydracarina*	1	
11130	*Baetis intercalaris*	10	+
13550	*Stenonema mexicanum integrum*	61	+
13570	*Stenonema terminatum*	98	+
16700	*Tricorythodes sp*	63	+
22300	*Argia sp*	1	
48410	*Corydalus cornutus*	1	
52200	*Cheumatopsyche sp*	141	+
52430	*Ceratopsyche morosa group*	67	+
52530	*Hydropsyche depravata group*	3	+
52540	*Hydropsyche dicantha*	9	+
52570	*Hydropsyche simulans*	95	+
52580	*Hydropsyche valanis*	1	
59140	*Ceraclea maculata*	2	
65800	*Berosus sp*	0	+
68130	*Helichus sp*	0	+
68601	*Ancyronyx variegata*	1	
68901	*Macronychus glabratus*	1	
69400	*Stenelmis sp*	3	+
77500	*Conchapelopia sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	100	+
77800	*Helopelopia sp*	33	
78401	*Natarsia species A (sensu Roback, 1978)*	0	+
79085	*Telopelopia okoboji*	5	+
80420	*Cricotopus (C.) bicinctus*	0	+
81240	*Nanocladius (N.) distinctus*	5	
81270	*Nanocladius (N.) spiniplenus*	2	
81825	*Rheocricotopus (Psilocricotopus) robacki*	30	
84450	*Polypedilum (P.) convictum*	51	+
84470	*Polypedilum (P.) illinoense*	3	
84520	*Polypedilum (Tripodura) halterale group*	7	+
84750	*Stictochironomus sp*	0	+
85625	*Rheotanytarsus exiguus group*	13	
87540	*Hemerodromia sp*	1	+
96900	*Ferrissia sp*	33	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 35 Total Taxa: 42
No. Qualitative Taxa: 25 ICI: **34**
Number of Organisms: 974 Qual EPT: **9**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/19/95 River Code: 17-500 River: Tuscarawas River RM: 73.60 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	0	+			
05800	*Caecidotea sp*	0	+			
06810	*Gammarus fasciatus*	0	+			
08250	*Orconectes (Procericambarus) rusticus*	0	+			
22300	*Argia sp*	0	+			
24900	*Gomphus sp*	0	+			
45300	*Sigara sp*	0	+			
79085	*Telopelopia okoboji*	0	+			
80420	*Cricotopus (C.) bicinctus*	0	+			
82820	*Cryptochironomus sp*	0	+			
84315	*Phaenopsectra flavipes*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
96900	*Ferrissia sp*	0	+			
97601	*Corbicula fluminea*	0	+			

No. Quantitative Taxa:	0	Total Taxa:	15
No. Qualitative Taxa:	15	ICI:	
Number of Organisms:	0	Qual EPT:	

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/01/95 River Code: 17-500 River: Tuscarawas River RM: 73.60 **B**

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	1	
03360	*Plumatella sp*	0	+
03600	*Oligochaeta*	0	+
05800	*Caecidotea sp*	0	+
06810	*Gammarus fasciatus*	80	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
08601	*Hydracarina*	1	
11130	*Baetis intercalaris*	5	
13550	*Stenonema mexicanum integrum*	228	+
13570	*Stenonema terminatum*	85	+
16700	*Tricorythodes sp*	22	+
21300	*Hetaerina sp*	0	+
22300	*Argia sp*	0	+
47600	*Sialis sp*	0	+
52200	*Cheumatopsyche sp*	145	+
52430	*Ceratopsyche morosa group*	46	+
52530	*Hydropsyche depravata group*	1	+
52540	*Hydropsyche dicantha*	1	+
52560	*Hydropsyche orris*	4	
52570	*Hydropsyche simulans*	20	+
53501	*Hydroptilidae*	0	+
59118	*Ceraclea enodis*	0	+
67700	*Paracymus sp*	0	+
68601	*Ancyronyx variegata*	1	+
68702	*Dubiraphia bivittata*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	1	
69400	*Stenelmis sp*	1	+
77750	*Hayesomyia senata or Thienemannimyia norena*	24	+
77800	*Helopelopia sp*	1	+
80370	*Corynoneura lobata*	1	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	1	
81240	*Nanocladius (N.) distinctus*	6	
81270	*Nanocladius (N.) spiniplenus*	1	
81825	*Rheocricotopus (Psilocricotopus) robacki*	7	
82141	*Thienemanniella xena*	1	
83300	*Glyptotendipes (Phytotendipes) sp*	1	
84450	*Polypedilum (P.) convictum*	6	+
84470	*Polypedilum (P.) illinoense*	0	+
84520	*Polypedilum (Tripodura) halterale group*	4	
84540	*Polypedilum (Tripodura) scalaenum group*	3	
84700	*Stenochironomus sp*	14	
85625	*Rheotanytarsus exiguus group*	8	
87510	*Chelifera sp*	1	
96900	*Ferrissia sp*	16	+
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa:	32	Total Taxa:	46
No. Qualitative Taxa:	29	ICI:	**42**
Number of Organisms:	737	Qual EPT:	**10**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/20/95 River Code: 17-500 River: Tuscarawas River RM: 71.60 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	0	+			
05800	*Caecidotea sp*	0	+			
06810	*Gammarus fasciatus*	0	+			
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+			
21200	*Calopteryx sp*	0	+			
22001	*Coenagrionidae*	0	+			
22300	*Argia sp*	0	+			
52200	*Cheumatopsyche sp*	0	+			
52430	*Ceratopsyche morosa group*	0	+			
52540	*Hydropsyche dicantha*	0	+			
74100	*Simulium sp*	0	+			
77500	*Conchapelopia sp*	0	+			
80430	*Cricotopus (C.) tremulus group*	0	+			
80440	*Cricotopus (C.) trifascia group*	0	+			
81650	*Parametriocnemus sp*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
95100	*Physella sp*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 18

