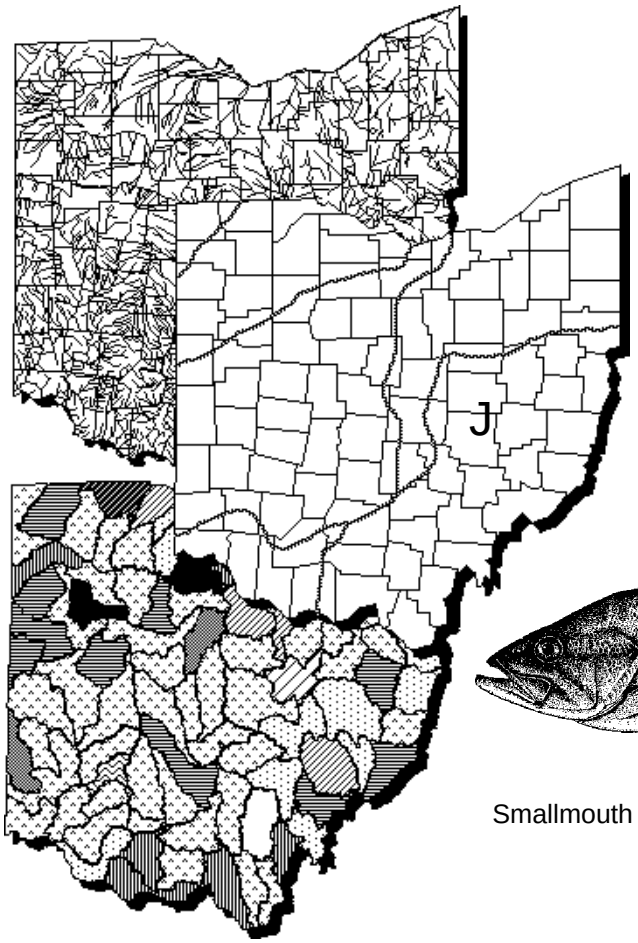
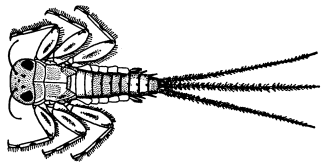
State of Ohio
Environmental Protection Agency

Ecological Assessment Unit
Division of Surface Water

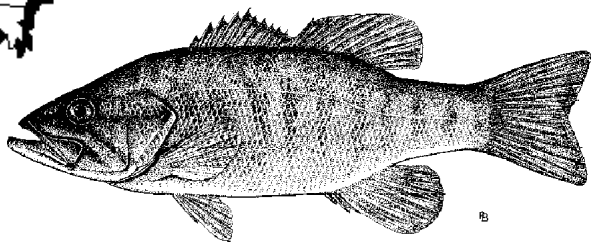
Biological and Water Quality Study of the Upper Muskingum River Basin

Tuscarawas, Coshocton, Licking, Muskingum, and Knox Counties, Ohio





Mayfly *(Stenonema)*



Smallmouth Bass *(Micropterus dolomieui)*

January 31, 1996

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43216-0149

Biological and Water Quality Study of the Upper Muskingum River Mainstem and Selected Tributaries

Tuscarawas, Coshocton, Licking, Muskingum and Knox Counties, Ohio

January 31, 1995

OEPA Technical Report MAS/1995-8-9

prepared by

State of Ohio Environmental Protection Agency
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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 Ohio EPA 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. Division of 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. Division of 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. Division of 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. Division of 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. Division of Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Division of 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
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(614) 728-3377

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This evaluation and report would not have been possible without the assistance of the study team and numerous full and part time staff in the field and the chemistry analyses provided by the Ohio EPA Division of Environmental Services.

Biological and Water Quality Survey of the Upper Muskingum River Mainstem and Selected Tributaries

Tuscarawas, Coshocton, Licking, Muskingum and Knox Counties, Ohio

State of Ohio Environmental Protection Agency
Division of Surface Water
1800 WaterMark Drive
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Columbus, Ohio 43216-1049

INTRODUCTION

The upper Muskingum River survey fully assessed the lower 7.2 miles of the Tuscarawas River (additional macroinvertebrate and chemical sampling was conducted at the fixed monitoring station in Newcomerstown [RM 21.2]), the lower 15.9 miles of the Walhonding River, the upper 19 miles of the Muskingum River between Coshocton and Dresden (RM 110.0-92.0) and the lower five miles of the Licking River from Dillon Dam to Zanesville (RMs 3.7-0.6). This sampling effort included 26 chemical, physical and biological sampling locations (see Figure 2 and Table 3). In addition to the major rivers in the upper Muskingum basin, fish and chemical sampling were conducted at 17 stations in the Wakatomika Creek subbasin (Muskingum River drainage), the Mill Creek subbasin (Walhonding River drainage) and several previously unassessed small tributaries. A summary of all biological sampling results is presented in Table 1.

Specific objectives of this evaluation were to:

1) monitor and assess the overall chemical, physical, and biological integrity of the water bodies within the 1994 upper Muskingum River study area,

2) evaluate the influence of the Stone Container Corporation, a manufacturer of corrugated cardboard that discharges pulp mill effluents to the Tuscarawas River from three outfalls between RMs 1.17 and 0.4,

3) evaluate biological community performance in the Exceptional Warmwater Habitat (EWH) designated sections of the lower Tuscarawas River (RMs 45-1.6), Walhonding River (entire mainstem), and Wakatomika Creek (entire mainstem) and in the remaining Warmwater Habitat (WWH) or Limited Warmwater Habitat (LWH) designated streams in the study area,

4) evaluate potential impacts from other point source discharges on the Muskingum River (including the Coshocton WWTP, Armco Steel, and the Conesville Electric Generating Station [EGS]), the Licking River (Burnham Boiler Corp.), and Wakatomika Creek (Frazeysburg WWTP),

5) evaluate any changes in ambient biological and water quality condition since a previous intensive survey of the upper Muskingum River in 1988, and expand the Ohio EPA data base for long term trend analysis (*e.g.*, 305[b] report),

6) establish chemical and biological monitoring stations in the Mill Creek drainage to evaluate nonpoint source pollution and existing conditions in the previously unmonitored watershed.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA such as NPDES permits, Director's Orders, the Ohio Water Quality Standards (OAC 3745-1). They may eventually be incorporated into the State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Water Resource Inventory (305[b] report).

SUMMARY

Tuscarawas River

Aquatic life use attainment in the lower 7.3 miles of the Tuscarawas River was PARTIAL in the EWH designated segment (upstream from Coshocton) and FULL in the WWH designated section (Coshocton to mouth). Tuscarawas River biological communities generally ranged from marginally good to exceptional throughout the lower stretches. Biological communities immediately upstream and downstream from Stone Container (RM 1.17-0.4) fully attained the existing WWH use designation and reflected minimal impacts in the form of organic enrichment. Mixing zone sampling indicated a lack of acute toxicity with community health ranging from fair (fish) to exceptional (macroinvertebrates). However, the mixing zone was the first location where extensive growths of "sewage fungus" were observed on both the natural substrates and some macroinvertebrate specimens. These growths persisted (in lesser amounts) downstream and into the Muskingum River for a distance of about ten miles.

The 1994 results downstream from Stone Container contrasted with the more severe impacts to dissolved oxygen levels and biological communities observed in 1988 under higher loading and very low flow conditions. Besides higher flows in 1994, Stone Container began to inject oxygen into the final effluent in 1993 which helped improve "near-field" water quality conditions. Also, recent bioassay testing suggests improvements in effluent quality since 1991 when the 002, 003, and 004 outfalls were both acutely and chronically toxic to each organism test group. While conditions improved in close proximity to the discharges, "far-field" influences from the pulp mill discharges on the Muskingum River could not be ruled out.

In contrast to the improved conditions downstream from Stone Container, declines in biological community performance were observed upstream from Coshocton (RM 7.2-3.4). Following the 1988 survey, approximately 45 miles of the Tuscarawas River from Stillwater Creek to Coshocton were upgraded to EWH based on the improved performance of the biological communities. The most recent survey showed a decline from predominantly full attainment of EWH (*i.e.*, very good to exceptional range) in 1988 to partial attainment (*i.e.*, marginally good to exceptional range) in 1994 in the lower reaches of this segment . The decline in fish community performance coincided with observations of increased turbidity during much of the summer sampling season and correspondingly low scores for fish assemblages that are sensitive to turbidity. Macroinvertebrates performed better than the fish, but still yielded dense populations of filter feeding midge larvae associated with high levels of suspended solids and organic enrichment. Based on the marginal condition of biological communities, the lower reaches of the Tuscarawas appeared to approach or exceed the assimilative capacity needed to maintain exceptional quality communities.

When compared to the exceptionally high quality Walhonding River, 5 day biochemical oxygen demand (BOD_5) concentrations in the lower Tuscarawas River were three to four times higher, both upstream and downstream from Stone Container. Suspended and dissolved solids levels were also consistently higher in the Tuscarawas and, from field observations, the river had an unusual stained appearance during much of the summer sampling period. Chlorophyll *a* sampling

conducted by Ohio EPA in 1989 (file data) revealed significant algal productivity upstream from Stone Container, an indication of high background nutrient levels upstream from Coshocton. A series of small municipalities (Newcomerstown, West Lafayette, Canal Lewisville) in the lower 20 miles of the Tuscarawas were also considered to be potential sources of enrichment but these alone seemed unlikely sources of impairment which persisted 15 to 20 miles downstream. The survey results point to significant background nutrient enrichment and turbidity in the lower reaches of the Tuscarawas River. However, the source(s) of these conditions and the resulting impairment remains unknown.

Muskingum River

The Muskingum River was in full attainment of the designated WWH use in the upper 9.7 river miles from Coshocton to Wills Creek, a short distance downstream from the Conesville EGS thermal discharge. Fish communities were in the good to marginally good ranges in this section while macroinvertebrates met the exceptional criterion. Aquatic life use attainment dropped to partial in the remaining 8.4 miles of the study area from Adamsville (downstream from Wills Creek) to Dresden. Fish communities declined to fair downstream from Wills Creek and remained impaired as far downstream as Dresden. Macroinvertebrates also experienced declines in community performance, but still reflected good and exceptional quality within the segment.

While the drop from full to partial attainment occurred downstream from Wills Creek, declining trends in biological performance were apparent upstream from the tributary. In the fish community, intolerant species and round bodied suckers gradually declined between Coshocton and Dresden (Figure 1). The diversity of mayfly, caddisfly and stonefly taxa collected from the natural substrates (qualitative EPT taxa) also showed a similar trend between Coshocton and Adamsville before improving slightly at Dresden (Figure 1). In contrast, physical habitat quality as measured by the QHEI (Qualitative Habitat Evaluation Index) was good to exceptional throughout the mainstem and was not considered a major factor in the trends observed (Figure 1). Using regression analysis, the declining trend in round bodied suckers, intolerant fish species and qualitative EPT taxa were significant at the 90 to 95 percent level (p values ranged from 0.09 for EPT taxa to 0.04 for intolerants). In contrast, the trend in QHEI was only significant at the 50% level (p=0.5; Figure 1). The higher quality communities in the vicinity of Coshocton suggest positive influences from the exceptional quality Walhonding River and perhaps, the injection of oxygen into the Stone Container final effluent. However, the higher quality was not maintained at stations further downstream. These results suggest additional stresses, either from slowly decaying pulp mill wastes at the downstream sites, excessive background enrichment from the Tuscarawas River upstream from Stone Container, and/or cumulative impacts from the series of point and nonpoint source discharges along the Muskingum River.

The Muskingum River survey included mixing zone sampling at the Armco Steel discharge at RM 105.8. Macroinvertebrates were in the exceptional range and not significantly different from collections upstream and downstream from the discharge. Fish communities were of lower quality (fair to poor range) but this was considered primarily related to poor habitat quality in the immediate vicinity of the discharge and not indicative of acutely toxic conditions. One concern was a thin oily sheen that was consistently observed at the discharge during the summer.

Since 1988, improvement has been noted in upper Muskingum River and lower Tuscarawas River biological communities, particularly downstream from Stone Container, the Coshocton WWTP, and immediately downstream from the Conesville EGS. Some of these changes may be the result of less extreme flow conditions and cooler stream temperatures during the summer of 1994 as

compared to 1988. However, improvements in point source characteristics, both in the upper Muskingum River and the lower Tuscarawas River could also result in improved biological performance. Since the 1988 drought year, Stone Container Corp. has injected oxygen into the final effluent in an effort to raise dissolved oxygen levels in stream. The Coshocton WWTP has experienced reductions in ammonia loadings since 1988 and the Conesville EGS plant has worked with Ohio EPA to reduce thermal loadings during critical periods of low flow through load management. The 1994 results probably reflect some of the positive benefits from these efforts.

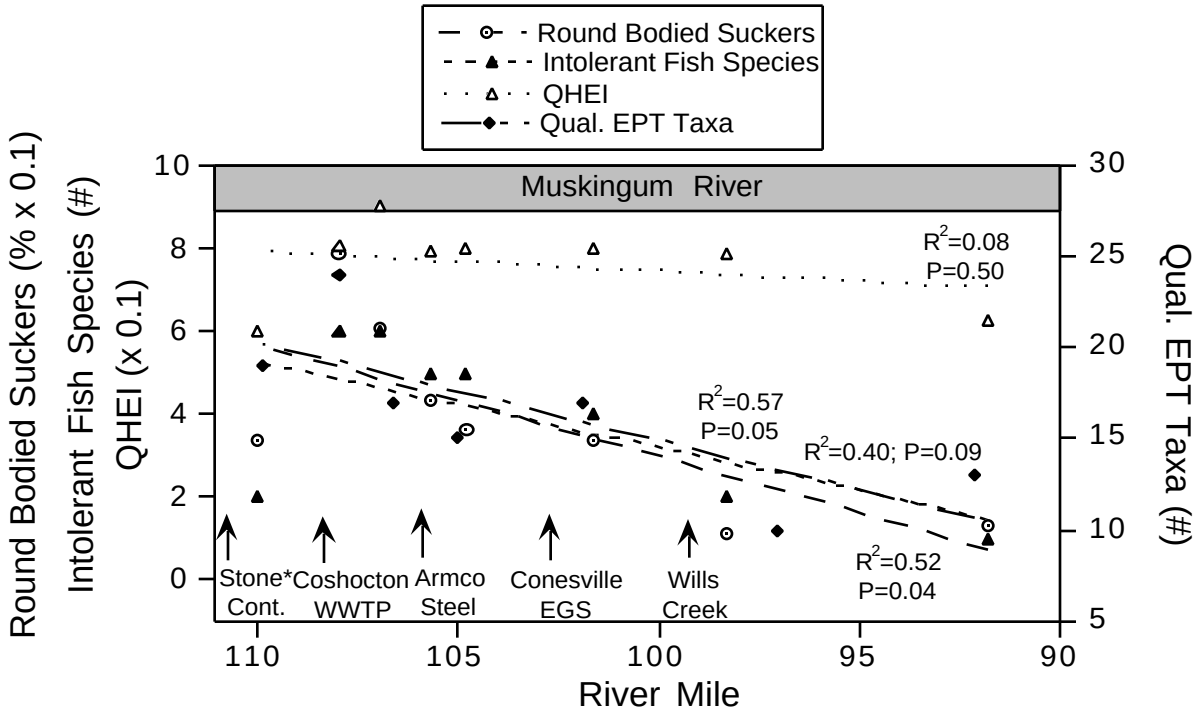

Figure 1. Numbers of qualitatively collected mayfly, stonefly, and caddisfly (Qual. EPT) taxa, intolerant fish species, percentages of round bodied suckers, Qualitative Habitat Evaluation Index (QHEI) scores and associated regression lines from stations in the upper Muskingum River, 1994.
*Stone Container discharges to the lower Tuscarawas River at RMs 1.17-0.4.

Walhonding River
The Walhonding River was in FULL attainment of the designated EWH aquatic life use designation from RMs 16.3-0.8. At each station, all biological indices consistently showed exceptional quality.

Licking River
Licking River sampling conducted in 1993 and 1994 showed no significant impairment associated with the Burnham Corporation industrial discharge at RM 1.9. Fish communities were exceptional throughout the approximate six-mile stretch of the Licking between the Dillon Reservoir dam and the Muskingum River confluence in Zanesville. Macroinvertebrates improved from a fair condition immediately downstream from the dam spillway to exceptional quality upstream and downstream

from Burnham Corp. Low dissolved oxygen and elevated ammonia levels associated with the Dillon Lake hypolimnion discharge were considered the major negative influences on the macroinvertebrates.

Wakatomika Creek
Chemical and fish community data collected from six sites on the mainstem of Wakatomika Creek and four tributaries confirm that Wakatomika Creek is an exceptional and diverse stream and continues to support the Exceptional Warmwater Habitat (EWH) use designation. No water quality exceedences were noted *including those for iron concentrations*. Nutrient values were quite low and most heavy metals values were below detection levels. Treated wastewater from the village of Frazeysburg had no discernable impact on either the chemical or biological quality of Wakatomika Creek.

Mill Creek Subbasin
All streams in the Mill Creek subbasin were designated as Limited Warmwater Habitat-Mine Drainage affected in the original 1978 water quality standards. These designations were based on a limited amount of chemical and land use information and were not verified by biological sampling until the 1994 survey. Each of the five streams sampled contained at least WWH quality fish communities and, with the exception of Spoon Creek, reached exceptional quality. Outside of Spoon Creek, nonpoint source impacts appeared minimal throughout the basin.

Major Sources of Pollution and Impacts

Stone Container Corporation-Coshocton Mill (Tuscarawas River RM 1.17- 0.4)
Macroinvertebrate and fish assemblages were in FULL attainment of the designated WWH aquatic life use designation upstream and downstream from the 003 main process outfall (RM 1.04). Mixing zone sampling reflected no evidence of acute toxicity with fair to exceptional biological communities. However, the effluent was a significant source of organic enrichment. The mixing zone was the first location in the survey where masses of “sewage fungus” were observed on the natural substrates and attached to benthic organisms. These growths persisted throughout the remainder of the Tuscarawas River and were observed for about ten miles further downstream in the Muskingum River. Filter feeding midges reached peak densities downstream from the discharge even though there were indications of significant background enrichment in the lower reaches of the Tuscarawas upstream from the discharges.

In the Muskingum River, some gradual declines in biological communities were noted downstream from Coshocton between Coshocton and Dresden (Figure 1). Besides the series of point and nonpoint source discharges along the length of the upper Muskingum and enriched conditions upstream from Stone Container, slowly decaying pulp mill wastes from the cardboard manufacturer could not be ruled out as a contributing source of impact.

Water quality exceedences in the lower Tuscarawas were limited to a single concentration immediately downstream from the 003 at RM 0.8 and occasional high concentrations of iron (*i.e.*, the >5,000 mg/l agricultural water supply criterion) from RMs 3.8 to 0.3. Effluent sampling indicated the 003 discharge was a source of sulfates while mine drainage was considered the major source of excessive iron.Elevated nitrate levels were also observed throughout the study area following a heavy rainfall event on July 6 and attributed to agricultural runoff. The Coshocton Mill was also a significant additional source of suspended solids and biochemical oxygen demand. The 003 discharge enters the river through a diffuser located just under the water surface and has a

distinctive dark brown color. Under the very low flow conditions observed in 1988, discoloration of the receiving water extended well downstream from the discharge and was noticeable throughout the 111-mile length of the Muskingum River. Stone Container effluent have also been suspected of contributing to nuisance surface foaming in the Tuscarawas and Muskingum Rivers for many miles downstream from Coshocton.

Bioassay sampling conducted by Ohio EPA in 1991 showed acute and chronic toxicity associated with each Stone Container outfall (002, 003, 004). However, additional testing in 1992 and 1994 suggested a lessening of toxicity in each discharge. Numerous pesticides were detected in effluent samples used during the 1991 tests; these compounds may have contributed to the observed toxicity.

Coshocton WWTP (Muskingum River RM 108.56)
Biological communities were good to exceptional and in FULL attainment of the designated WWH aquatic life use upstream and immediately downstream from the WWTP at RMs 108.3-108.0. No significant impacts were detected during chemical or biological sampling. This stretch of the river exhibited the highest quality in the upper mainstem in 1994 and may benefit from the exceptional quality Walhonding River, which enters approximately three miles upstream. Also, improvements in effluent quality from Stone Container and the injection of oxygen in their final effluent may have contributed to improvements in Muskingum River quality near Coshocton. However, declining trends in biological communities were observed over the over the next 10 to 15 miles downstream (Figure 1) and attainment dropped to partial beginning downstream from Wills Creek.

Nutrient loadings from the Coshocton WWTP (*e.g.*, $cBOD_5$ and TSS) were fairly consistent and followed the general trend in average discharge flow, which ranged from 1.3 to 2.0 MGD over the past decade. Ammonia loadings declined sharply in 1986 and continued a general declining trend up to the present. No NPDES violations have occurred since 1992.

Four screening bioassays were conducted in 1988 and 1994 on the WWTP effluent. Acute toxicity was limited to *Ceriodaphnia* in one 1988 test. Mixing zone and receiving stream samples showed a lack of acute toxicity in all tests.

Armco Steel (Muskingum River RM 105.88)
Mixing zone sampling revealed different results between the fish and macroinvertebrates. Fish communities were in the fair range (IBI=26) but may reflect limited habitat quality near the discharge more than pollution impacts. Macroinvertebrates were in the exceptional range (ICI=46) and predominated by toxic intolerant mayflies and midge larvae (Chironomidae). No chemical exceedences associated with the discharge were detected but thin oily sheens were observed in the mixing zone during the summer sampling period. There was little indication of influence on communities outside the mixing zone. However, the discharge is located in a section of the river where some aspects of the community experienced slight but consistent declines. These included a drop in the abundance of pollution sensitive round-bodied suckers and EPT macroinvertebrate taxa collected from the natural substrates (Figure 1) and an increasing trend in the abundance of pollution tolerant common carp.

Screening bioassay results from three tests in 1989 and 1994 have shown consistent effluent toxicity to *Ceriodaphnia*; toxicity did not extend to any of the mixing zone samples. The main process outfall (601) has experienced occasional permit violations for pH, zinc, and nickel. However, loadings of monitored metals (copper and chromium) have remained consistent over the

past decade and rarely exceeded one kilogram per day.

Conesville Electric Generating Station (EGS) [Muskingum River RM 103.0]
Biological communities were in FULL attainment of the WWH aquatic life use designation upstream and 1.0-2.0 miles downstream from the Conesville EGS thermal discharge. Beginning downstream from Wills Creek, attainment status declined to PARTIAL from RMs 98.3-92.1. However, there were no obvious indications of impacts from the thermal loading. Under the low flow conditions of 1988, significant violations of the dissolved oxygen and temperature criteria were recorded by datasonde continuous monitors. In contrast, no exceedences were detected during the cooler, higher flow conditions in the summer of 1994.

Frazeysburg Wastewater Treatment Plant (Wakatomika Creek RM 12.32)
The Frazeysburg WWTP is a minor municipal WWTP with an average daily discharge of 0.142 MGD in 1994. Biological sampling in the vicinity of the plant was limited to fish collections. Communities were in FULL attainment of the existing EWH aquatic life use designation immediately upstream and 0.5 miles downstream from the Frazeysburg WWTP. Chemical water quality from a limited number of grab samples was well within applicable water quality criteria and reflected no significant impacts. The effluent was clear during visits to the plant in 1994 and typical WWTP nutrient parameters tested very low (avg. BOD_5 = 3.3 mg/l; NH_3-N = 0.32 mg/l based on July-Sept. 1994 monthly operating report (MOR) data and Ohio EPA data during 1994).

As recently as 1989, the WWTP had an extensive record of NPDES permit violations for TSS, $cBOD_5$, D.O., and fecal coliform bacteria. However, permit exceedences were nearly eliminated following a major plant upgrade in 1990. The WWTP has only recently experienced occasional violations for dissolved oxygen and suspended solids in 1993 and 1994.

Burnham Corporation (Licking River RM 1.9)
Mixing zone sampling along the south bank of the Licking River at RM 1.9 was not indicative of acutely toxic conditions; macroinvertebrates were in the fair range while fish communities were good to very good. Lack of current over the artificial substrate samplers and physical habitat conditions in the mixing zone (shallow, pooled) were considered the primary influences on performance.

CONCLUSIONS

- The Stone Container 003 main process discharge is the largest source of point source loadings for TSS and BOD_5 in the study area. TSS loads have gradually increased since 1988 while BOD_5 has experienced a gradual decline over the same period. Flows from the 003 outfall have remained consistent over the past decade. The 002 outfall discharges a much larger volume of effluent, but accounts for only a fraction of the TSS load.

- The Stone Container Coshocton Mill experienced frequent exceedences of NPDES permit limitations in 1993 and 1994. During these years, an NPDES violation, pollutant spill or plant upset occurred about once every eleven days on average. The increase in exceedences was primarily attributed to improved reporting by Stone Container and not to significant changes in plant operations.

- Tuscarawas River fish communities were in the good range but below EWH expectations at the two stations in the EWH designated segment upstream from Coshocton (RM 7.2 and RM 3.4).

Physical habitat quality as measured by the QHEI ranged from 72.0 to 76.5 and reflected habitat conditions capable of supporting communities consistent with EWH criteria. The results imply that water quality was limiting the performance of the fish community.

- In contrast to 1988 sampling, 1994 macroinvertebrate communities in the stretch from Newcomerstown to Coshocton were strongly skewed by the dense populations of the filter feeding midges of the *Rheotanytarsus exiguus* group. These larvae reached densities over 17,000 per square foot and accounted for over 70% of the total organisms from West Lafayette to Coshocton (RMs 7.1-1.3). The 1994 results suggested enriched conditions and elevated levels of suspended solids beginning upstream from Coshocton.

- The mixing zone site was the first location where extensive growths of "sewage fungus" were observed growing on substrates and some of the macroinvertebrate specimens. A major component of this growth consisted of stalked protozoan colonies (genus *Epistilus*). Some mayflies downstream from the discharge were almost completely covered with the growth, which persisted (in lesser amounts) in the Muskingum River downstream for a distance of about ten miles. The ciliated protozoans are primarily bacteriavores (Taylor and Sanders 1991, Hynes 1960), suggesting a significant bacterial component in the pulp mill effluent.

- ICI scores from the mouth of the Tuscarawas River at RM 0.3 improved in 1994 compared to collections in 1988. The 1988 ICI of 36 barely exceeded the WWH criterion (good range) while the 1994 value of 48 reflected exceptional conditions.

- With the exception of iron, chemical water quality conditions in 1994 were generally well within water quality standards throughout the study area. Periodic exceedences of the agricultural water supply criterion for iron (>5,000 mg/l) in the lower Tuscarawas River (RMs 3.8 to 0.3) and the Muskingum River downstream from the Tuscarawas River (RM 109.8) and Wills Creek (RMs 97.1 and 92.0) suggests contamination above normal background conditions. Mine drainage was a likely source of excessive iron.

- Muskingum River fish communities generally achieved the WWH biocriteria and marginally met the EWH biocriteria at RM 108.0, immediately downstream from Coshocton. The improved performance was likely aided by the high water quality of the Walhonding River that enters three miles upstream. However, fish community performance decreased progressively moving downstream, failing to meet and partially meeting WWH criteria at RMs 98.3 and 91.8, respectively.

- Muskingum River macroinvertebrate communities met or slightly exceeded exceptional levels before declining to the good range downstream from Wills Creek. Like the fish community, some aspects of the macroinvertebrate community (*i.e.*, Qualitative EPT taxa) showed a declining trend downstream from Coshocton and prior to the confluence with Wills Creek.

- Continuous monitor temperature and D.O. data from 1988, 1989 and 1994 showed much more severe D.O. and temperature extremes during the 1988 drought. All 1994 results were within applicable WWH criteria. In 1988 D.O. concentrations dropped below WWH criteria at the mouth of the Tuscarawas River downstream from Stone Container. Lowest D.O. concentrations and highest temperatures (above WWH criteria) were found downstream from the Conesville EGS and Wills Creek extended to Dresden (RMs 102-92). Improvements measured in 1994 appeared to result from the combination of higher flows and cooler

temperatures since the summer of 1988, improved management of thermal loadings from the Conesville EGS, and the injection of oxygen into the final effluent at Stone Container.

- Biological communities throughout the Walhonding River and Wakatomika Creek were consistently of exceptional quality. The majority of tributaries sampled in these basins also revealed exceptional conditions and upgrades in aquatic life use designations were recommended. All streams previously designated as Limited Warmwater Habitat contained marginally good to exceptional fish communities; mine drainage influences in these streams were generally low.

RECOMMENDATIONS

Status of Aquatic Life Uses

Several streams evaluated during this study were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Therefore, because this study represents a first use of this type of biological data to evaluate and establish aquatic life use designations, several revisions are recommended. While some changes may appear to constitute "downgrades" (*i.e.*, EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.*, LWH to WWH, WWH to EWH, etc.), any changes should not be construed as such because this represents the first use of an objective and robust use evaluation system and database. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside the WWH use before basing any permitting actions on the existing, unverified use designations. Thus, some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

The following upper Muskingum River basin segments were surveyed in 1994 and are recommended to retain their current WWH or EWH aquatic life use designations. The designations apply to the entire length of the waterbody unless otherwise indicated.

1) Tuscarawas River - Stillwater Creek to Coshocton city limits (RMs 47.0-1.9): EWH existing
   Complete biological sampling coverage with *both* fish and macroinvertebrates was limited to the lower five miles of this segment. Communities were in partial attainment of EWH, but the fish community experienced some declines compared to 1988 sampling. Because of the comparatively small sampling area the existing EWH designation should be maintained. However, the entire 45-mile stretch should be revisited and thoroughly reevaluated at the next opportunity.

2) Walhonding River - Entire length: EWH
   Full attainment of the EWH designation was recorded at each station in the lower 16.3 miles of the river. The 1994 results confirmed the trend of exceptional conditions observed during the 1988 intensive survey.

3) Upper Muskingum River - From source to Dresden (RMs 111.1-92.0): WWH existing
   Biological communities were in full or partial attainment of the designated WWH use throughout the segment. Habitat conditions were clearly capable of supporting WWH communities (mean QHEI=76.4) so the current designation is considered appropriate.

4) Licking River- Dillon Reservoir to mouth (RMs 6.2 -0.0): WWH existing

Licking River sampling in 1993 revealed non attainment of WWH criteria near the hypolimnion discharge at Dillon Dam (RM 5.5). Attainment of WWH was full at remaining downstream sites (RMs 3.6-0.8) in both 1993 and 1994. Fish communities appeared unaffected by the dam discharge and were in the very good to exceptional ranges throughout the segment. Habitat quality was also very good, averaging 77.4 at the 1993 and 1994 sites.

The WWH designation is considered most reflective of attainment potential under current conditions. The Dillon Reservoir hypolimnion discharge is considered the major limiting factor on biological community performance in the lower section. Increases in ammonia-N concentrations were observed downstream from the dam in 1993 and 1994 and ammonia-N WQS exceedences were detected in 1988 (Ohio EPA, unpublished data). Thermal stratification of the water column in the lake likely induces anoxia within the hypolimnion. Lacking dissolved oxygen, nitrogenous compounds would undergo ammonification and result in increased concentrations of ammonia discharged to the Licking River downstream (Ohio EPA 1995). Future changes in the character of the dam release could result in improved water quality conditions and result in improved biological community performance.

5) Wakatomika Creek - Fivemile Run to mouth (RMs 17.2 - 0.0): EWH existing
This lower section of Wakatomika Creek was originally designated EWH following the 1988 survey. Fish sampling in 1994 revealed FULL attainment of EWH at three stations and PARTIAL attainment at one station within the EWH segment. The EWH use designation should be retained based on the 1994 results.

Changes in the current aquatic life use designation are recommended for the following upper Muskingum River basin stream segments. The designations apply to the entire length of the waterbody unless otherwise indicated.

1) Mill Creek Subbasin (Mill Creek, Little Mill Creek, and Turkey Run): LWH existing / EWH recommended
The three streams are listed in the Ohio WQS as Limited Warmwater Habitat-Acid Mine Drainage affected. Fish sampling revealed exceptional quality communities in each stream with IBIs ranging from 48 (Mill Creek RM 8.5) to 58 (Mill Creek RM 0.7). Physical habitat quality was somewhat marginal (mean QHEI=60.8) but attainment of the fish community demonstrates the adequacy of habitats to support the EWH use designation.

2) Mill Creek Subbasin (Spoon Creek): LWH existing / WWH recommended
Spoon Creek is listed in the Ohio WQS as Limited Warmwater Habitat-Acid Mine Drainage. Mine drainage influences were evident in chemical samples with exceedences of the Public Water Supply criterion for sulfate and the Agricultural Water Supply criterion for iron detected. Fish sampling in 1994 revealed a marginally good fish community (IBI=40). Habitat conditions were somewhat marginal (QHEI=50.0) but the demonstrated attainment of the fish community implies habitats were adequate to support the WWH use designation. Therefore, WWH is considered the most appropriate reflection of aquatic life use potential in Spoon Creek.

3) Wakatomika Creek: Headwaters to Fivemile Run (RM 17.2): WWH existing / EWH recommended
This upper section of Wakatomika Creek had not been previously surveyed and retained a

WWH designation. Sampling from RM 32.0 revealed an exceptional fish community (IBI=54) and physical habitat conditions (QHEI=82.0). Based on these results, extension of the EWH designation from the lower 17.2 miles to include the entire mainstem is recommended.

4) Moscow Brook: LWH existing / WWH recommended
Moscow Brook is listed in the Ohio WQS as Limited Warmwater Habitat-Acid Mine Drainage. Fish sampling and physical habitat measurements in 1994 revealed a marginally good fish community (IBI=40) and habitat conditions adequate to support the WWH designation (QHEI=60.0). Chemical sampling revealed some elevation of parameters associated with mine drainage but impacts were not considered severe. Attainment of the biological community shows that the WWH designation is appropriate.

5) Winding Fork and Fivemile Run: WWH existing / EWH recommended
Winding Fork and Fivemile Run are tributaries of Wakatomika Creek and currently designated WWH. Both streams revealed fish communities of clearly exceptional quality (IBIs = 58 and 56, respectively) and habitat quality appropriate for EWH attainment (QHEIs = 74.5 and 75.0, respectively).

6) Brushy Fork, Bucklew Run, Big Run, Beaver Run: WWH existing / EWH recommended
These streams were sampled for fish only. Communities were in the exceptional ranges with IBIs ranging from 50 in Brushy Fork, Bucklew Run and Beaver Run to 52 in Big Run. Habitat quality was rather low and not typical of EWH designated streams (QHEIs ranged from 50.5 in Bucklew Run to 57.5 in Beaver Run). However, attainment of the fish community indicates the EWH designation is appropriate.

Status of Non-Aquatic Life Uses
No changes in existing non-aquatic life use designations are recommended.

Other Recommendations
Under the five-year basin monitoring strategy, the lower Tuscarawas and upper Muskingum Rivers are currently scheduled for monitoring during different years. Stone Container has a significant potential influence on both rivers and a complete evaluation of the EWH designated segment of the lower Tuscarawas River (from Stillwater Creek to Coshocton) is needed. Therefore, both river segments should be evaluated concurrently as one survey.

Future Monitoring Needs
Fish community health in the lower Tuscarawas River upstream from Coshocton has declined since 1988. Future surveys should reevaluate the entire EWH segment (Stillwater Creek to Coshocton) to evaluate trends and upstream conditions.

The mainstem of Wakatomika Creek should be considered for future evaluation in the normal five-year basin rotation if there is evidence of significant land use changes from urban development (*i.e.*, subdivision construction, Longaberger Basket expansion, etc.).

Several small tributaries in the Wakatomika Creek basin, including upper Mill Fork, upper Little Wakatomika Creek, lower Brushy Fork and lower Mill Fork, should be assessed for nonpoint source impacts and potential mine drainage problems during the next five-year sampling rotation.

Table 1. Aquatic life use attainment status for stations sampled in the upper Muskingum River basin based on data collected July-September, 1994. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of fish and macroinvertebrate communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI[a]	Attainment Status[b]	Comment
Tuscarawas River	*Western Allegheny Plateau- EWH Use Designation*					
-- /21.1	--	--	52	--	(FULL)	@ Newcomerstown
7.2/7.1	37*	8.6*	50	76.5	PARTIAL	Near W. Lafayette
3.4/3.8	42*	8.8*	44[ns]	72.0	PARTIAL	@ Canal Lewisville
	Western Allegheny Plateau-WWH Use Designation					
1.4/1.3	39[ns]	9.3	46	80.5	FULL	Ust. Stone Container
1.0/1.0[mz]	*40*	*7.8*	*46*	*NA*	*NA*	*003 mix zone*
0.8/0.7	42	9.1	44	77.0	FULL	Dst. Stone Container
0.3/0.3	41	8.3[ns]	48	79.5	FULL	Near mouth
Muskingum River	*Western Allegheny Plateau-WWH Use Designation*					
110.0/109.9	41	8.1[ns]	46	60.0	FULL	Ust. Coshocton WWTP
108.0	47	9.4	46	80.5	FULL	Dst. Coshocton WWTP
107.0/106.6	41	9.0	48	90.5	FULL	@ Tyndal
105.8[mz]	*27*	*7.1*	*46*	*NA*	*NA*	*Armco mix zone*
105.7/ --	42	8.7	--	79.5	(FULL)	Dst. Armco mix zone
104.8/105.0	36[ns]	8.7	50	80.0	FULL	Ust. Conesville EGS
101.6/101.9	42	8.4[ns]	48	80.0	FULL	Dst. Conesville EGS
98.3/97.1	35*	7.5*	40	78.5	PARTIAL	Dst. Wills Creek
92.2/92.1	35*	8.2[ns]	46	62.5	PARTIAL	@ Dresden
Walhonding River	*Western Allegheny Plateau- EWH Use Designation*					
16.3/15.6	53	10.4	56	83.0	FULL	@ Nellie
8.0/7.7	51	9.8	56	86.0	FULL	Ust. Killbuck Creek
1.1/0.8	49	9.7	52	83.0	FULL	Near mouth
Licking River	*Western Allegheny Plateau - WWH Use Designation*					
5.5 (1993)	46	9.7	18*	72.5	PARTIAL	Dst. Dillon Dam
3.6	45	9.8	36	81.0	FULL	@ Dillon Falls
3.4 (1993)	48	9.9	38	76.5	FULL	@ Dillon Falls
1.9/1.9 South	*41*	*9.3*	*28*	*NA*	*NA*	*Burnham Corp. mix zone*
1.7/1.9 North	47	9.0	48	78.5	FULL	Dst./Opposite mix zone
0.8	49	9.4	48	78.5	FULL	@ State Street

Table 1. (continued).

River Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI[a]	Attainment Status[b]	Comment
Wills Creek *Western Allegheny Plateau - WWH Use Designation*						
0.3/5.2	39*	8.1*	44	66.0	FULL	@ Mouth / @ Village of Wills Creek
Wakatomika Creek						
Western Allegheny Plateau- EWH Use Designation Headwaters-RM 17.2 (Recommended)						
32.0	54	NA	NA	82.0	(FULL)	@ Girlscout Camp
Western Allegheny Plateau- EWH Use Designation RM 17.2-0.0 (Existing)						
14.8	54	9.8	NA	88.0	(FULL)	Near old USGS gage
12.5	51	9.6	NA	74.0	(FULL)	Ust. Frazeysburg
11.8	54	9.8	NA	66.0	(FULL)	Dst Frazeysburg WWTP
2.1	52	9.3[ns]	NA	77.5	(FULL)	SR 60
Moscow Brook *Western Allegheny Plateau- WWH Use Designation (Recommended)*						
0.3	40[ns]	NA	NA	60.0	(FULL)	Formerly LWH
Fivemile Run *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
1.5	56	NA	NA	75.0	(FULL)	Wakatomika Cr. Trib.
Brushy Fork *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
3.5	50	NA	NA	56.0	(FULL)	Wakatomika Cr. Trib. Ust NPS (livestock)
Winding Fork *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
1.8	58	NA	NA	74.5	(FULL)	Wakatomika Cr. Trib.
Bucklew Run *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
0.1	50	NA	NA	50.5	(FULL)	Killbuck Cr. Trib.
Big Run *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
0.2	52	NA	NA	52.0	(FULL)	Killbuck Cr. Trib.
Beaver Run *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
5.0	50	NA	NA	57.5	(FULL)	Walhonding R. Trib.
Mill Creek *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
8.5	48[ns]	NA	NA	56.5	(FULL)	Formerly LWH Ust. Little Mill Creek
0.7	58	9.3	NA	61.0	(FULL)	Near mouth
Little Mill Creek *Western Allegheny Plateau- EWH Use Designation (Recommended)*						
0.1	56	NA	NA	61.0	(FULL)	Formerly LWH

Table 1. (continued).

River Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI[a]	Attainment Status[b]	Comment
Spoon Run	*Western Allegheny Plateau- WWH Use Designation (Recommended)*					
0.6	40	NA	NA	50.0	(FULL)	Formerly LWH
Turkey Run	*Western Allegheny Plateau- EWH Use Designation (Recommended)*					
0.2	50	NA	NA	65.0	(FULL)	Formerly LWH

Biocriteria: Western Allegheny Plateau (WAP)

INDEX - Site Type	WWH	EWH	MWH
IBI - Boat	40	48	24
Mod. Iwb - Boat	8.4	9.4	5.8
IBI - Headwaters	44	50	24
IBI - Wading	42	50	24
Mod. Iwb - Wading	8.4	9.4	6.2[c] 5.5[d]
ICI	36	46	22[c]

[c] - Modified Warmwater Habitat for channel modified areas
[d] - Modified Warmwater Habitat for mine affected areas

ns non-significant departure from established criteria (≤4 IBI or ICI units; ≤0.5 MIwb units).
* significant departure from WWH or EWH biocriteria (>4 IBI or ICI units; >0.5 MIwb units), values in the poor and very poor range are underlined.
a Qualitative Habitat Evaluation Index (QHEI) values based on Rankin (1989).
b Attainment status based on one organism group is parenthetically expressed.
NA Not Applicable

STUDY AREA DESCRIPTION

The Walhonding and Tuscarawas Rivers join at Coshocton to form the Muskingum River, Ohio's largest river in drainage area and miles of tributary streams. The Upper Muskingum study area includes sampling sites radiating approximately 20 miles from the junctions of the three rivers in the City of Coshocton (Figure 2). The Tuscarawas River drains approximately 2,589 square miles (Ohio DNR 1960) but the great majority of the drainage is located upstream from the 1994 sampling area. Major urban areas upstream include Barberton, Massillon, Canton, New Philadelphia, Dover and Newcomerstown. The Walhonding River drains 2,252 square miles and approximately 1500 square miles are upstream from the 1994 sampling area. While the Walhonding River is not heavily influenced by industry, the basin is more intensively farmed than the Tuscarawas. Physical characteristics and a listing of point and nonpoint sources for each watershed in the study area are listed in Table 2.