No. Qualitative Taxa: 18 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/02/95 River Code: 17-500 River: Tuscarawas River RM: 71.60 **B**

Taxa Code	Taxa	Quan/Qual	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	4	+
06810	*Gammarus fasciatus*	67	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
08601	*Hydracarina*	2	
11130	*Baetis intercalaris*	2	
11200	*Callibaetis sp*	0	+
12200	*Isonychia sp*	1	
13400	*Stenacron sp*	0	+
13550	*Stenonema mexicanum integrum*	60	+
13570	*Stenonema terminatum*	418	+
16700	*Tricorythodes sp*	145	+
21300	*Hetaerina sp*	0	+
48410	*Corydalus cornutus*	3	
51300	*Neureclipsis sp*	1	+
52200	*Cheumatopsyche sp*	133	+
52430	*Ceratopsyche morosa group*	242	+
52530	*Hydropsyche depravata group*	2	+
52540	*Hydropsyche dicantha*	21	+
52560	*Hydropsyche orris*	17	+
52570	*Hydropsyche simulans*	28	+
52580	*Hydropsyche valanis*	0	+
60300	*Dineutus sp*	1	
64400	*Oreodytes sp*	0	+
65800	*Berosus sp*	0	+
67000	*Helophorus sp*	0	+
67700	*Paracymus sp*	0	+
68601	*Ancyronyx variegata*	1	+
68702	*Dubiraphia bivittata*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	6	+
69400	*Stenelmis sp*	0	+
74100	*Simulium sp*	2	+
77500	*Conchapelopia sp*	3	
77740	*Hayesomyia senata*	37	+
77800	*Helopelopia sp*	16	
79085	*Telopelopia okoboji*	0	+
80410	*Cricotopus (C.) sp*	3	+
80420	*Cricotopus (C.) bicinctus*	31	
80430	*Cricotopus (C.) tremulus group*	6	+
80440	*Cricotopus (C.) trifascia group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	3	
81240	*Nanocladius (N.) distinctus*	12	
81825	*Rheocricotopus (Psilocricotopus) robacki*	93	
82141	*Thienemanniella xena*	7	
83040	*Dicrotendipes neomodestus*	9	
83300	*Glyptotendipes (Phytotendipes) sp*	3	
84450	*Polypedilum (P.) convictum*	34	+
84460	*Polypedilum (P.) fallax group*	0	+
84470	*Polypedilum (P.) illinoense*	3	+
84540	*Polypedilum (Tripodura) scalaenum group*	6	
84700	*Stenochironomus sp*	6	
85625	*Rheotanytarsus exiguus group*	78	
85814	*Tanytarsus glabrescens group*	3	
87540	*Hemerodromia sp*	2	
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	3	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa:	41	Total Taxa:	58
No. Qualitative Taxa:	37	ICI:	**42**
Number of Organisms:	1515	Qual EPT:	**13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/20/95 River Code: 17-500 River: Tuscarawas River RM: 68.70 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	0	+			
06810	*Gammarus fasciatus*	0	+			
08200	*Orconectes sp*	0	+			
22300	*Argia sp*	0	+			
77500	*Conchapelopia sp*	0	+			
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+			
79085	*Telopelopia okoboji*	0	+			
80204	*Brillia flavifrons group*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
97601	*Corbicula fluminea*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 10