The Walhonding River is formed by the confluence of the Kokosing and Mohican Rivers in western Coshocton County, west of the City of Coshocton. Its tributaries flow easterly, through Knox, Morrow, Richland, Ashland, Wayne, Holmes, and Coshocton Counties. Major urban areas in the watershed include, Mt. Vernon, Mansfield, Ashland, Wooster, Loudonville, Salem and Millersburg. However, there are no known municipal WWTP discharges on the Walhonding River and the nearest major discharges in the watershed (i.e., > one MGD) were located 30 to 40 river miles upstream from the nearest 1994 sampling location.

The Walhonding watershed is primarily within the Erie/Ontario Lake Plain ecoregion but the mainstem is in the Western Allegheny Plateau (WAP) ecoregion. This region is a rolling glacial plateau underlain predominantly by sand and siltstones. Soils are derived mainly from glacial tills and lacustrine sediments. Maximum relief is 300 feet. Land uses are a mixture of rowcrop, pasture for beef and dairy production, poultry production, and woodland and urban areas. Cropland covers about one third of the land with interspersed pasture and woodlands. Primary crops are corn, wheat, hay and soybeans (USEPA 1987).

The Tuscarawas River arises north of Coshocton in the Portage Lakes region on the south side of Akron. Tributaries flow through Holmes, Wayne, Summit, Stark, Carroll, Tuscarawas, and Coshocton Counties. Excepting Stone Container Corp., the heaviest concentrations of major municipal/industrial discharges are found in the middle and upper basin, primarily in Summit and Stark Counties. Major impoundments include Beach City Reservoir and the series of Muskingum Conservancy District flood control reservoirs along the eastern edge of the watershed which form Atwood, Leesville, Tappan, Clendening and Piedmont Lakes.

The upper reaches of the Tuscarawas are in the Erie/Ontario Lake Plain Ecoregion, but most of the watershed is located in the northern portion of the Western Allegheny Plateau (WAP). The WAP has a more rugged, unglaciated terrain with local relief up to 500 feet. The underlying strata are made of sandstone, siltstone, shale, and limestone. Soils are from these same materials with some isolated loess soils. Coal, oil and gas deposits are found in much of this region.

Extraction of coal, oil, and gas has had and continues to have, a major effect on the ecology and culture of the region. Steep slopes in the region limit crop and cattle production to valley floors that reduces riparian corridors and concentrates animal wastes near stream. Cattle are given free access to streams resulting in increased sedimentation and direct nutrient loading. Timber harvesting contributes sediment loading to the streams.

The Licking River has a drainage of 779 miles and is the fourth largest direct tributary to the Muskingum River. The mainstem is 30.2 miles in length but the 1994 survey was limited to the lower six miles from Dillon Reservoir to the confluence in Zanesville. This section of the river is located in the unglaciated Western Allegheny Plateau ecoregion. The physiography of this area consists of a dissected plateau comprised of horizontally bedded sandstone, siltstone, shale, and limestone, and is characterized by steeper, more rugged terrain than other ecoregions within Ohio (Whittier *et. al.* 1987). Given the generally poor condition of the soils and the highly dissected relief, agriculture is not as prevalent within the WAP as other ecoregions in Ohio (Whittier *et. al.* 1987). Landuse downstream from the Dillon Reservoir becomes increasingly urbanized as the lower 1-2 river miles flow through the western Zanesville.

The Wakatomika Creek watershed has 234 square miles of drainage area and originates near Newcastle in Coshocton county, flowing 42.6 miles generally southwest, south then southeast to enter the Muskingum River at Dresden. The basin is glaciated and valleys are fairly wide with ridge systems of moderate to severe slope. The uppermost quarter of the watershed is quite flat to rolling topography and highly agricultural. The segment downstream of Bladensburg, in extreme northeast Licking county, is characterized by steep ravines, relict hemlock forest, rock outcrops and boulder/bedrock stream substrates. The remaining lower half of the watershed is also agricultural and consists largely of row crop corn, soy beans, hay fields and fenced pasture. Soil types within the basin are Coshocton-Westmoreland-Keene silt-loam association and Glenford-Newark-Fitchville silt-loam association. The former type is found on the hillsides and steep slopes of the basin and is deep and moderately well drained. The latter soil type is also deep and moderately well drained but is somewhat more fertile than the Glenford association type.

The Mill Creek subbasin and Beaver Run are Walhonding River tributaries (Figure 2, Table 2). Bucklew Run and Big Run are located in the lower reaches of Killbuck Creek, which enters the Walhonding River at RM 7.32 (Figure 2, Table 2).

Table 2. Stream characteristics and significant identified pollution sources in the upper Muskingum River study area.

Stream Name	Length (Miles)	Tributary Length (Miles)	Gradient (Ft/Mi.)	Drain. Area (Sq. Mi.)	Identified NPS Pollution Categories	Point Sources Evaluated
Tuscarawas R.	129.9	3,983	3.1	2589.7	Agriculture Silviculture	Stone Container
Walhonding R.	23.5	2,457	4.2	2252	Agriculture Silviculture Mineral extraction	--
Muskingum R.	111.1	10,739	1.3	8037.6	Agriculture Silviculture Urban runoff Mineral extraction	Coshocton WWTP Armco Steel Conesville EGS
Licking River*	30.2	--	9.1	779.0	Agriculture Urban Runoff	Burnham Corp.
Wakatomika Cr.	42.6	90	9.3	234	Agriculture Oil & Gas prod. Mineral extraction	Frazeysburg WWTP
Fivemile Creek	6.1	--	37.7	12.5	Agriculture Oil & Gas Prod.	--
Brushy Fork	8.3	--	31.9	27.7	Ag. (livestock) Oil & Gas Prod.	--
Winding Fork	8.0	--	23.6	21.3	Oil & Gas Prod.	--
Moscow Brook	6.3	--	53.9	7.1	Mineral extraction	--
Mill Creek	16.3	20	15.9	51.2	Agriculture Oil & Gas prod. Mineral extraction	--
Spoon Creek	4.7	--	61.9	8.2	Ag. (livestock) Mineral extraction	--
Turkey Run	2.4	--	41.7	6.0	Ag. (livestock) Mineral extraction	Stone Cont. Landfill
Little Mill Creek	5.4	--	39.3	8.7	Agriculture Oil & Gas prod. Mineral extraction	--
Beaver Run	8.1	--	46.8	13.8	Agriculture	--
Bucklew Run	3.9	--	26.4	8.08	Ag. (livestock)	--
Big Run	6.4	--	29.2	11.8	Ag. (livestock)	--

* 1994 sampling in the Licking River was limited to the lower six miles of the mainstem, from Dillon Reservoir to the mouth.

METHODS AND MATERIALS

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. Chemical, physical and biological sampling locations are listed in Table 3.

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 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 *et al.* 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is FULL if all three indices (or those available) meet the applicable biocriteria, PARTIAL if at least one of the indices does not attain and performance 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.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. During the present study, macroinvertebrates collected from the natural substrates were also assessed using a new index 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 upper Muskingum River study area, the median tolerance value of all organisms from a site resulted in a score termed the Qualitative Community Tolerance Value (QCTV). The QCTV shows potential as a method to supplement existing assessment methods using the natural substrate collections. QCTV scores for sampling locations in the study area were used in conjunction with other aspects of the community data to make evaluations and were not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Fish Community Assessment

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

Area of Degradation Value (ADV)

An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1995) was calculated for the study area based on the longitudinal performance of the biological community indices. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance (Figure 3). The "magnitude" of impact refers to the vertical departure of each index below the biocriterion or the upstream level of performance. The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile. The results are also expressed as ADV/mile to normalize comparisons between segments and other streams and rivers.

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 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 1995a) 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.

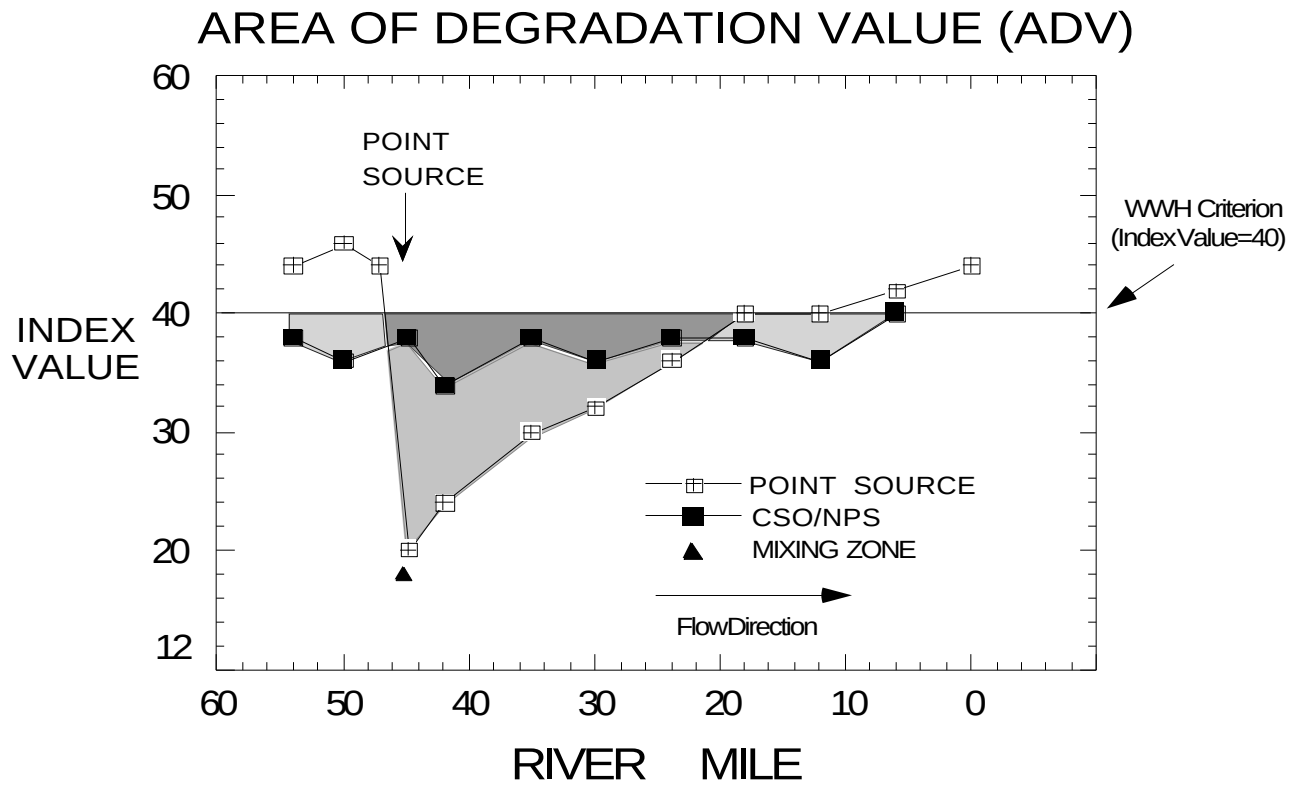

Figure 3. Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle); the filled boxes and dashed shading (area of departure) represent a typical response to a nonpoint source or combined sewer overflow impact. The blended shading represents the overlapping impact of the point and nonpoint sources.

Table 3. Sampling locations in the Upper Muskingum study area, 1994 (E - effluent sample, C - water chemistry, S - sediment contaminants, M - macroinvertebrates, F - fish, FT - fish tissue, D- datasonde/continuous monitoring).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Tuscarawas River				
21.2	C	40 15 41 / 81 36 33	River Street	Newcomerstown
21.1	M	40 15 40 / 81 36 40	River Street	Newcomerstown
10.7	C	40 17 30 / 81 36 40	River Street	Newcomerstown
7.2	F, FT	40 17 34 / 81 45 00	US 36 adj Co Rd 116	Coshocton
7.1	M	40 17 29 / 81 47 49	US 36 adj Co Rd 116	Coshocton
3.8	C,M	40 17 54 / 81 49 49	@ Canal Lewisville	Coshocton
3.4	F, FT	40 17 48 / 81 50 14	@ Canal Lewisville	Coshocton
1.4	F	40 16 52 / 81 51 15	Ust. Stone Container	Coshocton
1.3	M,D	40 16 52 / 81 51 28	Ust. Stone Container	Coshocton
1.17	E	40 16 53 / 81 51 32	Stone Container 002	Coshocton
1.1	D	40 16 53 / 81 51 36	Dst. Stone Container 002	Coshocton
1.04	E	40 16 53 / 81 51 40	Stone Container 003	Coshocton
1.0	M,F	40 16 55 / 81 51 44	Stone 003 Mix Zone	Coshocton
0.95	D	40 16 55 / 81 51 49	Dst. Stone Container 003	Coshocton
0.8	C,F, FT,D	40 17 00 / 81 51 59	Dst. Stone Container	Coshocton
0.7	M	40 16 58 / 81 52 00	Dst. Stone Container	Coshocton
0.3	C,M, F, FT	40 16 44 / 81 52 14	2nd Street Bridge	Coshocton
Walhonding River				
16.3	F	40 20 39 / 82 04 30	@ Nellie	Warsaw
15.7	C	40 20 29 / 82 03 56	@ Nellie	Warsaw
15.6	M	40 20 27 / 82 03 21	@ Nellie	Warsaw
8.0	F	40 19 41 / 81 57 03	US 36, ust. Killbuck Creek	Randle
7.7	M	40 19 06 / 81 56 47	US 36, ust. Killbuck Creek	Randle
7.5	C	40 19 38 / 81 56 35	US 36, ust. Killbuck Creek	Randle
1.1	F	40 17 13 / 81 52 30	US 36 @ Roscoe Village	Coshocton
0.8	C,M,D	40 17 20 / 81 52 14	US 36 @ Roscoe Village	Coshocton
Muskingum River				
110.0	F	40 15 39 / 81 52 20	Ust.Coshocton WWTP	Coshocton
109.9	M	40 15 35 / 81 52 17	Ust.Coshocton WWTP	Coshocton
109.8	C	40 15 28 / 81 52 13	Ust.Coshocton WWTP	Coshocton
108.56	E	40 14 22 / 81 52 23	Coshocton WWTP 001	Wills Creek
108.3	C,D	40 14 02 / 81 52 16	SR 83	Wills Creek
108.0	M, F	40 13 56 / 81 52 10	Dst. SR 83	Wills Creek
107.0	F	40 13 27 / 81 52 35	Ust. Tyndal	Wills Cr. /Conesville
106.6	M	40 13 15 / 81 52 51	@ Tyndal	Conesville
106.4	C	40 13 06 / 81 52 49	@ Tyndal	Conesville
106.1	D		@ Tyndal	Conesville
105.88	E	40 12 39 / 81 52 42	Armco Outfall	Conesville
105.8	F, M	40 12 32 / 81 52 40	RR trestle, Armco Mix	Conesville

Table 3. (continued).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Muskingum River (continued)				
105.7	F, FT	40 12 31 / 81 52 39	Dst. Armco Mix Zone	Conesville
105.0	M	40 11 58 / 81 52 19	End of T-279	Wills Creek
104.8	F	40 10 47 / 81 52 27	Dst. T-279	Wills Creek
103.5	C,D	40 11 16 / 81 53 17	@ Conesville	Wills Creek
102.8	D	40 10 44 / 81 52 54	@ Conesville EGS Mix Zone	Wills Creek
101.9	M	40 10 04 / 81 53 05	Dst. Cones. EGS @ T-263	Conesville
101.8	C,D	40 09 59 / 81 53 15	Dst. Cones. EGS @ T-263	Conesville
101.6	F	40 09 56 / 81 53 30	Dst. Cones. EGS @ T-263	Conesville
98.3	F	40 08 40 / 81 55 58	Ust. Stillwell Road	Conesville
97.1	C,M,D	40 08 40 / 81 59 15	Stillwell Road	Conesville
92.2	F	40 07 25 / 82 00 00	Ust. SR 208	Trinway/Dresden
92.0	C,M,D	40 07 14 / 82 00 00	SR 208	Dresden
Conesville EGS Effluent Channel (RM 102.89)				
0.02	D	40 11 16 / 81 53 17	@ Conesville EGS	Wills Creek
Wills Creek				
5.25	C	40 10 39 / 81 51 03	@ Wills Cr. Dam Rd.	Wills Creek
5.2	M	40 10 43 / 81 51 05	@ Wills Cr. Dam Rd.	Wills Creek
1.75	D	40 09 31 / 81 53 29	Near mouth	Conesville
0.3	F	40 09 23 / 81 54 12	@ Mouth	Conesville
Licking River				
3.7	C	39 58 14 / 82 05 24	@ Dillon Falls	Zanesville West
3.6	D,M, F	39 58 13 / 82 03 24	@ Dillon Falls	Zanesville West
1.9 S	E	39 57 19 / 81 02 00	Burnham 005 Effluent	Zanesville West
1.9 S	M,F	39 57 24 / 82 02 01	Burnham Corp. Mix Zone	Zanesville West
1.9 N	M		Opposite Burnham Mix Zone	Zanesville West
1.7	C,F	39 57 16 / 81 01 46	Dst. Burnham Mix Zone	Zanesville West
0.8	M, F	39 56 47 / 82 01 29	Ust. State Street	Zanesville West
0.6	D,C	39 56 32 / 82 01 25	Ust. State Street	Zanesville West
Wakatomika Creek				
32.0	C,F	40 14 18 / 82 15 04	Near Camp Wakatomika	Hickman
14.8	C,F	40 07 52 / 82 08 49	Near USGS Gage	Perryton
12.5	C,F	40 06 30 / 82 07 41	SR 586	Toboso
11.8	C,F	40 06 34 / 82 07 07	@ end of Narrows Rd.	Dresden
2.1	F	40 08 00 / 82 01 38	SR 60	Trinway
1.9	C	40 07 57 / 82 01 38	SR 60	Trinway
Fivemile Run				
1.5	C,F	40 09 50 / 82 07 40	Adj. CR 80	Perryton
Winding Fork				
1.8	C,F	40 13 34 / 82 09 53	SR 79	Perryton
Brushy Fork				
3.5	C,F	40 07 55 / 82 12 35	Ust. Priest Run	Perryton

Table 3. (continued).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Moscow Brook				
0.3	C,F	40 11 32 / 81 58 57	SR 60	Trinway
Bucklew Run				
0.1	F	40 19 56 / 81 56 48	T-28	Randle
Big Run				
0.2	F	40 26 06 / 81 58 26	SR 60	Killbuck
Beaver Run				
5.0	F	40 22 27 / 82 03 19	T-341	Warsaw
Mill Creek				
8.5	C,F	40 22 03 / 81 51 20	CR 12 & T-206	Randle
0.7	F	40 17 55 / 81 52 21	Adj. SR 83	Randle
0.4	C	40 17 49 / 81 52 20	Adj. SR 83	Randle
Spoon Creek				
0.6	C,F	40 19 36 / 81 50 49	CR 193	Randle
Little Mill Creek				
0.7	C	40 21 37 / 81 50 52	SR 643	Randle
0.1	F	40 22 00 / 81 51 31	SR 643	Randle
Turkey Run				
0.2	C,F	40 21 39 / 81 52 16	CR 12	Randle

RESULTS AND DISCUSSION

Pollutant Loadings: 1984-1994

For the purpose of comparing source data and loadings over the past ten-year period, the fiftieth percentile for annual loadings (as kg/day) will be the figures discussed in the following section.

Stone Container Corporation

The Coshocton Mill produces approximately 850 tons of brown paper per day. The final product, corrugation medium, is shipped for further processing into cardboard. The wastewater goes through a primary clarifier and the supernatant is sent to two aeration stabilization basins. It is then sent to a series of two secondary clarifiers. Oxygen is added to the effluent to attain the minimum dissolved oxygen requirement and discharged via the 003 outfall to the Tuscarawas River. Solids are removed throughout the process and blended with wasted fiber or paper stock. This is added to natural gas and burned in their boiler as a power source for the facility.

High BOD and COD levels are usually associated with pulp mill effluents, and are the focus of effluent treatment in the paper mill industry (Norton 1991, 1992; Srinivasan 1994). Dissolved oxygen measurements were well within WWH criteria at all stations sampled (see Water Chemistry section), indicating that any negative effects of high BOD/COD on dissolved oxygen associated with the Stone Container effluents were not manifest in the study area. Toxicity of pulp mill effluents is traditionally associated with organochlorines (Kovacs 1986, Crooks and Sikes 1990, Karås et al. 1991), however, Stone Container does not employ bleaching in its pulping process. Resins and fatty acids are a component of unbleached effluents that can be toxic. Resins are only a significant component of effluent when pine is the primary raw material, but Stone Container primarily uses hardwoods. Fatty acids, though toxic, are generally toxic when concentrations exceed 1000 µg/L. Fatty acid concentrations in raw, undiluted, kraft mill effluents are reported between <20-9300 µg/L (Crooks and Sikes 1990).

Stone Container has three outfalls (002, 003, and 004) of which only two (002 and 003) were evaluated for this survey.

- Recent improvements at the plant include the elimination in 1993 of stormwater discharges from the waste paper storage area (006) and the wood yard storage area (005). An oxygen system has been added at the 003 effluent after treatment and prior to discharge to increase dissolved oxygen levels.

- **002**- (RM 1.17) Flow at the 002 outfall for the years 1985 to 1988 had a downward trend from approximately 6.4 million gallons per day (MGD) to 5.2 MGD (Figure 4). From the period 1988 to 1994 the flows have increased to the original levels of 1985 (6.4 MGD).

- Total Suspended Solids (TSS) at this outfall showed a trend similar to flow with a low in 1989 of about 50 kg/day to the 1994 value of slightly over 100 kg/day.

- Five-day Biochemical Oxygen Demand (BOD_5) at this outfall progressively decreased from 1000 kg/day to 100 kg/day between 1984 and 1994.

- **003**- (RM 1.04) Flow at the 003 outfall increased between 1984 and 1988 from 1.85 to 2.05 MGD. From 1988 to 1994 the flow declined slightly in the first two years (1989 and 1990) and has been constantly near 2.0 MGD since 1991.

- The TSS loadings trend has been erratic from 1984 through 1989. Since 1989 the loadings have stabilized near 3000 kg/day. BOD_5 loadings, similar to TSS, were erratic from 1984 to 1989. Since 1989 there has been a general downward trend from 1600 kg/day to 900 kg/day in 1994.

- Bioassay testing conducted by Ohio EPA in 1991 revealed significant toxicity (acute and chronic) associated with the Stone Container 002, 003, and 004 discharges (Table 4.). Toxicity was detected in each organism group tested (fish, macroinvertebrate, algae) but was mostly limited to effluent and near-field mixing zone samples. Chemical analysis of the effluents was made in conjunction with the bioassays and numerous pesticides and pesticide metabolites were detected (Table 5); many pesticide concentrations in 1991 were well in excess of water quality standards. Additional bioassay testing in 1992 indicated a reduction in toxicity in the 002 and 004 effluent, and 1994 tests revealed a lack of acute toxicity in all but the 004 discharge (*Ceriodaphnia* only). Fewer pesticides were detected in 1992 and 1994 and concentrations were generally from one to three orders of magnitude lower by 1994 (Table 5).

Table 4. A summary of bioassay results conducted by Ohio EPA on Stone Container Corporation 002, 003, and 004 effluent, 1991-1994. Acute (Ac) toxicity is defined as >20% mortality within 48 hours of commencement of testing. Chronic (Chron) toxicity is defined as >20% mortality within 96 hours of commencement of testing. Test organisms included fathead minnow (fish), *Ceriodaphnia dubia* (Daphnia), and the algae *Selanastrum capricornutum*.

Year	1991						1992						1994					
Outfall	002		003		004		002		003		004		002		003		004	
Toxicity	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron	Ac	Chron
Effluent																		
Fish	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--	No	--	No	--	No	--
Daphnia	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	No	--	**Yes**	**Yes**	No	--	No	--	No	--	**Yes**	--
Algae	--	--	**Yes**	**Yes**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mixing Zone (near field)																		
Fish	**Yes**	**Yes**	--	--	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--	No	--	No	--	No	--
Daphnia	No	**Yes**	--	--	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--	No	--	No	--	No	--
Algae	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mixing Zone (far field)																		
Fish	No	No	**Yes**	No	No	No	No	--	No	No	No	--	No	--	No	--	No	--
Daphnia	No	No	No	No	No	No	No	--	No	No	No	--	No	--	No	--	No	--
Algae	--	--	No	No	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tuscarawas River Control																		
Fish	No	No	No	No	No	No	No	--	No	No	No	--	No	--	No	--	No	--
Daphnia	No	No	No	No	No	No	No	--	No	No	No	--	No	--	No	--	No	--
Algae	--	--	No	No	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5. Concentrations of pesticides (in ug/l) from Stone Container Corp.-Coshocton Mill effluents in 1991, 1992 and 1994 bioassay tests. Only results above detection limits are reported; all other parameters listed were not detected (ND).

Year	1991		1992	1994	Water Quality
Outfall	002	003	003	003	Standard[a]
Parameter					
a-BHC	ND	**0.184**	ND	**0.010**	--
b-BHC	ND	**0.049**	ND	ND	--
y-BHC	**0.057**	**0.055**	ND	ND	--
d-BHC	ND	**0.061**	ND	**0.006**	--
Aldrin	**0.034**	**0.016**	ND	ND	0.01
Heptachlor epoxide	ND	**0.077**	ND	**0.009**	0.1[b]
Endosulfan I	**0.089**	**0.150**	ND	**0.007**	--
4,4'-DDE	ND	**0.111**	**0.031**	ND	--
Dieldrin	**0.039**	ND	ND	**0.004**	0.005
Endrin	**0.037**	ND	**0.025**	**0.004**	--
Endosulfan II	ND	**0.096**	ND	ND	--
4,4'-DDD	**0.031**	ND	ND	ND	--
Endosulfan Sulfate	**0.034**	**0.152**	ND	ND	0.003
4,4'-DDT	**0.032**	ND	ND	ND	--
Methoxychlor	**0.019**	**0.072**	ND	ND	0.005
Mirex	ND	**0.076**	ND	ND	0.001

[a] Standards listed are for Outside Mixing Zone - 30 day average unless otherwise indicated.

[b] Public Water Supply criterion.

- Bioassay testing conducted by Stone Container in June, July and August of 1991 also reported acute and chronic toxicity in some 002, 003 and 004 effluent tests (Ohio EPA file data). Unlike Ohio EPA results, Stone Container also reported toxicity in the upstream control (Tuscarawas River water) in the July test.

Coshocton WWTP

- The plant was originally constructed in 1951 with an average daily flow capacity of 2.5 MGD and a peak flow of 6.0 MGD. In 1967 three new primary settling tanks, a new trickling filter, three new final settling tanks, a secondary digester, chlorination equipment and mechanical bar screen/grit removal equipment were added. This increased the capacity to 4.4 MGD average daily flow and 10.6 MGD peak flow.

- Considerable renovation work over the past few years has included tank and digester improvements, replacement of sludge drying beds, improvements to chlorination processes, and the addition of dechlorination equipment. The current treatment system involves mechanical primary treatment, trickling filter secondary treatment, final settling, chlorination and dechlorination prior to its discharge into the Muskingum River at RM 108.56.

- Flows have been somewhat erratic over the past ten years. A precipitous drop occurred between 1985 and 1986 (from 2.3 to 1.35 MGD) before gradually increasing to 1.8 MGD in 1988. Flows again dropped 1.3 MGD by 1992, then gradually increased to 2.0 MGD by 1994 (Figure 5).

- Loadings of carbonaceous five-day biochemical oxygen demand ($cBOD_5$) and suspended solids have been relatively stable since 1985 but have generally followed the trend in flow (Figure 5). Following a severe drop in 1986, ammonia loadings have experienced a general declining trend from 1986 through 1994 (Figure 5).

- The Coshocton WWTP has had no NPDES permit violations between December 1992 and the present.

- Results of four screening bioassay tests conducted in 1988 and 1994 show acute toxicity was limited to *Ceriodaphnia* in one 1988 effluent test. Mixing zone and Muskingum River control samples were not acutely toxic to test organisms.

Armco Steel

- Armco, Coshocton Stainless was formerly known as Cyclops Industries Inc., Coshocton Stainless Division. The company receives and processes coiled steel using various procedures that include annealing, pickling, cold rolling and alkaline cleaning.

- Process wastewater is discharged from the treatment facility that includes neutralization and settling via the 601 station (1.1 MGD). The 602 station consists of sanitary wastewater (approximately 0.020 MGD) treated by extended aeration, settling and chlorination. This combined with non-contact cooling water and any stormwater run-off make up the 001 discharge (1.2 MGD) to the Muskingum River at RM 105.88.

- There have been occasional violations of the NPDES permit for the treatment plant (601) discharge for pH, zinc and nickel.

- Loading trends over the past years have been consistent for the heavy metals monitored at the plant. These values have been near 0.5 kg/day (Figure 6).

- Three screening bioassay tests conducted by Ohio EPA in 1989 (one test) and 1994 (two tests) have consistently revealed acute toxicity to*Ceriodaphnia* in effluent samples. Mixing zone and Muskingum River control samples were not acutely toxic to test organisms.

Conesville EGS

- The Conesville Electric Generating Station (EGS) is a coal fired 2000 megawatt steam turbine electric generating facility. There are six generating units. The facility uses 3.6 million tons of coal per year.

- The facility has one major outfall (001) which discharges approximately 220 MGD consisting mainly of non-contact cooling water. The 601 station holding pond discharges 20 MGD to 001. The 602 and 607 stations are sewage treatment plants (combined flow 0.012 MGD) which discharge to 001. The 002 outfall is a small discharge of stormwater run-off. The 001 outfall discharges to the Muskingum River at RM 102.89.

- After stream temperature and dissolved oxygen violations were detected during the 1988 drought, Ohio EPA and American Electric Power negotiated a thermal load management plan for the Conesville EGS. Under this permit, receiving stream temperatures are calculated using a formula based on electrical production (in BTUs) and stream flow. Using these limits, Muskingum River temperatures from May through October cannot exceed a 7-day rolling average of 86.5^{o} F., a one-day average of 89^{o} F., or an instantaneous maximum of 92^{o} F. Exemptions are allowed for short durations if followed by prescribed cool down periods.

- The cooling water effluent was not acutely toxic to test organisms in a 1994 Ohio EPA bioassay. Mixing zone and control sampling also revealed a lack of toxicity in the vicinity of the discharge.

Burnham Corporation

- The company produces gray and ductile castings and moldings predominantly from scrap metal. The final products include manifolds, boilers and radiators. The average production is 415 tons per month. Burnham Corporation has nine outfalls that discharge to the Licking River between RMs 2.0 and 1.9. Outfalls 001, 002, and 004 are non-contact cooling water with a combined flow of 0.70 MGD. Outfall 003 is a sanitary extended aeration plant discharging 0.017 MGD. Outfall 005 is the main process outfall at RM 1.90 and the only station sampled for this survey. The treatment system consists of oil-water separation, chemical conditioning, clarification and recycling of some water. The average discharge is 0.024 MGD. Outfalls 008-011 are stormwater discharges which include roof runoff. Due to limitations in the 005 database and the small volume of the discharge, loadings trends were not produced for this report.

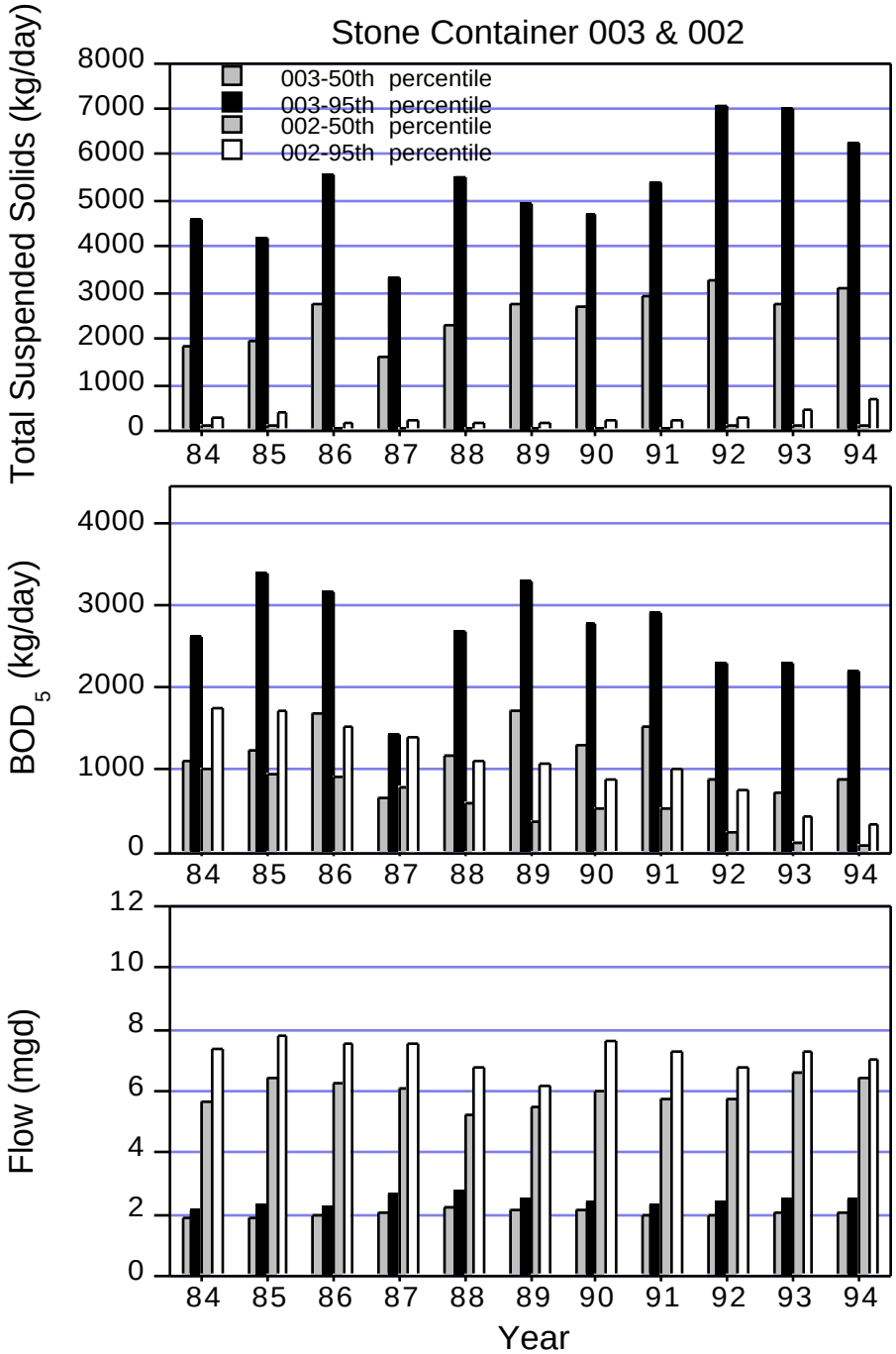

Figure 4. Mean annual flow (MGD) and loadings (kg/day) of Total Suspended Solids (TSS), and Five-day Biochemical Oxygen Demand (BOD_5) at the Stone Container Corp. 002 and 003 discharges in the upper Muskingum River study area, 1984-1994.

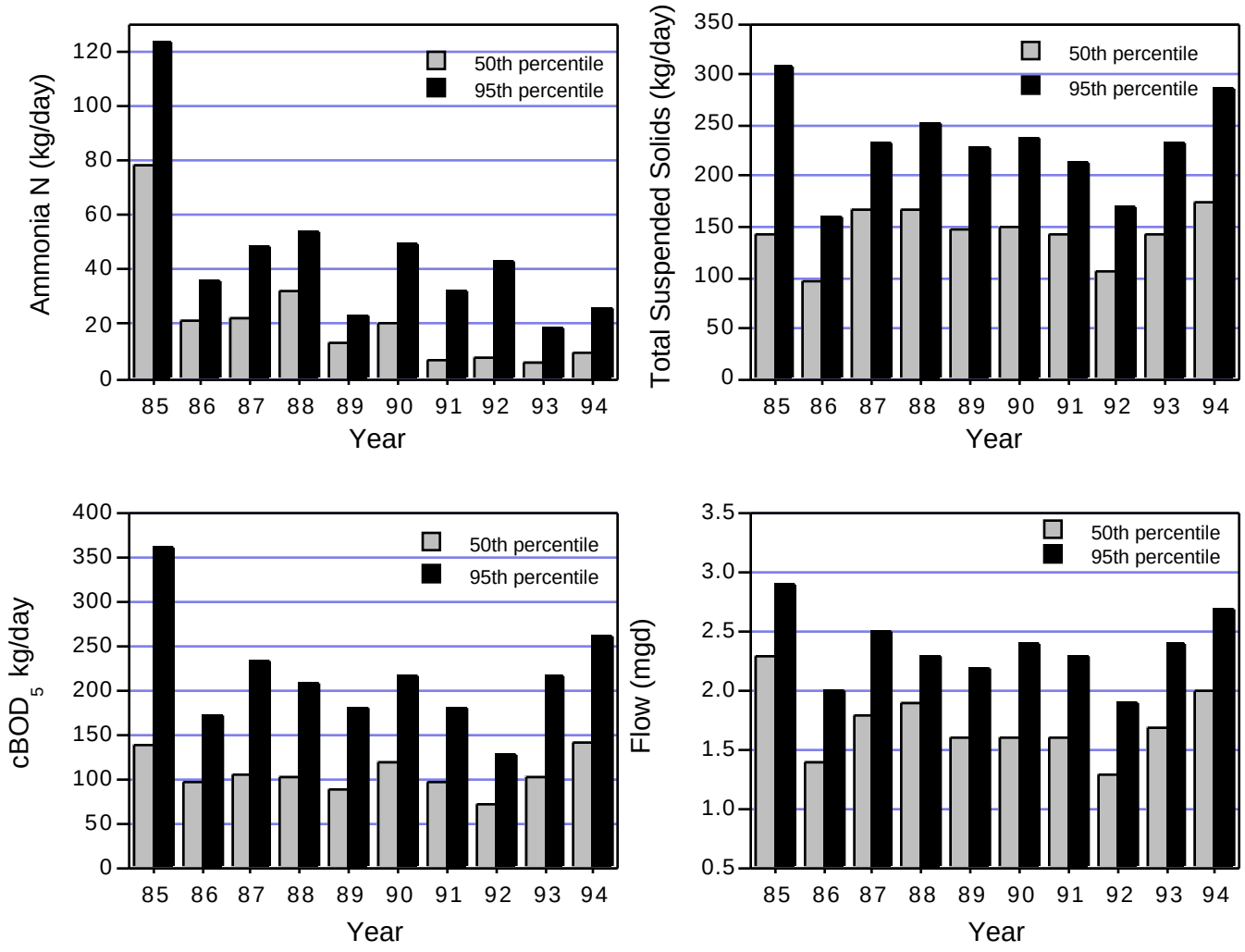

Figure 5. Mean annual flow (MGD) and loadings (kg/day) of Ammonia, Total Suspended Solids (TSS), and Carbonaceous Five-day Biochemical Oxygen Demand ($cBOD_5$), at the Coshocton WWTP in the upper Muskingum River study area, 1985-1994.

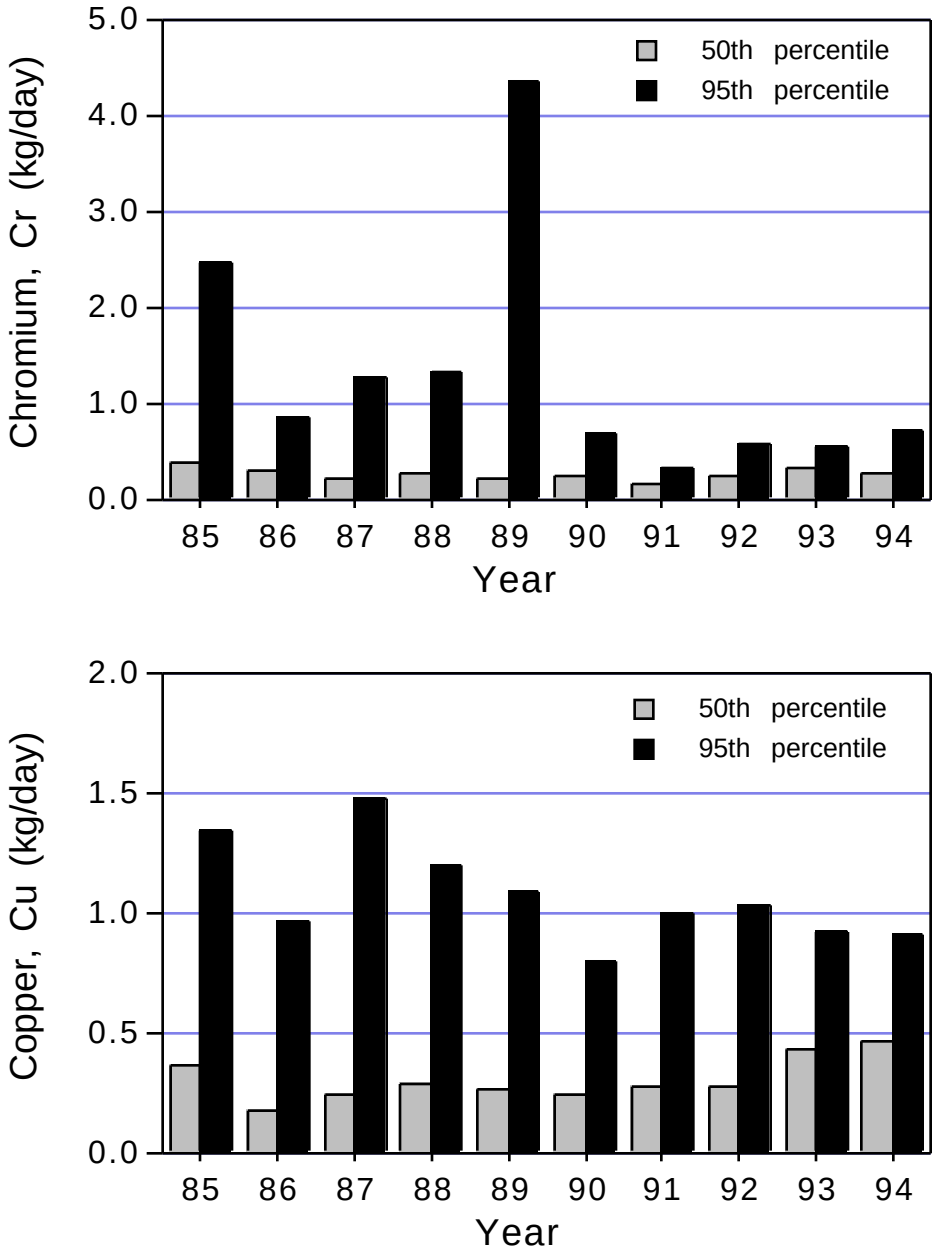

Figure 6. Annual loadings (kg/day) of total copper (Cu), and chromium (Cr), at the Armco Steel 005 discharge in the upper Muskingum River study area, 1985-1994.

NPDES Compliance History: 1983-1994

Stone Container Corporation

- A total of 44 NPDES permit violations were recorded from outfalls at the Stone Container Coshocton Mill from 1988 through 1994 (Table 6). The largest number of violations occurred in 1993 (29) and 1994 (9). TSS was most often in violation (18 occasions), followed by BOD_5 (10), pH (8), copper (5), cyanide (2), and zinc (1). Before its elimination in August 1993, most violations occurred at the 006 waste paper storage stormwater discharge and primarily involved BOD_5. Since then, the 003 process waste discharge was most often in violation, principally for excessive discharges of suspended solids.

- Upsets and spills have been an historical problem at the facility and are currently a major source of exceedences. Table 7 presents a narrative list of unauthorized discharges and upsets from the Stone Coshocton Mill to the Tuscarawas River.

Table 6. A list of NPDES permit effluent violations from Stone Container Corporation (Coshocton Mill, 0IA00005*HD) from 1988 to the present.

Year Outfall Number	Date (Month/Year) of Violation	Parameter Violated	Value Reported	Units	Permit Limitation
1988					
Combined	1/20/88*	BOD_5	8,602	kg/d	6,398
1991					
004	2/91*	pH	4.4-10.5	SU	6.0-9.0
004	2/91	TSS	242	mg/l	70
1992					
003	5/92+	TSS	5,620	kg/d	4,045
006	11/92	BOD_5	47	mg/l	45
006	11/92+	BOD_5	41	mg/l	30
1993					
006	1/93+	BOD_5	32.9	mg/l	30
006	1/93+	TSS	40.5	mg/l	30
006	3/93	BOD_5	49.2	mg/l	45
006	3/93+	BOD_5	39.3	mg/l	30
006	3/93+	TSS	58	mg/l	30
006	3/93	pH	10.2	SU	9.0
006	4/93	BOD_5	72	mg/l	45
006	4/93	BOD_5	83	mg/l	45
006	4/93+	BOD_5	77	mg/l	30
002	5/93	pH	9.7	SU	9.0
006	5/93+	BOD_5	37.6	mg/l	30
006	6/93+	TSS	55.4	mg/l	30
004	7/93	pH	9.1	SU	9.0

Table 6. (continued).

Outfall Number	Date (Month/Year) of Violation	Parameter Violated	Value Reported	Units	Permit Limitation
1993 (continued)					
006	7/93	pH	9.8	SU	9.0
006	7/93	TSS	80.5	mg/l	45
006	7/93+	TSS	43.0	mg/l	30
003	8/93+	TSS	4,539	kg/d	4,500
004	8/93	TSS	81	mg/l	70
003	9/93+	TSS	5,510	kg/d	4,500
003	10/93	CN	0.27	mg/l	0.09
003	10/93	CN	1.89	kg/d	0.092
003	11/93	TSS	9,244	kg/d	9,000
003	11/93	TSS	13,120	kg/d	9,000
003	11/15/93*	TSS	12,128	kg/d	9,000
003	11/15/93	TSS	15,865	kg/d	9,000
003	11/93+	TSS	6,743	kg/d	4,500
003	11/93*	ZN	7.48	kg/d	4.95
003	11/93*	CU	1.19	kg/d	0.93
004	12/93	TSS	98.1	mg/l	70
1994					
003	4/21/94	CU	420	ug/l	120
003	4/21/94	CU	3.04	kg/d	0.93
002	7/21/94	pH	9.3	SU	6.5-9.0
002	7/27/94	pH	6.3	SU	6.5-9.0
002	8/22/94	pH	6.26	SU	6.5-9.0
003	8/29/94	TSS	9,336	kg/d	9,000
003	9/94	TSS	5,434	kg/d	4,500
003	11/16/94	CU	180	ug/l	120
003	11/16/94	CU	1.2	kg/d	0.93

* OEPA monitoring
\+ Monthly average

Table 7. A list of unauthorized discharges and upsets from Stone Container Corporation (Coshocton Mill, 0IA00005*HD) from 1983 to the present.

Date (Month/Year) of Violation	Description of Violation
2/23/83	Collapse of 700,000 gallon heavy liquor tank February 23; release of 400,000 gallons heavy liquor. A nearby weak liquor tank was damaged releasing 130,000 gallons of weak liquor to river. Both releases were via outfalls 002 and 004. Contributed to violations at 003. One million gallons spilled.
9/30/83	Switch failure at primary clarifier; caused overflow of 294,000 gallons primary effluent to 004 in October (BOD 2100 mg/l, TSS 290 mg/l). No related permit limit violations.
9/84	Pump blockage caused release of primary effluent to 004. Contributed to BOD_5 violation.
9/85	Sodium carbonate tank leak to 004; caused pH limit violation.
7/9/86	Evidence wood chips had been washed into river observed by Lecznar. Reported in letter 8/12/86, not corrected as of 10/86.
12/23/87	Sludge line failed grounding out clarifier sludge pumps during OEPA sampling visit. OEPA measured TSS violations. Stone claims OEPA samples invalid in 12/29/87 letter.
1/20/88	156,000 gallons primary clarifier effluent released to 004 and observed during OEPA visit. Contributed to BOD_5 violation.
2/6/90	High water and pipe obstruction caused clarifier backup. Stone installed bypass line, observed during OEPA visit. Caused foaming in river.
2/4/91	Process water released to 002, 004 and observed during OEPA visit.
2/4/91	Paper fiber buildup along stream bank near 004 observed February 4. Stone claimed it was leaves, etc., from high water.
2/4/91	Clarifiers upset, solids carryover observed during OEPA visit. No limit violations measured. Low D.O. measured at 003 outfall.
5/12/92	Release of 10,000 gallons process water to 004 from broken pipe.
7/13/92	Black sediment observed found denitrifying near 002.
7/17/92	Discharge of process water to 002, 004 due to power failure.
9/9/92	Release of 100 gallons phosphoric acid to 004 from tank leak.
11/16/92	Release of 500 gallons spent pulping liquor to 002 during tank sludge removal.
5/10/93	Release of sodium carbonate to 002 in Copeland area; caused pH violation.
6/16/93	Release of solids to 002 from pipe maintenance in Copeland area. Observed during OEPA visit.
8/27/93	Release of 4500 gallons weak liquor to 002 from stress crack in tank.
11/15/93	Upset of final clarifiers observed during OEPA visit. OEPA sampling showed TSS, zinc, and copper violations at 003. Stone sampling showed TSS violations at 003.
12/12/93	Storm drain connected to 004 allowed scrap to wash into system; caused TSS violation.
7/21/94	Approximately 50 pounds of liquor sludge was washed into 002 drain during maintenance activities. A pH violation resulted.
1/10/95	Approximately 2400 gallons of pulping liquor were released to outfall 002 due to a plugged line and subsequent overflow in the Copeland Recovery Unit.

Pollutant Spills and Wild Animal Kills

Upper Muskingum River Basin
A total of 146 spills have been reported in the study area basins from 1989 through 1994 (Appendix A). The number of spills increased dramatically over the past two years with 43 reported prior to 1993 and 103 reported in 1993-94. The increase can primarily be attributed to the increased diligence of the entities and citizens in reporting spills and to increased enforcement of regulations concerning reporting requirements.

The two major sources of spills in the upper Muskingum basin were petrochemical and wastewater. Twelve of the 146 spills had no known source. Twenty-four (18% of five year total) were attributed to General Electric on the Muskingum River in Coshocton; 75% of these spills occurred in 1993 and 1994. Only five spills were reported in the lower Licking River, outside of the upper Muskingum River study area.

Eighty spills (59% of five year total) were attributable to Stone Container Corporation. Almost half of these were reported from the Mill Creek basin, a watershed which drains to the Walhonding River immediately north of Coshocton. Stone Container operates a small landfill located on a tributary to Turkey Run (a Mill Creek tributary). The landfill was formerly a strip pit and historically, some pulp liquor and solids from Stone Container were disposed of at the site. Runoff is regulated by NPDES permit at three outfalls and permit violations have been reported when excessive solids (primarily associated with mine seepage from the old pit) are discharged to the Turkey Run drainage following rain events. These permit violations are ultimately reported as pollutant spills, hence the large number over the past several years. In recent years, Stone Container has been constructing and improving a wetland at the landfill to slow runoff and reduce discharges of suspended solids. The magnitude of the spills is considered relatively minor, particularly when compared to waste loadings discharged by Stone Container to the Tuscarawas River. Fish collections from Turkey Run in 1994 near the confluence with Mill Creek revealed exceptional quality (IBI=50) and no observable water quality impacts.

Forty-one spill incidents detected in the lower Tuscarawas River and upper Muskingum River were attributed to the Stone Container plant located on the Tuscarawas River. Nearly ninety percent of these spills occurred in 1993 and 1994. The increase was most likely due to reasons mentioned in the first paragraph (i.e., more rigorous reporting requirements and attention to spillage by the entity) and not to significant changes in plant operations. The most common material discharged was denoted as “wastewater”. In addition, six of the spills were described as “pulping liquor”, “brown foamy pulpy substance”, “brown water”, and “black stuff”.

Eight fish and wild animal kills were reported in the study area since 1983 (Table 8). All of the incidents occurred in small tributaries in Coshocton County. The two largest kills occurred in 1983 when 3,260 animals were killed in Little Mill Creek (Walhonding River drainage) and in 1984 when 13,170 animals were killed in the headwaters of the White Eyes Creek basin (Tuscarawas River drainage). The spills were attributed to petroleum and cow manure, respectively.

Based on the DERR spill information, permit violation table and unauthorized discharge list, a total of 67 separate incidents associated with the Stone Container Coshocton Mill (Tuscarawas River discharges) were documented during 1993 and 1994; dates and descriptions from each list were cross checked to avoid duplicating events. Based on these numbers, a spill, permit violation or

unauthorized discharge from Stone Container occurred, on average, about once every eleven days in 1993 and 1994.

Table 8. List of fish and wild animal kills reported to Ohio EPA and Ohio Department of Natural Resources in the upper Muskingum River Study area, 1983-1994.

Date	Waterbody	Material	County	Number of Fish or (Animals) Killed
09-09-83	Little Mill Creek	Petroleum	Coshocton	3,620
1984	Crooked Creek basin	Unknown	Coshocton	365
05-03-84	White Eyes Creek basin	Oil and Brine	Coshocton	12
1984	White Eyes Creek basin	Cow Manure	Coshocton	13,170
05-17-84	Blue Ridge Run	Acidic Mine Water	Coshocton	410
06-11-84	White Eyes Creek	Unknown	Coshocton	45
03-16-87	Blue Ridge Run	Detergents	Coshocton	27
09-12-91	Winding Fork	Brine	Coshocton	45

Chemical Water Quality

Lower Tuscarawas / Upper Muskingum Rivers
Eleven sites were surveyed in the lower Tuscarawas and upper Muskingum Rivers on six occasions from 6 July through 14 October 1994. The survey area was bounded by RM 10.7 of the Tuscarawas River and RM 92.0 of the Muskingum River. A summary of the chemical grab sampling and continuous monitor results can be found in Appendix B.

There are four major dischargers in the study area with a total of six discharges to the basin. In addition there are several minor dischargers (See Pollution Sources Section). The lower Tuscarawas River is designated EWH from RMs 47.0 to 1.9, and WWH from RM 1.9 to the mouth.

The following are listings of important water column quality results.

- Flows for the upper Muskingum River in 1994 were always above the Q_{7-10} and generally above the 80% flow duration (Figure 7). Consequently, temperatures did not exceed 27^{o}C downstream from the Conesville plant in 1994. Dissolved oxygen levels ranged from 6-12 mg/l in field measurements during routine chemical sampling (Figure 8).

- A single exceedence of the Public Water Supply criterion for sulfates (250 mg/l) was observed at RM 0.8 on the Tuscarawas River (Table 9; Figure 8), immediately downstream from Stone Container. Stone Container was considered a probable source since average 003 effluent concentrations were about twice as high as in the Tuscarawas River immediately upstream.

Table 9. Exceedences of Ohio EPA Warmwater and Exceptional Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the upper Muskingum River study area, 1994 (units are µg/l for metals and mg/l for all other parameters).

Stream Name	River Mile	Violation: Parameter (value)
Tuscarawas River	3.80	Iron (5,040†, 10,100†)
	0.8	Sulfate (280††), Iron (5,370†)
	0.3	Iron (5,900†)
Muskingum River	109.8	Iron (5,460†)
	97.1	Iron (5,090†)
	92.0	Iron (6,040†)
Upper Muskingum Basin		Iron (55 of 87 samples [63.2%] exceeded 1.0 mg/l* in the upper Muskingum basin study area-Tuscarawas, Walhonding, and Muskingum Rivers.)
Will Creek	5.2	Sulfate (265††) Iron (4 of 5 samples [80.0%] exceeded 1.0 mg/l* at the Wills Creek site.) [*for more information see Ohio EPA 1995b*]
Licking River	5.5-0.6	Iron (20 of 30 samples [66.7%] exceeded 1.0 mg/l* in the Licking River study area [1993 and 1994 sampling].)
Mill Creek basin		Iron (21 of 30 samples [70.0%] exceeded 1.0 mg/l* in the Mill Creek basin study area.)
Spoon Creek	0.6	Sulfate (252††), Iron (5,190†, 19,700†)

† exceedence of the Agricultural Water Supply criterion.
†† exceedence of the Public Water Supply criterion.
* indicates an exceedence of the numerical criterion for prevention of chronic toxicity (CAC).

- Total suspended solids (TSS) and total dissolved solids (TDS) varied within a range that could be expected for high flows in watersheds affected by nonpoint sources of pollution (Figure 8). TSS values ranged from 20 to 120 mg/l while TDS ranged from 300 to 650 mg/l.

- Nitrite-nitrate levels in samples collected throughout the basin on 6 July 1994 were the highest of the six samples collected (Figure 9). On this date the values ranged from 4 to 6 mg/l. Values from samples collected on all other dates ranged from 0.5 to 1.8 mg/l. The 6 July sample coincided with an increase in stream discharge after an early summer rain period. Row crop agriculture (especially corn) is abundant along the bottoms in these segments. The National Resource Conservation Service reported that area farmers were 'top dressing' corn

with nitrogen compounds during this period; this strongly suggested the high nitrite levels were of this nonpoint origin.

- Phosphorus and ammonia-N levels in survey samples were near normal levels on all sampling dates (Figure 9). Ammonia levels throughout the study area were quite low and ranged from below detection (< 0.05 mg/l) to 0.1 mg/l. Phosphorus was generally below 0.2 mg/l with maximum values near 0.4 mg/l immediately downstream from Stone Container. Phosphorus concentrations in the 003 effluent averaged 12.6 mg/l compared to 0.4 mg/l in the 002 effluent.

- BOD_5 levels were mostly at moderate levels for ambient conditions and typical of large warmwater rivers (i.e., >1,000 sq. mi.) in the WAP ecoregion (Ohio EPA unpublished data). However, when compared to the exceptional quality Walhonding River (Figure 9), and other EWH designated rivers in the ecoregion (Ohio EPA unpublished data), BOD_5 levels in the lower Tuscarawas River were considerably higher. Concentrations gradually increased from upstream to downstream between Newcomerstown (RM 21.2) and Coshocton with peak concentrations detected immediately downstream from Stone Container (11 mg/l at RM 0.8). However, the levels were not greatly different from those upstream from Stone Container at RM 3.8. Known sources of BOD_5 upstream from Coshocton include the Newcomerstown and West Lafayette WWTPs (minor discharges) and possibly agricultural runoff. However, these sources may not entirely explain the trends observed. BOD_5 levels in the Muskingum River declined downstream from the confluence with the Walhonding River (Figure 9).

- Datasonde continuous monitors were deployed in 1994 in the lower four miles of the Tuscarawas River and in the Muskingum River from Coshocton to Dresden. The 48 hour exposure period was plotted as two 24 hour sampling periods on September 14 and 15 (Figure 10). Minimum dissolved oxygen levels in the Tuscarawas River were recorded at RM 1.3 immediately upstream from Stone Container (5.2 mg/l) and in the Muskingum River at RM 92.0 near Dresden (5.3 mg/l). All values were above the WWH criterion. In both plots, slight increases in D.O. were observed downstream from Stone Container in the Tuscarawas River and declines were noted in the Muskingum River downstream from the Coshocton WWTP and Conesville EGS. Increases in the lower Tuscarawas River may result from the injection of dissolved oxygen in the 003 final effluent.

- Continuous monitor results in 1994 revealed no exceedences of temperature criteria and only a slight elevation in stream temperature downstream from the Conesville EGS discharge.

- Exceedences of the iron standard were common throughout the study area; 58.6% of samples from the Tuscarawas and Muskingum Rivers (41 of 70) exceeded 1000 mg/l. In addition, four samples from the lower 3.8 miles of the Tuscarawas River and three samples in the Muskingum River exceeded the Agricultural Water Supply criterion of 5,000 mg/l. These results suggested additional nonpoint source contributions over normal background levels. Mine drainage in the lower reaches of the Tuscarawas River and Wills Creek were considered likely sources.

- There were an unusually high number of complaints in 1994 throughout the entire Tuscarawas/Muskingum basin in the Southeast District concerning foaming and floating scum. It was especially evident after aeration by the numerous low-level dams along the Muskingum River. These problems are thought to be caused by biological organisms and may be related to the amount of *additional* nutrients being added from nonpoint sources.

- There appeared to be no chemical concentration impacts derived from the permitted dischargers for cadmium, copper, lead, TDS, and TSS in the downstream stations monitored during the survey. Effluent concentrations of zinc and nitrite-nitrate may have had a contributory effect to the levels found instream. BOD_5 levels did not show any increase instream despite elevated levels found in the dischargers (Table 10, Appendix B).

Parameter Discharger	River* Mile	Cd (ug/l)	Cu (ug/l)	Pb (ug/l)	Zn (ug/l)	BOD_5 (mg/l)	NO_2-NO_3 (mg/l)	NH_3 (mg/l)	Total Dissolved Solids (mg/l)	Total Suspend-ed Solid (mg/l)
Stone Cont. 002	1.17	0.94	10.8	3.4	31	95	0.99	0.8	642	58
Stone Cont. 003	1.04	1.70	96.0	16.3	253	146	2.60	10.9	2380	633
Armco 001	105.88	0.22	12.2	2.2	29	19	96.0	2.2	1958	11
Coshocton 001	108.5	0.20	16.3	2.8	71	15	6.50	1.5	525	21
Burnham 005	1.9	0.24	11.2	6.0	74	3.0	0.50	0.9	460	16

Table 10. Mean values of selected parameters discharged during the 1994 study of the Upper Muskingum River Basin. *Stone Container discharges to the Tuscarawas River, the Coshocton WWTP and Armco Steel discharge to the Muskingum River, and Burnham Corporation discharges to the Licking River.

Walhonding River

Three sites were sampled on the Walhonding River between Nellie (RM 15.73) and Coshocton (RM 0.76). There are no major dischargers within the study area. The Walhonding River is currently designated as EWH.

- Iron exceedences were recorded for 93% of the samples collected (13 of 14).

- Cadmium, chromium, nickel, and ammonia were never detected above detection level. Copper was detected once above the detection limit (19 ug/l at RM 7.54 on August 4).

- Arsenic was detected just above detection limits in ten of fourteen samples (2-4 ug/l). No explanation beyond background conditions can explain these values.

- Lead and zinc were detected several times at slightly above detection levels. One sample at RM

7.54 had a lead value of 12 ug/l on July 21 and a zinc value of 162 ug/l on 8/4/94. Neither of these occurrences were exceedences of Water Quality Standards criteria.

- Dissolved oxygen levels ranged from 6.2 to 11.4 mg/l throughout the basin during the survey, thus meeting the EWH criterion.

- On 6 July, the nitrite-nitrate levels were in the mid 4 mg/l range, similar to values found in the Tuscarawas/Muskingum basin on the same date. The basin bottoms are heavily farmed for row crops. These levels appear to coincide with the explanation discussed in the Tuscarawas/ Muskingum basin above.

- With the exception of iron, the Walhonding basin is currently meeting all chemical criteria for its EWH use designation.

Licking River

Licking River stations in the 1994 study were located at RMs 3.68, 1.70, and 0.56. The Burnham Corporation is the single major point source discharger in this segment and effluent samples were taken at the 005 main process outfall (RM 1.9). The lower reaches of the Licking River from Dillon Dam to Dillon Falls (RMs 5.5-3.7) were also sampled in 1993 as part of an intensive survey of the Licking River basin (Ohio EPA 1995[a]). The Licking River is currently designated WWH.

1994 Sampling

- The only Water Quality Standards exceedences detected in the Licking River in 1994 were for iron. Sixty-nine percent of the samples (9 of 13) exceeded the 1,000 ug/l criterion for the prevention of chronic toxicity (CAC).

- Cadmium, chromium, copper and nickel concentrations were all below minimum detection levels.

- Three of the fourteen samples for lead were between 2-3 ug/l. The remainder were below the detection level.

- Arsenic and zinc concentrations were occasionally above detection levels but did not exceed Water Quality Standards criteria.

- Nutrient parameters (i.e., BOD_5, nitrate-nitrite, ammonia, and phosphorus) were detected at very low levels in 1994, showing no significant water quality impacts.

- Chemical criteria for the WWH use designation were met at all sampling sites in 1994 except iron.

1993 Sampling

- No water quality exceedences were detected in chemical grabs in 1993. However, a sharp increase in ammonia was observed immediately downstream from Dillon Dam at RM 5.5 Thermal stratification of the impounded water column during the summer months likely induced anoxia within the hypolimnion. Lacking D.O., nitrogenous compounds would undergo ammonification and, as a result, subsequent discharges of water from the hypolimnion would contain elevated levels of NH_3-N. Under drought conditions in 1988, ammonia exceedences did occur at Dillon Falls (RM 3.6) and were attributed to the hypolimnetic

discharge from Dillon Reservoir (Ohio EPA file data).

- Despite the lack of water quality exceedences from chemical grabs in 1993-94, continuous monitor sampling in 1993 recorded diurnal D.O. levels consistently below the WWH criterion at RM 3.9. During a three day period from August 24-27, nearly all measurements were below the 4 mg/l minimum D.O. standard and some dropped below the Limited Resource Water criterion of 2 mg/l. Again, the hypolimnetic reservoir discharge was considered primarily responsible for the depressed D.O. levels.

Wills Creek near Mouth

For this survey, one site was used at RM 5.2 to evaluate water quality entering the Muskingum River. This segment is designated WWH. Analysis of the entire 1994 Wills Creek intensive survey is available (Ohio EPA 1995b).

- The iron standard was exceeded in 80% of the sample collections (4 of 5).

- Phosphorus and ammonia levels were at or below the detection limits throughout the survey. Nitrite-Nitrate showed an increase following the 6 July rainfall event (1.38 mg/l) but concentrations were quite low during the remainder of the survey (mean = 0.26 mg/l). Both concentrations were much lower when compared to the elevated measurements on the Tuscarawas and Muskingum Rivers during the same period (Figure 9). Row crop agriculture is less prevalent in the Wills Creek basin and this probably accounts for the lower nutrient levels.

- The Public Water Supply criterion for sulfate (250 mg/l) was exceeded once during the survey. This was during the 6 July sampling (265 mg/l).

- Cadmium, chromium, copper, and lead were never reported above minimum detection limits.

- Zinc and arsenic were both at or slightly above detection limits on several sampling dates.

- The Wills Creek basin is currently meeting chemical criteria for its WWH use designation with the exception of iron.

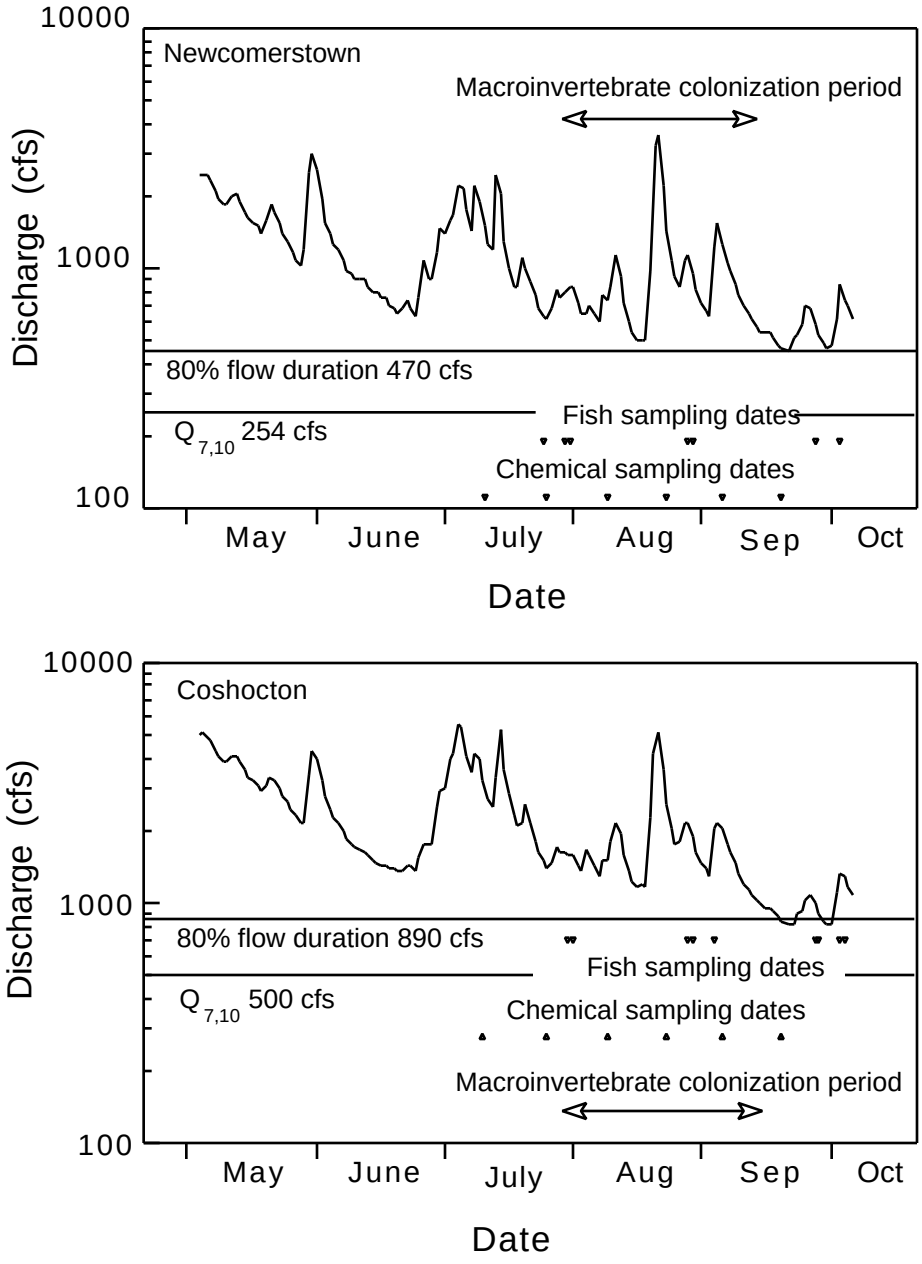

Figure 7. A comparison of flow hydrographs for the Tuscarawas River at Newcomerstown, Ohio (RM 21.2) and the Muskingum River near Coshocton (RM 108.3) from May through September, 1994. Sampling dates and May through November low-flow conditions [Q_{7-10} to 80% duration flow; period of record 1921 (Newcomerstown gage) and 1936 (Coshocton gage) to 1994] are indicated on the flow hydrograph.

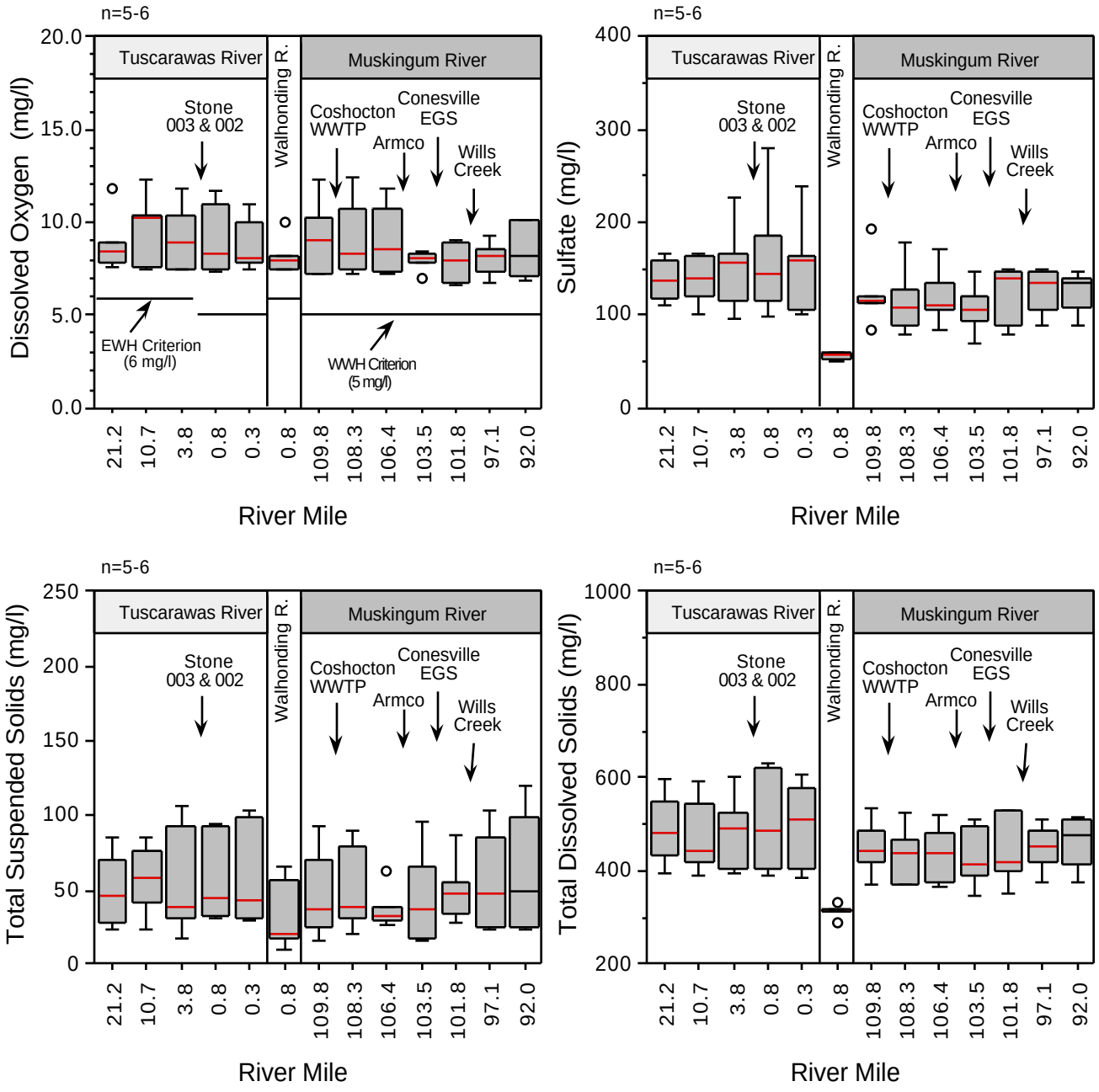

Figure 8. Longitudinal trend of dissolved oxygen, sulfate, total suspended solids, and total dissolved solids in the upper Muskingum River study area, 1994.

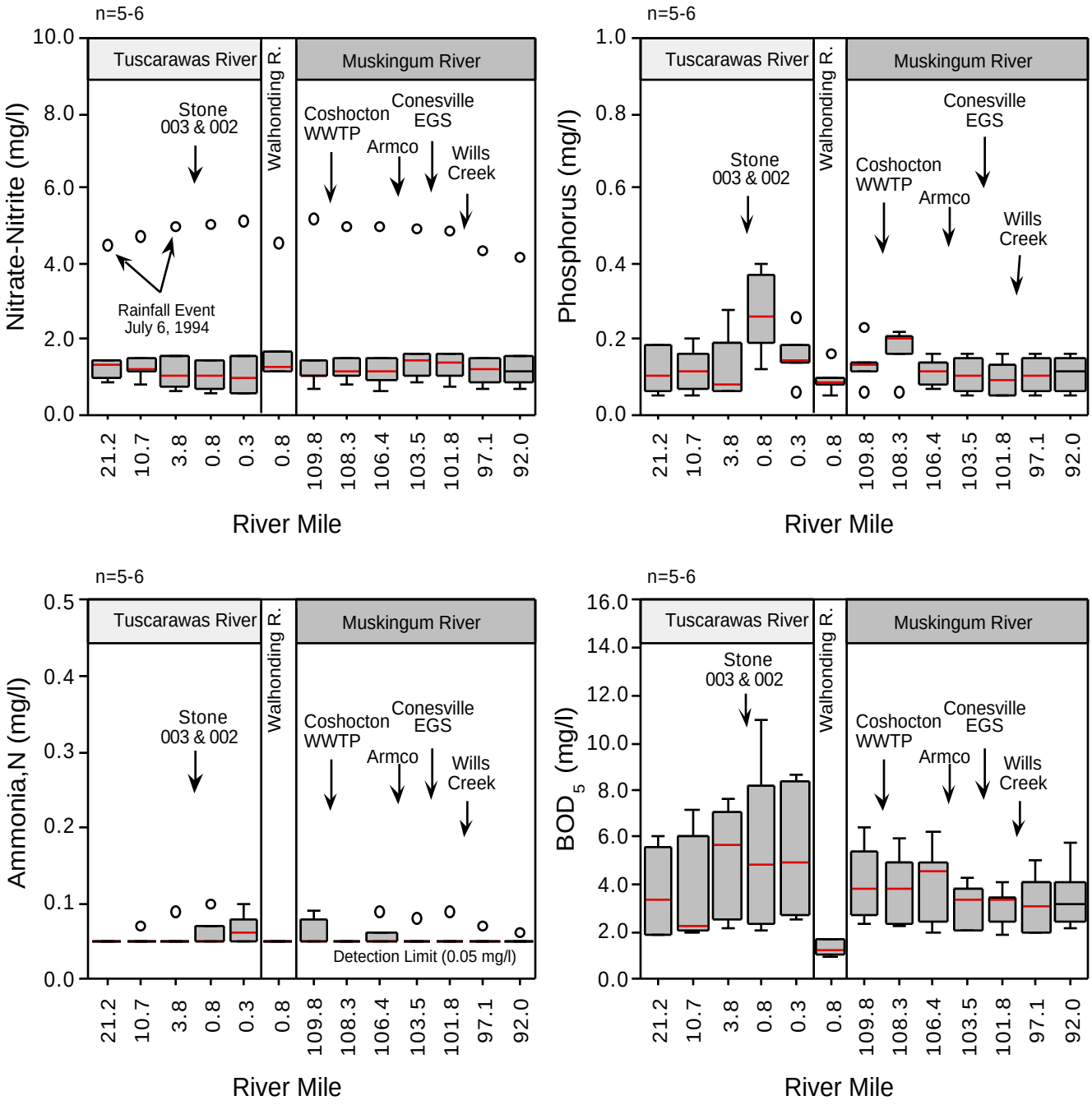

Figure 9. Longitudinal trend of nitrate-nitrite, phosphorus, ammonia as N, and five-day biochemical oxygen demand (BOD_5) in the upper Muskingum River study area, 1994.

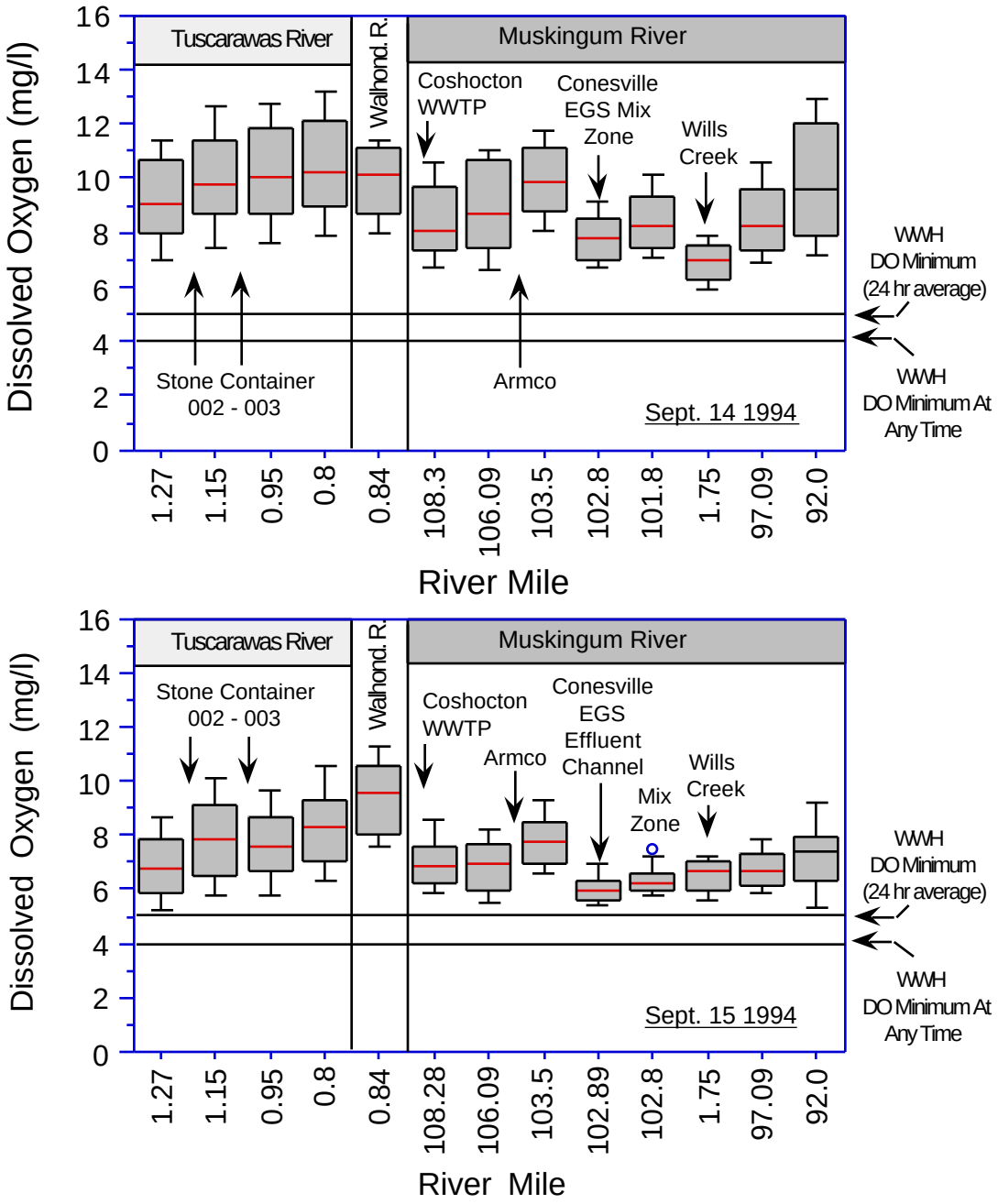

Figure 10. Continuous monitor results from the Tuscarawas River and Muskingum River on September 14 and 15, 1994.

Sediment Chemistry

Upper Muskingum River Basin
Sediments from the upper Muskingum River basin were evaluated using a system developed by Hayton, Jaagumagi, and Persaud (1993) for management of aquatic sediment in Ontario, Canada. This system, unlike the classification system developed by Kelly and Hite, bases its classification on the toxicity of the sediments. The Kelly and Hite system developed its classification on background conditions in Illinois streams.

The Hayton et al. system establishes guidelines for three levels of effect - No Effect Level (NEL), Lowest Effect Level (LEL) and Severe Effect Level (SEL). The Lowest Effect level and Severe Effect Level are based on the long-term effects that contaminants may have on the sediment-dwelling organisms. The No Effect Level is based on levels of chemicals that are so low that no contaminants are passed through the food chain.

The three levels of effect are:

--**No Effect Level:** This level suggests that the sediment will have no adverse effect on aquatic life or water quality. At this level no transfer of chemicals through the food chain and no effect on water quality is expected.

--**Lowest Effect Level:** This suggests a level of contamination that may have an adverse effect on some benthic biological resources. The sediment is clean to marginally polluted.

--**Severe Effect Level:** At this level, the sediment is considered heavily polluted and will likely have a significant effect on benthic biological resources.

Sediment Metals
The results of the 1994 survey show that most of the samples collected exceeded the Lowest Effect Level for all the metals analyzed (Table 11). Two samples exceeded the Severe Effect Level for Iron in the Muskingum River (RM 103.52 and 97.11). Nickel (Ni) levels approached the SEL category throughout the study area with maximums about 60 in mg/kg in the Muskingum River (SEL=75).

The remainder of sediment data were near the LEL for each parameter. This consistency at low levels suggests very little impact would occur to the aquatic bottom dwelling organisms from the sediments. The nickel values found throughout the basin may be indicators of previous poorly treated plating operations. The iron levels may be related to mine drainage and the high values of iron found in the water column.

The 1994 survey shows mixed results when the Kelly and Hite system of classification of sediments is used to analyze the data.

Copper and cadmium concentrations were all in the non to slightly elevated range indicating very little potential impact (Table 12). Arsenic ranged from non to highly elevated. The highly elevated value was detected at the mouth of the Walhonding River (RM 0.76) despite a lack of point source discharges to the mainstem.

Chromium was highly elevated at four of six Tuscarawas and Muskingum River sites, and at the

previously mentioned Walhonding River site. Iron was found in the highly elevated range in the Walhonding River (RM 0.76) and the Muskingum River at Conesville (RM 103.52) and downstream from Wills Creek (RM 97.11). Wills Creek is a mine drainage influenced tributary which suggests its potential as a metals source. Highest iron concentrations (41,800-42,800 mg/kg) were found at the Muskingum River sites.

Lead concentrations were generally in the non to slightly elevated range. Exceptions were the downstream stations in all three rivers where values were in the elevated range.

Table 11. Concentrations of heavy metals in sediments of the Upper Muskingum River study area, 1994*.

	Sediment Concentration (mg/kg dry weight)							
	As	Cu	Cd	Cr	Fe	Pb	Ni	Zn
(LEL/SEL)[a]	(6/33)	(16/110)	(0.6/10)	(26/110)	(20,000/ 40,000)	(31/250)	(16/75)	(120/820)
River Mile								
Tuscarawas River								
1.6	12.4[b]	24.7[b]	0.672[b]	44.6[b]	25800[b]	36.8[b]	59.4[b]	160[b]
0.9	11.9[b]	23.3[b]	0.629[b]	32.9[b]	21500[b]	32.5[b]	52.5[b]	136[b]
0.3	13.7[b]	29.0[b]	0.818[b]	33.8[b]	21000[b]	51.1[b]	51.8[b]	148[b]
Walhonding River								
7.54	10.7[b]	22.9[b]	0.413	25.0	22500[b]	26.9	27.4[b]	96.4
0.76	18.1[b]	36.7[b]	0.666[b]	39.7[b]	33800[b]	38.8[b]	47.1[b]	151[b]
Muskingum River								
108.28	6.18[b]	10.5	0.654[b]	10.7	13400	<18.2	24.9[b]	96.3
103.52	14.3[b]	22.4[b]	0.733[b]	43.1[b]	**41800[c]**	33.6[b]	60.4[b]	166[b]
97.11	15.6[b]	30.3[b]	0.967[b]	49.0[b]	**42800[c]**	42.0[b]	67.3[b]	184[b]

* All parameter concentrations were ranked based on a stream sediment classification system described by Hayton, Jaagumagi, and Persaud (1993).