No. Qualitative Taxa: 10 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/02/95 River Code: 17-500 River: Tuscarawas River RM: 68.70 **B**

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	8	+
03600	*Oligochaeta*	10	+
05800	*Caecidotea sp*	0	+
06810	*Gammarus fasciatus*	27	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	2	
13400	*Stenacron sp*	1	
13550	*Stenonema mexicanum integrum*	72	+
13570	*Stenonema terminatum*	535	+
16700	*Tricorythodes sp*	117	+
17200	*Caenis sp*	0	+
25620	*Stylurus spiniceps*	0	+
48410	*Corydalus cornutus*	1	
52200	*Cheumatopsyche sp*	181	+
52430	*Ceratopsyche morosa group*	250	+
52530	*Hydropsyche depravata group*	2	
52540	*Hydropsyche dicantha*	88	+
52560	*Hydropsyche orris*	14	+
52570	*Hydropsyche simulans*	1	
52801	*Potamyia flava*	9	
53501	*Hydroptilidae*	1	
68130	*Helichus sp*	0	+
68601	*Ancyronyx variegata*	3	
68901	*Macronychus glabratus*	8	+
74100	*Simulium sp*	4	
77750	*Hayesomyia senata or Thienemannimyia norena*	92	+
79085	*Telopelopia okoboji*	10	
80410	*Cricotopus (C.) sp*	10	+
80420	*Cricotopus (C.) bicinctus*	10	+
80430	*Cricotopus (C.) tremulus group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	5	
81825	*Rheocricotopus (Psilocricotopus) robacki*	68	
82200	*Tvetenia bavarica group*	5	
82220	*Tvetenia discoloripes group*	5	
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	19	+
84450	*Polypedilum (P.) convictum*	24	+
84470	*Polypedilum (P.) illinoense*	10	+
84480	*Polypedilum (P.) laetum group*	0	+
84520	*Polypedilum (Tripodura) halterale group*	5	
84700	*Stenochironomus sp*	5	
85625	*Rheotanytarsus exiguus group*	87	
85800	*Tanytarsus sp*	5	
87540	*Hemerodromia sp*	2	

No. Quantitative Taxa:	36	Total Taxa:	46
No. Qualitative Taxa:	27	ICI:	**42**
Number of Organisms:	1696	Qual EPT:	**8**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 06/20/95 River Code: 17-500 River: Tuscarawas River RM: 64.90 **A**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03360	*Plumatella sp*	0	+			
03600	*Oligochaeta*	0	+			
06810	*Gammarus fasciatus*	0	+			
08200	*Orconectes sp*	0	+			
22300	*Argia sp*	0	+			
24900	*Gomphus sp*	0	+			
52560	*Hydropsyche orris*	0	+			
77500	*Conchapelopia sp*	0	+			
82820	*Cryptochironomus sp*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 9

No. Qualitative Taxa: 9 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/02/95 River Code: 17-500 River: Tuscarawas River RM: 64.90 **B**

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
01801	*Turbellaria*	0	+			
03360	*Plumatella sp*	0	+			
06810	*Gammarus fasciatus*	0	+			
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+			
13400	*Stenacron sp*	0	+			
13550	*Stenonema mexicanum integrum*	0	+			
13570	*Stenonema terminatum*	0	+			
16700	*Tricorythodes sp*	0	+			
23909	*Boyeria vinosa*	0	+			
45100	*Palmacorixa sp*	0	+			
48210	*Chauliodes pectinicornis*	0	+			
52200	*Cheumatopsyche sp*	0	+			
52430	*Ceratopsyche morosa group*	0	+			
52540	*Hydropsyche dicantha*	0	+			
52560	*Hydropsyche orris*	0	+			
52570	*Hydropsyche simulans*	0	+			
68601	*Ancyronyx variegata*	0	+			
68702	*Dubiraphia bivittata*	0	+			
68901	*Macronychus glabratus*	0	+			
69400	*Stenelmis sp*	0	+			
74100	*Simulium sp*	0	+			
80410	*Cricotopus (C.) sp*	0	+			
80420	*Cricotopus (C.) bicinctus*	0	+			
81250	*Nanocladius (N.) minimus*	0	+			
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+			
82141	*Thienemanniella xena*	0	+			
82820	*Cryptochironomus sp*	0	+			
84060	*Parachironomus pectinatellae*	0	+			
84450	*Polypedilum (P.) convictum*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
84700	*Stenochironomus sp*	0	+			
85625	*Rheotanytarsus exiguus group*	0	+			
97601	*Corbicula fluminea*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 33
No. Qualitative Taxa: 33 ICI:
Number of Organisms: 0 Qual EPT:

Appendix Table 3. Invertebrate Community Index (ICI) metrics and scores for the Tuscarawas River study area, 1995.