[a] LEL is the Lowest Effect Level for that parameter. The SEL is the Severe Effect Level for that parameter. Values are in milligram per kilogram.

[b] Exceeds Lowest Effect Level (LEL).

[c] **Exceeds Severe Effect Level (SEL).**

Zinc was generally in the elevated range throughout the study area with the exceptions being in the slightly elevated range (Walhonding RM 7.54 and Muskingum RM 108.28).

Concentrations of heavy metals in the water column were low throughout the upper Muskingum River survey. There were slightly higher amounts in the point source discharges but not at the exceedingly high levels that could be attributed to the values being found in the sediments.

The most downstream Walhonding River site (RM 0.76) had three values (arsenic, chromium and

iron) in the highly elevated range, and two values (lead and zinc) in the elevated range. As stated above this seemed incongruous in relation to the exceptional water quality and use designation status of the watershed. Potential sources of iron, arsenic and zinc may include mine drainage or historical agricultural practices, but sources of chromium and lead are unknown. The biosurvey results and analysis using the sediment classification criteria in Table 11 (Hayton et. al. 1993.) indicate that these sediment metals are not a major concern in the Walhonding River.

Table 12. Concentrations of heavy metals in sediments of the Upper Muskingum study area, 1994. All parameter concentrations, excluding nickel, were ranked based on a stream sediment classification system described by Kelly and Hite (1984). The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

River Mile	Sediment Concentration (mg/kg dry weight) As	Cu	Cd	Cr	Fe	Pb	Ni	Zn
Tuscarawas River								
1.6	12.4[c]	24.7[a]	0.672[b]	**44.6[d]**	25800[c]	36.8[b]	59.4	160[c]
0.9	11.9[c]	23.3[a]	0.629[b]	32.9[c]	21500[b]	32.5[b]	52.5	136[c]
0.3	13.7[c]	29.0[a]	0.818[b]	33.8[c]	21000[b]	51.1[c]	51.8	148[c]
Walhonding River								
7.54	10.7[b]	22.9[a]	0.413[a]	25.0[c]	22500[b]	26.9[a]	27.4	96.4[b]
0.76	**18.1[d]**	36.7[a]	0.666[b]	**39.7[d]**	**33800[d]**	38.8[c]	47.1	151[c]
Muskingum River								
108.28	6.18[a]	10.5[a]	0.654[b]	10.7[a]	13400[a]	<18.2[a]	24.9	96.3[b]
103.52	14.3[c]	22.4[a]	0.733[b]	**43.1[d]**	**41800[d]**	33.6[b]	60.4	166[c]
97.11	15.6[c]	30.3[a]	0.967[b]	**49.0[d]**	**42800[d]**	42.0[c]	67.3	**184[d]**

[a]Non-elevated; [b] Slightly elevated; [c] Elevated; **[d] Highly elevated**; **[e] Extremely elevated**

Sediment Organics

Hexachlorobenzene was found at all three sediment sites sampled on the Tuscarawas and the one site sampled on the Muskingum River (Table 13). Each concentration exceeded the LEL but none exceeded the SEL, based on an assumed range of 5-10% total organic carbon content of the sample. There was a slight increase below the Stone Container outfalls but there was also a positive result upstream from the discharges at RM 1.6. Historical contamination from industrial sources in the upper reaches of the Tuscarawas River are the most likely source of Hexachlorobenzene upstream from Coshocton. The results suggest clean to moderately polluted sediment conditions for Hexachlorobenzene in the upper Muskingum study area.

Endrin was detected in the lower Tuscarawas River beginning at stations downstream from Stone Container (RMs 0.8 and 0.3). Concentrations fell between the NEL (No Effect Level) and the LEL (Lowest Effect Level), indicating contamination was not severe. Endrin is used as an

insecticide on cotton and grains, as an avicide and rodenticide. Endrin will extensively sorb to sediment and will significantly bioconcentrate in aquatic organisms (Howard et. al. 1991). Endrin is banned or severely restricted in its usage in many countries. The USEPA STORET database reports endrin in 24% of 1,802 sediment samples in the U.S. through January 1984. The median concentration was 0.01 ug/kg (Staples et. al. 1985). Stone Container was considered a probable source of endrin based on pesticide samples analyzed in conjunction with bioassay testing in 1991 and 1992. A total of 16 pesticide compounds (including endrin) were detected in the 002 and 003 effluent.

Table 13. Concentrations of organics (VOCs and BNAs) and pesticides in sediments from the upper Muskingum River study area, 1994*. Results above detection limits are reported. All other parameters were not detected.

	Sediment Concentration (ug/kg dry weight)		
	Hexachloro-benzene	Bis(2-ethylhexyl) phthalate	Endrin
NEL / LEL / SEL#	(10 / 20 / 1,200-2,400)	(no criteria)	(0.5 / 3 / 6,500-13,000)
River Mile			
Tuscarawas River			
1.6	253.34[b]	ND[c]	ND
0.8	309.24[b]	0.8	0.97[a]
0.3	215.10[b]	3.0	1.49[a]
Walhonding River			
0.76	ND	ND	ND
Muskingum River			
108.28	94.70[b]	1.4	ND

* All parameter concentrations were ranked based on a stream sediment classification system described by Hayton, Jaagumagi, and Persaud (1993).

\# NEL (No Effect Level) / LEL (Lowest Effect Level) / SEL (Severe Effect Level) for that parameter. Since total organic carbon (TOC) was not analyzed, a range of SELs are presented based on an assumed 5% - 10% TOC content in the samples. Values are in micrograms per kilogram.

[a] Exceeds No Effect Level (NEL).

[b] Exceeds Lowest Effect Level (LEL).

[c] Not Detected

Fish Tissue Contaminants

Lower Tuscarawas / Upper Muskingum Rivers

Fish samples from the lower Tuscarawas River revealed low to moderate body burdens of hexachlorobenzene and PCBs between RM 7.2 and the mouth (Table 14). A few specimens also

contained detectable quantities of the pesticide metabolites 4,4 DDE (a DDT metabolite), Alpha-Chlordane, and Trans-Nonachlor (Chlordane isomeres). Hexachlorobenzene concentrations were not elevated. PCB concentrations were consistently in the slightly to moderately elevated ranges. Hexachlorobenzene and PCBs are common contaminants in fish flesh throughout the Tuscarawas River. The compounds are primarily associated with historical contamination from industrial discharges upstream in the Barberton, Massillon and Dover areas. Concentrations of PCBs have been sufficient to trigger a consumption advisory issued by the Ohio Department of Health in the Tuscarawas River from Barberton to Massillon.

Body burdens of organics continued to be detected in the Muskingum River at RM 105.7 but hexaclhorobenzene and PCB concentrations were generally lower than in samples from the Tuscarawas River (Table 14). All concentrations were in the "not elevated" or "slightly elevated" ranges. As expected, highest concentrations were found in a whole body composite sample from three channel catfish. All other tissue samples from the survey and the criteria used to evaluate them are based on fillet samples which contain lower amounts of lipids where organics tend to concentrate.

Table 14. Summary of organic compounds detected in fillet fish tissue analysis of samples collected on September 27, 1994 in the Tuscarawas River. All results are reported as ug/kg (*i.e.*, parts per billion).

Stream	River Mile			
Parameter	Sample-Fillet Type-Concentration			
Tuscarawas River	RM 7.2	RM 7.2	RM 7.2	RM 7.2
	1 x Smallmouth Bass	1 x Flathead Catfish	1 x Channel Catfish	2 x Saugeye
	SOFC[a]	SFFC[b]	SFFC[b]	SOFC[a]
4,4' DDE	ND	10	24	ND
Hexachlorobenzene	190	180	390	220
PCB 1248	290	420	480	360
PCB 1260	99	130	190	ND
Tuscarawas River	RM 3.4	RM 3.4	RM 3.4	
	5 x Smallmouth Bass	1 x Channel Catfish	1 x Saugeye	
	SOFC[a]	SFFC[b]	SOFC[a]	
Alpha-Chlordane	ND	9.9	ND	
Trans-Nonachlor	ND	18.0	ND	
4,4' DDE	ND	26	ND	
Hexachlorobenzene	160	220	180	
PCB 1248	260	570	160	
PCB 1260	ND	180	ND	

Table 14. (continued).

Stream / Parameter	River Mile / Sample-Fillet Type-Concentration			
Tuscarawas River	RM 0.4	RM 0.4	RM 0.4	
	2 x Smallmouth Bass	1 x Smallmouth Bass	2 x Saugeye	
	SOFC[a]	SOFC[a]	SOFC[a]	
Hexachlorobenzene	110	98	100	
PCB 1248	250	180	210	
Tuscarawas River	RM 0.8	RM 0.8	RM 0.8	
	5 x Smallmouth Bass	2 x Channel Catfish	2 x Saugeye	
	SOFC[a]	SFFC[b]	SOFC[a]	
Hexachlorobenzene	160	250	150	
4,4' DDE	ND	16	ND	
PCB 1248	250	470	350	
PCB 1260	ND	120	ND	
Muskingum River	RM 105.7	RM 105.7	RM 105.7	RM 105.7
	3 x Channel Catfish	3 x Channel Catfish	1 x Saugeye	1 x Smallmouth Bass
	WBC[C]	SFFC[b]	SOFC[a]	SOFC[a]
Aldrin	9.2	ND	4.5	ND
Dieldrin	5.7	ND	ND	ND
4,4' DDE	20	8.7	8.2	9.3
Hexachlorobenzene	350	94	55	95
Alpha-Chlordane	8.4	ND	ND	ND
Cis-Nonachlor	4.4	ND	ND	ND
Trans-Nonachlor	14	4.5	ND	4.4
PCB 1248	190	44	45	65
PCB 1260	140	55	44	51

[a] SOFC (Skin On Fillet Composite)
[b] SFFC (Skin Off Fillet Composite)
[C] WBC (Whole Body Composite)
ND Not Detected

Physical Habitat for Aquatic Life

The macrohabitats of the upper Muskingum River study area were evaluated at the 38 fish sampling locations in 1994. At the 16 mainstem stations in the Tuscarawas, Walhonding and Muskingum Rivers, Qualitative Habitat Evaluation Indices (QHEIs) ranged from 62.5 to 90.5; both scores were from the Muskingum River at RMs 91.8 and 107.0, respectively. When habitat conditions are evaluated within a river or large river segment, mean QHEI scores greater than 60 are generally considered adequate to support WWH communities. Mean QHEI scores greater than 70-75 are generally considered adequate to support exceptional (*i.e.*, EWH) fish assemblages. A mean QHEI score less than 60 or 70 does not rule out a WWH or EWH designation but suggests the need to closely evaluate the quality of near and instream physical habitats to support biotic communities consistent with the aquatic life use designation (Rankin 1989).

Tuscarawas River
The mean QHEI of the five stations scored on the Tuscarawas River was 77.1 ± 3.3 SD. The scores indicated that the physical habitat of all locations (including those downstream from Stone Container) was of sufficient quality to support assemblages of aquatic fauna consistent with EWH criteria (Table 15). Siltation and moderately embedded substrates were common to all locations, as the flood plain, where topography permits, is farmed intensively. Silt cover and embedded substrates are known to limit the potential of the habitat to sustain the most sensitive species (*e.g.*, rosyface shiner, bigeye chub, black redhorse). Severe bank erosion was noted at RM 3.6, where a residential neighborhood encroached on the stream bank leaving no riparian habitat.

Muskingum River
The mean QHEI score for all stations evaluated in the Muskingum River was 76.4 ± 10.1 SD, showing good to excellent habitat quality. The physical habitats at six of the eight stations evaluated in the Muskingum River were capable of supporting faunal assemblages achieving EWH criteria as measured by the QHEI (Table 15). At the two stations scoring less than 70, riffles were absent (RM 110.0) or poorly developed (RM 91.8). Riparian widths were generally wide, including most banks adjacent to farmland, which minimized bank erosion and contributed large woody debris as instream cover. However, moderately embedded riffle and parent substrates were evidence of agricultural and mine drainage influences. Riffle embeddedness in the Muskingum River in particular, was exacerbated by the dense populations and associated retreat construction of the caddisfly *Macrostemum zebratum*. Large sections of substrate were bound together by the strong silk secretions used to build and anchor the larval retreats. This bonding resulted in a "crust-like" condition, similar but less severe than the "armored" substrates often observed in mine drainage streams.

Walhonding River
Excellent habitat quality (mean QHEI = 84.0 ± 1.7 SD) was recorded at each of the three locations scored in the Walhonding River (Table 15). The Walhonding, Tuscarawas and upper Muskingum were similar with respect to amounts of instream cover, substrate types, riparian widths and adjacent land use practices. However, the Walhonding differed from the Tuscarawas and Muskingum in that substrates in the Walhonding were only lightly embedded.

Licking River
The instream habitat in the lower Licking River was relatively free of embedding sand and silt due to Dillon Reservoir acting as a sediment sink. Consequently, the lower Licking River is physically capable of supporting aquatic assemblages of EWH quality. The mean QHEI score for the three sites investigated was 79.3 ± 1.4 SD. Silt was noticeably heavier at the two downstream sites

where the riparian area was narrow due to urban encroachment. Several CSOs were noted in this downstream area, one downstream from Burnham Corporation, and two upstream from the State Street bridge.

Wills Creek

Habitat quality at the mouth of Wills Creek, though influenced by extensive channel modifications and land use practices in the upper watershed, was sufficient to expect the fish community to achieve WWH criteria. Extensive areas of channel modifications and intensive livestock grazing throughout the watershed, combined with open stream access for livestock, add an enormous silt load to Wills Creek. Wills Creek Reservoir relieves part of the silt load, and helps habitat quality downstream. Effects of the silt load are seen as heavy to moderate silt cover, and highly embedded parent and riffle substrates (Table 15).

Other Muskingum River Tributaries

See pages 77-80.

Table 15. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Upper Muskingum River Basin study area, July - September 1994.

Key QHEI Components			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total H.I. MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
(17-001) Muskingum River																																		
Year: 94																																		
110.0	60.0BM	1.73	■	■				■	■		■		5						0		▲			▲	▲			▲	▲		▲	6	0.17	1.17
108.0	80.5BM	1.73	■	■		■	■	■	■	■	■		9						0		▲								▲	▲		3	0.10	0.40
107.0	90.5BM	1.73	■	■		■	■	■	■	■	■	■	9						0		▲								▲			2	0.10	0.30
105.7	79.5BM	1.73	■	■		■	■	■	■	■	■		9						0										▲	▲		2	0.10	0.30
104.8	80.0BM	1.73	■	■		■	■	■	■	■	■	■	9		●				1													0	0.20	0.20
101.6	80.0BM	1.96	■	■		■	■	■	■	■	■		9						0		▲								▲	▲		3	0.10	0.40
98.3	78.5BM	1.96	■	■		■	■	■	■	■	■		9						0		▲								▲	▲		3	0.10	0.40
92.2	62.5BM	1.40	■				■		■		■		4						0		▲			▲					▲	▲		4	0.20	1.00
(17-151) Bucklew Run																																		
Year: 94																																		
0.1	50.5JG	12.42						■				■	2	●	●	●			3	▲	▲			▲	▲			▲	▲			6	1.33	3.33
(17-157) Big Run																																		
Year: 94																																		
0.2	52.0JG	12.59									■		1	●	●				2	▲	▲			▲	▲			▲	▲	▲		7	1.50	5.00
(17-200) Licking River																																		
Year: 94																																		
3.8	81.0BM	6.89	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
1.9	78.5BM	6.89	■	■		■	■	■	■	■	■	■	9						0		▲											1	0.10	0.20
1.0	78.5BM	6.89	■	■		■	■	■	■	■	■	■	9						0		▲											1	0.10	0.20
(17-500) Tuscarawas River																																		
Year: 94																																		
7.2	76.5BM	2.58	■	■		■	■	■	■	■	■		9						0									▲	▲	▲		3	0.10	0.40
3.4	72.0BM	2.58	■	■		■	■		■		■		7		●				1		▲								▲			2	0.25	0.50
1.4	80.5BM	1.73	■	■		■	■	■	■	■	■	■	9		●				1		▲											1	0.20	0.30
0.8	77.0BM	1.73	■	■		■	■	■	■	■	■	■	9		●				1		▲					▲						2	0.20	0.40
0.3	79.5BM	1.73	■	■		■	■	■	■	■	■	■	9						0		▲								▲			2	0.10	0.30
(17-600) Walhonding River																																		
Year: 94																																		
16.3	83.0BM	3.33	■	■		■	■	■	■	■	■		9						0													0	0.10	0.10

Table 15. (continued).

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH Attributes (*High Influence*): Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total H.I. MWH Attributes	MWH Attributes (*Moderate Influence*): Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
(17-600) Walhonding River																																	
Year: 94																																	
8.0	86.0BM	5.71	■■	■	■	■	■	■	■	■	■	■	9					0														0	0.10	0.10
1.1	83.0BM	4.31	■■	■	■	■	■	■	■	■	■	■	9					0														0	0.10	0.10
(17-605) Beaver Run																																	
Year: 94																																	
5.0	57.5JG	14.71	■■				■	■					5		●		●	2		▲		▲▲		▲▲▲							6	0.50	1.50
(17-610) Mill Creek																																	
Year: 94																																	
8.5	56.5JG	7.12	■		■	■				■			4			●		1		▲				▲▲▲							4	0.40	1.20
0.7	61.0JG	5.09	■			■	■	■		■			6	●				1		▲▲		▲▲		▲▲							6	0.29	1.14
(17-611) Spoon Creek																																	
Year: 94																																	
0.6	50.0JG	14.08	■		■	■			■	■			5	●		●		2		▲				▲▲▲							4	0.50	1.17
(17-612) Turkey Run																																	
Year: 94																																	
0.2	65.0JG	29.41	■■	■	■	■	■	■	■	■	■	■	9					0								▲						1	0.10	0.20
(17-613) Little Mill Creek																																	
Year: 94																																	
0.1	61.0JG	15.19	■■		■	■							4			●	●	2		▲		▲		▲▲▲							5	0.60	1.60
(17-800) Wills Creek																																	
Year: 94																																	
0.3	66.0BM	1.54	■■			■			■				4					0		▲		▲▲		▲▲▲							6	0.20	1.40
(17-960) Wakatomika Creek																																	
Year: 94																																	
32.0	82.0JG	10.99	■■		■	■	■	■	■	■	■	■	9					0														0	0.10	0.10
14.8	88.0JG	4.23	■		■	■	■	■	■	■	■	■	8					0		▲												1	0.11	0.22
12.5	74.0JG	3.11	■		■	■	■	■		■			6					0		▲				▲▲							3	0.14	0.57
11.8	66.0JG	3.11	■			■	■	■	■	■			6					0		▲		▲▲		▲▲							5	0.14	0.86
2.1	77.5JG	2.88	■■	■		■	■	■	■	■	■		8			●		1				▲▲										2	0.22	0.44

Table 15. (continued).

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total HL MWH Attributes	MWH Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Bout)	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 ML MWH Attributes	MWH HL/WWH Ratio	MWH ML/WWH Ratio
(17-963) Moscow Brook																																	
Year: 94																																	
0.3	60.0JG	18.69	■	■		■	■	■	■	■	■		8		●	●			2			▲				▲				2	0.33	0.56
(17-969) Fivemile Creek																																	
Year: 94																																	
1.5	75.0JG	15.15	■	■			■	■	■		■		7		●				1		▲	▲				▲	▲				4	0.25	0.75
(17-971) Brushy Fork																																	
Year: 94																																	
3.5	56.0JG	7.14	■	■			■			■	■		6		●	●			2		▲	▲				▲	▲	▲			5	0.43	1.14
(17-973) Winding Fork																																	
Year: 94																																	
1.8	74.5JG	9.90	■	■		■	■	■	■		■	■	8		●				1		▲		▲				▲				3	0.22	0.56

Biological Assessment: Macroinvertebrate Community

Tuscarawas River

Artificial substrate samples were collected at seven Tuscarawas River stations between the National Ambient Water Quality Monitoring Network (NAWQMN) site in Newcomerstown (RM 21.1) and RM 0.3 near the mouth (Table 16; Figure 11). Three sites at RM 21.1, 7.1 and 3.8 were collected from the EWH designated section of the river. Four stations from RMs 1.3 to 0.3 were located in the WWH designated section, upstream and downstream from the Stone Container Corp. outfalls (RMs 1.17-0.4). Lists of macroinvertebrate taxa and ICI metric scores from each site in the upper Muskingum River study area can be found in Appendix C.

ICI scores from the Tuscarawas River were in the very good and exceptional ranges in both the EWH and WWH designated sections of the river. Scores ranged from 52 at RMs 21.1 to 44 at RM 0.7, downstream from Stone Container. Natural substrate communities reflected good to exceptional quality at all sites. Mayfly, caddisfly, and stonefly richness on the natural substrates (Qual. EPT Metric) received the maximum score of "6" at each site except at RM 0.7, which scored a "4". The pollution sensitive stonefly taxon *Agnetina capitata complex* was found at all stations.

Although ICI scores remained relatively high, a sharp change in community composition and density was noted between Newcomerstown (RM 21.1) and additional downstream stations from West Lafayette to Stone Container (RMs 7.1-1.3). Densities increased from 3,000 organisms per square foot to an average 15,000 at the downstream sites. Based on visual observations, the river appeared to become murkier as it flowed from Newcomerstown to Coshocton.

Increased densities were primarily related to the increased abundance of filter feeding Tanytarsini midges of the *Rheotanytarsus exiguus* group. These midges accounted for over 70% of the organisms at stations between West Lafayette and Coshocton compared to 26.6% at Newcomerstown. *Rheotanytarsus* densities closely followed the increasing trend in community densities in the lower Tuscarawas River (Figure 12). The results suggested high levels of suspended particulate matter in the water column, before the Stone Container discharges.

The Stone Container 003 mixing zone yielded a community similar in quality and composition to Tuscarawas River stations immediately upstream. The ICI of 46 met the exceptional criterion and was predominated by *R. exiguus* group midges (45,531 individuals, 70.3% of total organisms). The discharge had a coffee-brown color and the diffuser produced moderate amounts of foam where the discharge spray broke the water surface. Effluents were not considered acutely toxic to the benthic macroinvertebrate community.

Stone Container discharges were an additional source of nutrient enrichment in the lower Tuscarawas River. The highest community density in the survey was found downstream from the 002 and 003 discharges at RM 0.7 (24,000 per square foot) and included over 15,000 per square foot *R. exiguus* group individuals. The ICI of 44 remained in the very good range but community composition reflected enriched conditions and high levels of suspended organic material. The ICI increased to 48 (exceptional range) at RM 0.3, prior to the confluence with the Walhonding River and the formation of the Muskingum River.

Beginning at the 003 mixing zone and extending downstream, many mayfly specimens (e.g., the genera *Stenonema spp, Isonychia, Tricorythodes*) were covered with thick, fluffy masses of "sewage fungus". Under microscopic examination, the growth was largely composed of stalked

protozoan colonies of the genus *Epistilus*. Some authors have reported instances where growths on crustaceans may have been heavy enough to impair the hosts (Taylor and Sanders 1991). Besides the mayflies, the colonies formed slimy patches on nearly all inert substrates downstream from the Stone discharge. The protozoans are often a constituent in the broader category "sewage fungus" and similar growths have been observed on substrates and macroinvertebrates below pulp mill discharges and poorly treated WWTP effluent (Hynes 1960, Tarzwell and Gaufin 1953). The colonies can become particularly abundant in areas with large bacteria populations and high oxygen levels (Hynes 1960), conditions probably similar to those found downstream from Stone Container in 1994. The severity of this condition appeared to lessen with increased distance downstream but was still observed on macroinvertebrates from Muskingum River sites for approximately ten miles.

Walhonding River

Artificial substrates were collected from three stations at RMs 15.6, 7.7 and 0.8. ICI scores ranged from 52 at RM 0.8 to 56 at RMs 15.6 and 7.7; all fell well within the exceptional range (*i.e.*, ICI = 46-60). When compared to Tuscarawas River sites, the Walhonding River macroinvertebrates were of generally higher quality. Beyond a higher average ICI score, the Walhonding sites yielded greater numbers of pollution mayflies and stoneflies, and lacked the highly skewed distribution of Tanytarsini midges. Community densities were also lower in the Walhonding River stations and ranged from 797 to 2,751 organisms per square foot. Overall, the sites were most comparable to the most upstream Tuscarawas River site at Newcomerstown (RM 21.1).

Muskingum River

Artificial substrates were collected from eight Muskingum River stations between RM 109.7 at Coshocton and RM 92.1 at Dresden. ICI scores at all but one site were in the exceptional range and scored between 46 and 50. At RM 97.1, downstream from Wills Creek, the ICI of 40 dropped into the good range.

Station RM 109.7 was located downstream from the confluence of the Tuscarawas and Walhonding Rivers. Community densities were high at nearly 15,000 per square foot and *Rheotanytarsus exiguus* group midges accounted for 64.5% of the total organisms. Some mayfly and stonefly taxa collected in the Walhonding River extended into the Muskingum River. However, the general composition was most characteristic of collections in the lower Tuscarawas River.

Beginning at RM 108.0 and extending downstream, community densities and the *Rheotanytarsus exiguus* group densities in particular, declined markedly (Figure 12). The RM 108.0 site was also the first location where dense populations of the net-spinning caddisfly *Macrostemumzebratum*. were observed on the natural substrates. Large sections of riffle and run substrates were bound together by the silk secretions used to build and anchor the large caddisfly larvae retreats. This bonding resulted in a "crust-like" condition, similar but less severe than the "armored" substrates often observed in mine drainage streams. The reason for the marked change in community composition is not known. However, there was no obvious indication of declines in water quality based on communities immediately downstream from the WWTP. The ICI of 46 at RM 108.0 was in the exceptional range and the number of EPT taxa (24) collected from natural substrates was the highest recorded in the survey.

Sampling in the Armco Steel mixing zone at RM 105.8 yielded an ICI of 46 (exceptional range). The artificial substrate community was very similar to collections upstream and downstream from

the discharge and was not indicative of a toxic impact. The unusually low numbers of EPT taxa (6) collected from natural substrates was primarily related to deep water and lack of available habitat near the discharge. One concern was a thin surface sheen of oil often observed in the mixing zone during the late summer sampling period.

The Conesville EGS thermal discharge had no significant influence on the macroinvertebrates downstream at RM 101.9. The ICI of 48 was similar to the ICI of 50 found upstream from the discharge at RM 105.0.

Communities declined into the good range at RM 97.1 (ICI = 40), three miles downstream from the confluence with Wills Creek. The drop in scoring resulted from declines in EPT taxa (Metric 10) and percentages of caddisflies and Tanytarsini midges. Communities improved to the exceptional range downstream at RM 92.1, at the head of the Ellis Dam pool in Dresden.

The decline in the ICI at RM 97.1 was possibly related to mine drainage influences associated with the Wills Creek watershed. However, declining trends from upstream to downstream were apparent in natural substrate communities (qualitative sampling) beginning well upstream from Wills Creek (see Figure 1). These results suggest some additional stresses from upstream sources which may include, slowly decaying pulp mill wastes, excessive background enrichment in the lower reaches of the Tuscarawas River, and/or cumulative impacts from the series of point source discharges along the Muskingum River.

Wills Creek

A very good community was found at RM 5.2, downstream from Wills Creek Reservoir. Compared to additional stations upstream, a sharp increase in community density (4,232 organisms per square foot) and the abundance of net-spinning hydropsychid caddisflies (78.9% of total organisms) was observed downstream from the reservoir. Increases in filter-feeders are often associated with dam releases due to increased algal and plankton growth within the impoundments. For additional information, see *Biological and Water Quality Survey of the Wills Creek Basin* (Ohio EPA 1995a).

Licking River

Artificial substrates were collected from four Licking River sites from RMs 3.6 to 0.7, including the Burnham Corporation mixing zone at RM 1.9 South. Artificial substrate samples were also collected in 1993 between Dillon Reservoir and the mouth (RMs 5.5-0.7; Ohio EPA 1995b); results from both years are presented in Figure 12. ICI scores improved from the fair range at RM 5.5 to the exceptional range at RM 1.9 North (directly opposite the Burnham Corporation mixing zone) and RM 0.7. The hypolimnetic discharge from Dillon Reservoir was considered the major negative influence on the community at RM 5.5. The Burnham Corporation discharge appeared to have no significant impact.

Burnham Corporation mixing zone samples were collected from nondetectable current in a shallow section along the south side of the river. The ICI of 28 was lower than at other Licking River stations but this was considered primarily the result of slow current and a localized area of low habitat quality. The artificial substrate community included numerous mayflies (7 taxa, 26.4% of total organisms) and was not considered indicative of acutely toxic conditions.

Table 16. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the upper Muskingum River basin study area, July to September, 1994, 1988, 1984 and 1983. Licking River 1993 sites are included with the 1994 results.

Quantitative Evaluation

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	QCTV	ICI	Narrative Evaluation
			1994 RESULTS				
Tuscarawas River		*Western Allegheny Plateau - EWH Use designation*					
21.1	3094	33	58	18	38.9	52	Exceptional
7.1	13,675	35	62	18	37.1	50	Exceptional
3.8	14,546	32	57	17	39.1	44	Very Good
		Western Allegheny Plateau - WWH Use designation					
1.3	17,603	32	60	19	40.3	46	Exceptional
1.0 mz	*12,954*	*31*	*38*	*15*	*42.4*	*46*	*Exceptional*
0.7	23,379	36	46	13	38.6	44	Very Good
0.3	14,413	37	53	16	38.9	48	Exceptional
Walhonding River		*Western Allegheny Plateau - EWH Use designation*					
15.6	1,401	50	34	14	41.5	56	Exceptional
7.7	797	43	57	18	40.3	56	Exceptional
0.8	2,751	35	42	18	43.7	52	Exceptional
Muskingum River		*Western Allegheny Plateau - WWH Use designation*					
109.9	14,647	39	41	19	42.4	46	Exceptional
108.0	1,775	38	66	24	41.3	46	Exceptional
106.6	1,591	42	49	17	41.4	48	Exceptional
105.8 mz	*939*	*40*	*28*	*6*	*35.3*	*46*	*Exceptional*
105.0	1,820	41	59	14	38.2	50	Exceptional
101.9	2,771	39	56	17	37.8	48	Exceptional
97.1	2,455	39	55	10	37.7	40	Good
92.1	4,410	37	46	13	38.9	46	Exceptional
Wills Creek		*Western Allegheny Plateau - WWH Use designation*					
5.2	4,232	38	46	17		44	Very Good
Licking River		*Western Allegheny Plateau - WWH Use designation*					
5.5 (1993)	1,993	17	30	4	24.6	18*	Fair
3.6 (1993)	3,540	31	40	13	38.6	38	Good
3.6	2,298	41	40	11	38.6	36	Good
1.9 North	1,768	39	35	10	37.1	48	Exceptional
1.9 South mz	*532*	*43*	*9*	*3*	*40.3*	*28*	*Fair*
0.7	2,161	45	36	14	41.5	48	Exceptional

Table 16. (continued).

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	QCTV	ICI	Narrative Evaluation
			Quantitative Evaluation				
			1988 RESULTS				
Tuscarawas River		*Western Allegheny Plateau - EWH Use designation*					
21.1	2,635	38	45	14	37.1	52	Exceptional
19.6	2,341	36	53	16	38.9	52	Exceptional
10.7	2,395	37	44	13	39.1	56	Exceptional
3.8	2,716	32	37	13	41.1	48	Exceptional
		Western Allegheny Plateau - WWH Use designation					
0.3	5,939	37	47	12	36.8	36	Good
Walhonding River		*Western Allegheny Plateau - EWH Use designation*					
15.6	824	50	43	13	40.1	52	Exceptional
0.8	818	43	47	19	41.3	54	Exceptional
Muskingum River		*Western Allegheny Plateau - WWH Use designation*					
109.7	5,945	43	38	15	41.1	36	Good
108.4 mz	*1,698*	*39*	*37*	*16*	*39.9*	*38*	*Good*
106.4	2,710	42	37	13	37.8	50	Exceptional
105.7	1,402	37	39	15	38.9	52	Exceptional
105.0	3,456	34	45	16	40.3	52	Exceptional
102.8 mz	*2,493*	*36*	*33*	*13*	*38.9*	*46*	*Exceptional*
101.8	4,462	32	38	11	37.1	36	Good
97.2	3,526	26	47	12	38.2	44	Very Good
92.1	3,884	27	39	14	41.5	50	Exceptional
Licking River		*Western Allegheny Plateau - WWH Use designation*					
3.6	2,847	35	43	10	34.6	34	Marg. Good
1.9 North	2,699	34	34	11	37.8	42	Very Good
0.7	3,182	40	37	15	38.9	46	Exceptional
Wakatomika Creek		*Western Allegheny Plateau - EWH Use designation*					
12.4	1,292	41	45	13	38.5	46	Exceptional
11.7	1,854	37	40	6	25.8	26*	Fair
2.0	874	46	55	17	39.0	48	Exceptional
			1984 RESULTS				
Wakatomika Creek		*Western Allegheny Plateau - EWH Use designation*					
2.0	1,718	45	29	10	41.2	46*	Exceptional

Table 16.(continued).

Quantitative Evaluation

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	QCTV	ICI	Narrative Evaluation
			1983 RESULTS				
Tuscarawas River		*Western Allegheny Plateau - EWH Use designation*					
21.1	3,910	27	39	10	39.1	40	Good
18.4	1,378	27	39	12	39.9	42	Very Good
10.7	3,855	28	42	11	38.2	42	Very Good

Ecoregion Biocriteria: Western Allegheny Plateau -(WAP)

INDEX	WWH	EWH	MWH[b]
ICI	36	46	22

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

ns Nonsignificant departure from biocriterion (≤4 ICI units).

mz Mixing Zone results are presented in italics; biocriteria do not apply to mixing zone samples.

a Qual. EPT= total Ephemeroptera (mayflies), Plectoptera (stoneflies) and Trichoptera (caddisflies) taxa richness collected from the natural substrates using qualitative protocols.

b Modified Warmwater Habitat for channel modified areas.

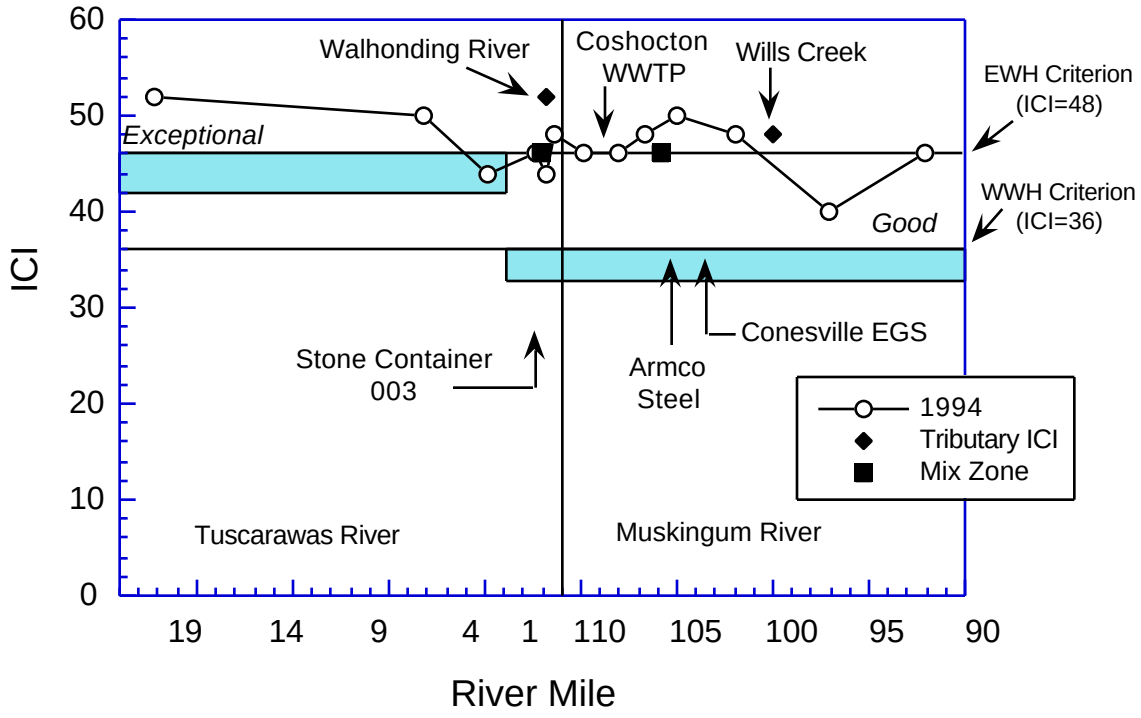

Figure 11. Longitudinal trend of the Invertebrate Community Index (ICI) by river mile for the Tuscarawas and Muskingum Rivers, 1994. Scores obtained near the mouths of the Walhonding River (EWH) and Wills Creek (WWH) are plotted for reference.

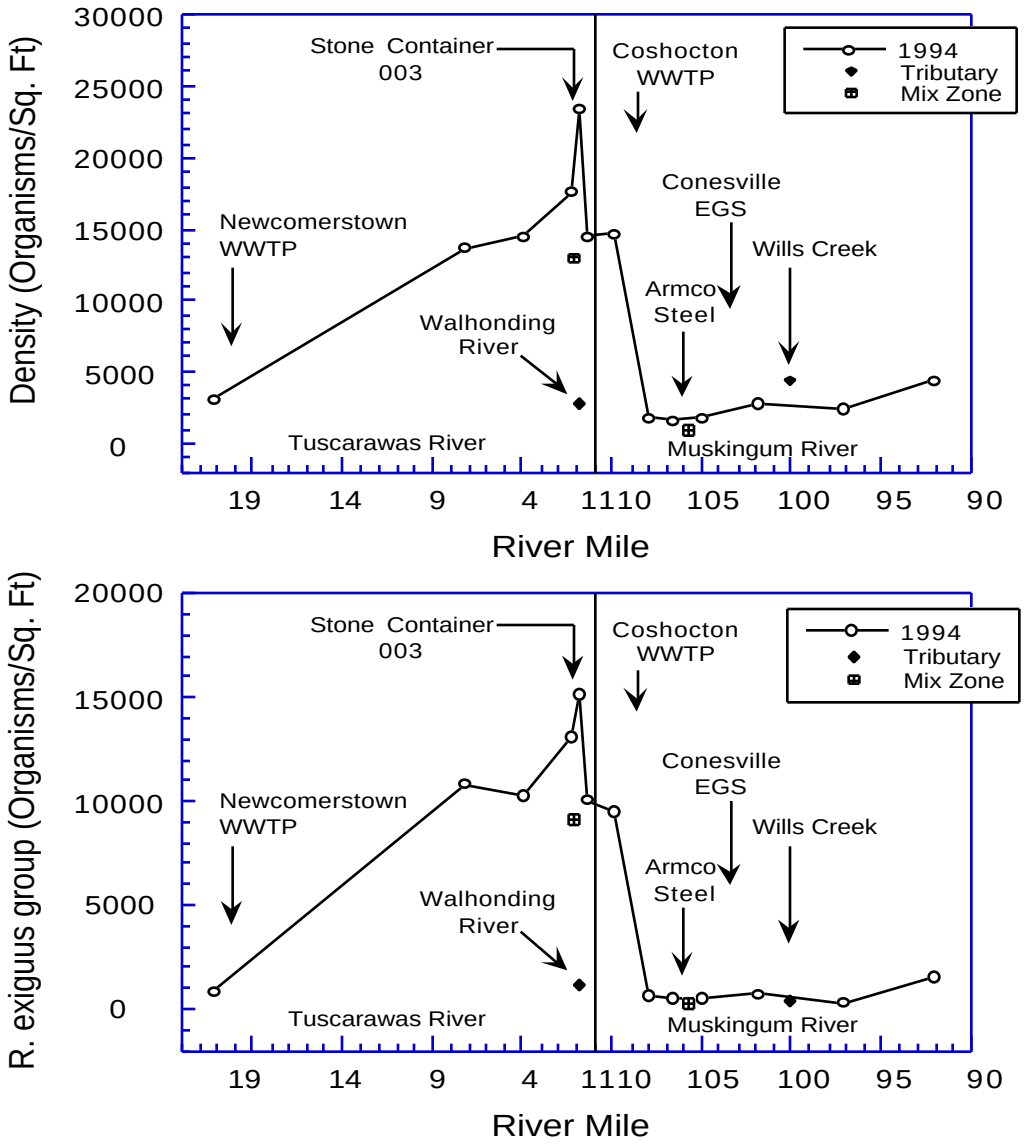

Figure 12. Longitudinal trends in community density (upper plot) and the density of *Rheotanytarsus exiguus* group midge larvae (lower plot) in the Tuscarawas and Muskingum Rivers, July-September 1994. Densities obtained near the mouths of the Walhonding River and Wills Creek are plotted for reference.

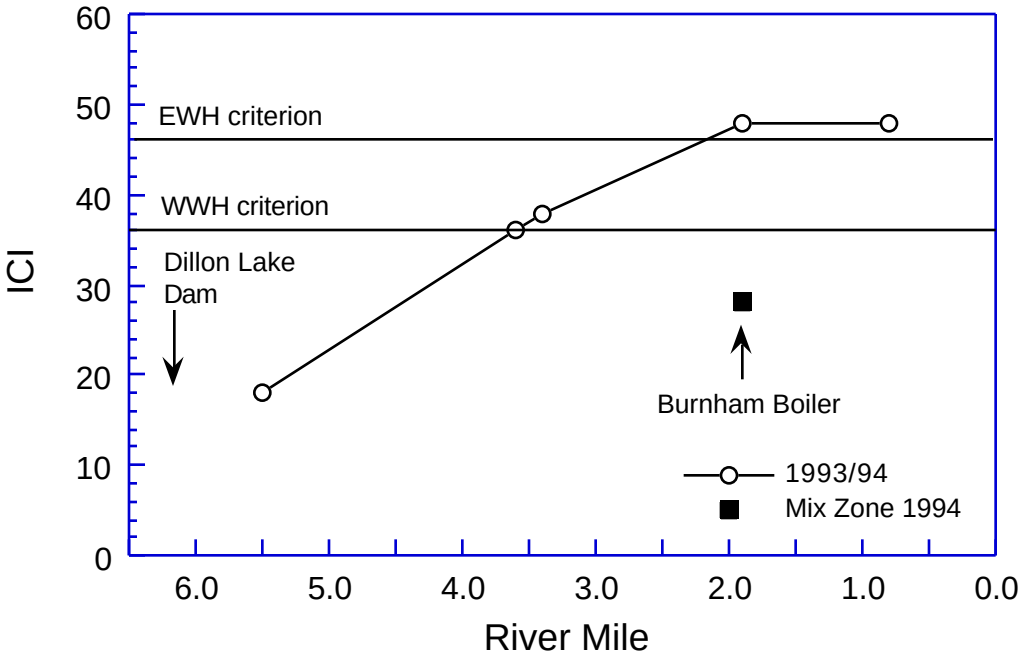

Figure 13. Longitudinal trend of the Invertebrate Community Index (ICI) by river mile for the Licking River, 1993 and 1994.