ICI metric summary for the Tuscarawas River, 1989-95.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Taxa	Qual. EPT	Eco-region	ICI
TUSCARAWAS RIVER — 17-500													
Year: 95													
81.40 B	547.0	25(4)	5(2)	6(6)	10(4)	10.6(2)	73.4(6)	5.4(2)	10.4(6)	0.8(6)	9(2)	3	**40**
79.80 B	550.0	28(4)	6(4)	6(6)	8(2)	36.3(6)	51.1(6)	0.3(2)	11.9(6)	1.5(6)	12(4)	3	**46**
78.20 B	580.0	35(6)	4(2)	7(6)	11(4)	23.8(4)	32.6(6)	1.3(2)	41.5(2)	16.6(0)	9(2)	3	**34**
73.60 B	586.0	32(4)	4(2)	6(6)	15(6)	46.1(6)	29.4(6)	1.1(2)	22.9(4)	3.0(4)	10(2)	3	**42**
71.60 B	1092.0	41(6)	5(2)	7(6)	20(6)	41.3(6)	29.3(4)	5.3(2)	23.3(4)	3.5(2)	13(4)	4	**42**
68.70 B	1103.0	36(6)	5(2)	8(6)	17(6)	42.9(6)	32.2(4)	5.4(2)	18.8(4)	1.8(4)	8(2)	4	**42**
Year: 89													
81.40	547.0	39(6)	5(2)	6(6)	13(4)	10.0(2)	12.0(2)	14.2(2)	61.4(0)	1.7(6)	14(4)	3	**34**
78.20	580.0	43(6)	6(4)	5(4)	15(6)	46.4(6)	22.2(4)	6.2(2)	22.3(4)	5.3(2)	9(2)	3	**40**
73.60	586.0	34(4)	5(2)	6(6)	15(6)	42.9(6)	27.7(4)	4.4(2)	24.1(4)	1.9(6)	8(2)	3	**42**
68.80	1103.0	29(4)	4(2)	8(6)	12(6)	5.8(2)	69.0(6)	10.6(2)	14.5(6)	0.9(6)	9(2)	4	**42**

Appendix Table 4. Summary of relative numbers and weight of fish and species collected at each location by river mile sampled in the Tuscarawas River area, 1995. Relative numbers are per 1.0 km.

Species List

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **81.40**	Basin: Muskingum River	Date Range: 06/19/95
Data Source: 01	Time Fished: 2844 sec Drain Area: 547.0 sq mi	Thru: 08/24/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN PIKE (C)	F	P	M		1	1.00	0.69	0.02	0.01	16.00
QUILLBACK CARPSUCKER (C)	C	O	M		1	1.00	0.69	0.63	0.56	634.00
SILVER REDHORSE (C)	R	I	S	M	1	1.00	0.69	0.38	0.33	378.00
NORTHERN HOG SUCKER (C)	R	I	S	M	27	27.00	18.75	5.34	4.73	197.90
WHITE SUCKER (C)	W	O	S	T	27	27.00	18.75	4.20	3.71	155.43
COMMON CARP (C)	G	O	M	T	58	58.00	40.28	96.05	85.01	1,656.08
SPOTFIN SHINER (C)	N	I	M		4	4.00	2.78	0.04	0.04	10.75
BLUNTNOSE MINNOW (C)	N	O	C	T	2	2.00	1.39	0.01	0.00	2.50
COM. CARP X GOLDFISH (C)	G	O		T	3	3.00	2.08	0.59	0.53	198.00
CHANNEL CATFISH (C)	F		C		5	5.00	3.47	2.90	2.57	579.80
YELLOW BULLHEAD (C)		I	C	T	1	1.00	0.69	0.38	0.33	376.00
BROWN BULLHEAD (C)		I	C	T	1	1.00	0.69	0.27	0.24	272.00
TROUT-PERCH (C)		I	M		1	1.00	0.69	0.01	0.01	12.00
ROCK BASS (A)	S	C	C		2	2.00	1.39	0.28	0.25	138.50
SMALLMOUTH BASS (A)	F	C	C	M	4	4.00	2.78	1.71	1.51	427.75
WARMOUTH SF (C)	S	C	C		1	1.00	0.69	0.06	0.05	55.00
BLUEGILL SUNFISH (C)	S	I	C	P	4	4.00	2.78	0.09	0.08	21.25
PUMPKINSEED SUNFISH (C)	S	I	C	P	1	1.00	0.69	0.04	0.04	44.00
Mile Total					144	144.00		112.99		
Number of Species					17					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **79.80**	Basin: Muskingum River	Date Range: 06/19/95
Data Source: 01	Time Fished: 3202 sec Drain Area: 550.0 sq mi	Thru: 08/24/95
Purpose:	Dist Fished: 1.10 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		1	1.00	0.76	0.06	0.08	62.00
SILVER REDHORSE (C)	R	I	S	M	3	2.67	2.03	3.63	4.63	1,350.00
NORTHERN HOG SUCKER (C)	R	I	S	M	33	28.67	21.86	4.73	6.03	160.34
WHITE SUCKER (C)	W	O	S	T	25	22.50	17.15	3.39	4.33	146.00
COMMON CARP (C)	G	O	M	T	43	39.00	29.73	63.48	81.06	1,630.85
GOLDFISH (C)	G	O	M	T	1	0.83	0.64	0.19	0.24	226.00
CREEK CHUB (C)	N	G	N	T	1	1.00	0.76	0.00	0.01	4.00
SPOTFIN SHINER (C)	N	I	M		4	3.67	2.80	0.04	0.05	10.75
SAND SHINER (C)	N	I	M	M	2	2.00	1.52	0.00	0.01	2.00
BLUNTNOSE MINNOW (C)	N	O	C	T	15	15.00	11.44	0.08	0.10	5.20
CENTRAL STONEROLLER (C)	N	H	N		3	3.00	2.29	0.01	0.01	2.33
COM. CARP X GOLDFISH (C)	G	O		T	1	0.83	0.64	0.22	0.28	261.00
CHANNEL CATFISH (C)	F		C		1	0.83	0.64	0.74	0.95	893.00
BROWN BULLHEAD (C)		I	C	T	1	1.00	0.76	0.34	0.43	338.00
WHITE CRAPPIE (C)	S	I	C		1	0.83	0.64	0.05	0.07	62.00
ROCK BASS (A)	S	C	C		2	2.00	1.52	0.37	0.47	182.50
GREEN SUNFISH (C)	S	I	C	T	1	1.00	0.76	0.04	0.05	43.00
BLUEGILL SUNFISH (C)	S	I	C	P	1	1.00	0.76	0.03	0.04	31.00
PUMPKINSEED SUNFISH (C)	S	I	C	P	2	1.83	1.40	0.11	0.14	58.00
YELLOW PERCH (C)			M		2	1.67	1.27	0.03	0.04	19.00
SAUGER X WALLEYE (C)	E	P			1	0.83	0.64	0.77	0.98	924.00
Mile Total					144	131.17		78.31		
Number of Species					19					
Number of Hybrids					2					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **78.20**	Basin: Muskingum River	Date Range: 06/19/95
Data Source: 01	Time Fished: 2531 sec Drain Area: 580.0 sq mi	Thru: 08/24/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
SILVER REDHORSE (C)	R	I	S	M	1	1.00	0.77	0.52	0.68	515.00
NORTHERN HOG SUCKER (C)	R	I	S	M	42	42.00	32.31	6.00	7.90	142.79
WHITE SUCKER (C)	W	O	S	T	21	21.00	16.15	2.10	2.77	100.00