Biological Assessment: Fish Community

Tuscarawas River

Expectations of an exceptional fish community were not met at the two stations located in the reach designated as EWH upstream from Coshocton (RMs 7.2 and 3.6), but did meet WWH criteria (Figure 14). Physical habitat as measured by the QHEI was capable of supporting a fish community consistent with EWH criteria (Table 17), implying that water quality was limiting the performance of the fish community. Component metrics of the IBI that scored low for the two locations sampled were number of sunfish and intolerant species, and percent of round bodied suckers and top carnivores. All of those components are sensitive to turbidity. The Tuscarawas River was stained and turbid (secchi depth ~ 30 cm) on the first two sampling passes, which suggested an unidentified problem.

The fish communities at the three locations sampled in the reach designated WWH within the city limits of Coshocton met the ecoregional biocriteria (Table 17, Figure 14). Immediate toxic impacts within the Stone Container mixing zone were not detected, nor were impacts found in the zone immediately downstream.

Cumulatively, forty-three species were recorded for six stations sampled in the lower Tuscarawas River. Several pollution intolerant species were recorded, notably river and streamline chubs, silver shiner, stonecat madtom, and banded and variegate darters. However, all of these species were very low in relative abundance, except banded darter. Also, the widely distributed, but highly intolerant black redhorse, rosyface shiner and bigeye chub, were absent from all samples. The low relative abundance of intolerant species demonstrated that a water quality problem existed, but their presence indicated that fish assemblages in the lower Tuscarawas (including those in the reach within Coshocton) have the potential to achieve EWH. The mean MIwb at RM 0.8 showed nonsignificant departure from EWH, and one MIwb and IBI score from RMs 7.2 and 3.6, respectively, met EWH criteria, confirming the exceptional potential. The nature of the water quality problem was unidentified but may be symptomatic of the Tuscarawas River reaching or exceeding its assimilative capacity. Species lists and relative abundance data by station for all stations sampled in the upper Muskingum River survey are located in Appendix D.

Walhonding River

Expectations for an exceptional fish community were realized at all stations sampled in the Walhonding River (Table 17). Bluebreast darter and river redhorse, species listed respectively as threatened and of special interest by the State of Ohio were well represented in samples collected from the two upstream sites. Bigeye chubs were found only at the site downstream from Mohawk Dam. Although the fish community met EWH criteria at RM 1.2 in Roscoe Village, species least tolerant of pollution (*e.g.*, bluebreast darter, silver and rosyface shiners, black and river redhorse, and streamlined chub) were absent or rare when compared to the upstream locations. The results suggested increasing nonpoint source impacts from flood plain agriculture and urbanization in proximity to Coshocton.

Muskingum River

Upper Muskingum River fish communities generally achieved WWH criteria (Table 17), and marginally achieved EWH at RM 108.0, downstream from the Coshocton WWTP. Fish community performance in the vicinity of Coshocton may have been promoted by the exceptional quality of the nearby Walhonding River. However, community performance decreased progressively downstream, failing to meet and partially meeting WWH criteria at RMs 98.3 and

91.8, respectively (Figure 14). A loss of intolerant species (Figure 15-lower plot) and a decrease in the percent composition of round bodied suckers from upstream to downstream accounted for the decreasing trend in metric scores. Round bodied suckers were increasingly supplanted by carp in downstream samples (Figure 15-upper plot). The decreasing trend in community performance was not related to changes in habitat quality as QHEI scores did not markedly differ between sites (Table 15 and 17; Figure 1, Figure 16). Moreover, no grossly observable evidence of nonpoint influences (*e.g.*, siltation, nutrient enrichment, septic leaching) were noted in the QHEI attributes.

Four major entities discharge into the upper Muskingum River mainstem: Stone Container (via the Tuscarawas River), the Coshocton WWTP, Armco Steel, and the Conesville Electric Generating Station (EGS). The fish community was depressed in the Armco Steel mixing zone but this was considered more related to marginal habitat quality than a toxic impact. Armco Steel was not considered responsible for the declining trend since it started upstream from the discharge, and recovery of the fish community to upstream levels was found below the mixing zone. Similarly, the Conesville EGS did not appear to impact the fish community given that the trend started upstream from the plant. The fish community performed at nearly exceptional levels immediately downstream from the Coshocton WWTP and the discharge was considered a relatively small source of nutrient loadings when compared to contributions from Stone Container upstream. The steady loss of pollution intolerant species and decrease in relative number of intolerant individuals downstream from Stone Container discharges suggest that the effluent was in some way responsible. However, direct acute toxicity does not appear to be implicated. Shifts in community composition of benthic macroinvertebrates and fishes due to changes in trophic conditions caused by pulp effluents have been documented (Kovacs 1986), and could account for those observed in the Muskingum River. Also, the cumulative influences of point source discharges and background enrichment in the Tuscarawas River may contribute to the declining trends observed.

Wills Creek

Although the quality of the habitat at RM 98.3 of the Muskingum River was better than that found at the mouth Wills Creek (Table 17), the fish communities in Wills Creek and the Muskingum River performed similarly. The habitat at the mouth of Wills Creek was sufficient to fully support a WWH community. However the MIwb and IBI scores for the fish community only marginally achieved WWH criteria (Table 17), implying degraded conditions. These results however, are not unlike those obtained from other large river tributaries in Ohio. The lower section of Wills Creek is periodically flooded by the Muskingum River which in turn impacts the fauna.

Licking River

Good to exceptional assemblages of fishes were sampled at three sites and one mixing zone in the lower Licking River (Table 17, Figure 17). No toxic impacts associated with the Burnham Corporation effluent were detected, although one of the outfalls (apparently the sanitary discharge) smelled of raw sewage. The low relative abundance of pollution tolerant species and low frequency of DELT (deformity, lesion and tumor) anomalies in the fish population indicated that chemical pollution was not severe. However, two components of the IBI sensitive to minor degradations of water quality, percent round bodied suckers and number of intolerant species, scored low. The lower reaches of the Licking River become increasingly urbanized near Zanesville. Moderate silt cover was noted in the lower two miles and the RM 0.8 site was downstream from two urban tributaries; Joes Run drains the highly urbanized North Zanesville area and Timber Run receives highway runoff from US 40 and I-70. For fish communities in the lower Licking River to continue to perform at exceptional levels, no further deterioration in water or habitat quality can be tolerated.

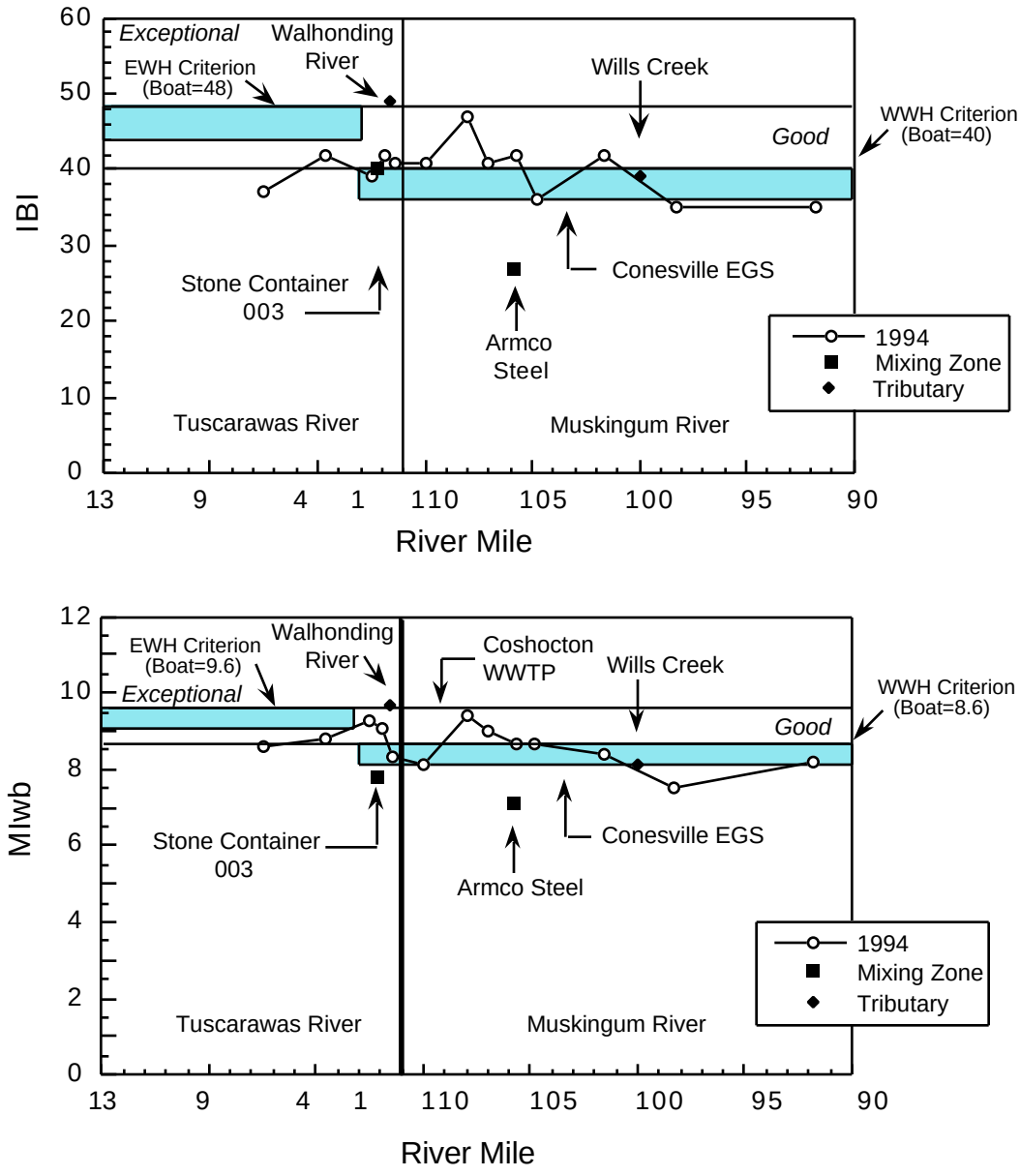

Figure 14. Longitudinal trend of the Index of Biotic Integrity (IBI) and Modified Index of Well-being (MIwb) scores by river mile for the Tuscarawas and Muskingum Rivers, 1994. Scores obtained near the mouth of the Walhonding River and Wills Creek are plotted for reference.

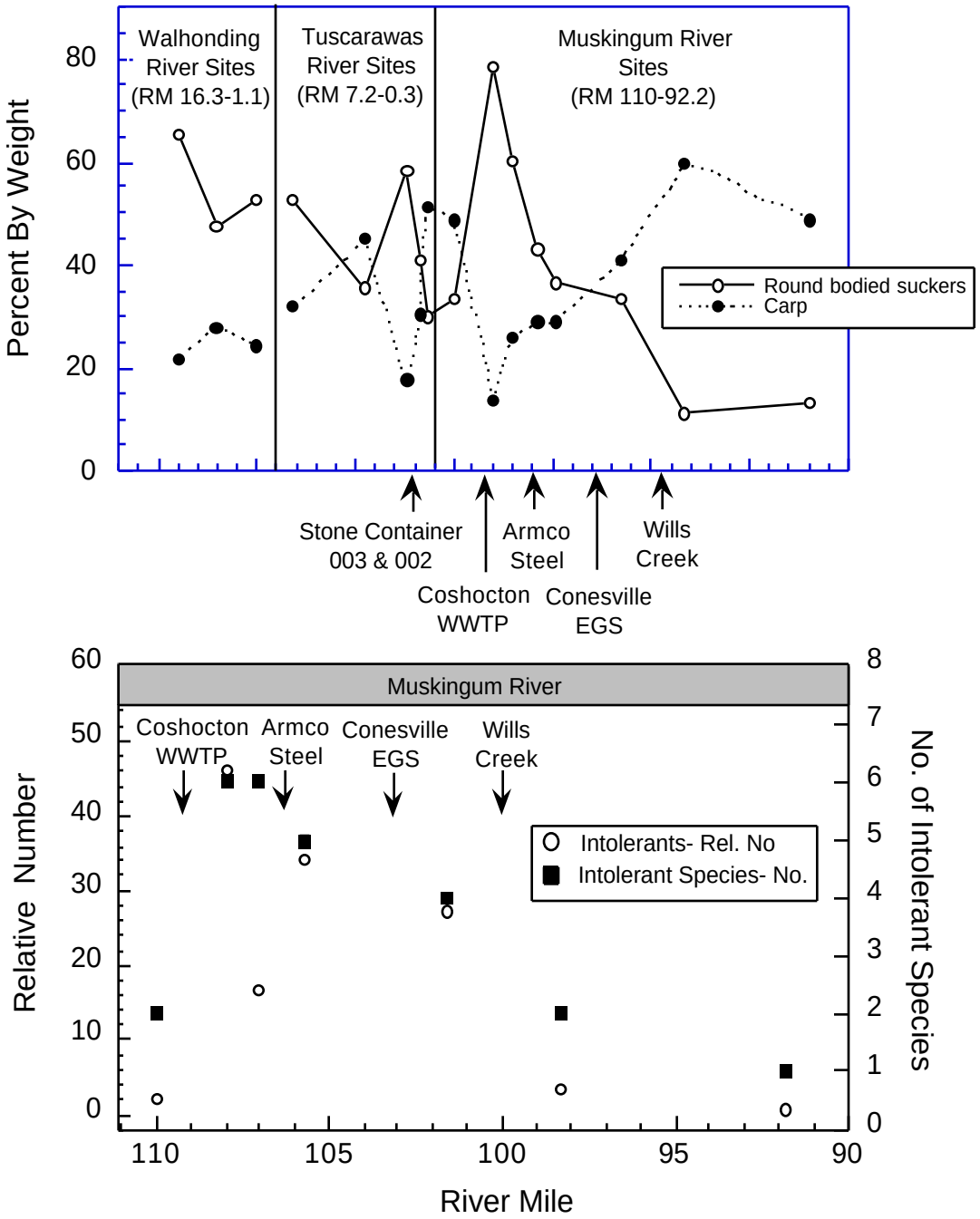

Figure 15. Percent composition of round bodied suckers and carp by river mile in the Walhonding, Tuscarawas, and Muskingum Rivers (upper plot:). Relative number of intolerant fish (right axis) and number of intolerant fish species (left axis) sampled by river mile in the Muskingum River, 1994. The sites at RMs 110.0 and 92.0 did not have well defined riffles; all other locations had well defined riffles and comparable habitat (lower plot).

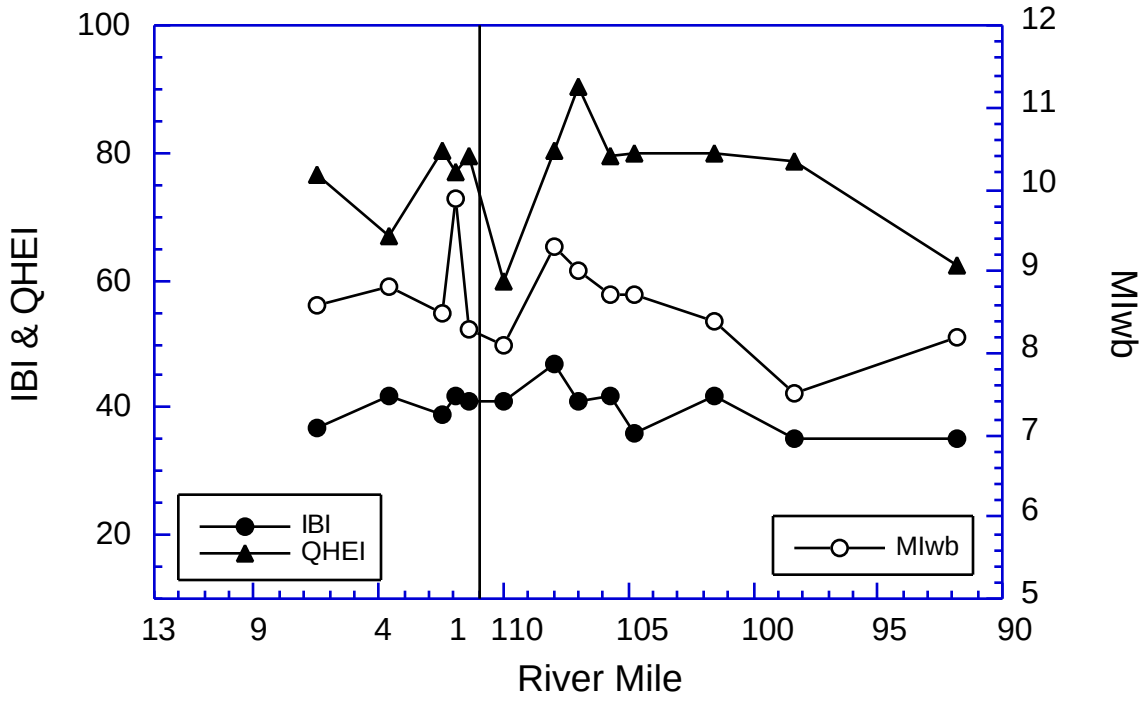

Figure 16. A comparison of IBI, MIwb, and QHEI scoring trends in the Tuscarawas River and Muskingum River, 1994.

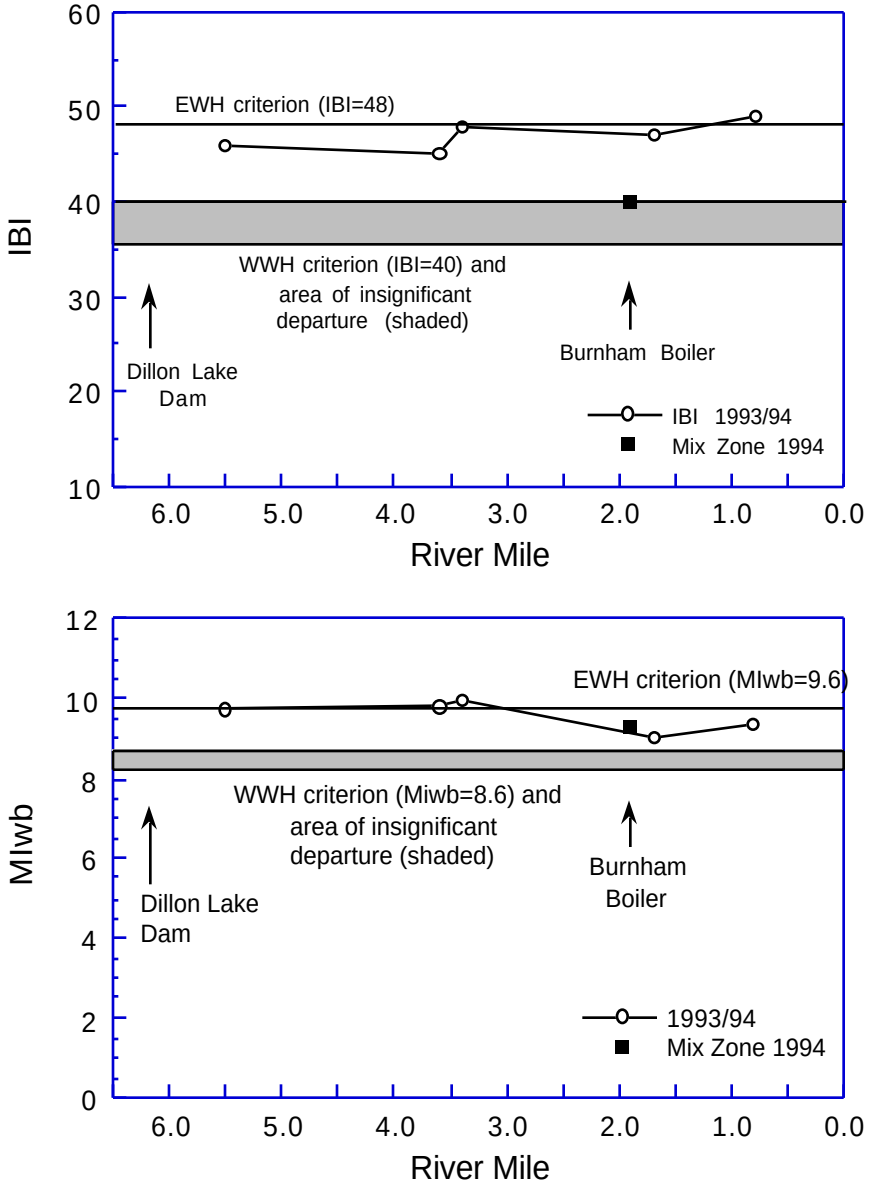

Figure 17. Longitudinal trend of the IBI (top) and MIwb (bottom) by river mile for the Licking River, 1994.

Table 17. Fish community indices for sites in the Upper Muskingum River drainage, 1994 to 1983.

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Tuscarawas River (1994) *Western Allegheny Plateau- EWH Use Designation*								
7.2	17.6	24	525	93	76.5	8.6*	37*	Good/M.G
3.6	22.0	30	530	70	72.0	8.8*	42*	Good
Western Allegheny Plateau-WWH Use Designation								
1.4	21.0	28	462	99	80.5	9.3	39ns	V.Good/M.G
1.0mz	*10.0*	*18*	*766*	*88*	*NA*	*7.8*	*40*	*Fair/Good*
0.8	20.0	24	417	91	77.0	9.1	42	Excep./Good
0.3	19.0	29	245	104	79.5	8.3ns	41	M.G/Good
Tuscarawas River (1989) *Western Allegheny Plateau- EWH Use Designation*								
6.3	17.0	17	221	102	--	9.3ns	46ns	V.Good
Tuscarawas River (1988) *Western Allegheny Plateau-EWH Use Designation*								
6.9	18.5	25	560	126	69.5	8.7*	45ns	Good/V.G
Western Allegheny Plateau-WWH Use Designation								
0.6	14.0	18	316	190	89.0	7.9*	30*	Fair
Tuscarawas River (1987) *Western Allegheny Plateau- EWH Use Designation*								
2.4	18.0	18	380	147	--	8.2*	32*	M.Good/Fair
Western Allegheny Plateau-WWH Use Designation								
0.4	18.0	18	214	204	--	8.9	36ns	Good/M.G
Tuscarawas River (1983) *Western Allegheny Plateau- EWH Use Designation*								
6.9	20.0	28	716	97	67	8.7*	34*	Good/Fair
Western Allegheny Plateau-WWH Use Designation								
0.3	20.5	28	449	185	76	7.8*	35*	Fair
Muskingum River (1994) *Western Allegheny Plateau-WWH Use Designation*								
110.0	18.0	24	252	116	60	8.1ns	41	M.G./Good
108.0	22.3	30	409	152	81	9.4	47	V.Good
107.0	18.7	24	385	104	91	9.0	41	Good
105.8mz	*8.7*	*19*	*276*	*204*	*NA*	*7.1*	*27*	*Fair/Poor*
105.7	19.3	29	341	100	80	8.7	42	Good
104.8	18.0	22	394	79	80	8.7	36ns	Good/M.G.
101.6	19.0	26	468	76	80	8.4ns	42	M.G./Good
98.3	18.0	28	230	97	79	7.5*	35*	Fair
92.2	16.3	22	250	172	63	8.2ns	35*	M.G./Fair
Muskingum River (1988)								
110.0	21.5	27	870	134	65.0	8.2ns	43	M.G./Good
108.5	24.5	33	1,123	71	76.0	8.3ns	47	M.G./V.G
106.6	18.0	26	1,089	54	74.0	8.2ns	34*	M.G./Fair
105.8	19.7	26	423	46	76.0	8.7	38ns	Good/M.G.
104.9	21.7	30	793	120	77.0	8.4ns	43	M.G./Good

Table 17. (continued).

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Muskingum River (1988) continued								
102.5	16.7	25	607	51	71.0	7.6*	31*	Fair
101.7	19.0	25	643	50	78.0	8.3[ns]	33*	M.G./Fair
98.2	17.3	23	381	69	83.0	7.7*	34*	Fair
92.0	19.3	27	758	298	62.0	8.8	39[ns]	Good/M.G.
Muskingum River (1987)								
109.3	18.0	18	298	141	--	8.4[ns]	28*	M.G./Fair
105.2	18.0	18	431	92	--	8.7	36[ns]	Good/M.G.
Walhonding River (1994)	*Western Allegheny Plateau- EWH Use Designation*							
16.3	30.6	49	571	117	83	10.4	53	Exceptional
8.0	28.3	42	857	173	86	9.8	51	Exceptional
1.1	29.3	36	509	113	83	9.7	49	Exceptional
Walhonding River (1988)								
15.8	18.5	23	575	75	72	8.9*	49	Good/Excep.
1.2	30.5	35	1,026	121	94	10.0	49	Exceptional
Walhonding River (1983)								
8.0	18.0	28	238	85	91	8.7*	45[ns]	Good/V.G.
1.2	17.7	28	246	`76	94	8.7*	41*	Good
Licking River (1994)	*Western Allegheny Plateau - WWH Use Designation*							
3.6	27.0	37	584	172	81	9.8	45	Excep./V.G.
1.9[mz]	*19.0*	*28*	*2,516*	*107*	*NA*	*9.3*	*41*	*V.G./Good*
1.7	27.3	40	551	72	79	9.0	47	Good/V.G.
0.8	27.7	36	596	87	79	9.4	49	V.G./Excep.
Licking River (1993)	*Western Allegheny Plateau - WWH Use Designation*							
5.5	27.0	32	798.0	150.8	72.5	9.7	46	Excep./V.G.
3.4	24.5	31	592.9	161.9	76.5	9.9	48	Exceptional
Licking River (1988)								
3.6	25.0	35	615	151	85	9.2	40	V.G./Good
0.8	26.7	36	748	136	--	9.5	43	V.G./Good
Wills Creek (1994)	*Western Allegheny Plateau - WWH Use Designation*							
0.3	23.7	28	363	101	66	8.1[ns]	39[ns]	Marg. Good
Wills Creek (1988)								
0.3	26.0	32	958	108	72	8.9	44	Good
Wakatomika Creek (1994)	*Western Allegheny Plateau- EWH Use Designation (Recommended)*							
32.0	30.0	34	NA	NA	82.0	NA	54	Exceptional

Table 17. (continued).

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Wakatomika Creek (1994) continued								
			Western Allegheny Plateau- EWH Use Designation (Existing)					
14.8	30.5	35	1106	21.4	88.0	9.8	54	Exceptional
12.5	34.5	39	749	9.5	74.0	9.6	51	Exceptional
11.8	31.0	38	962	28.2	66.0	9.8	54	Exceptional
2.1	25.0	25	821	21.5	77.5	9.3[ns]	52	Exceptional
Wakatomika Creek (1988)								
			Western Allegheny Plateau- EWH Use Designation (Existing)					
14.9	29.0	29	1440	19.8	92.0	9.6	54	Exceptional
12.5	33.0	33	791	10.8	59.0	9.7	51	Exceptional
11.8	35.0	35	951	63.6	61.0	9.6	54	Exceptional
2.0	32.5	42	860	24.2	78.0	9.6	52	Exceptional
Wakatomika Creek (1984)								
			Western Allegheny Plateau- EWH Use Designation (Existing)					
2.0	29.5	40	979	52.7	59.0	9.5	49[ns]	Excep./V. G.
Fivemile Run (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
1.5	23.0	23	1,213	NA	75.0	NA	56	Exceptional
Winding Fork (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
1.8	31.0	31	1,258	NA	74.5	NA	58	Exceptional
Brushy Fork (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
3.5	17.0	17	1,429	NA	56.0	NA	50	Exceptional
Moscow Brook (1994) *Western Allegheny Plateau- WWH Use Designation (Recomended)*								
0.3	15.0	15	1,050	NA	60.0	NA	40[ns]	Marg. Good
Bucklew Run (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
0.1	24	24	1,314	NA	50.5	NA	50	Exceptional
Big Run (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
0.2	22	22	1,403	NA	52.0	NA	52	Exceptional
Mill Creek (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
8.5	26	27	NA	NA	56.5	NA	48[ns]	Very Good
0.7	33	33	1,167	NA	61.0	9.3	58	Exceptional

Table 17. (continued).

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Beaver Run (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
5.0	13	13	1,375	NA	57.5	NA	50	Exceptional
Spoon Run (1994) *Western Allegheny Plateau- WWH Use Designation (Recomended)*								
0.6	17	17	2,130	NA	50.0	NA	40[ns]	Marg. Good
Turkey Run (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
0.2	20	20	2,864	NA	65.0	NA	50	Exceptional
Little Mill Creek (1994) *Western Allegheny Plateau- EWH Use Designation (Recomended)*								
0.1	22	22	2,226	NA	61.0	NA	56	Exceptional

a Narrative evaluation is based on applicable biological criteria.
ns Nonsignificant departure from applicable biological criteria (≤4 IBI units or ≤0.5 MIwb units).
* Significant departure from WWH or EWH biological criteria (>4 IBI units or >0.5 MIwb units); underlined values are in the poor or very poor range.
mz Mixing zone sample.
NA Not Applicable

Ecoregion Biocriteria: Western Allegheny Plateau

INDEX - Site Type	WWH	EWH	MWH[b]
IBI - Boat	40	48	24
Mod. Iwb - Boat	8.4	9.6	5.8
IBI - Headwaters	44	50	24
IBI - Wading	42	50	24
Mod. Iwb - Wading	8.4	9.4	6.2 5.5[c]

b - Modified Warmwater Habitat for channel modified areas.
c - Modified Warmwater Habitat for mine affected areas.

Other Muskingum River Basin Tributaries

Mill Creek Subbasin

This basin was chosen to investigate potential nonpoint source (NPS) problem areas and to reevaluate the outdated Limited Warmwater Habitat (Mine Drainage) aquatic life use designation. In addition to inactive surface mining, the basin has high agricultural usage and row crops were adjacent to most stream channels (see Table 2). In the headwaters of Turkey Run, Stone Container Corp. maintains an abandoned landfill/strip pit that has received some solid waste from the Coshocton Mill. Runoff from the site is regulated by NPDES permit and has recorded numerous exceedences for suspended solids (see Pollutant Spill and Wild Animal Kills, page 41).

Chemical sampling was conducted at two sites on Mill Creek (RMs 8.51 and 0.43) and one site on Little Mill Creek (RM 0.68), Spoon Creek (RM 0.62) and Turkey Run (RM 0.19). Sampling results are found in Appendix B. Fish were sampled once near the chemical sampling locations in August and September, 1994 (Table 17; Appendix D) Electro-shocking equipment and the wading method were employed. Approximately 150 meters of stream were sampled and all fish not saved as voucher specimens were returned to the stream.

Chemical Water Quality

Spoon Creek showed evidence of localized problems of habitat degradation by unrestricted cattle access. BOD_5 measurements of 15 and 30 mg/l were reported. In addition, maximum values of nitrite-nitrate (1.34 mg/l), ammonia (1.36 mg/l), TDS (576 mg/l) and TSS (576 mg/l) were well above maximum results reported for the rest of the basin.

The 1,000 mg/l WQS aquatic life criterion for iron was exceeded in 70% of the samples collected in the basin (21 of 30). Elevated background levels of iron are common in Ohio streams and these concentrations are generally not indicative of significant water quality problems. However, sampling in Spoon Creek included two exceedences of the Agricultural Water Supply iron criterion ($\geq$5 ,000 mg/l) with a maximum value of 19,700 mg/l. These concentrations indicated significant NPS influences from cattle disturbance and possibly mine drainage, beyond normal background conditions. Contrary to the rest of the basin, Turkey Run samples exceeded the limit only once, suggesting minimal influence from nonpoint sources.

Except for iron in Spoon Run, heavy metals were not a concern within the basin. Cadmium, chromium, and nickel were not detected above minimum detection limits. One copper (Spoon Creek) and four arsenic samples (three for Spoon Creek) were at or slightly above detection limits. Lead and zinc concentrations above detection limits were occasionally detected throughout the basin.

Fish Community/Physical Habitat Assessment

Mill Creek at RM 8.5 was located immediately upstream from Little Mill Creek. The IBI of 48 was in the very good range with 26 species collected. Intolerant species included American brook lamprey, banded darter and redside dace while moderately intolerant logperch, smallmouth bass, northern hog sucker and golden redhorse were also found. The site was less turbid and had a more intact riparian corridor than the downstream site at RM 0.7. Stream substrates were predominantly sand and small gravel and riffles had good current but were uncommon. The QHEI score was 56.5.

Mill Creek at RM 0.7 was located adjacent to SR 83. The IBI of 58 was within two points of the

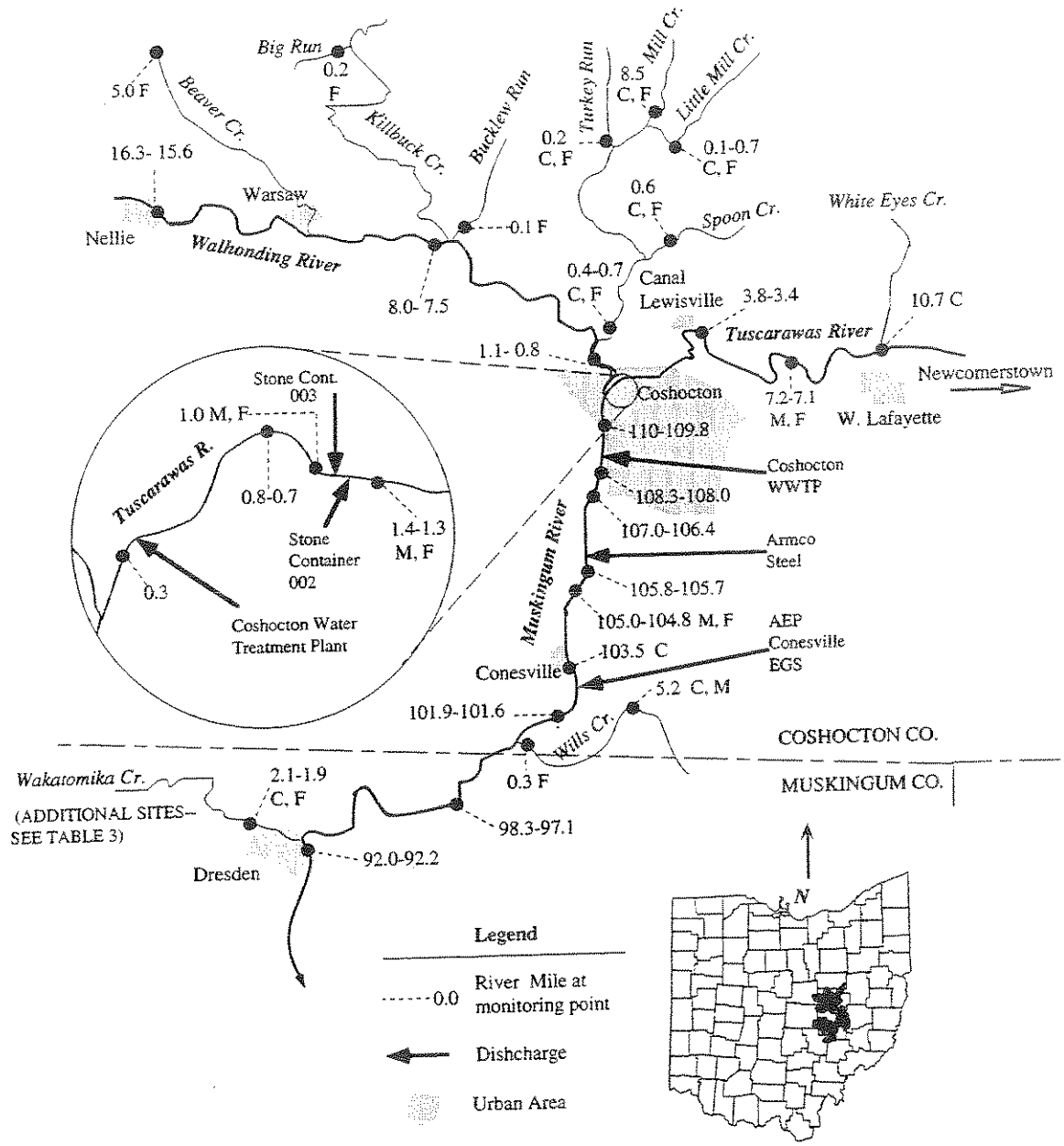

Figure 2. The upper Muskingum River study area showing principal streams and tributaries, population centers, and pollution sources. All sampling locations include chemical (C), fish (F), and macroinvertebrate (M) sampling unless otherwise indicated.

maximum IBI score (60) and 34 species were collected. Pollution intolerant species included banded darter, eastern sand darter, stonecat madtom, and black redhorse. Species considered moderately intolerant of pollution were silver, golden and shorthead redhorse, northern hog sucker, logperch and smallmouth bass. Yellow perch and saugeye collected at this site probably migrated from the Walhonding River. The community exhibited exceptional diversity and biological health. This site had a QHEI of 61 and contained excellent pools with good depth, riffles having large boulders, cobble and slabs and good current. The riparian corridor was narrow to very narrow, offering little bank stability. Despite the proximity of SR 83 to the east and encroachment of row crop corn to the west, impacts from agricultural, siltation and road runoff were minimal and appeared limited to some reductions in habitat quality.

Little Mill Creek was sampled near the confluence with Mill Creek at RM 0.1. The IBI of 56 reflected exceptional quality and included 22 species. Intolerant species were silver shiner, banded darter and redside dace. Moderately intolerant species found were smallmouth bass, northern hog sucker and golden redhorse. This small stream was clear and had good flow, current, and deep pools. The riparian corridor was composed of mature trees scattered throughout a fenced pasture. Damage to the streambed or banks from cattle was minimal. The stream substrate was mostly sand and gravel, offering marginal habitat diversity for bottom-dwelling fish. A QHEI score of 61 was calculated.

Turkey Run, a small headwater tributary to Mill Creek, was sampled at RM 0.2. The IBI of 50 met the exceptional criterion and the sample included 20 species. Collections included a single intolerant species (redside dace) and two moderately intolerant species (smallmouth bass and northern hog sucker). Stream gradient was measured at 29 ft./mi., the highest within the study area. This stream appears to have been channelized but has largely recovered. Some sinuosity has developed within the channel and shrubs and willows have grown up along the banks. Good flow volume and current existed but few substrate types were noted besides sand, gravel and small cobble. A QHEI of 65 was calculated for the site.

Spoon Run was the tributary to Mill Creek most significantly impacted by nonpoint source pollution. The segment at RM 0.6, just downstream from Coshocton Co. Rd. 193, was in the middle of a dairy farm and cattle were frequently seen in the stream. Seventeen species were collected and an IBI of 40 (marginally good range) was scored. Two intolerant species, redside dace and silver shiner, were identified and 2 moderate intolerants, golden redhorse and northern hog sucker, were collected as well. Many blacknose dace collected at this site were very heavily infected with blackspot, almost to the point of non recognition. This may be due to the abundance of aquatic snails, an intermediate host of the aquatic trematode that causes blackspot. The stream flows through a fenced pasture but scattered mature trees provided some shade. Other than some small willows and an occasional mature tree growing along the creek, little riparian habitat existed. Deep pools were found to contain much silt and some slower riffles were also silted. The QHEI of 50 reflected the marginal habitat conditions.

Wakatomika Creek Basin

The Wakatomika Creek study area extended from River Mile 32.0 in Licking Co. to R.M. 1.9 near Dresden in Muskingum Co. Specific objectives of the survey were to evaluate the Frazeysburg WWTP at RM 12.32 and determine aquatic life use designation status in the relatively unmonitored upper Wakatomika Creek mainstem. Several tributaries in the watershed (Moscow Brook, Brushy Fork, Winding Fork, and Fivemile Run) were also assessed to determine if present stream classifications were appropriate. These evaluations were made by collecting and assessing both

chemical samples (Ohio EPA file data) and fish communities (Table 17, Appendix D). A more detailed description of the basin can be found in the Study Area Description section on pages 15-18 (Table 2; Figure 2).

Frazeysburg Wastewater Treatment Plant

The village of Frazeysburg operates a 0.18 MGD wastewater treatment plant that discharges to Wakatomika Creek at RM 12.32. The average daily discharge to Wakatomika Creek for January, 1993 through December, 1994 was 0.143 MGD. Current treatment includes screening, aeration, settling, polishing and ultraviolet disinfection. Sludge is stored in a holding basin until it can be land applied. The biolac treatment system was constructed in 1990 and replaced an extended aeration package plant. At this time, the village has no significant industrial users.

Prior to the upgrade in 1990, the Frazeysburg WWTP had an extensive history of NPDES exceedences. From 1989-94, almost all permit violations recorded for TSS (28), $CBOD_5$ (23), dissolved oxygen (25) and fecal coliform bacteria (17) occurred in 1989. Since that year no exceedences were reported until 1993, when dissolved oxygen and suspended solids were occasionally out of compliance with permit limits.

Chemical Water Quality

Results from two chemical runs at five Wakatomika Creek mainstem stations revealed no water quality exceedences. Heavy metals, nutrients, bacteria and demand parameters such as BOD_5 and TSS were well below WQS criteria. Tributary samples were also within water quality standards although, elevated levels of conductivity, dissolved solids, sulfate and several heavy metals were detected at the mouth of Moscow Brook (RM 0.1). Moscow Brook was previously designated as Limited Warmwater Habitat - Mine Drainage and the concentrations were considered a result of past mining activities.

Physical Habitat for Aquatic Life

QHEI evaluations were made for each fish sampling site and all scored well. Scores ranged from 66.0 at RM 11.8 to 88.0 at RM 14.8 for an average of 77.5. The scores represent habitat conditions capable of supporting exceptional quality communities. All sites had very diverse habitats with good to excellent riffle-pool formation, deep pools, swift deep riffles, varied cobble/gravel/boulder/slab substrates, and stable banks. The stream flows through a heavily agricultural valley but the riparian corridor has remained largely intact. With the exception of RM 31.8, which was adjacent to a township road, all riparian widths were moderate or wider (10-50 meters or greater).

Fish Community Assessment

Fish assessments at all Wakatomika Creek mainstem sites confirmed the presence of diverse, healthy and stable communities; IBI and MIwb scores were consistently in exceptional ranges (Table 17). Carp, the only exotic species collected, were relatively uncommon and predators such as northern pike and smallmouth bass were well represented. Darters were also abundant in numbers and species; 6-8 species were collected at most sites. The sample from RM 2.1 included 12 species, including bluebreast darter, previously unrecorded in the watershed, and the eastern sand darter, first collected at RM 2.1 in 1988 and reconfirmed in 1994. Both species are considered rare and pollution intolerant. Other pollution sensitive species from Wakatomika Creek included greenside, variegate, banded, rainbow, logperch and dusky darters, smallmouth bass, longear sunfish, American brook lamprey, golden, black, silver and shorthead redhorse, river and gravel chub, sand, mimic, silver and rosyface shiner, northern hog sucker and stonecat madtom.