COMMON CARP (C)	G	O	M	T	33	33.00	25.38	64.16	84.53	1,944.16
SUCKERMOUTH MINNOW (C)	N	I	S		2	2.00	1.54	0.01	0.01	4.00
COMMON SHINER (C)	N	I	S		3	3.00	2.31	0.04	0.05	12.00
SPOTFIN SHINER (C)	N	I	M		4	4.00	3.08	0.06	0.08	14.38
SAND SHINER (C)	N	I	M	M	2	2.00	1.54	0.01	0.01	3.00
BLUNTNOSE MINNOW (C)	N	O	C	T	5	5.00	3.85	0.03	0.04	5.60
CENTRAL STONEROLLER (C)	N	H	N		2	2.00	1.54	0.01	0.02	6.00
COM. CARP X GOLDFISH (C)	G	O		T	1	1.00	0.77	0.73	0.96	725.00
ROCK BASS (A)	S	C	C		7	7.00	5.38	1.02	1.34	145.57
SMALLMOUTH BASS (A)	F	C	C	M	4	4.00	3.08	1.18	1.55	294.00
LARGEMOUTH BASS (A)	F	C	C		1	1.00	0.77	0.05	0.07	54.00
GREENSIDE DARTER (C)	D	I	S	M	2	2.00	1.54	0.01	0.01	5.50
Mile Total					130	130.00		75.90		
Number of Species					14					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **73.40**	Basin: Muskingum River	Date Range: 06/19/95
Data Source: 01	Time Fished: 2831 sec Drain Area: 586.0 sq mi	Thru: 08/24/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN (C)		P	C		1	1.00	0.92	0.24	0.30	240.00
SILVER REDHORSE (C)	R	I	S	M	2	2.00	1.83	0.64	0.80	320.00
GOLDEN REDHORSE (C)	R	I	S	M	1	1.00	0.92	0.17	0.21	168.00
NORTHERN HOG SUCKER (C)	R	I	S	M	1	1.00	0.92	0.01	0.02	13.00
WHITE SUCKER (C)	W	O	S	T	5	5.00	4.59	1.33	1.66	265.60
COMMON CARP (C)	G	O	M	T	54	54.00	49.54	72.06	90.08	1,334.53
GOLDFISH (C)	G	O	M	T	2	2.00	1.83	0.19	0.24	95.00
SPOTFIN SHINER (C)	N	I	M		7	7.00	6.42	0.05	0.07	7.57
BLUNTNOSE MINNOW (C)	N	O	C	T	1	1.00	0.92	0.01	0.01	6.00
COM. CARP X GOLDFISH (C)	G	O		T	2	2.00	1.83	1.20	1.50	599.00
SMALLMOUTH BASS (A)	F	C	C	M	5	5.00	4.59	1.47	1.84	294.20
LARGEMOUTH BASS (A)	F	C	C		2	2.00	1.83	1.56	1.95	781.50
WARMOUTH SF (C)	S	C	C		2	2.00	1.83	0.06	0.08	31.00
GREEN SUNFISH (C)	S	I	C	T	1	1.00	0.92	0.03	0.03	27.00
BLUEGILL SUNFISH (C)	S	I	C	P	19	19.00	17.43	0.78	0.97	40.99
B'GILL X PUMPKINSEED (C)					1	1.00	0.92	0.06	0.07	58.00
YELLOW PERCH (C)			M		3	3.00	2.75	0.14	0.17	45.67
Mile Total					109	109.00		80.00		
Number of Species					15					
Number of Hybrids					2					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **70.80**	Basin: Muskingum River	Date Range: 06/20/95
Data Source: 01	Time Fished: 2752 sec Drain Area: 1093.0 sq mi	Thru: 08/25/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
QUILLBACK CARPSUCKER (C)	C	O	M		1	1.00	0.64	0.96	0.91	962.00
SILVER REDHORSE (C)	R	I	S	M	1	1.00	0.64	0.35	0.33	353.00
NORTHERN HOG SUCKER (C)	R	I	S	M	53	53.00	33.76	9.76	9.24	184.23
WHITE SUCKER (C)	W	O	S	T	7	7.00	4.46	2.38	2.25	339.29
COMMON CARP (C)	G	O	M	T	39	39.00	24.84	83.25	78.81	2,134.73
GOLDFISH (C)	G	O	M	T	7	7.00	4.46	0.91	0.86	129.43
SUCKERMOUTH MINNOW (C)	N	I	S		1	1.00	0.64	0.00	0.00	4.00
SPOTFIN SHINER (C)	N	I	M		4	4.00	2.55	0.04	0.03	9.00
SAND SHINER (C)	N	I	M	M	1	1.00	0.64	0.00	0.00	4.00
BLUNTNOSE MINNOW (C)	N	O	C	T	6	6.00	3.82	0.02	0.02	3.67
COM. CARP X GOLDFISH (C)	G	O		T	1	1.00	0.64	0.42	0.40	418.00
CHANNEL CATFISH (C)	F		C		2	2.00	1.27	1.33	1.26	666.00
YELLOW BULLHEAD (C)		I	C	T	1	1.00	0.64	0.34	0.33	344.00
WHITE CRAPPIE (C)	S	I	C		1	1.00	0.64	0.06	0.06	64.00
ROCK BASS (A)	S	C	C		3	3.00	1.91	0.73	0.69	241.67
ROCK BASS (B)	S	C	C		4	4.00	2.55	0.15	0.14	36.25
SMALLMOUTH BASS (A)	F	C	C	M	17	17.00	10.83	4.85	4.59	285.29
WARMOUTH SF (C)	S	C	C		1	1.00	0.64	0.02	0.02	21.00
GREEN SUNFISH (C)	S	I	C	T	1	1.00	0.64	0.01	0.01	8.00
BLUEGILL SUNFISH (C)	S	I	C	P	2	2.00	1.27	0.02	0.02	9.00
YELLOW PERCH (C)			M		1	1.00	0.64	0.03	0.03	28.00
GREENSIDE DARTER (C)	D	I	S	M	2	2.00	1.27	0.01	0.01	3.00
BANDED DARTER (C)	D	I	S	I	1	1.00	0.64	0.00	0.00	2.00
Mile Total					157	157.00		105.64		
Number of Species					21					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **68.70**	Basin: Muskingum River	Date Range: 06/20/95
Data Source: 01	Time Fished: 2572 sec Drain Area: 1103.0 sq mi	Thru: 08/25/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
QUILLBACK CARPSUCKER (C)	C	O	M		1	1.00	0.42	0.94	0.66	936.00
SILVER REDHORSE (C)	R	I	S	M	1	1.00	0.42	0.03	0.02	31.00
GOLDEN REDHORSE (C)	R	I	S	M	3	3.00	1.26	0.36	0.25	119.33
NORTHERN HOG SUCKER (C)	R	I	S	M	89	89.00	37.39	16.96	12.04	190.54
WHITE SUCKER (C)	W	O	S	T	8	8.00	3.36	3.31	2.35	414.00
COMMON CARP (C)	G	O	M	T	54	54.00	22.69	110.81	78.67	2,051.95
GOLDFISH (C)	G	O	M	T	1	1.00	0.42	0.14	0.10	136.00
RIVER CHUB (C)	N	I	N	I	8	8.00	3.36	0.51	0.36	64.23
SPOTFIN SHINER (C)	N	I	M		18	18.00	7.56	0.13	0.09	7.09
SAND SHINER (C)	N	I	M	M	1	1.00	0.42	0.00	0.00	3.00
BLUNTNOSE MINNOW (C)	N	O	C	T	11	11.00	4.62	0.05	0.04	4.73
CHANNEL CATFISH (C)	F		C		1	1.00	0.42	0.63	0.45	634.00
YELLOW BULLHEAD (C)		I	C	T	1	1.00	0.42	0.34	0.24	339.00
BROWN BULLHEAD (C)		I	C	T	1	1.00	0.42	0.24	0.17	242.00
WHITE CRAPPIE (C)	S	I	C		1	1.00	0.42	0.04	0.03	43.00
ROCK BASS (A)	S	C	C		8	8.00	3.36	1.10	0.78	138.00
ROCK BASS (B)	S	C	C		5	5.00	2.10	0.18	0.13	36.20
SMALLMOUTH BASS (A)	F	C	C	M	14	14.00	5.88	4.89	3.47	349.29
LARGEMOUTH BASS (A)	F	C	C		1	1.00	0.42	0.03	0.02	28.00
GREEN SUNFISH (C)	S	I	C	T	2	2.00	0.84	0.01	0.01	5.00
BLUEGILL SUNFISH (C)	S	I	C	P	1	1.00	0.42	0.04	0.03	41.00
PUMPKINSEED SUNFISH (C)	S	I	C	P	1	1.00	0.42	0.01	0.01	12.00
YELLOW PERCH (C)			M		2	2.00	0.84	0.08	0.06	40.50
GREENSIDE DARTER (C)	D	I	S	M	4	4.00	1.68	0.02	0.01	3.75
BANDED DARTER (C)	D	I	S	I	1	1.00	0.42	0.00	0.00	2.00
Mile Total					238	238.00		140.85		
Number of Species					24					
Number of Hybrids					0					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1995**
River Mile: **64.10**	Basin: Muskingum River	Date Range: 06/20/95
Data Source: 01	Time Fished: 3353 sec Drain Area: 1403.0 sq mi	Thru: 08/25/95
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
QUILLBACK CARPSUCKER (C)	C	O	M		3	3.00	2.26	2.22	1.10	740.67
SILVER REDHORSE (C)	R	I	S	M	2	2.00	1.50	2.41	1.20	1,202.50
GOLDEN REDHORSE (C)	R	I	S	M	2	2.00	1.50	1.24	0.61	617.50
NORTHERN HOG SUCKER (C)	R	I	S	M	29	29.00	21.80	4.85	2.41	167.16
WHITE SUCKER (C)	W	O	S	T	9	9.00	6.77	3.38	1.68	375.44
COMMON CARP (C)	G	O	M	T	74	74.00	55.64	184.52	91.71	2,493.45
SPOTFIN SHINER (C)	N	I	M		3	3.00	2.26	0.03	0.01	8.33
BLUNTNOSE MINNOW (C)	N	O	C	T	3	3.00	2.26	0.01	0.00	2.00
COM. CARP X GOLDFISH (C)	G	O		T	1	1.00	0.75	0.32	0.16	320.00
CHANNEL CATFISH (C)	F		C		1	1.00	0.75	0.67	0.33	674.00
ROCK BASS (A)	S	C	C		1	1.00	0.75	0.15	0.08	153.00
SMALLMOUTH BASS (A)	F	C	C	M	1	1.00	0.75	0.49	0.25	493.00
YELLOW PERCH (C)			M		2	2.00	1.50	0.05	0.02	24.50
JOHNNY DARTER (C)	D	I	C		1	1.00	0.75	0.00	0.00	2.00
SAUGER X WALLEYE (C)	E	P			1	1.00	0.75	0.87	0.43	870.00
	Mile Total				133	133.00		201.20		
	Number of Species				13					
	Number of Hybrids				2					