Moscow Brook, a tributary of Mill Fork of Little Wakatomika Creek, was of good quality and should be upgraded from the current Limited Warmwater Habitat (LWH) classification to WWH. While chemical sampling detected elevated levels of some mine drainage parameters, fish revealed a stable community (15 species) with an IBI of 40 (marginally good range). The QHEI of 60 indicated physical habitat conditions were capable of supporting WWH communities.

Brushy Fork at RM 3.5 had an IBI of 50 (exceptional quality) and is recommended for a classification upgrade. The QHEI of 56 reflected physical habitat quality capable of supporting WWH communities but is not normally associated with an EWH designation. Furthur downstream, severe nonpoint source degradation due to poor cattle-grazing practices was observed near the mouth. EWH criteria would probably not be met in these physically degraded sections of the stream.

Individual stations on Winding Fork (RM 1.5) and Fivemile Run (RM 0.9) yielded communities clearly in the exceptional range (IBIs = 56). Both communities were diverse with 21 and 23 species from Winding Fork and Fivemile Run, respectively. Physical habitat conditions were also of high quality with QHEI scores of 78 in Winding Fork and 75 in Fivemile Run. Based on these results, both streams should be upgraded from the current WWH use designation to EWH.

Trend Assessment

Since a previous water quality survey in 1984, the 1990 upgrades at the Frazeysburg WWTP have resulted in less impact from sewage in Wakatomika Creek. Although never very high, BOD_5, nitrate, ammonia and total phosphorus were all lower during the 1994 survey than in 1988 (Figure 18). In 1994, each parameter was at or below detection limits except a single phosphorus measurement at RM 0.9 (0.43 mg/l). Historical data for fecal coliform bacteria were not available but no violations were detected in 1994 during three sampling runs. Variations in bacteria concentrations were random and the single highest value was just upstream from the Frazeysburg WWTP. Nitrate concentrations in 1994 were also significantly lower than in 1984, when the highest mean and maximum values were noted at RM 1.2 (0.98 mg/l and 2.77, respectively). The highest nitrate value found in 1994 was 0.56 mg/l at RM 11.32, immediately downstream from the Frazeysburg WWTP.

Fish sampling was conducted in Wakatomika Creek at six stations from RM 14.9-2.0 in 1988 and RM 2.0 in 1984 (Table 17). Compared to 1994 sampling, IBI and MIwb scores were consistently in the exceptional ranges during each survey. Several species collected in 1994 that were not seen previously included bluebreast darter, northern pike, sauger and saugeye. Species collected during previous surveys but not found in 1994 included river redhorse, quillback carpsucker, black crappie, white crappie and spotted bass.

Additional Tributaries

Fish sampling was conducted at three additional tributaries in the Walhonding River basin. Beaver Run and Bucklew Run are Walhonding River tributaries that enter the mainstem at RMs 10.86 and 7.32, respectively. Big Run enters Killbuck Creek, a Walhonding River tributary, at RM 18.23. All three sites yielded exceptional quality communities (Table 17) but had comparatively low habitat quality with QHEIs ranging from 50.5 to 57.5. Based on demonstrated attainment of the EWH aquatic life use criterion, an upgrade from WWH to EWH was considered most appropriate for all three streams.

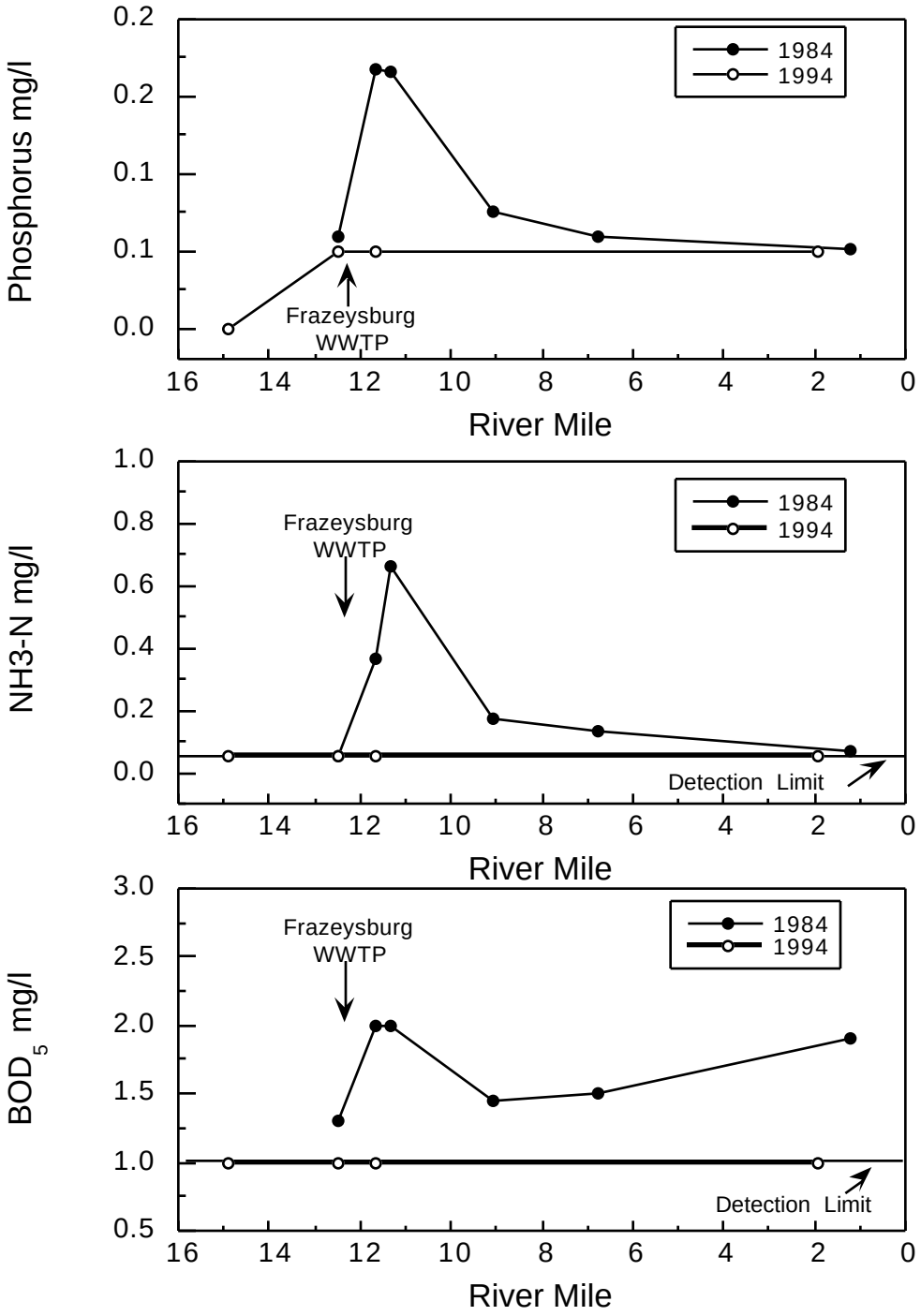

Figure 18. Longitudinal trend of phosphorus, ammonia-N (NH_3-N), and biochemical oxygen demand in Wakatomika Creek, 1984-1994.

TREND ASSESSMENT

Chemical, Physical Water Quality Changes; 1988-1994

In 1988 the Muskingum and Lower Tuscarawas Rivers were sampled but there was no report written. In this section the mean values from that study and the current study will be reviewed.

Most of Ohio suffered various degrees of drought severity in 1988. Flows in the lower Tuscarawas River and upper Muskingum River showed indications of this drought, especially during early July (Figure 19). Flows dropped below the 80% duration (470-890 cfs at Newcomerstown and Coshocton, respectively) for much of the summer and neared Q_{7-10} during July. At times there were tremendous flow variations because of rainfall events. In contrast, summer flows during the 1994 study and a 1989 continuous monitor survey were consistently above 80% duration (Figure 19).

The BOD_5 levels were nearly identical to those found in 1988 (Figure 20). In both years the values in the Tuscarawas River were rising downstream to the confluence with the Walhonding River which accounts for about one-half of the flow of the Muskingum River. This dilution by the cleaner water reduced the BOD_5 levels downstream during each survey.

Total suspended solids (TSS) were considerably higher during the 1994 study (Figure 20). In 1988 the level of suspended solids was consistent from upstream to downstream. The 1988 values were less than one half the values reported from 1994. Lower flows and lack of rainfall events during the 1988 drought were probable reasons for the differences between surveys.

Both total dissolved solids (TDS) and nitrite-nitrate levels were lower in 1994 (Figure 20). The reduction in nitrates is even more extreme if the abnormally high levels detected on July 6, 1994 are excluded from the comparison. As stated earlier the 6 July values were attributed to nitrogen top dressing on row crops followed by a large rainfall event.

Dissolved oxygen readings in 1994 exceeded levels measured in 1988 (Figure 21). In both surveys the lowest mean valuewas above 6.0 mg/l. In 1994 there were two decreases, each below major discharges. In 1988 there was a gradual downward trend from approximately RM 10 in the Tuscarawas River to downstream.

Kjeldahl nitrogen (TKN), and sulfate levels were nearly identical during both surveys (Figure 21). Phosphorus levels were also very similar with the exception of the 1988 Muskingum River site at RM 108.3, immediately downstream from the Coshocton WWTP (Figure 21).

Chloride levels have shown a general decrease especially with the dilution factor of the Walhonding River (Figure 21). Historically there had been high levels of chloride from the upper Tuscarawas emanating from the Barberton, Akron-Canton area. The Tuscarawas stations in 1988 were in the 120 mg/l range. In 1994 the values were in the mid 70 mg/l range.

The 1994 values for iron were considerably higher than in 1988 (Figure 22). In the latter study the means were all at or below the 1,000 mg/l Water Quality Standard criterion. In 1994 the means were all at or near 2,000 mg/l. The trends in iron and TSS were similar as iron tends to sorb to suspended clay or silt particles. Results suggest increased NPS runoff and turbidity under the higher flow conditions of 1994.

Lead and zinc values were slightly higher during the 1994 survey (Figure 22). In 1988 these values were at or near the minimum detection level (2 and 10 ug/l, respectively). Arsenic values were nearly the same in the Tuscarawas in both surveys. In 1994 the arsenic measurements in the Muskingum samples were slightly lower.

Continuous monitoring for dissolved oxygen and temperature reflected significant improvement downstream from Stone Container and the Conesville EGS since the 1988 drought year (Figure 23). All diurnal D.O. concentrations and temperatures met WQS criteria during the higher flow years of 1989 and 1994. In contrast, August 1988 D.O. concentrations fell below the LRW criterion (2.0 mg/l) in the Tuscarawas River downstream from Stone Container (RM 0.01) and in the Muskingum River downstream from Wills Creek and the Conesville EGS (RM 96.2). Beginning downstream from Armco Steel and extending downstream to Dresden (RM 103.5-92.0), the majority of August 1988 D.O measurements in the Muskingum River fell below the WWH criterion.

Temperatures downstream from the Conesville EGS thermal discharge consistently exceeded the WWH criteria under severe drought conditions in August 1988 (Figure 24). The already depressed D.O. regime in the Muskingum River was further aggravated by the heavy thermal load associated with the EGS.

The improvements observed between 1988 and 1994 may be partially explained by the practice of injecting oxygen in the Stone Container final effluent beginning in 1993. Also, the Conesville plant has worked to reduce thermal loadings since the 1988 drought. Perhaps more importantly, flow and ambient temperature conditions were less severe during the 1994 survey. The positive benefits of higher flows and cooler temperatures on D.O. and temperature extremes in the upper Muskingum River were also observed in 1989. Continuous monitor surveys during that summer revealed D.O. and temperature levels consistently meeting the WWH criteria under the cooler, higher flow conditions that typified the summer months.

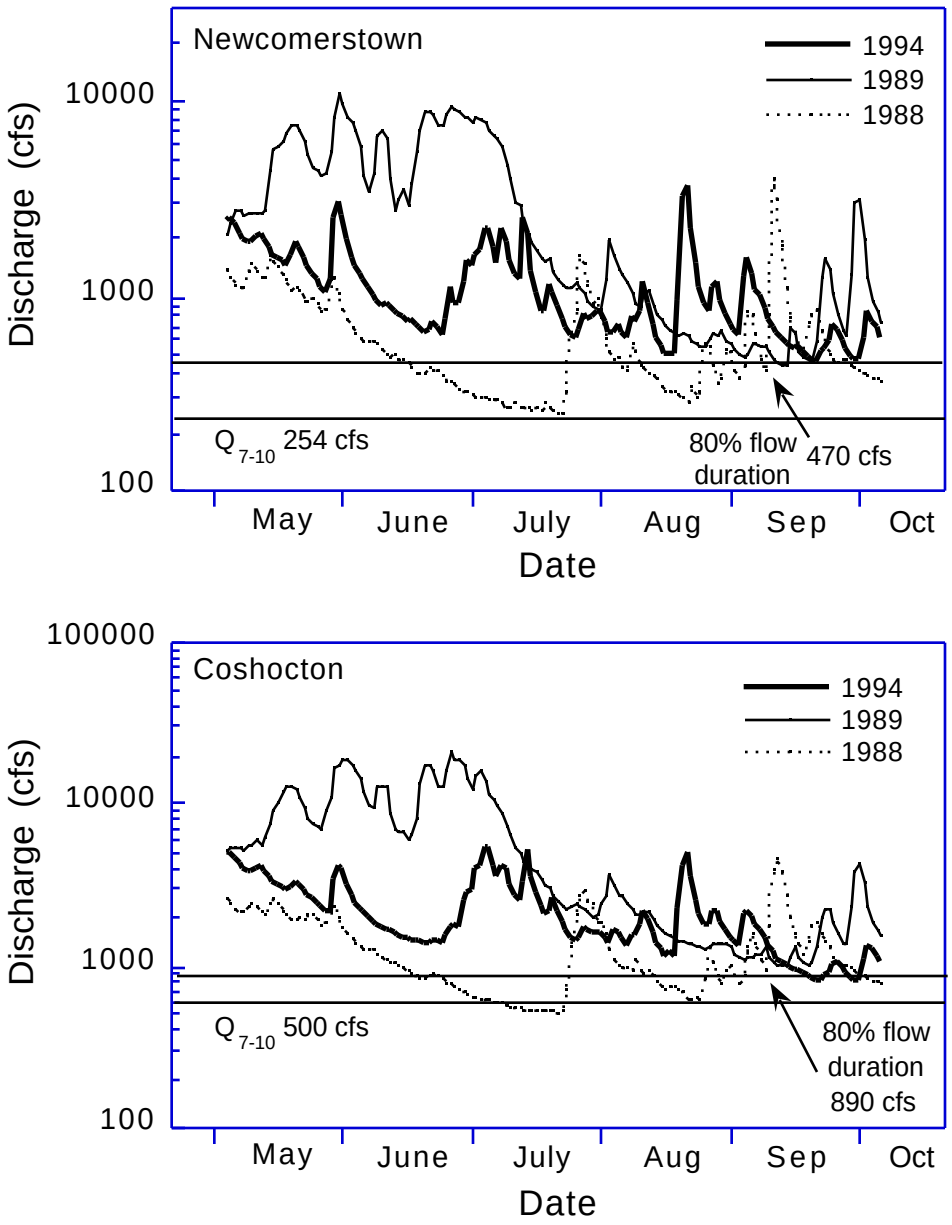

Figure 19. A comparison of flow hydrographs for the Tuscarawas River at Newcomerstown, Ohio (RM 21.2) and the Muskingum River near Coshocton (RM 108.3) from May through September, 1994, 1989 and 1988. May through November low-flow conditions [Q_{7-10} to 80% duration flow; period of record 1921 (Newcomerstown gage) and 1936 (Coshocton gage) to 1994] are indicated on the flow hydrograph.

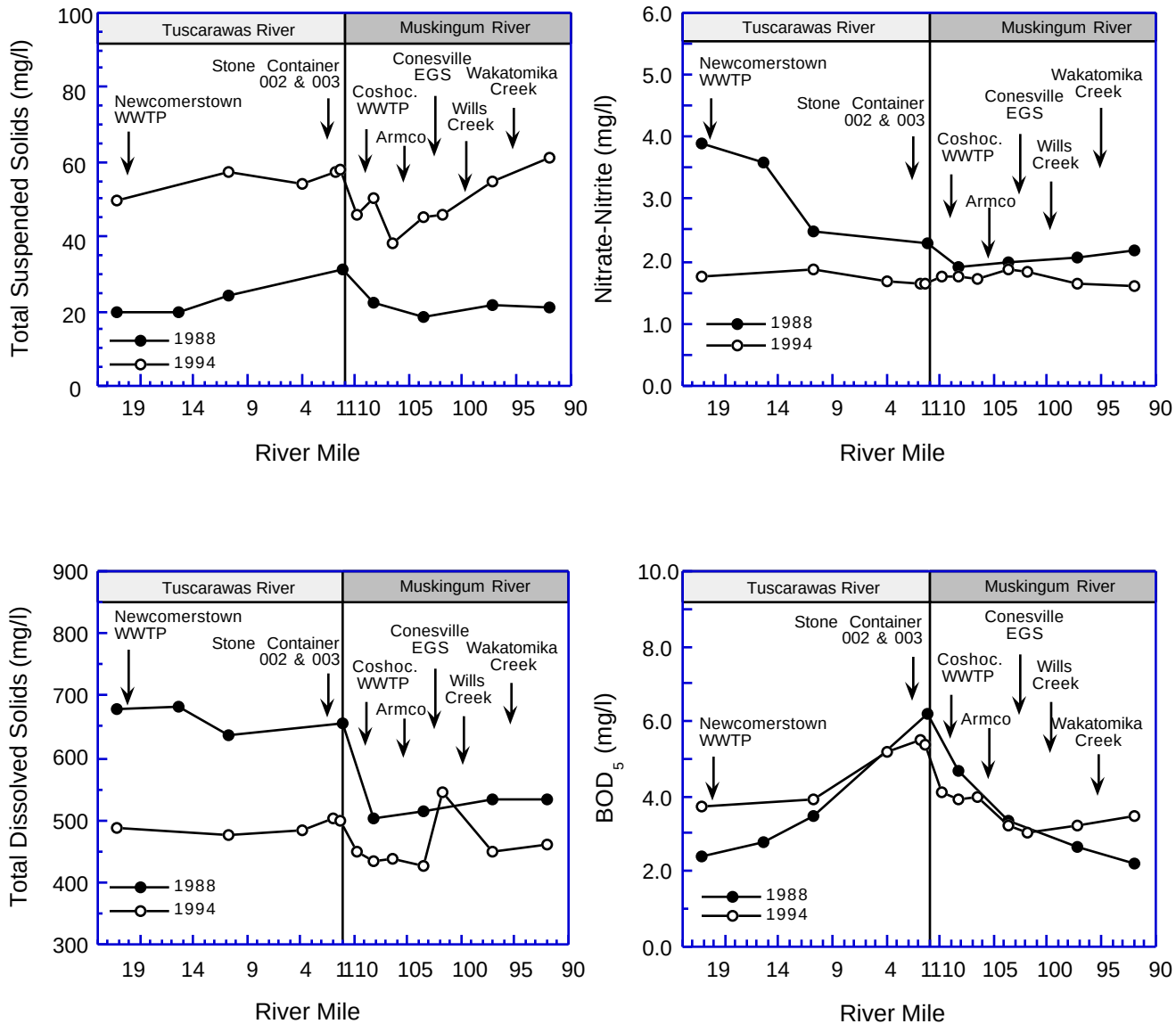

Figure 20. Longitudinal trend of total suspended solids, nitrate-nitrite, total dissolved solids and five day biochemical oxygen demand (BOD_5) in the upper Muskingum River study area, 1988-1994.

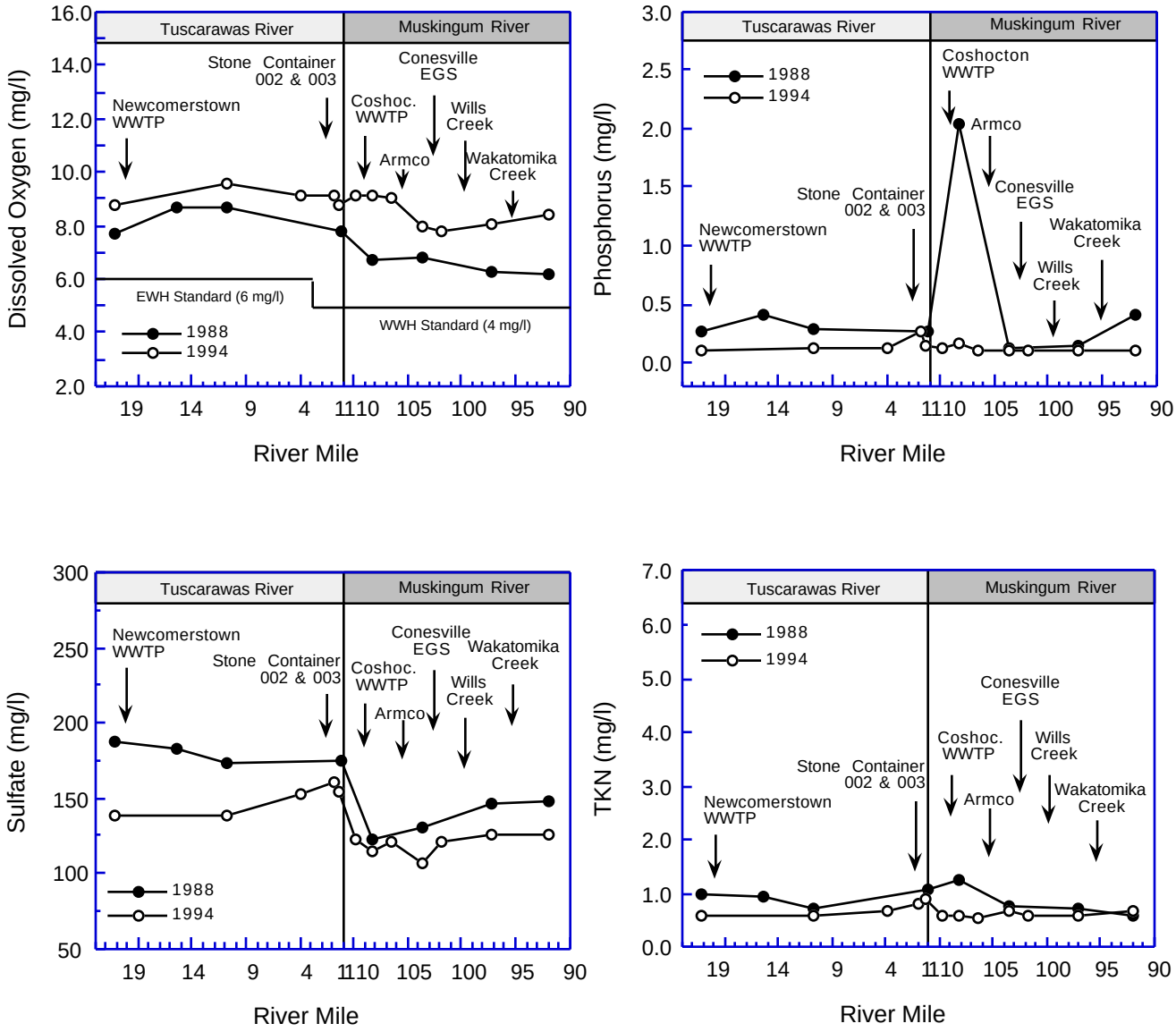

Figure 21. Longitudinal trend of dissolved oxygen, phosphorus, sulfate, and total kjeldahl nitrogen (TKN) in the upper Muskingum River study area, 1988-1994.

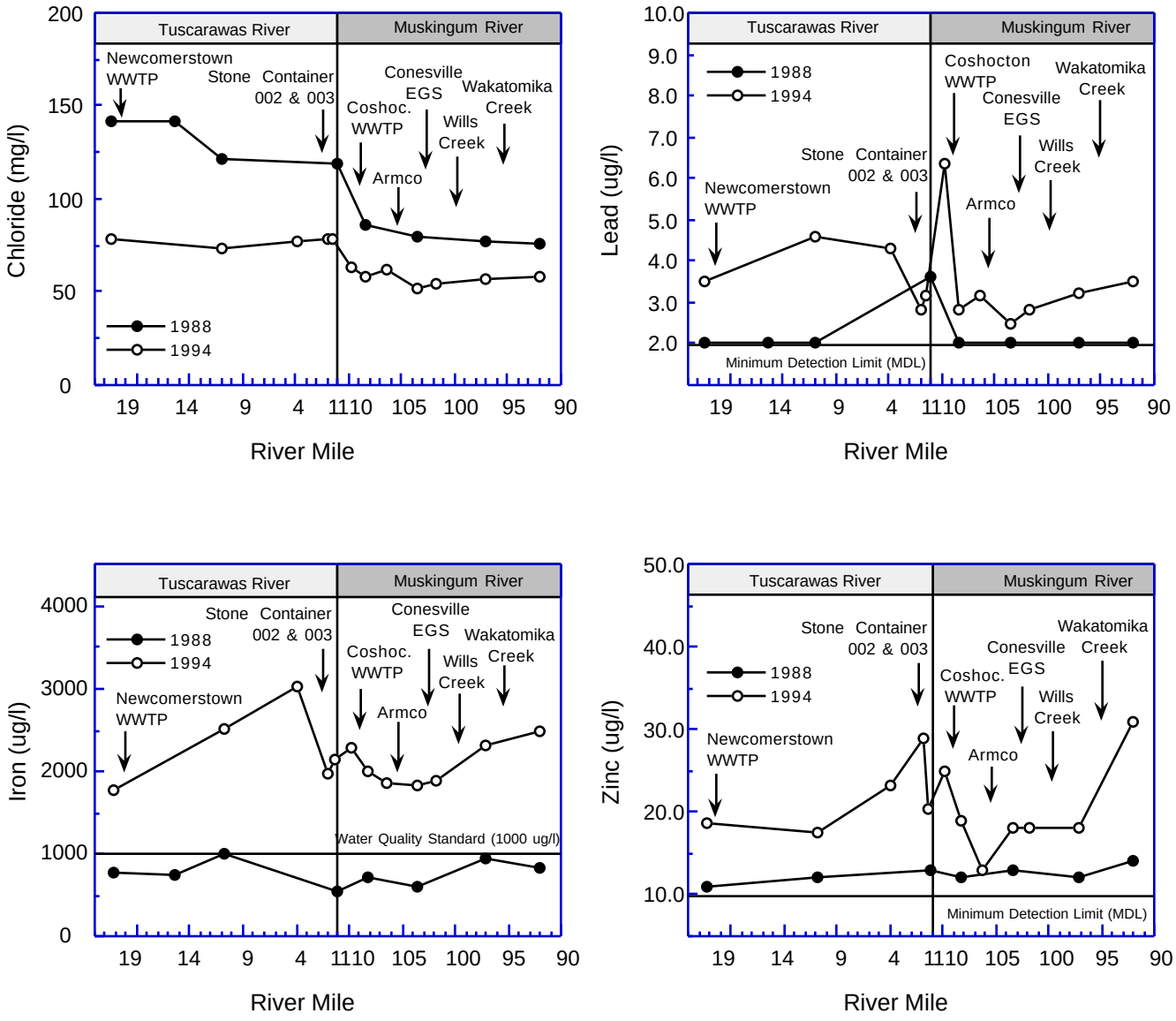

Figure 22. Longitudinal trend of chloride, lead, iron, and zinc in the upper Muskingum River study area, 1988-1994.

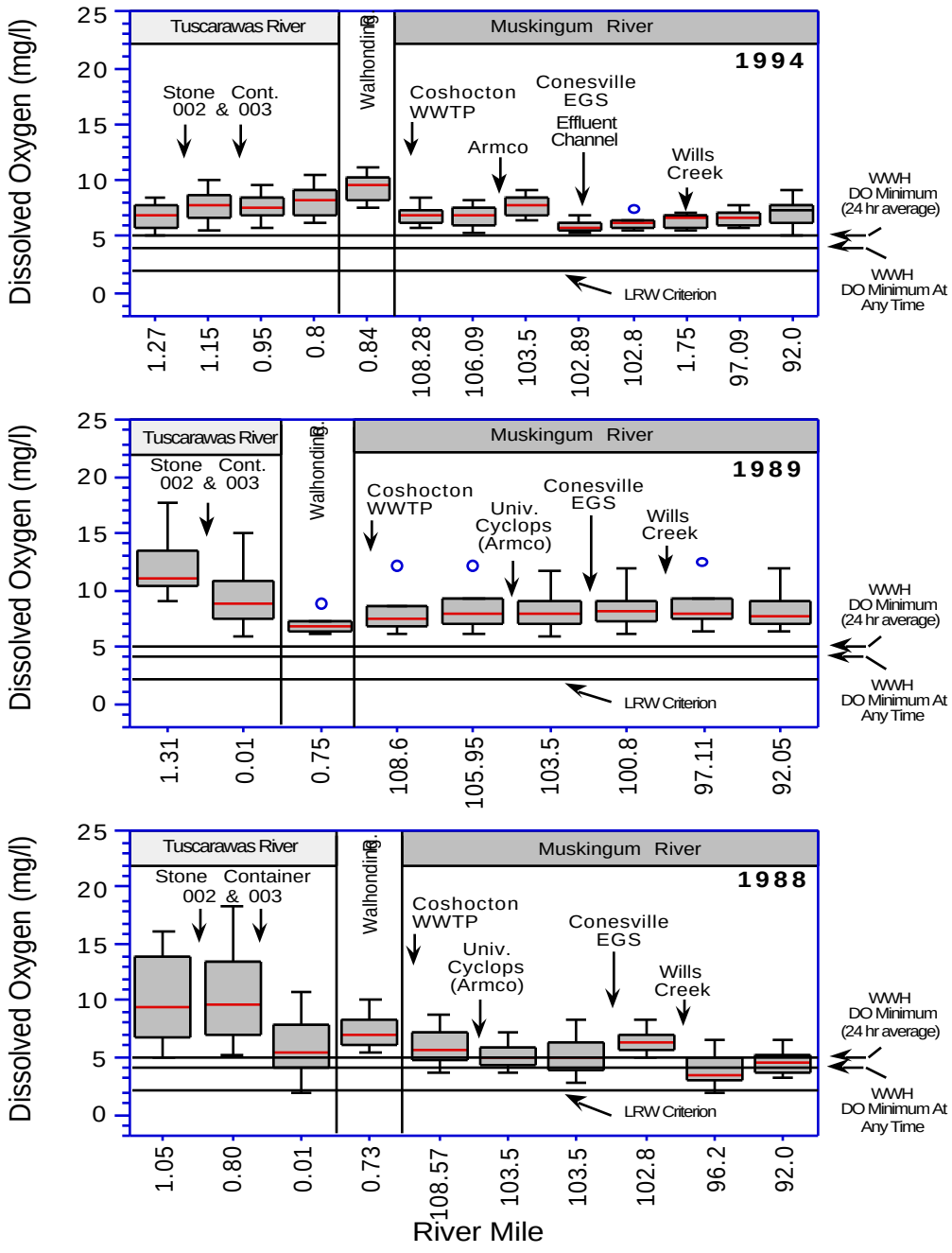

Figure 23. Continuous monitor dissolved oxygen concentrations from the upper Muskingum River study area during August 1988, July 1989, and September 1994.

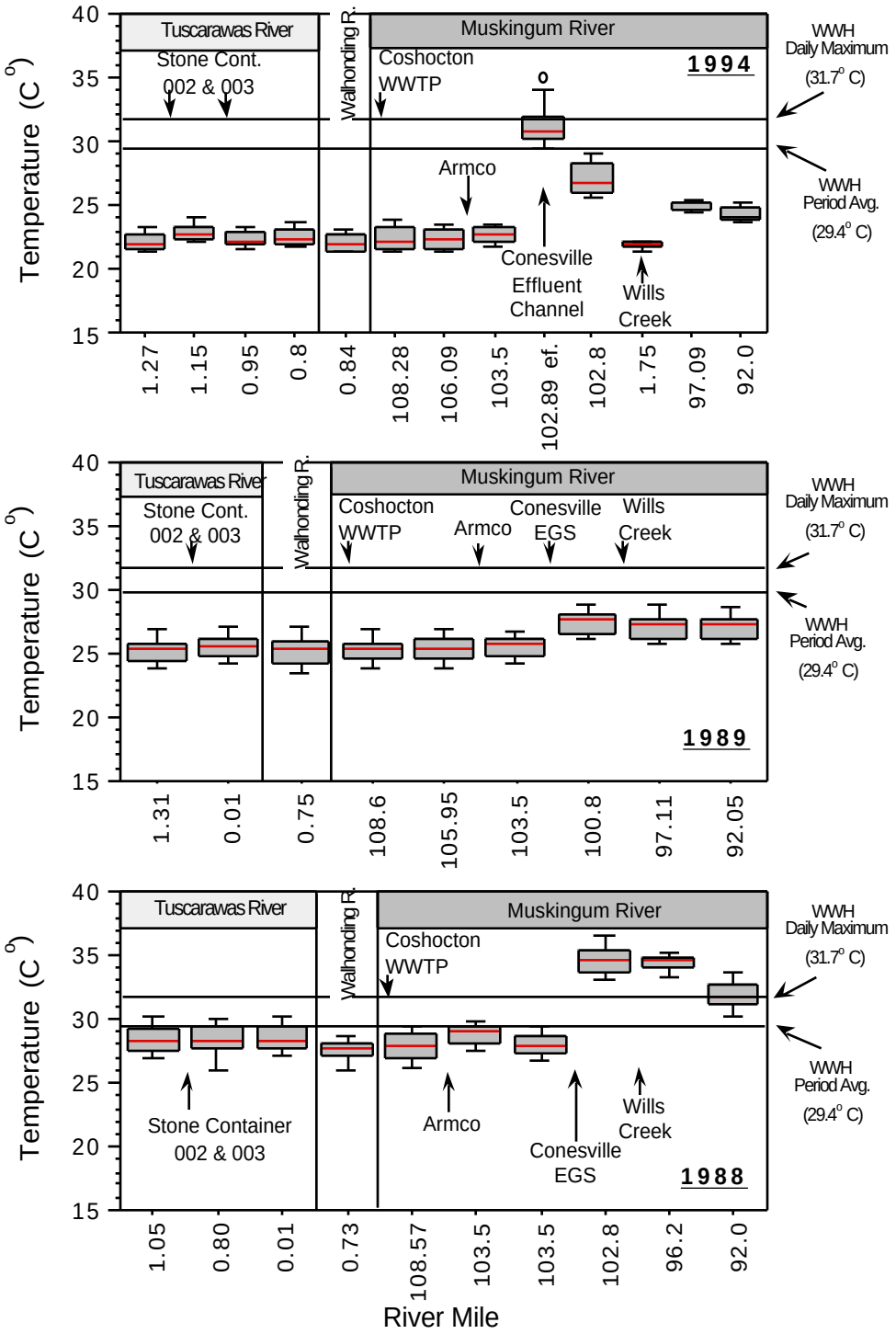

Figure 24. Continuous monitor temperature measurements from the upper Muskingum River study area during August 1988, July 1989, and September 1994.

Changes in Biological Community Performance: 1983-1994

Macroinvertebrate Community Trends

Tuscarawas River

Macroinvertebrates were sampled in the lower 21.1 miles of the Tuscarawas River in 1994, 1988, and 1983. The major difference in sampling between surveys was the more robust coverage in 1994 in the immediate vicinity of Stone Container between RMs 1.3 and 0.3. The 1983 sampling in this segment was limited to three sites from RMs 21.1 to 10.7.

At RM 21.1 in Newcomerstown, the 1988 and 1994 surveys indicated exceptional conditions and very similar community composition from year to year. The ICI scores of 52 were identical in both years and reflected improvement over earlier sampling in 1983 when the ICI of 40 was in the good range.

In 1988, additional downstream stations between Newcomerstown and Coshocton maintained exceptional quality throughout the reach but did show a drop in the ICI score between RMs 10.7 and 3.8 (from 56 to 48, respectively). The most recent survey also showed exceptional quality from Newcomerstown to West Lafayette (RMs 21.1-7.1) but also revealed a slight decline between RMs 7.1 and 3.8 (from exceptional to very good quality). Both surveys showed improvement when compared to 1983 when ICI scores of 42 were found at RMs 18.4 and 10.7, respectively.

A major difference between 1994 and 1988 samples was the increased density and predominance of the filter-feeding midges of the *Rheotanytarsus exiguus* group (Tribe Tanytarsini) in the lower 7.1 miles of the river (Figure 25). The 1988 communities were predominated by hydropsychid caddisflies (also filter-feeders) but community populations were more evenly distributed between mayflies, caddisflies and *R. exiguus* group. Community densities in 1988 did not exceed 4,000 organisms per square foot in this stretch and were not especially different from collections upstream in Newcomerstown. In contrast, 1994 communities downstream from Newcomerstown were strongly skewed by the dense populations of *R. exiguus* group which exceeded 15,000 per square foot at some stations and accounted for over 70% of the total organisms. The 1994 results suggested highly enriched conditions and elevated levels of suspended solids in the lower reaches of the Tuscarawas River.

The macroinvertebrate surveys revealed differences in community composition in the lower Tuscarawas River both between sampling years (1988 and 1994), and from upstream to downstream (RMs 21.1-7.1). Possible reasons for this variation may be differences in the feeding selectivity between organism groups or variation in the particle size or types of seston suspended in the water column. Hydropsychid caddisfly larvae spin a net from salivary secretions but mesh sizes among the net-spinning caddisflies are often relatively coarse, generally exceeding 5 x 40 um in late instars (Lamberti and Moore, 1984). For this reason, bacteria, finely divided detritus, and many species of algae are not fully exploited as food sources (Lamberti and Moore 1984). Midges of the genus *Rheotanytarsus* are small dipteran larvae which construct cases of silt and attach them to the substrate. The larvae extend a rib or ribs from the anterior end of the case and attach a "sheet-like" net of salivary secretions to trap small particles from the passing current (Walshe 1950, Wallace and Merritt 1980). Entire sections of the net are periodically eaten along with the attached food particles. While information was not found on the mesh size of these "salivary sheets", the available references suggest variation between the caddisflies and midges in the type or size of food particles ingested. This variation may help explain the longitudinal and temporal changes observed in communities from the lower Tuscarawas River.

Collections downstream from Stone Container appeared extremely enriched but were improved over 1988 collections. ICI scores from RMs 1.1-0.3 averaged 46 in 1994 compared to 36 at RM 0.3 in 1988. Growths of "sewage fungus" were observed on natural substrates and attached to macroinvertebrate specimens in both 1988 and 1994, downstream from Stone Container. A component of these growths was a stalked ciliate protozoan, genus *Epistilus*, which probably feeds on bacteria associated with the wood pulp effluent. These growths and further increases in macroinvertebrate densities downstream from Stone Container indicated an additional input of nutrients to the mainstem. Improvements in the macroinvertebrates in 1994 were probably related to improved effluent quality and less severe D.O. and flow conditions compared to 1988.

Walhonding River

Data from both 1994 and 1988 revealed exceptional communities at all stations between RMs 15.6-0.8. The Walhonding River ranks among the highest quality large river systems in the state based on the macroinvertebrates.

Muskingum River

Most macroinvertebrate sampling sites indicated similar or improved conditions in 1994 compared to 1988 (Figure 25). Greatest improvement was indicated immediately downstream from the confluence with the Tuscarawas River (station RMs 109.7 and 109.9) and immediately downstream from the Conesville EGS thermal mixing zone (station RMs 101.9 and 101.8). Communities at both sites improved from the good to the exceptional ranges between surveys.

The stations downstream from Wills Creek at RMs 97.2 and 92.1 were the only locations where the ICI declined compared to 1988. Both ICIs declined four points, which is within a four point area of acceptable variation in the ICI. The declines were not considered indicative of a serious decline in water quality conditions. However, when qualitatively collected EPT taxa are evaluated between the surveys, stations downstream from Wills Creek were also the only locations where EPT richness declined compared to 1988 (Figure 26). The drops in both sample sets are more conclusive evidence of an actual decline in water quality conditions in this section of the river. Nonpoint impacts from coal mining in the Wills Creek watershed may have exerted a more significant influence during the high flows of 1994 than were observed in 1988 under low flow conditions. However, the declining trend was observed beginning upstream from Wills Creek, suggesting nonpoint influences were not entirely responsible for the declines (see Figure 1).

Like the Tuscarawas River communities, point source impacts appeared to moderate in 1994 when compared to 1988 results. This was probably due to the less severe temperature, flow and D.O. regimes in 1994 compared to 1988, as well as point source effluent quality.

Licking River

Collections from the 1988 survey (RMs 3.6-0.7) and additional sampling in 1993-94 (RMs 5.5-0.7) indicated very similar conditions and no observable impacts from the Burnham Corporation discharge at RM 1.9. Sampling in 1993 immediately downstream from the Dillon Falls dam revealed a fair quality community (ICI=18) and significant impacts associated with the hypolimnetic discharge (Figure 27). Further downstream at RM 3.6, ICIs were consistently in the low good range and improved to an exceptional condition upstream and downstream from Burnham Corporation. The Dillon Dam discharge was considered the major negative influence on macroinvertebrates in the lower Licking River.