Appendix Table 5. Index of Biotic Integrity (IBI) metrics and scores and Modified Index of Well-being (MIwb) scores by river mile for locations sampled in the Tuscarawas River study area, 1995.

Appendix Table 5. IBI metrics and scores for the Tuscarawas River, 1995.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Percent of Individuals: Rnd-bodied suckers	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(1.0 km)		IBI	Modified Iwb
Tuscarawas River - (17-500)																		
Year: 95																		
81.40	A	06-19-95	547	11(3)	2(3)	3(3)	0(1)	18(1)	42(3)	70(1)	67(1)	4(1)	28(3)	2.5(3)	40(1)	*	24	5.1
81.40	A	08/24/95	547	12(3)	4(5)	3(3)	0(1)	21(3)	35(3)	58(1)	60(1)	6(3)	27(3)	17.9(1)	64(1)	*	28	5.9
79.80	A	06-19-95	550	14(3)	4(5)	3(3)	0(1)	12(1)	27(3)	70(1)	67(1)	3(1)	24(1)	12.0(1)	40(1)	*	22	5.7
79.80	A	08/24/95	550	8(1)	2(3)	3(3)	0(1)	36(3)	56(5)	53(1)	53(1)	1(1)	42(3)	14.3(1)	60(1)	*	24	5.6
78.20	A	06-19-95	580	10(3)	1(1)	2(1)	0(1)	33(3)	54(5)	38(1)	38(1)	11(5)	48(3)	9.8(1)	76(1)	*	26	5.9
78.20	A	08/24/95	580	9(1)	1(1)	3(3)	0(1)	33(3)	55(5)	54(1)	54(1)	7(3)	39(3)	14.7(1)	64(1)	*	24	5.4
73.40	A	06-19-95	586	8(1)	2(3)	2(1)	0(1)	4(1)	11(1)	61(1)	61(1)	15(5)	24(1)	2.2(3)	36(1)	*	20	5.1
73.40	A	08/24/95	586	11(3)	3(3)	3(3)	0(1)	3(1)	6(1)	59(1)	57(1)	5(1)	32(3)	24.6(1)	52(1)	*	20	4.3
70.80	A	06-20-95	1093	15(3)	4(5)	4(3)	0(1)	28(3)	36(3)	32(1)	33(1)	24(5)	41(3)	1.3(3)	106(1)	*	32	7.4
70.80	A	08/25/95	1093	10(3)	3(3)	2(1)	1(1)	41(5)	47(5)	47(1)	44(1)	8(3)	46(3)	22.5(1)	84(1)	*	28	5.8
68.70	A	06-20-95	1103	10(3)	1(1)	2(1)	1(1)	43(5)	46(5)	36(1)	35(1)	10(3)	56(5)	3.5(1)	104(1)	*	28	5.9
68.70	A	08/25/95	1103	20(3)	5(5)	5(3)	2(3)	37(3)	44(5)	31(1)	30(1)	13(5)	55(5)	10.9(1)	216(3)		38	7.7
64.10	A	06-20-95	1403	6(1)	0(1)	4(3)	0(1)	8(1)	17(1)	85(1)	90(1)	0(1)	10(1)	17.7(1)	16(1)	*	14	3.8
64.10	A	08/25/95	1403	11(3)	1(1)	4(3)	0(1)	36(3)	41(3)	53(1)	53(1)	4(1)	40(3)	31.9(1)	76(1)	*	22	5.5

▲ - IBI is low end adjusted.