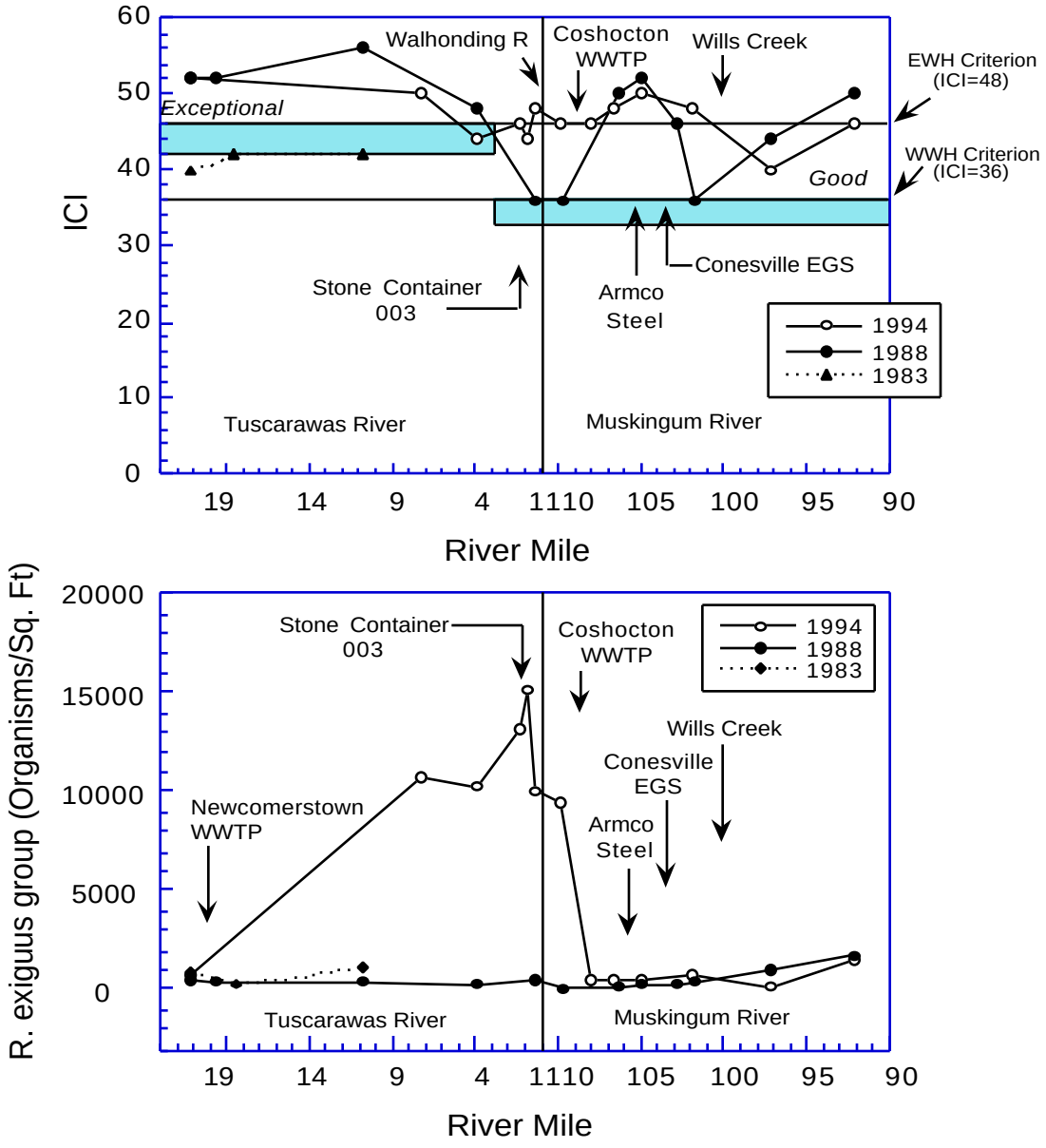

Figure 25. Longitudinal trends of the ICI (upper plot) and densities of *Rheotanytarsus exiguus* group (lower plot) in the lower Tuscarawas and upper Muskingum Rivers, 1983, 1988 and 1994.

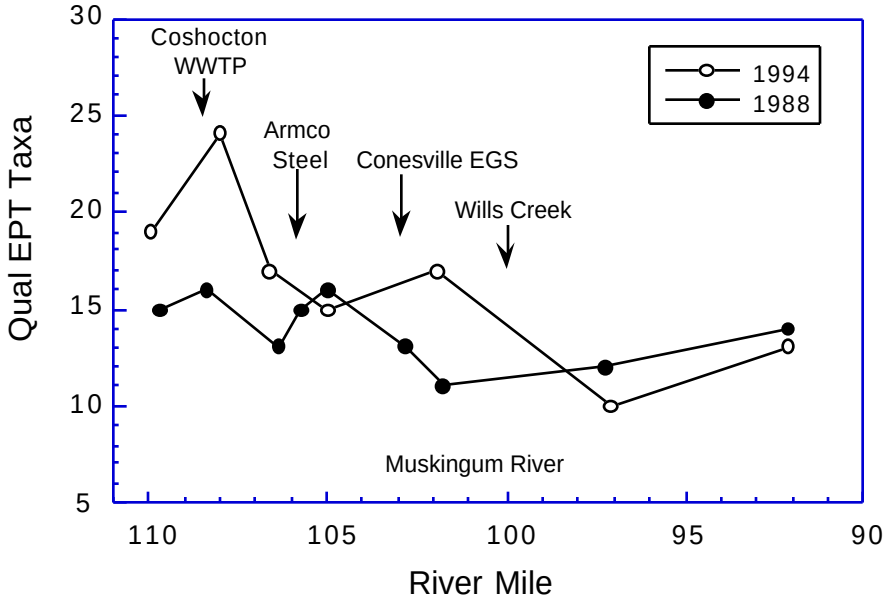

Figure 26. Number of mayfly, caddisfly and stonefly taxa collected during qualitative sampling (Qual. EPT taxa) at stations in the Muskingum River in 1988 and 1994.

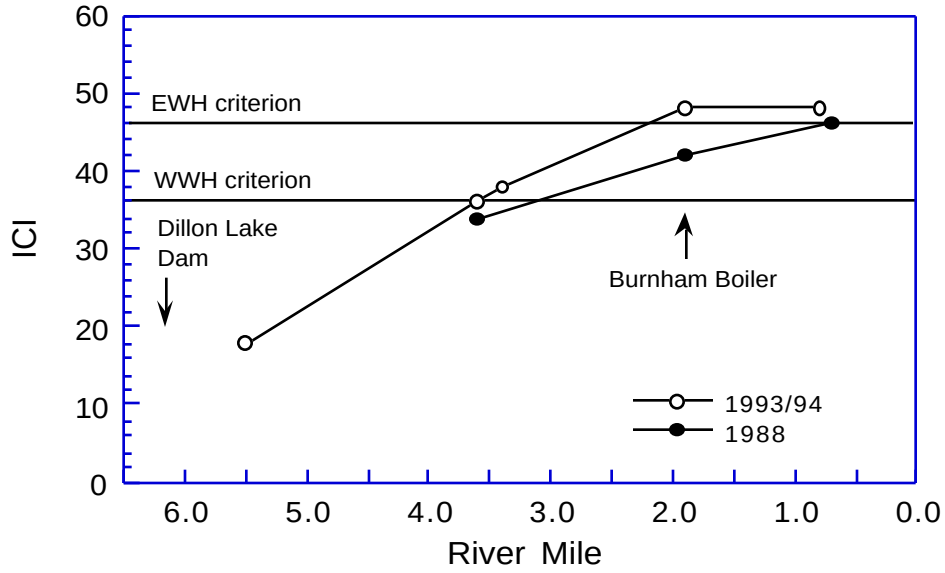

Figure 27. Longitudinal trends of the ICI in the lower Licking River in 1988 and 1993-94.

Fish Community Trends

Tuscarawas River

Various sites in the lower Tuscarawas River have been surveyed in 1983 and 1988-89 (Figure 28). The fish community performed at or below WWH criteria in 1983. Improvement in the performance of the fish community between the 1983 and 1988-89 survey was documented, resulting in an upgrade in use designation from WWH to EWH for the reach upstream from Coshocton.

The trend toward improvement was apparently not maintained for this reach between 1988-89 and 1994. IBI scores at the sites near RM 7.0 in 1994 were similar to those obtained in 1983, whereas scores were near EWH in 1988 and 1989. Comparison of individual IBI metrics showed that the difference between 1988-89 and 1994 was mostly accounted for by the percent of individuals as top carnivores. Smallmouth bass were more numerous in 1988 and 1989 (metric score = 5) than in 1994 (metric score = 1). Otherwise, individual metric scores were similar in 1988, 1989 and 1994, indicating that the difference may not have been due entirely to changes in water quality, but due in part to natural variation in year class strength of smallmouth bass. Although the carnivore metric scored 5 in 1983, the percent of individuals as simple lithophiles, tolerant fishes and omnivores generally scored lower in 1983 than in 1988-94, which suggested that water quality was lower in 1983 than in 1988-94.

Improvement was observed for the reach in Coshocton. Index scores were higher at all sites surveyed in this reach (RMs 1.5 to 0.0) in 1994 than in previous surveys, except at RM 0.3 where MIwb scores were similar between years. The improvement immediately downstream from Stone Container appeared due to recent improvements in effluent quality and effluent treatment (*i.e.*, oxygen injection, toxicity reduction). Dissolved oxygen levels were well above the minimum criterion at all stations monitored in 1994 whereas DO violations occurred in 1988. Mixing zone samples in 1994 was not indicative of acutely toxic conditions while bioassay results from 1991 suggested significant effluent and near field toxicity associated with the effluent.

Walhonding River

A progressive improvement in community performance since 1983 was evident for the Walhonding River. Both the IBI and MIwb scored in the exceptional range at all sites sampled in 1994 (RMs 16.3, 8.0 and 1.2), whereas scores at RMs 8.0 and 1.2 departed from EWH criteria in 1983 (Table 17). Several rare species were present in 1994 that were not observed in 1983 or 1988, notably streamline and bigeye chubs, and bluebreast darters.

Muskingum River

The upper Muskingum River was surveyed in 1988. Overall, no increasing or decreasing trend in IBI scores was evident between 1988 (mean IBI = 38.0 ± 5.45 SD) and 1994 (mean IBI = 39.9 ± 4.22) (Figure 28). IBI scores oscillated longitudinally in both years, but the oscillations were less pronounced in 1994 as evidenced by the lower variance. MIwb scores were also similar between years (1988 mean = 8.3 ± 0.34 SD, 1994 mean = 8.5 ± 0.56 SD). Two differences in metric components of the IBI were noticed between years. The percent of individuals as omnivores (gizzard shad and quillback carpsucker) scored lower at all sites in 1988 than in 1994 (Kruskal-Wallis nonparametric ANOVA, $\chi^2 = 18.8$, 1 df; $p < 0.0001$), with a complimentary increase in scores for insectivores ($\chi^2 = 8.31$, 1 df; $p < 0.01$). Also, the percent of tolerant fishes tended to score lower on average in 1988 ($\chi^2 = 6.28$, 1 df; $p < 0.012$). The omnivore metric is sensitive to changes in the food base, with relative abundance of omnivores increasing in response to environmental degradation as invertebrates become less diverse. Similarly, tolerant species represent a larger proportion of fishes in degraded streams. The decrease in the relative abundance

of these two species groups may indicate improvements in water quality since 1988, as suggested by the increased average index scores in 1994. However, both indexes departed from WWH criteria in 1994 at RM 98.1, as they did in 1988.

Licking River

Fish community performance met or exceeded WWH criteria in both 1988 and 1994 (Figure 29). Scores at RMs 3.6 and 0.8 in 1994 were higher than in 1988, indicating water quality has been maintained or improved between surveys. The performance of the fish communities and the high quality habitat in the lower Licking River (as indicated by high QHEI scores), may warrant redesignation of the aquatic life use from WWH to EWH.

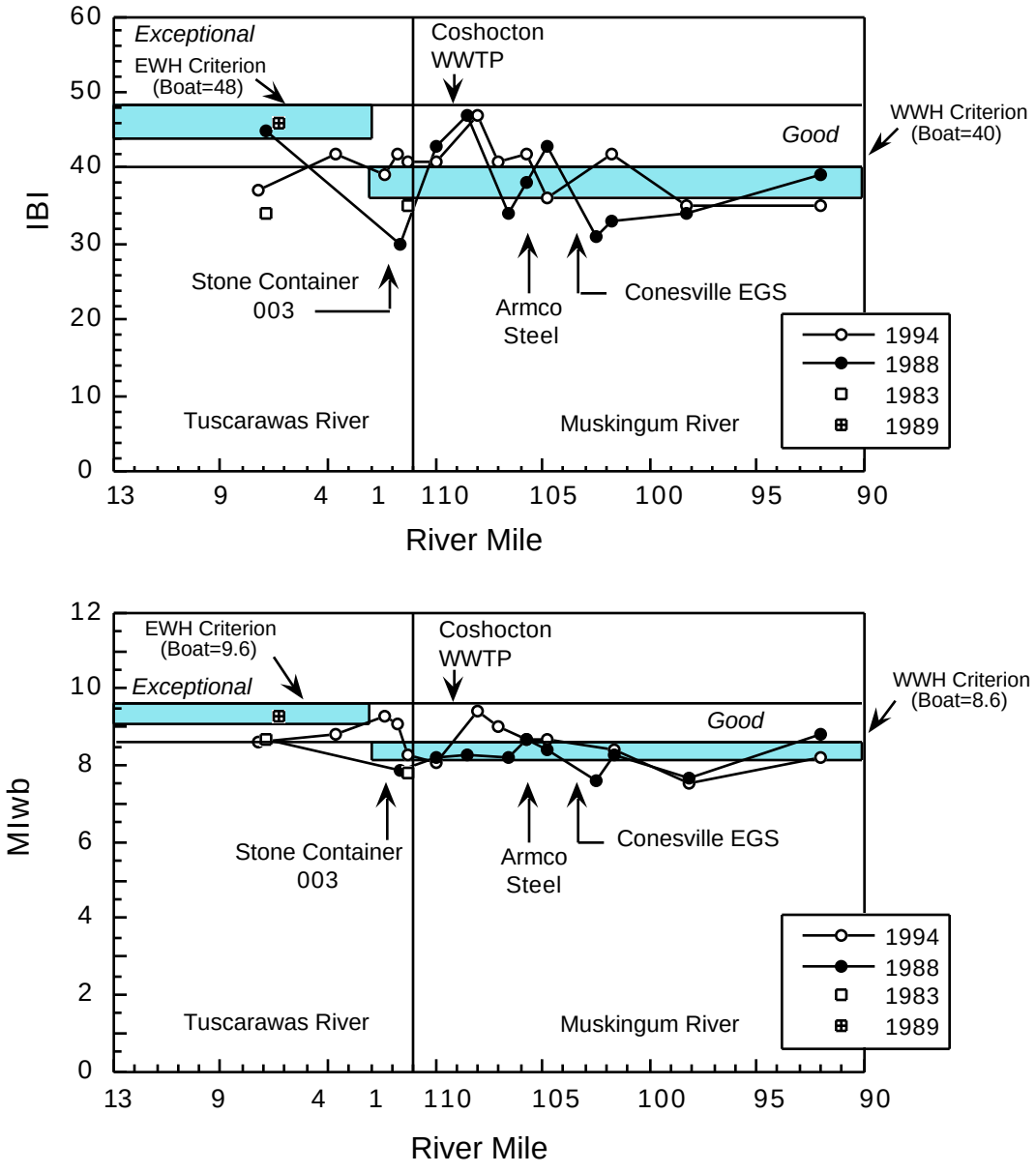

Figure 28. Longitudinal trends of the IBI (top) and MIwb (bottom) scores for the lower Tuscarawas and upper Muskingum Rivers, 1983, 1988, 1989 and 1994.

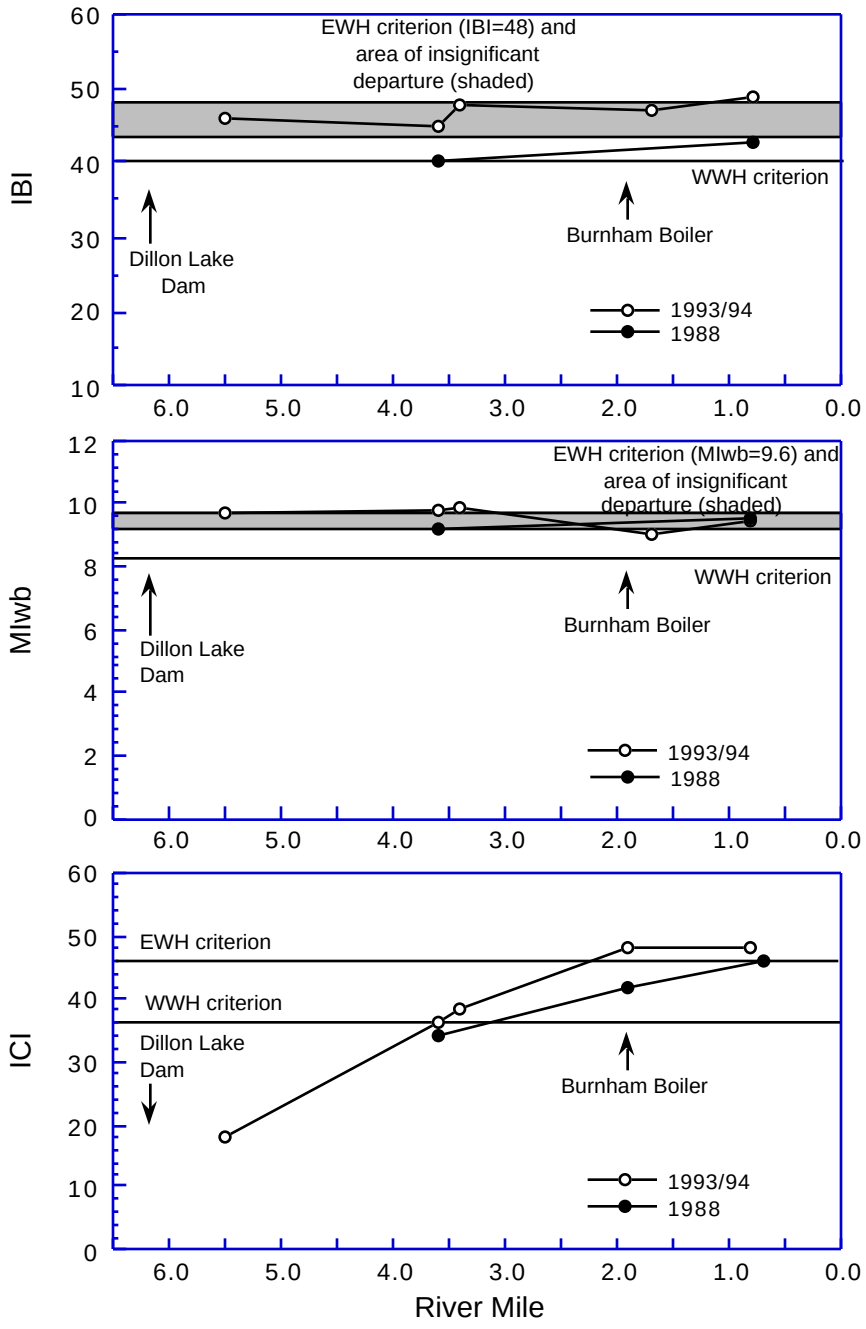

Figure 29. Longitudinal trends in the IBI and MIwb in the lower Licking River, 1988 and 1993-94.

Area of Degradation Value (ADV)Trends

Improvements in biological community health and attainment status in the lower seven miles of the Tuscarawas River was primarily limited to the Coshocton area, downstream from Stone Container (Table 18). All 1994 and 1988 stations in the lower reaches of the EWH designated segment (upstream from Coshocton) were in partial attainment. In contrast, attainment improved from partial to full downstream from Stone Container in the WWH designated section. Improvements in 1994 conincide with the injection of oxygen in the final efflent beginning in 1993 and apparent reductions in effluent toxicity in recent years. Upstream from the discharge fish communities experienced declines from 1988 to 1994 and macroinvertebrates, while maintaining exceptional quality, reflected significant background enrichment. Reduced biological performance in 1994 suggests the lower Tuscarawas River upstream from Coshocton was near or exceeding the assimilative capacity for support of exceptional quality communities.

Miles of attainment and ADV statistics for Muskingum River communities were very similar in 1994 and 1988. During both surveys, the most persistent area of partial attainment was found in the lower stretch of the study area, between Wills Creek and Dresden. However, in 1988 the decline from full to partial attainment began just downstream from the Conesville thermal discharge and upstream from the Wills Creek confluence. This same section showed significant improvement in 1994 and full attainment prior to the Wills Creek confluence. Residual impacts from discharges upstream in the Coshocton area may contribute to the impairment observed in the downstream stretch between Wills Creek and Dresden.

Wakatomika Creek communities continued to maintain exceptional quality with full EWH attainment and a “0” ADV score since 1988. The Walhonding River also maintained exceptional quality throughout its length in 1994 and improved slightly over collections in 1988.

Table 18. Area of Degradation Values (ADVs) for the lower Tuscarawas and upper Muskingum Rivers, 1988-1994. Values obtained for the upper Muskingum and lower Tuscarawas were calculated using Western Allegheny Plateau EWH and WWH biocriteria, respectively, as the baseline for community performance.

	Biological Index Scores				ADV Statistics			Attainment Status (miles)			
Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	Poor/VP ADV	FULL	PARTIAL	**NON**	Poor/VP
Tuscarawas River											
1994											
IBI			37	42	238	**32.6**	0				
MIwb	7.2	0.3	8.3	9.3	80	**11.0**	0	1.5	5.8	**0**	0
ICI			44	50	0	**0**	0				
1988											
IBI			30	45	437	**59.9**	0				
MIwb	6.9	0.3	7.9	8.7	250	**34.2**	0	0	7.3	**0**	0
ICI			36	48	0	**0**	0				
Muskingum River											
1994											
IBI			35	47	66	**3.6**	0				
MIwb	110.0	92.1	7.5	9.3	110	**6.1**	0	9.7	8.4	**0**	0
ICI			40	50	0	**0**	0				
1988											
IBI			31	47	173	**9.6**	0				
MIwb	110.0	92.0	7.6	8.8	70	**3.9**	0	10.0	8.1	**0**	0
ICI			36	52	0	**0**	0				
Walhonding River											
1994											
IBI			49	53	0	**0**	0				
MIwb	16.3	0.8	9.7	10.4	0	**0**	0	16.1	0	**0**	0
ICI			52	56	0	**0**					
1988											
IBI			49	49	0	**0**	0				
MIwb	15.8	0.8	8.9	10.0	15	**1.0**	0	13.5	2.1	**0**	0
ICI			52	54	0	**0**	**0**				
Wakatomika Creek											
1994											
IBI			45	54	11	**0**	0				
MIwb	14.8	2.1	9.0	9.8	0	**0**	0	12.7	0	**0**	0
ICI			--	--	--	--	--				
1988											
IBI			50	54	11	**0**	0				
MIwb	14.9	2.0	9.3	9.7	0	**0**	0	12.9	0	**0**	0
ICI			na*	na	na	na	na				

* not applicable. 1994 biological sampling was limited to fish only; for comparison purposes, 1988 macroinvertebrate results are not included.

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APPENDIX TABLES

Appendix A. Lists of pollutant spills and unauthorized discharges in the upper Muskingum River study area, 1989-1994.

Appendix B. Results of chemical/physical stream sampling in the upper Muskingum River study area, 1994.

Results of chemical/physical effluent sampling in the upper Muskingum River study area, 1994.

Summary of diurnal D.O.(mg/l) data from continuous monitors at twelve locations in the upper Muskingum River study area, duing consecutive 24 hour periods on September 14 and 15, 1994.

Appendix C. Macroinvertebrate sampling data (species lists and Invertebrate Community Index [ICI] metric scores) by station from the upper Muskingum River study area, 1994.

Appendix D. Fish sampling data (species lists, Index of Biotic Integrity [IBI] and Modified Index of well being [MIwb] metric scores) by station from the upper Muskingum River study area, 1994.

APPENDIX A

Spill Reports

Electronic copies of the Spill Reports are not available.
A hard copy may be obtained by writing to:

Ohio EPA Monitoring and Assessment Section
Attn: Dennis Mishne
1685 Westbelt Drive
Columbus Ohio, 43228

APPENDIX B

Chemical Data

Electronic copies of Chemical Tables are not available.
A hard copy may be obtained by writing to:

Ohio EPA Monitoring and Assessment Section
Attn: Dennis Mishne
1685 Westbelt Drive
Columbus Ohio, 43228

Appendix B. Summary of diurnal D.O.(mg/l) data from continuous monitors at twelve locations in the upper Muskingum River study area, duing consecutive 24 hour periods on September 14 and 15, 1994.

River Mile	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %ile (mg/l)	75th %ile (mg/l)
			September 14				
Tuscarawas River							
1.27	24	9.16	9.03	6.95	11.43	8.03	10.35
1.15	24	9.96	9.79	7.45	12.69	8.86	11.35
0.95	24	10.17	10.09	7.60	12.78	8.94	11.57
0.80	24	10.44	10.26	7.86	13.15	9.02	11.95
Walhonding River							
0.84	24	9.86	10.10	7.94	11.40	8.74	10.95
Muskingum River							
108.28	24	8.37	8.10	6.70	10.57	7.37	9.42
106.09	24	8.91	8.73	6.66	11.05	7.59	10.41
103.5	24	9.88	9.91	8.07	11.72	8.80	10.98
102.8	24	7.84	7.75	6.74	9.14	7.08	8.53
101.8	24	8.41	8.27	7.07	10.16	7.55	9.12
97.09	24	8.44	8.23	6.89	10.57	7.39	9.37
92.00	24	9.79	9.61	7.18	12.93	8.11	11.63
Conesville EGS Effluent Channel							
0.02, 102.89	NA	NA	NA	NA	NA	NA	NA
Wills Creek							
1.75	24	6.92	6.95	5.94	7.88	6.34	7.42
			September 15				
Tuscarawas River							
1.27	24	6.88	6.79	5.19	8.69	5.91	7.77
1.15	24	7.83	7.86	5.74	10.10	6.70	8.88
0.95	24	7.66	7.62	5.79	9.69	6.78	8.63
0.80	24	8.27	8.27	6.27	10.52	7.11	9.20
Walhonding River							
0.84	24						
Muskingum River							
108.28	24	6.95	6.82	5.82	8.58	6.24	7.51
106.09	24	6.89	6.98	5.49	8.18	6.04	7.65
103.5	24	7.79	7.80	6.56	9.32	7.02	8.47
102.8	19	6.34	6.19	5.77	7.49	5.95	6.55
101.8	NA	NA	NA	NA	NA	NA	NA
97.09	24	6.76	6.69	5.89	7.87	6.14	7.28
92.00	24	7.24	7.38	5.31	9.16	6.34	7.92
Conesville EGS Effluent Channel							
0.02, 102.89	24	6.00	5.93	5.42	6.91	5.65	6.28
Wills Creek							
1.75	24	6.51	6.68	5.60	7.25	5.93	7.01

APPENDIX C

Macroinvertebrate Data

Invertebrate Community Index (ICI) metrics and scores for the upper Muskingum River basin study area, 1993-94.

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
MUSKINGUM RIVER — 17-001													
Year: 94													
109.90	4856.0	39(6)	9(6)	10(6)	9(6)	3.8(2)	7.6(2)	64.5(6)	23.9(0)	0.2(6)	19(6)	4	**46**
108.00	4862.0	38(6)	9(6)	9(6)	9(6)	12.3(4)	21.3(2)	32.8(6)	31.7(0)	1.3(4)	24(6)	4	**46**
106.60	4868.0	42(6)	9(6)	10(6)	12(6)	17.7(6)	10.6(2)	29.5(6)	41.0(0)	1.4(4)	17(6)	4	**48**
105.80	4870.0	40(6)	10(6)	9(6)	10(6)	20.3(6)	8.6(2)	26.2(6)	41.3(0)	0.7(6)	6(2)	4	**46**
105.00	4875.0	41(6)	9(6)	8(6)	12(6)	16.7(6)	17.9(2)	28.6(6)	35.4(0)	0.1(6)	15(6)	4	**50**
101.90	4883.0	39(6)	9(6)	7(4)	13(6)	10.7(4)	34.9(4)	26.2(6)	27.2(0)	0.7(6)	17(6)	4	**48**
97.10	5745.0	39(6)	6(4)	7(4)	11(6)	8.6(4)	17.1(2)	8.3(4)	63.8(0)	1.2(6)	10(4)	4	**40**
92.10	5993.0	37(6)	9(6)	8(6)	8(6)	5.5(2)	16.9(2)	34.7(6)	40.6(0)	0.2(6)	13(6)	4	**46**
LICKING RIVER — 17-200													
Year: 94													
3.60	753.0	41(6)	3(2)	9(6)	16(6)	9.6(2)	44.6(6)	11.1(2)	34.6(2)	4.8(2)	11(2)	4	**36**
1.90 N	756.0	39(6)	10(6)	8(6)	11(4)	25.7(4)	34.5(6)	16.2(4)	23.2(4)	1.1(6)	10(2)	4	**48**
1.90 S	756.0	43(6)	7(4)	3(4)	21(6)	26.4(6)	3.2(0)	4.6(2)	63.1(0)	7.4(0)	3(0)	4	**28**
0.70	779.0	45(6)	10(6)	11(6)	11(4)	20.5(4)	50.1(6)	8.5(2)	20.2(4)	0.6(6)	14(4)	4	**48**
Year: 93													
5.50	742.0	17(2)	1(0)	4(4)	10(4)	0.1(2)	18.4(4)	0.8(2)	80.6(0)	25.7(0)	4(0)	4	**18**
3.60	753.0	31(4)	6(4)	8(6)	11(4)	4.9(2)	44.5(6)	11.5(2)	39.1(2)	3.3(4)	13(4)	4	**38**
TUSCARAWAS RIVER — 17-500													
Year: 94													
21.10	2443.0	33(6)	7(4)	9(6)	7(4)	16.6(4)	42.2(6)	26.6(6)	13.4(4)	0.0(6)	18(6)	4	**52**
7.10	2576.0	35(6)	6(4)	9(6)	10(6)	1.8(2)	10.3(2)	78.7(6)	8.2(6)	0.1(6)	18(6)	4	**50**
3.80	2588.0	32(4)	7(4)	10(6)	8(4)	3.6(2)	13.3(2)	70.5(6)	12.2(4)	0.0(6)	17(6)	4	**44**
1.30	2595.0	32(4)	8(6)	8(6)	7(4)	2.9(2)	9.2(2)	74.3(6)	13.3(4)	0.7(6)	19(6)	4	**46**
1.00	2596.0	31(4)	8(6)	8(6)	9(6)	4.6(2)	10.4(2)	70.3(6)	13.7(4)	1.3(4)	15(6)	4	**46**
0.70	2596.0	36(6)	7(4)	8(6)	12(6)	2.0(2)	13.5(2)	66.2(6)	18.1(4)	2.5(4)	13(4)	4	**44**
0.30	2596.0	37(6)	7(4)	10(6)	9(6)	4.9(2)	6.0(2)	69.7(6)	18.4(4)	0.6(6)	16(6)	4	**48**
WALHONDING RIVER — 17-600													
Year: 94													
15.60	1505.0	50(6)	15(6)	9(6)	15(6)	36.4(6)	19.8(4)	28.8(6)	13.8(6)	0.1(6)	14(4)	4	**56**
7.70	1577.0	43(6)	10(6)	8(6)	14(6)	47.0(6)	20.5(4)	17.6(4)	13.2(6)	0.8(6)	18(6)	4	**56**
0.80	2255.0	35(6)	11(6)	9(6)	7(4)	11.9(4)	30.5(4)	41.0(6)	16.2(4)	0.0(6)	18(6)	4	**52**
WILLS CREEK — 17-800													
Year: 94													

Invertebrate Community Index (ICI) metrics and scores for the upper Muskingum River basin study area, 1993-94.

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
5.20	842.0	38(6)	5(2)	11(6)	7(2)	5.6(2)	78.9(6)	7.1(2)	8.3(6)	0.4(6)	17(6)	4	**44**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/07/94 River Code: 17-001 River: Muskingum River RM: 109.90

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	16	+
03073	*Lophopodella carteri*	1	+
03600	*Oligochaeta*	176	
06810	*Gammarus fasciatus*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	146	+
12200	*Isonychia sp*	72	
13400	*Stenacron sp*	41	+
13510	*Stenonema exiguum*	75	+
13550	*Stenonema mexicanum integrum*	111	+
13561	*Stenonema pulchellum*	238	+
13570	*Stenonema terminatum*	563	+
16700	*Tricorythodes sp*	1479	+
17200	*Caenis sp*	32	+
18100	*Anthopotamus sp*	0	+
22300	*Argia sp*	8	+
30800	*Pteronarcys sp*	0	+
34410	*Paragnetina media*	1	
45100	*Palmacorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	1	
51300	*Neureclipsis sp*	4	+
52200	*Cheumatopsyche sp*	726	+
52430	*Ceratopsyche morosa group*	403	+
52520	*Hydropsyche bidens*	9	
52530	*Hydropsyche depravata group*	75	
52550	*Hydropsyche frisoni*	83	+
52560	*Hydropsyche orris*	1332	+
52570	*Hydropsyche simulans*	363	+
52620	*Macrostemum zebratum*	606	+
52801	*Potamyia flava*	1959	+
57400	*Neophylax sp*	0	+
68601	*Ancyronyx variegata*	1	
68708	*Dubiraphia vittata group*	8	
68901	*Macronychus glabratus*	33	
69400	*Stenelmis sp*	110	+
74100	*Simulium sp*	16	
77120	*Ablabesmyia mallochi*	0	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	4501	+
78750	*Rheopelopia paramaculipennis*	750	+
79085	*Telopelopia okoboji*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	750	+
82220	*Tvetenia discoloripes group*	1500	
83300	*Glyptotendipes (Phytotendipes) sp*	7501	+
84450	*Polypedilum (P.) convictum*	2250	+
85625	*Rheotanytarsus exiguus group*	47259	+
87540	*Hemerodromia sp*	26	
93900	*Elimia sp*	8	+
96900	*Ferrissia sp*	0	+
98200	*Pisidium sp*	0	+
98600	*Sphaerium sp*	0	+
99420	*Amblema plicata plicata*	0	+

No. Quantitative Taxa:	39	Total Taxa:	53
No. Qualitative Taxa:	41	ICI:	**46**
Number of Organisms:	73233	Qual EPT:	**19**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 108.00

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	0	+
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	40	+
04666	*Helobdella triserialis*	0	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	8	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
08601	*Hydracarina*	16	
11130	*Baetis intercalaris*	478	+
11503	*Heterocloeon curiosum*	0	+
12200	*Isonychia sp*	31	+
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	18	+
13510	*Stenonema exiguum*	54	+
13550	*Stenonema mexicanum integrum*	97	+
13561	*Stenonema pulchellum*	202	+
13570	*Stenonema terminatum*	72	+
16700	*Tricorythodes sp*	133	+
17200	*Caenis sp*	0	+
18100	*Anthopotamus sp*	8	+
18750	*Hexagenia limbata*	0	+
21200	*Calopteryx sp*	0	+
22300	*Argia sp*	0	+
24820	*Gomphurus externus*	0	+
24900	*Gomphus sp*	0	+
25305	*Ophiogomphus aspersus*	0	+
30800	*Pteronarcys sp*	0	+
34410	*Paragnetina media*	1	+
34700	*Agnetina capitata complex*	1	+
45100	*Palmacorixa sp*	0	+
45400	*Trichocorixa sp*	0	+
48410	*Corydalus cornutus*	37	+
52200	*Cheumatopsyche sp*	298	+
52430	*Ceratopsyche morosa group*	341	+
52520	*Hydropsyche bidens*	31	+
52550	*Hydropsyche frisoni*	16	+
52560	*Hydropsyche orris*	355	+
52570	*Hydropsyche simulans*	164	+
52620	*Macrostemum zebratum*	101	+
52801	*Potamyia flava*	573	+
59500	*Oecetis sp*	16	
60300	*Dineutus sp*	0	+
68708	*Dubiraphia vittata group*	8	
68901	*Macronychus glabratus*	35	+
69400	*Stenelmis sp*	80	+
74100	*Simulium sp*	50	+
77470	*Coelotanypus sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	253	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	0	+
79085	*Telopelopia okoboji*	0	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	16	
80430	*Cricotopus (C.) tremulus group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	0	+
81240	*Nanocladius (N.) distinctus*	63	
82220	*Tvetenia discoloripes group*	379	
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	1265	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	506	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85265	*Cladotanytarsus vanderwulpi group Type 5*	0	+
85625	*Rheotanytarsus exiguus group*	2909	+
87540	*Hemerodromia sp*	212	+
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	8	+
98600	*Sphaerium sp*	0	+
99001	*Unionidae*	0	+

No. Quantitative Taxa:	38	Total Taxa:	73
No. Qualitative Taxa:	66	ICI:	**46**
Number of Organisms:	8876	Qual EPT:	**24**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 106.60

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	232	+
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	54	+
05800	*Caecidotea sp*	0	+
06810	*Gammarus fasciatus*	57	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	32	+
12200	*Isonychia sp*	9	
13400	*Stenacron sp*	86	+
13510	*Stenonema exiguum*	0	+
13550	*Stenonema mexicanum integrum*	112	+
13561	*Stenonema pulchellum*	239	+
13570	*Stenonema terminatum*	356	+
16700	*Tricorythodes sp*	549	+
17200	*Caenis sp*	22	+
18100	*Anthopotamus sp*	4	+
22300	*Argia sp*	4	+
23909	*Boyeria vinosa*	0	+
24900	*Gomphus sp*	0	+
34140	*Acroneuria internata*	0	+
34700	*Agnetina capitata complex*	1	+
45100	*Palmacorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	4	+
51300	*Neureclipsis sp*	40	
51600	*Polycentropus sp*	40	
52200	*Cheumatopsyche sp*	191	+
52430	*Ceratopsyche morosa group*	41	+
52550	*Hydropsyche frisoni*	14	
52560	*Hydropsyche orris*	57	+
52570	*Hydropsyche simulans*	18	+
52620	*Macrostemum zebratum*	65	+
52801	*Potamyia flava*	367	+
59420	*Nectopsyche pavida*	12	
68708	*Dubiraphia vittata group*	4	
68901	*Macronychus glabratus*	18	
69400	*Stenelmis sp*	60	+
74100	*Simulium sp*	0	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	294	+
78140	*Labrundinia pilosella*	0	+
78750	*Rheopelopia paramaculipennis*	0	+
79085	*Telopelopia okoboji*	49	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	16	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	441	+
81250	*Nanocladius (N.) minimus*	98	
82730	*Chironomus (C.) decorus group*	49	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	1421	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	49	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	196	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	196	+
85265	*Cladotanytarsus vanderwulpi group Type 5*	0	+
85625	*Rheotanytarsus exiguus group*	2351	+
86100	*Chrysops sp*	0	+
87540	*Hemerodromia sp*	100	
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	8	+

No. Quantitative Taxa:	42	Total Taxa:	61
No. Qualitative Taxa:	49	ICI:	**48**
Number of Organisms:	7957	Qual EPT:	**17**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 105.80

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	31	+
03073	*Lophopodella carteri*	0	+
03360	*Plumatella sp*	12	
03600	*Oligochaeta*	24	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	1	
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	72	
11155	*Baetis punctiventris*	16	
12200	*Isonychia sp*	10	
13400	*Stenacron sp*	11	+
13510	*Stenonema exiguum*	49	
13550	*Stenonema mexicanum integrum*	166	+
13561	*Stenonema pulchellum*	137	+
13570	*Stenonema terminatum*	128	
16700	*Tricorythodes sp*	361	+
18100	*Anthopotamus sp*	3	+
22300	*Argia sp*	1	+
24900	*Gomphus sp*	0	+
34700	*Agnetina capitata complex*	1	
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	2	+
52200	*Cheumatopsyche sp*	25	
52430	*Ceratopsyche morosa group*	23	
52520	*Hydropsyche bidens*	1	
52550	*Hydropsyche frisoni*	1	
52560	*Hydropsyche orris*	20	
52570	*Hydropsyche simulans*	40	
52620	*Macrostemum zebratum*	129	+
52801	*Potamyia flava*	161	
59140	*Ceraclea maculata*	4	
68601	*Ancyronyx variegata*	4	
68901	*Macronychus glabratus*	18	
69400	*Stenelmis sp*	143	+
77130	*Ablabesmyia rhamphe group*	32	+
77750	*Hayesomyia senata or Thienemannimyia norena*	851	
77800	*Helopelopia sp*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	95	
81250	*Nanocladius (N.) minimus*	63	
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	378	+
84060	*Parachironomus pectinatellae*	32	
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	347	
84540	*Polypedilum (Tripodura) scalaenum group*	32	+
85625	*Rheotanytarsus exiguus group*	1229	+
87540	*Hemerodromia sp*	32	
93900	*Elimia sp*	0	+
96900	*Ferrissia sp*	8	+
96930	*Laevapex fuscus*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa: 40 Total Taxa: 52

No. Qualitative Taxa: 28 ICI: **46**

Number of Organisms: 4693 Qual EPT: **6**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 105.00

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	40	+
03073	*Lophopodella carteri*	1	
03221	*Pectinatella magnifica*	0	+
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	4	+
04750	*Myzobdella lugubris*	0	+
06810	*Gammarus fasciatus*	1	+
08601	*Hydracarina*	0	+
11130	*Baetis intercalaris*	277	+
11503	*Heterocloeon curiosum*	0	+
12200	*Isonychia sp*	35	+
13400	*Stenacron sp*	23	
13510	*Stenonema exiguum*	55	
13550	*Stenonema mexicanum integrum*	175	+
13561	*Stenonema pulchellum*	159	
13570	*Stenonema terminatum*	385	+
16700	*Tricorythodes sp*	308	+
17200	*Caenis sp*	105	+
18100	*Anthopotamus sp*	0	+
21200	*Calopteryx sp*	0	+
22300	*Argia sp*	0	+
23909	*Boyeria vinosa*	0	+
24915	*Gomphus fraternus*	0	+
34700	*Agnetina capitata complex*	3	+
45400	*Trichocorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	2	+
52200	*Cheumatopsyche sp*	127	
52430	*Ceratopsyche morosa group*	131	+
52520	*Hydropsyche bidens*	0	+
52550	*Hydropsyche frisoni*	20	
52560	*Hydropsyche orris*	83	+
52570	*Hydropsyche simulans*	94	+
52620	*Macrostemum zebratum*	592	+
52801	*Potamyia flava*	562	+
59500	*Oecetis sp*	16	
68601	*Ancyronyx variegata*	5	
68708	*Dubiraphia vittata group*	4	+
68901	*Macronychus glabratus*	29	+
69400	*Stenelmis sp*	83	+
74100	*Simulium sp*	16	+
77130	*Ablabesmyia rhamphe group*	0	+
77500	*Conchapelopia sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1174	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	157	+
80440	*Cricotopus (C.) trifascia group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	347	
81240	*Nanocladius (N.) distinctus*	0	+
82220	*Tvetenia discoloripes group*	58	+
82730	*Chironomus (C.) decorus group*	0	+
83250	*Gillotia alboviridis*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	694	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84060	*Parachironomus pectinatellae*	0	+
84300	*Phaenopsectra obediens group*	58	+
84450	*Polypedilum (P.) convictum*	463	+
84470	*Polypedilum (P.) illinoense*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	174	+
85625	*Rheotanytarsus exiguus group*	2546	+
85840	*Tanytarsus guerlus group*	58	
86200	*Tabanus sp*	0	+
87540	*Hemerodromia sp*	32	+
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	0	+
97601	*Corbicula fluminea*	1	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa:	41	Total Taxa:	69
No. Qualitative Taxa:	59	ICI:	**50**
Number of Organisms:	9098	Qual EPT:	**15**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 101.90

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	52	+
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	16	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	1	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11110	*Baetis armillatus*	0	+
11130	*Baetis intercalaris*	578	+
11503	*Heterocloeon curiosum*	0	+
12200	*Isonychia sp*	20	+
13400	*Stenacron sp*	18	
13510	*Stenonema exiguum*	64	
13550	*Stenonema mexicanum integrum*	108	+
13561	*Stenonema pulchellum*	108	+
13570	*Stenonema terminatum*	334	+
16700	*Tricorythodes sp*	208	+
17200	*Caenis sp*	42	+
18100	*Anthopotamus sp*	0	+
22001	*Coenagrionidae*	0	+
24820	*Gomphurus externus*	0	+
30800	*Pteronarcys sp*	1	
34700	*Agnetina capitata complex*	10	
42700	*Belostoma sp*	0	+
45100	*Palmacorixa sp*	0	+
45400	*Trichocorixa sp*	0	+
48410	*Corydalus cornutus*	2	
52200	*Cheumatopsyche sp*	174	+
52430	*Ceratopsyche morosa group*	409	+
52550	*Hydropsyche frisoni*	41	
52560	*Hydropsyche orris*	619	+
52570	*Hydropsyche simulans*	532	+
52620	*Macrostemum zebratum*	1269	+
52801	*Potamyia flava*	1786	+
59500	*Oecetis sp*	0	+
65501	*Hydrophilidae*	0	+
65800	*Berosus sp*	0	+
67800	*Tropisternus sp*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	29	
69400	*Stenelmis sp*	106	+
74100	*Simulium sp*	26	+
77500	*Conchapelopia sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	605	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	135	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	16	
80420	*Cricotopus (C.) bicinctus*	67	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	67	
81240	*Nanocladius (N.) distinctus*	0	+
82220	*Tvetenia discoloripes group*	605	+
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	673	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	67	+
84000	*Parachironomus sp*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	1345	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	67	+
85625	*Rheotanytarsus exiguus group*	3632	+
87540	*Hemerodromia sp*	8	
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	16	+
97601	*Corbicula fluminea*	0	+
98200	*Pisidium sp*	0	+
99001	*Unionidae*	0	+

No. Quantitative Taxa:	39	Total Taxa:	68
No. Qualitative Taxa:	56	ICI:	**48**
Number of Organisms:	13857	Qual EPT:	**17**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 97.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	930	+
03073	*Lophopodella carteri*	5	+
03221	*Pectinatella magnifica*	0	+
03360	*Plumatella sp*	6	+
03600	*Oligochaeta*	48	+
04660	*Helobdella sp*	0	+
04682	*Placobdella montifera*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	3	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	702	+
13510	*Stenonema exiguum*	24	
13550	*Stenonema mexicanum integrum*	50	
13570	*Stenonema terminatum*	147	+
16700	*Tricorythodes sp*	110	+
17200	*Caenis sp*	25	
18100	*Anthopotamus sp*	0	+
22001	*Coenagrionidae*	16	+
22300	*Argia sp*	1	+
24820	*Gomphurus externus*	0	+
28955	*Libellula lydia*	0	+
34140	*Acroneuria internata*	1	
43300	*Ranatra sp*	0	+
45100	*Palmacorixa sp*	0	+
48410	*Corydalus cornutus*	1	+
51300	*Neureclipsis sp*	57	
52430	*Ceratopsyche morosa group*	19	+
52550	*Hydropsyche frisoni*	19	+
52560	*Hydropsyche orris*	21	+
52570	*Hydropsyche simulans*	28	+
52620	*Macrostemum zebratum*	1710	+
52801	*Potamyia flava*	251	+
60300	*Dineutus sp*	1	+
62300	*Coptotomus sp*	0	+
63900	*Laccophilus sp*	0	+
67800	*Tropisternus sp*	0	+
68601	*Ancyronyx variegata*	8	+
68901	*Macronychus glabratus*	103	+
69400	*Stenelmis sp*	137	+
71100	*Hexatoma sp*	0	+
74100	*Simulium sp*	202	+
77750	*Hayesomyia senata or Thienemannimyia norena*	873	+
78650	*Procladius sp*	0	+
79085	*Telopelopia okoboji*	0	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	32	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	364	
82220	*Tvetenia discoloripes group*	0	+
82820	*Cryptochironomus sp*	0	+
83250	*Gillotia alboviridis*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	3785	+
84000	*Parachironomus sp*	73	
84040	*Parachironomus frequens*	0	+
84060	*Parachironomus pectinatellae*	0	+
84450	*Polypedilum (P.) convictum*	1019	+
84470	*Polypedilum (P.) illinoense*	73	
84480	*Polypedilum (P.) laetum group*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	218	+
85625	*Rheotanytarsus exiguus group*	1019	+
87540	*Hemerodromia sp*	162	
93900	*Elimia sp*	8	+
95100	*Physella sp*	25	+
96900	*Ferrissia sp*	0	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa:	39	Total Taxa:	65
No. Qualitative Taxa:	55	ICI:	**40**
Number of Organisms:	12276	Qual EPT:	**10**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-001 River: Muskingum River RM: 92.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	70	
03360	*Plumatella sp*	2	+
03600	*Oligochaeta*	32	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	54	+
11130	*Baetis intercalaris*	412	+
12200	*Isonychia sp*	19	
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	28	+
13510	*Stenonema exiguum*	91	
13550	*Stenonema mexicanum integrum*	73	
13561	*Stenonema pulchellum*	56	+
13570	*Stenonema terminatum*	234	+
16700	*Tricorythodes sp*	270	+
17200	*Caenis sp*	40	+
18100	*Anthopotamus sp*	0	+
18600	*Ephemera sp*	0	+
21200	*Calopteryx sp*	0	+
22300	*Argia sp*	1	
24915	*Gomphus fraternus*	0	+
34700	*Agnetina capitata complex*	1	
45100	*Palmacorixa sp*	0	+
47600	*Sialis sp*	0	+
50300	*Chimarra sp*	8	
51300	*Neureclipsis sp*	8	
52200	*Cheumatopsyche sp*	3	
52430	*Ceratopsyche morosa group*	46	+
52560	*Hydropsyche orris*	40	
52570	*Hydropsyche simulans*	42	
52620	*Macrostemum zebratum*	2880	+
52801	*Potamyia flava*	694	+
59400	*Nectopsyche sp*	0	+
60300	*Dineutus sp*	0	+
60900	*Peltodytes sp*	0	+
65800	*Berosus sp*	0	+
68130	*Helichus sp*	0	+
68601	*Ancyronyx variegata*	17	
68901	*Macronychus glabratus*	268	+
69400	*Stenelmis sp*	212	+
74100	*Simulium sp*	366	+
77750	*Hayesomyia senata or Thienemannimyia norena*	2427	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	64	+
82220	*Tvetenia discoloripes group*	187	+
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83250	*Gillotia alboviridis*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	1867	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	3735	+
84470	*Polypedilum (P.) illinoense*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85230	*Cladotanytarsus mancus group*	0	+
85625	*Rheotanytarsus exiguus group*	7656	+
87540	*Hemerodromia sp*	74	+
93200	*Hydrobiidae*	0	+
93900	*Elimia sp*	55	+
96900	*Ferrissia sp*	8	+
97601	*Corbicula fluminea*	9	

No. Quantitative Taxa:	37	Total Taxa:	59
No. Qualitative Taxa:	46	ICI:	**46**
Number of Organisms:	22049	Qual EPT:	**13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-200 River: Licking River RM: 3.60

Taxa Code	Taxa	Quan/Qual	
00653	*Eunapius fragilis*	0	+
01320	*Hydra sp*	16	
01801	*Turbellaria*	505	+
03073	*Lophopodella carteri*	3	
03360	*Plumatella sp*	1	+
03451	*Urnatella gracilis*	160	
03600	*Oligochaeta*	200	
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
08601	*Hydracarina*	32	
12200	*Isonychia sp*	3	+
13400	*Stenacron sp*	0	+
16700	*Tricorythodes sp*	1058	+
17200	*Caenis sp*	40	
18100	*Anthopotamus sp*	0	+
22300	*Argia sp*	8	+
45400	*Trichocorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	3	+
49200	*Climacia sp*	0	+
51206	*Cyrnellus fraternus*	73	
52200	*Cheumatopsyche sp*	4202	+
52430	*Ceratopsyche morosa group*	163	+
52520	*Hydropsyche bidens*	1	+
52540	*Hydropsyche dicantha*	1	+
52560	*Hydropsyche orris*	548	+
52570	*Hydropsyche simulans*	7	
52620	*Macrostemum zebratum*	4	+
53800	*Hydroptila sp*	123	+
65800	*Berosus sp*	1	+
69400	*Stenelmis sp*	1	+
74100	*Simulium sp*	93	+
77130	*Ablabesmyia rhamphe group*	44	
77750	*Hayesomyia senata or Thienemannimyia norena*	88	+
78750	*Rheopelopia paramaculipennis*	44	+
80410	*Cricotopus (C.) sp*	44	+
80420	*Cricotopus (C.) bicinctus*	133	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	0	+
81240	*Nanocladius (N.) distinctus*	177	+
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	88	+
83051	*Dicrotendipes simpsoni*	44	
83300	*Glyptotendipes (Phytotendipes) sp*	133	+
84300	*Phaenopsectra obediens group*	44	
84450	*Polypedilum (P.) convictum*	1679	+
84540	*Polypedilum (Tripodura) scalaenum group*	265	
84612	*Saetheria tylus*	0	+
85625	*Rheotanytarsus exiguus group*	1237	+
85814	*Tanytarsus glabrescens group*	44	
87540	*Hemerodromia sp*	117	+
93900	*Elimia sp*	7	+
96900	*Ferrissia sp*	0	+
97601	*Corbicula fluminea*	54	+

No. Quantitative Taxa:	41	Total Taxa:	54
No. Qualitative Taxa:	40	ICI:	**36**
Number of Organisms:	11488	Qual EPT:	**11**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-200 River: Licking River RM: 1.90 **N**

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*	0	+
01200	*Cordylophora lacustris*	1	
01320	*Hydra sp*	192	
01801	*Turbellaria*	125	+
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	32	+
05800	*Caecidotea sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
08601	*Hydracarina*	48	
11130	*Baetis intercalaris*	2	
12200	*Isonychia sp*	16	
13400	*Stenacron sp*	518	+
13510	*Stenonema exiguum*	10	
13550	*Stenonema mexicanum integrum*	8	
13561	*Stenonema pulchellum*	65	+
13570	*Stenonema terminatum*	443	
16700	*Tricorythodes sp*	1136	+
17200	*Caenis sp*	64	+
18100	*Anthopotamus sp*	9	+
22300	*Argia sp*	2	+
44501	*Corixidae*	0	+
48410	*Corydalus cornutus*	0	+
51206	*Cyrnellus fraternus*	59	+
52200	*Cheumatopsyche sp*	2310	+
52430	*Ceratopsyche morosa group*	200	+
52520	*Hydropsyche bidens*	77	
52560	*Hydropsyche orris*	56	
52570	*Hydropsyche simulans*	232	+
52620	*Macrostemum zebratum*	0	+
52801	*Potamyia flava*	56	
59500	*Oecetis sp*	64	
65800	*Berosus sp*	0	+
69400	*Stenelmis sp*	35	+
74100	*Simulium sp*	0	+
77130	*Ablabesmyia rhamphe group*	398	+
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+
80370	*Corynoneura lobata*	70	
80420	*Cricotopus (C.) bicinctus*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	70	
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	0	+
83050	*Dicrotendipes lucifer*	23	+
83300	*Glyptotendipes (Phytotendipes) sp*	117	+
84450	*Polypedilum (P.) convictum*	726	+
84540	*Polypedilum (Tripodura) scalaenum group*	94	+
84888	*Xenochironomus xenolabis*	47	
85625	*Rheotanytarsus exiguus group*	1359	+
85840	*Tanytarsus guerlus group*	70	
87540	*Hemerodromia sp*	26	
93900	*Elimia sp*	14	+
96900	*Ferrissia sp*	66	
96930	*Laevapex fuscus*	0	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa:	39	Total Taxa:	54
No. Qualitative Taxa:	35	ICI:	**48**
Number of Organisms:	8841	Qual EPT:	**10**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-200 River: Licking River RM: 1.90 **S**

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	15	
01801	*Turbellaria*	107	+
03360	*Plumatella sp*	1	
03451	*Urnatella gracilis*	1	
03600	*Oligochaeta*	56	
08601	*Hydracarina*	13	
13400	*Stenacron sp*	74	+
13550	*Stenonema mexicanum integrum*	3	
13561	*Stenonema pulchellum*	10	
13570	*Stenonema terminatum*	31	
16700	*Tricorythodes sp*	451	+
17200	*Caenis sp*	104	
18100	*Anthopotamus sp*	30	+
22300	*Argia sp*	4	+
48410	*Corydalus cornutus*	0	+
51206	*Cyrnellus fraternus*	50	
52200	*Cheumatopsyche sp*	31	
52570	*Hydropsyche simulans*	4	
68708	*Dubiraphia vittata group*	1	
69400	*Stenelmis sp*	67	
72420	*Chaoborus sp*	1	
77120	*Ablabesmyia mallochi*	24	
77130	*Ablabesmyia rhamphe group*	85	
77470	*Coelotanypus sp*	12	
77750	*Hayesomyia senata or Thienemannimyia norena*	61	
78750	*Rheopelopia paramaculipennis*	12	
79085	*Telopelopia okoboji*	12	
80410	*Cricotopus (C.) sp*	12	
80430	*Cricotopus (C.) tremulus group*	12	
83040	*Dicrotendipes neomodestus*	218	
83050	*Dicrotendipes lucifer*	12	
83051	*Dicrotendipes simpsoni*	12	
83300	*Glyptotendipes (Phytotendipes) sp*	255	
84300	*Phaenopsectra obediens group*	85	
84450	*Polypedilum (P.) convictum*	121	
84540	*Polypedilum (Tripodura) scalaenum group*	328	
84700	*Stenochironomus sp*	49	
84790	*Tribelos fuscicorne*	12	
85625	*Rheotanytarsus exiguus group*	61	+
85800	*Tanytarsus sp*	36	
85814	*Tanytarsus glabrescens group*	24	
93900	*Elimia sp*	13	+
96900	*Ferrissia sp*	129	+
97601	*Corbicula fluminea*	20	

No. Quantitative Taxa: 43 Total Taxa: 44

No. Qualitative Taxa: 9 ICI: **28**

Number of Organisms: 2659 Qual EPT: **3**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/08/94 River Code: 17-200 River: Licking River RM: 0.70

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*	0	+
01200	*Cordylophora lacustris*	1	
01320	*Hydra sp*	40	
01801	*Turbellaria*	110	+
03121	*Paludicella articulata*	0	+
03360	*Plumatella sp*	0	+
03451	*Urnatella gracilis*	16	
03600	*Oligochaeta*	24	
04666	*Helobdella triserialis*	0	+
06201	*Hyalella azteca*	0	+
08250	*Orconectes (Procericambarus) rusticus*	1	+
11130	*Baetis intercalaris*	25	
12200	*Isonychia sp*	23	+
13400	*Stenacron sp*	91	+
13510	*Stenonema exiguum*	4	+
13550	*Stenonema mexicanum integrum*	23	+
13561	*Stenonema pulchellum*	228	+
13570	*Stenonema terminatum*	578	
16700	*Tricorythodes sp*	1171	+
17200	*Caenis sp*	65	+
18100	*Anthopotamus sp*	4	+
22300	*Argia sp*	0	+
48410	*Corydalus cornutus*	1	+
49200	*Climacia sp*	0	+
50906	*Psychomyia flavida*	8	
51206	*Cyrnellus fraternus*	34	
51300	*Neureclipsis sp*	24	
52200	*Cheumatopsyche sp*	3054	+
52430	*Ceratopsyche morosa group*	8	+
52520	*Hydropsyche bidens*	254	
52560	*Hydropsyche orris*	75	
52570	*Hydropsyche simulans*	670	+
52620	*Macrostemum zebratum*	896	+
52801	*Potamyia flava*	350	+
53800	*Hydroptila sp*	41	+
68901	*Macronychus glabratus*	8	
69400	*Stenelmis sp*	72	+
71910	*Tipula abdominalis*	8	
77750	*Hayesomyia senata or Thienemannimyia norena*	258	+
79085	*Telopelopia okoboji*	0	+
80410	*Cricotopus (C.) sp*	0	+
82220	*Tvetenia discoloripes group*	57	+
83300	*Glyptotendipes (Phytotendipes) sp*	86	+
84450	*Polypedilum (P.) convictum*	1433	+
84460	*Polypedilum (P.) fallax group*	29	
84700	*Stenochironomus sp*	29	
84888	*Xenochironomus xenolabis*	0	+
85625	*Rheotanytarsus exiguus group*	860	+
85814	*Tanytarsus glabrescens group*	29	
85840	*Tanytarsus guerlus group*	29	
87540	*Hemerodromia sp*	8	
93900	*Elimia sp*	44	+
96900	*Ferrissia sp*	15	+
97601	*Corbicula fluminea*	3	+
98600	*Sphaerium sp*	17	

No. Quantitative Taxa: 45 Total Taxa: 55
No. Qualitative Taxa: 36 ICI: **48**
Number of Organisms: 10804 Qual EPT: **14**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/16/93 River Code: 17-200 River: Licking River RM: 5.50

Taxa Code	Taxa	Quan/Qual	
00653	*Eunapius fragilis*	0	+
01801	*Turbellaria*	0	+
03221	*Pectinatella magnifica*	0	+
03360	*Plumatella sp*	0	+
03451	*Urnatella gracilis*	0	+
03600	*Oligochaeta*	1440	+
06201	*Hyalella azteca*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
13400	*Stenacron sp*	0	+
13510	*Stenonema exiguum*	8	
13521	*Stenonema femoratum*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
45300	*Sigara sp*	0	+
45400	*Trichocorixa sp*	0	+
51206	*Cyrnellus fraternus*	1212	+
52200	*Cheumatopsyche sp*	138	+
52560	*Hydropsyche orris*	480	
53501	*Hydroptilidae*	8	
63300	*Hydroporus sp*	0	+
65800	*Berosus sp*	0	+
69400	*Stenelmis sp*	4	
74100	*Simulium sp*	3	
77130	*Ablabesmyia rhamphe group*	0	+
78650	*Procladius sp*	0	+
81240	*Nanocladius (N.) distinctus*	991	+
82730	*Chironomus (C.) decorus group*	0	+
83003	*Dicrotendipes fumidus*	84	+
83040	*Dicrotendipes neomodestus*	42	+
83050	*Dicrotendipes lucifer*	251	
83051	*Dicrotendipes simpsoni*	126	+
83300	*Glyptotendipes (Phytotendipes) sp*	4192	+
84450	*Polypedilum (P.) convictum*	838	
84470	*Polypedilum (P.) illinoense*	0	+
85625	*Rheotanytarsus exiguus group*	84	
87501	*Empididae*	64	
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	0	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	17	Total Taxa:	39
No. Qualitative Taxa:	30	ICI:	**18**
Number of Organisms:	9965	Qual EPT:	**4**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/16/93 River Code: 17-200 River: Licking River RM: 3.60

Taxa Code	Taxa	Quan/Qual	
00653	*Eunapius fragilis*	0	+
01801	*Turbellaria*	644	+
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	344	
06201	*Hyalella azteca*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
08601	*Hydracarina*	16	
12200	*Isonychia sp*	1	+
13400	*Stenacron sp*	0	+
13510	*Stenonema exiguum*	34	+
13550	*Stenonema mexicanum integrum*	17	
13570	*Stenonema terminatum*	17	+
16700	*Tricorythodes sp*	802	+
17200	*Caenis sp*	1	
18100	*Anthopotamus sp*	0	+
22300	*Argia sp*	0	+
48410	*Corydalus cornutus*	4	+
49400	*Sisyra sp*	0	+
51206	*Cyrnellus fraternus*	172	+
52200	*Cheumatopsyche sp*	4831	+
52430	*Ceratopsyche morosa group*	647	+
52540	*Hydropsyche dicantha*	154	+
52560	*Hydropsyche orris*	1847	+
52570	*Hydropsyche simulans*	67	
52620	*Macrostemum zebratum*	8	+
53800	*Hydroptila sp*	152	+
63900	*Laccophilus sp*	0	+
69400	*Stenelmis sp*	0	+
74100	*Simulium sp*	270	+
77750	*Hayesomyia senata or Thienemannimyia norena*	461	+
80410	*Cricotopus (C.) sp*	184	+
80420	*Cricotopus (C.) bicinctus*	92	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	646	+
81240	*Nanocladius (N.) distinctus*	92	
82220	*Tvetenia discoloripes group*	0	+
83040	*Dicrotendipes neomodestus*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	184	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	3782	+
84460	*Polypedilum (P.) fallax group*	0	+
84470	*Polypedilum (P.) illinoense*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85625	*Rheotanytarsus exiguus group*	1937	+
85814	*Tanytarsus glabrescens group*	92	
87501	*Empididae*	137	
93900	*Elimia sp*	0	+
96900	*Ferrissia sp*	66	
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa: 31 Total Taxa: 50

No. Qualitative Taxa: 40 ICI: **38**

Number of Organisms: 17702 Qual EPT: **13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-500 River: Tuscarawas River RM: 21.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	10	+
03073	*Lophopodella carteri*	6	
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	0	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	3	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	1138	+
12200	*Isonychia sp*	22	+
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	0	+
13510	*Stenonema exiguum*	2	+
13550	*Stenonema mexicanum integrum*	94	+
13570	*Stenonema terminatum*	524	+
16700	*Tricorythodes sp*	736	+
17200	*Caenis sp*	58	+
18100	*Anthopotamus sp*	0	+
21300	*Hetaerina sp*	8	+
22300	*Argia sp*	0	+
23909	*Boyeria vinosa*	0	+
24820	*Gomphurus externus*	0	+
24950	*Gomphus vastus*	0	+
26700	*Macromia sp*	0	+
34700	*Agnetina capitata complex*	3	+
45100	*Palmacorixa sp*	0	+
48410	*Corydalus cornutus*	4	+
52200	*Cheumatopsyche sp*	4539	+
52430	*Ceratopsyche morosa group*	611	+
52520	*Hydropsyche bidens*	3	
52540	*Hydropsyche dicantha*	85	+
52550	*Hydropsyche frisoni*	609	+
52560	*Hydropsyche orris*	85	
52570	*Hydropsyche simulans*	215	
52620	*Macrostemum zebratum*	288	+
52801	*Potamyia flava*	90	+
53501	*Hydroptilidae*	0	+
60300	*Dineutus sp*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	65	
69400	*Stenelmis sp*	91	+
74100	*Simulium sp*	1145	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	174	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	0	+
80310	*Cardiocladius obscurus*	0	+
82220	*Tvetenia discoloripes group*	58	
82770	*Chironomus (C.) riparius group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	232	+
84040	*Parachironomus frequens*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	406	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
84750	*Stictochironomus sp*	0	+
85625	*Rheotanytarsus exiguus group*	4121	+
87540	*Hemerodromia sp*	40	
93200	*Hydrobiidae*	0	+
93900	*Elimia sp*	4	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+
99100	*Anodonta grandis*	0	+

No. Quantitative Taxa: 33 Total Taxa: 65
No. Qualitative Taxa: 58 ICI: **52**
Number of Organisms: 15470 Qual EPT: **18**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-500 River: Tuscarawas River RM: 7.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	34	+
03073	*Lophopodella carteri*	12	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	0	+
05800	*Caecidotea sp*	0	+
06810	*Gammarus fasciatus*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
08601	*Hydracarina*	288	
11130	*Baetis intercalaris*	528	+
12200	*Isonychia sp*	6	+
13400	*Stenacron sp*	0	+
13550	*Stenonema mexicanum integrum*	8	+
13570	*Stenonema terminatum*	317	+
16700	*Tricorythodes sp*	259	+
17200	*Caenis sp*	145	+
18100	*Anthopotamus sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
24915	*Gomphus fraternus*	0	+
24950	*Gomphus vastus*	0	+
34700	*Agnetina capitata complex*	0	+
45100	*Palmacorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	9	+
52200	*Cheumatopsyche sp*	2320	+
52430	*Ceratopsyche morosa group*	804	+
52520	*Hydropsyche bidens*	2	+
52540	*Hydropsyche dicantha*	2	
52550	*Hydropsyche frisoni*	126	
52560	*Hydropsyche orris*	271	+
52570	*Hydropsyche simulans*	12	+
52620	*Macrostemum zebratum*	331	+
52801	*Potamyia flava*	3176	+
53501	*Hydroptilidae*	0	+
59407	*Nectopsyche candida*	0	+
60900	*Peltodytes sp*	0	+
67800	*Tropisternus sp*	0	+
68601	*Ancyronyx variegata*	256	
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	65	+
69400	*Stenelmis sp*	271	+
74100	*Simulium sp*	620	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1840	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	0	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	32	
80430	*Cricotopus (C.) tremulus group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	460	
82220	*Tvetenia discoloripes group*	460	
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	460	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	920	+
84460	*Polypedilum (P.) fallax group*	0	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	460	+
85260	*Cladotanytarsus vanderwulpi group*	0	+
85500	*Paratanytarsus sp*	0	+
85625	*Rheotanytarsus exiguus group*	53831	+
86200	*Tabanus sp*	0	+
87540	*Hemerodromia sp*	41	+
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	9	+
97601	*Corbicula fluminea*	0	+
98200	*Pisidium sp*	0	+
98600	*Sphaerium sp*	1	+

No. Quantitative Taxa:	35	Total Taxa:	71
No. Qualitative Taxa:	62	ICI:	**50**
Number of Organisms:	68377	Qual EPT:	**18**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-500 River: Tuscarawas River RM: 3.80

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	8	+
03073	*Lophopodella carteri*	4	+
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	0	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
06810	*Gammarus fasciatus*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
08601	*Hydracarina*	128	
11130	*Baetis intercalaris*	1172	+
12200	*Isonychia sp*	29	+
13400	*Stenacron sp*	0	+
13510	*Stenonema exiguum*	28	+
13550	*Stenonema mexicanum integrum*	352	+
13570	*Stenonema terminatum*	614	+
16700	*Tricorythodes sp*	370	+
17200	*Caenis sp*	33	+
18100	*Anthopotamus sp*	0	+
21200	*Calopteryx sp*	0	+
21300	*Hetaerina sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
23909	*Boyeria vinosa*	0	+
24900	*Gomphus sp*	0	+
34700	*Agnetina capitata complex*	1	
43570	*Neoplea sp*	0	+
45100	*Palmacorixa sp*	0	+
48410	*Corydalus cornutus*	0	+
52200	*Cheumatopsyche sp*	3653	+
52430	*Ceratopsyche morosa group*	1472	+
52520	*Hydropsyche bidens*	78	
52540	*Hydropsyche dicantha*	7	+
52550	*Hydropsyche frisoni*	307	+
52560	*Hydropsyche orris*	933	+
52570	*Hydropsyche simulans*	307	+
52620	*Macrostemum zebratum*	83	+
52801	*Potamyia flava*	2867	+
59100	*Ceraclea sp*	1	
60900	*Peltodytes sp*	0	+
63900	*Laccophilus sp*	0	+
68901	*Macronychus glabratus*	37	
69400	*Stenelmis sp*	265	+
74100	*Simulium sp*	51	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1235	+
78750	*Rheopelopia paramaculipennis*	0	+
79085	*Telopelopia okoboji*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	0	+
82220	*Tvetenia discoloripes group*	2470	+
82730	*Chironomus (C.) decorus group*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	618	+
84040	*Parachironomus frequens*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	3705	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	618	+
85625	*Rheotanytarsus exiguus group*	51258	+
86200	*Tabanus sp*	0	+
87540	*Hemerodromia sp*	24	
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa:	32	Total Taxa:	63
No. Qualitative Taxa:	57	ICI:	**44**
Number of Organisms:	72729	Qual EPT:	**17**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/07/94 River Code: 17-500 River: Tuscarawas River RM: 1.30

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	4	+
03073	*Lophopodella carteri*	4	+
03360	*Plumatella sp*	7	+
03600	*Oligochaeta*	592	+
06810	*Gammarus fasciatus*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	1153	+
11670	*Procloeon irrubrum*	0	+
12200	*Isonychia sp*	4	+
13400	*Stenacron sp*	0	+
13510	*Stenonema exiguum*	7	
13550	*Stenonema mexicanum integrum*	161	+
13561	*Stenonema pulchellum*	51	+
13570	*Stenonema terminatum*	839	+
16700	*Tricorythodes sp*	307	+
17200	*Caenis sp*	53	+
18100	*Anthopotamus sp*	0	+
21300	*Hetaerina sp*	0	+
22001	*Coenagrionidae*	0	+
24800	*Gomphurus sp*	0	+
34700	*Agnetina capitata complex*	0	+
45100	*Palmacorixa sp*	0	+
45400	*Trichocorixa sp*	0	+
48410	*Corydalus cornutus*	3	+
52200	*Cheumatopsyche sp*	1269	+
52430	*Ceratopsyche morosa group*	290	+
52520	*Hydropsyche bidens*	80	+
52550	*Hydropsyche frisoni*	149	+
52560	*Hydropsyche orris*	551	+
52570	*Hydropsyche simulans*	85	+
52620	*Macrostemum zebratum*	114	+
52801	*Potamyia flava*	5541	+
60300	*Dineutus sp*	0	+
67800	*Tropisternus sp*	0	+
68601	*Ancyronyx variegata*	36	
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	12	
69400	*Stenelmis sp*	258	+
74100	*Simulium sp*	371	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	2842	+
78650	*Procladius sp*	0	+
78750	*Rheopelopia paramaculipennis*	0	+
80440	*Cricotopus (C.) trifascia group*	0	+
81240	*Nanocladius (N.) distinctus*	0	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+
82220	*Tvetenia discoloripes group*	711	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	1421	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84300	*Phaenopsectra obediens group*	0	+
84450	*Polypedilum (P.) convictum*	5685	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85625	*Rheotanytarsus exiguus group*	65373	+
86200	*Tabanus sp*	0	+
87540	*Hemerodromia sp*	4	
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	36	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+
99001	*Unionidae*	0	+

No. Quantitative Taxa:	32	Total Taxa:	64
No. Qualitative Taxa:	60	ICI:	**46**
Number of Organisms:	88013	Qual EPT:	**19**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/07/94 River Code: 17-500 River: Tuscarawas River RM: 1.00

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	16	
03600	*Oligochaeta*	865	+
06810	*Gammarus fasciatus*	0	+
11130	*Baetis intercalaris*	1126	+
12200	*Isonychia sp*	24	+
13510	*Stenonema exiguum*	24	
13550	*Stenonema mexicanum integrum*	213	+
13561	*Stenonema pulchellum*	22	
13570	*Stenonema terminatum*	518	+
16700	*Tricorythodes sp*	786	+
17200	*Caenis sp*	265	+
34700	*Agnetina capitata complex*	4	+
48410	*Corydalus cornutus*	3	+
52200	*Cheumatopsyche sp*	767	+
52430	*Ceratopsyche morosa group*	483	+
52520	*Hydropsyche bidens*	64	
52540	*Hydropsyche dicantha*	0	+
52550	*Hydropsyche frisoni*	116	+
52560	*Hydropsyche orris*	392	+
52570	*Hydropsyche simulans*	63	+
52620	*Macrostemum zebratum*	175	+
52801	*Potamyia flava*	4695	+
68901	*Macronychus glabratus*	365	
69400	*Stenelmis sp*	262	+
74100	*Simulium sp*	321	+
77750	*Hayesomyia senata or Thienemannimyia norena*	506	+
78750	*Rheopelopia paramaculipennis*	506	+
79085	*Telopelopia okoboji*	0	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	32	
80440	*Cricotopus (C.) trifascia group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	1518	+
82220	*Tvetenia discoloripes group*	0	+
82770	*Chironomus (C.) riparius group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	1518	+
84450	*Polypedilum (P.) convictum*	3541	+
84480	*Polypedilum (P.) laetum group*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85625	*Rheotanytarsus exiguus group*	45531	+
87540	*Hemerodromia sp*	51	+
93900	*Elimia sp*	0	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa: 31 Total Taxa: 44

No. Qualitative Taxa: 38 ICI: **46**

Number of Organisms: 64772 Qual EPT: **15**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/07/94 River Code: 17-500 River: Tuscarawas River RM: 0.70

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	61	+
03360	*Plumatella sp*	6	
03600	*Oligochaeta*	2984	+
05800	*Caecidotea sp*	0	+
06810	*Gammarus fasciatus*	0	+
11130	*Baetis intercalaris*	965	+
12200	*Isonychia sp*	6	+
13510	*Stenonema exiguum*	24	
13550	*Stenonema mexicanum integrum*	139	+
13570	*Stenonema terminatum*	285	+
16700	*Tricorythodes sp*	549	+
17200	*Caenis sp*	394	+
18100	*Anthopotamus sp*	0	+
22300	*Argia sp*	0	+
24800	*Gomphurus sp*	0	+
34700	*Agnetina capitata complex*	4	+
45100	*Palmacorixa sp*	0	+
45400	*Trichocorixa sp*	0	+
48410	*Corydalus cornutus*	2	
52200	*Cheumatopsyche sp*	3538	+
52430	*Ceratopsyche morosa group*	662	+
52520	*Hydropsyche bidens*	6	
52550	*Hydropsyche frisoni*	3	
52560	*Hydropsyche orris*	2356	+
52570	*Hydropsyche simulans*	16	
52620	*Macrostemum zebratum*	42	+
52801	*Potamyia flava*	9177	+
67800	*Tropisternus sp*	0	+
68700	*Dubiraphia sp*	0	+
68901	*Macronychus glabratus*	42	
69400	*Stenelmis sp*	97	+
74100	*Simulium sp*	217	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1700	+
78750	*Rheopelopia paramaculipennis*	850	+
79085	*Telopelopia okoboji*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	2550	+
82220	*Tvetenia discoloripes group*	0	+
82770	*Chironomus (C.) riparius group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	6802	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84300	*Phaenopsectra obediens group*	850	+
84450	*Polypedilum (P.) convictum*	4251	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	850	+
85265	*Cladotanytarsus vanderwulpi group Type 5*	850	
85625	*Rheotanytarsus exiguus group*	75675	+
85840	*Tanytarsus guerlus group*	850	
87540	*Hemerodromia sp*	56	+
93200	*Hydrobiidae*	0	+
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	4	+
98600	*Sphaerium sp*	32	+

No. Quantitative Taxa:	36	Total Taxa:	55
No. Qualitative Taxa:	46	ICI:	**44**
Number of Organisms:	116895	Qual EPT:	**13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/07/94 River Code: 17-500 River: Tuscarawas River RM: 0.30

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	217	+
03073	*Lophopodella carteri*	51	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	384	+
04666	*Helobdella triserialis*	0	+
04935	*Erpobdella punctata punctata*	0	+
05800	*Caecidotea sp*	4	
06810	*Gammarus fasciatus*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11130	*Baetis intercalaris*	272	+
12200	*Isonychia sp*	5	
13400	*Stenacron sp*	0	+
13550	*Stenonema mexicanum integrum*	121	+
13561	*Stenonema pulchellum*	9	+
13570	*Stenonema terminatum*	325	+
16700	*Tricorythodes sp*	2610	+
17200	*Caenis sp*	230	+
18100	*Anthopotamus sp*	0	+
34700	*Agnetina capitata complex*	1	+
45100	*Palmacorixa sp*	0	+
45400	*Trichocorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	1	+
52200	*Cheumatopsyche sp*	602	+
52430	*Ceratopsyche morosa group*	106	+
52520	*Hydropsyche bidens*	8	
52540	*Hydropsyche dicantha*	83	
52550	*Hydropsyche frisoni*	169	+
52560	*Hydropsyche orris*	257	+
52570	*Hydropsyche simulans*	8	+
52620	*Macrostemum zebratum*	131	+
52801	*Potamyia flava*	2907	+
59500	*Oecetis sp*	64	
63300	*Hydroporus sp*	0	+
63900	*Laccophilus sp*	0	+
65800	*Berosus sp*	0	+
68601	*Ancyronyx variegata*	32	
68901	*Macronychus glabratus*	51	+
69400	*Stenelmis sp*	580	+
74100	*Simulium sp*	101	+
77120	*Ablabesmyia mallochi*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+
78650	*Procladius sp*	0	+
79085	*Telopelopia okoboji*	0	+
79100	*Thienemannimyia group*	718	
80310	*Cardiocladius obscurus*	0	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	718	
82220	*Tvetenia discoloripes group*	0	+
82730	*Chironomus (C.) decorus group*	0	+
82770	*Chironomus (C.) riparius group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	5023	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	718	+
84300	*Phaenopsectra obediens group*	718	
84450	*Polypedilum (P.) convictum*	2870	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	0	+
85625	*Rheotanytarsus exiguus group*	50229	+
85840	*Tanytarsus guerlus group*	0	+
87540	*Hemerodromia sp*	1663	
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	77	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa:	37	Total Taxa:	65
No. Qualitative Taxa:	53	ICI:	**48**
Number of Organisms:	72064	Qual EPT:	**16**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-600 River: Walhonding River RM: 15.60

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*	0	+
01801	*Turbellaria*	0	+
03360	*Plumatella sp*	2	+
03451	*Urnatella gracilis*	9	+
03600	*Oligochaeta*	8	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11010	*Acentrella sp*	1	
11110	*Baetis armillatus*	10	
11118	*Baetis dubius*	9	
11130	*Baetis intercalaris*	55	+
11155	*Baetis punctiventris*	2	
11650	*Procloeon sp (w/ hindwing pads)*	0	+
11670	*Procloeon irrubrum*	0	+
12200	*Isonychia sp*	1006	+
13400	*Stenacron sp*	74	+
13510	*Stenonema exiguum*	64	
13550	*Stenonema mexicanum integrum*	7	
13561	*Stenonema pulchellum*	950	+
13570	*Stenonema terminatum*	24	
14950	*Leptophlebia sp or Paraleptophebia sp*	16	
16324	*Serratella deficiens*	56	
16700	*Tricorythodes sp*	270	+
17200	*Caenis sp*	8	+
18100	*Anthopotamus sp*	0	+
22300	*Argia sp*	16	+
23804	*Basiaeschna janata*	0	+
23909	*Boyeria vinosa*	0	+
24900	*Gomphus sp*	0	+
25620	*Stylurus spiniceps*	0	+
27406	*Neurocordulia obsoleta*	0	+
30800	*Pteronarcys sp*	1	+
34140	*Acroneuria internata*	8	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	15	+
51300	*Neureclipsis sp*	11	+
52200	*Cheumatopsyche sp*	504	+
52430	*Ceratopsyche morosa group*	424	
52550	*Hydropsyche frisoni*	230	
52560	*Hydropsyche orris*	2	
52570	*Hydropsyche simulans*	108	
52620	*Macrostemum zebratum*	9	+
52801	*Potamyia flava*	81	
59500	*Oecetis sp*	16	
60300	*Dineutus sp*	0	+
68075	*Psephenus herricki*	0	+
68601	*Ancyronyx variegata*	8	
68901	*Macronychus glabratus*	29	+
69400	*Stenelmis sp*	5	+
74100	*Simulium sp*	8	
78750	*Rheopelopia paramaculipennis*	59	
80350	*Corynoneura sp*	29	
80410	*Cricotopus (C.) sp*	117	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	29	
82141	*Thienemanniella xena*	123	
82220	*Tvetenia discoloripes group*	29	
84060	*Parachironomus pectinatellae*	29	
84450	*Polypedilum (P.) convictum*	497	
84540	*Polypedilum (Tripodura) scalaenum group*	29	
85615	*Rheotanytarsus distinctissimus group*	88	
85625	*Rheotanytarsus exiguus group*	1755	
85752	*Sublettea coffmani*	59	
85800	*Tanytarsus sp*	29	
85814	*Tanytarsus glabrescens group*	88	
96900	*Ferrissia sp*	1	

No. Quantitative Taxa:	50	Total Taxa:	66
No. Qualitative Taxa:	34	ICI:	**56**
Number of Organisms:	7007	Qual EPT:	**14**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-600 River: Walhonding River RM: 7.70

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	0	+
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	8	+
04685	*Placobdella ornata*	0	+
05900	*Lirceus sp*	0	+
06201	*Hyalella azteca*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
11010	*Acentrella sp*	0	+
11101	*Baetis sp (w/o hindwing pads)*	0	+
11118	*Baetis dubius*	22	+
11130	*Baetis intercalaris*	147	+
11503	*Heterocloeon curiosum*	0	+
12200	*Isonychia sp*	818	+
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	55	+
13510	*Stenonema exiguum*	71	
13550	*Stenonema mexicanum integrum*	25	
13561	*Stenonema pulchellum*	673	+
16324	*Serratella deficiens*	32	
16700	*Tricorythodes sp*	25	+
17200	*Caenis sp*	10	
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	2	+
25620	*Stylurus spiniceps*	0	+
27406	*Neurocordulia obsoleta*	0	+
30800	*Pteronarcys sp*	0	+
34140	*Acroneuria internata*	2	+
34410	*Paragnetina media*	9	
45100	*Palmacorixa sp*	0	+
48410	*Corydalus cornutus*	4	+
51300	*Neureclipsis sp*	9	
51600	*Polycentropus sp*	0	+
52200	*Cheumatopsyche sp*	185	+
52430	*Ceratopsyche morosa group*	385	+
52540	*Hydropsyche dicantha*	14	
52550	*Hydropsyche frisoni*	67	+
52570	*Hydropsyche simulans*	25	+
52620	*Macrostemum zebratum*	133	+
59520	*Oecetis cinerascens*	1	
59970	*Petrophila sp*	0	+
60300	*Dineutus sp*	1	+
68901	*Macronychus glabratus*	36	+
69400	*Stenelmis sp*	14	+
74100	*Simulium sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	24	
78650	*Procladius sp*	0	+
79400	*Zavrelimyia sp*	0	+
80310	*Cardiocladius obscurus*	0	+
80370	*Corynoneura lobata*	8	
80410	*Cricotopus (C.) sp*	0	+
80420	*Cricotopus (C.) bicinctus*	0	+
82141	*Thienemanniella xena*	76	
82220	*Tvetenia discoloripes group*	36	+
83300	*Glyptotendipes (Phytotendipes) sp*	48	
84060	*Parachironomus pectinatellae*	0	+
84450	*Polypedilum (P.) convictum*	230	+
84460	*Polypedilum (P.) fallax group*	24	
84480	*Polypedilum (P.) laetum group*	12	
84540	*Polypedilum (Tripodura) scalaenum group*	36	
84700	*Stenochironomus sp*	12	
85615	*Rheotanytarsus distinctissimus group*	48	+
85625	*Rheotanytarsus exiguus group*	653	+
86100	*Chrysops sp*	0	+
86401	*Atherix lantha*	1	+
87540	*Hemerodromia sp*	8	
92615	*Cipangopaludina japonica*	0	+
93900	*Elimia sp*	1	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	1	+
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+
99240	*Lasmigona complanata*	0	+
99280	*Lasmigona costata*	0	+
99680	*Leptodea fragilis*	0	+

No. Quantitative Taxa:	43	Total Taxa:	74
No. Qualitative Taxa:	57	ICI:	**56**
Number of Organisms:	3992	Qual EPT:	**18**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/06/94 River Code: 17-600 River: Walhonding River RM: 0.80

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*	0	+
01801	*Turbellaria*	11	+
03073	*Lophopodella carteri*	33	
03360	*Plumatella sp*	0	+
05800	*Caecidotea sp*	0	+
06700	*Crangonyx sp*	0	+
11010	*Acentrella sp*	13	
11130	*Baetis intercalaris*	408	+
11503	*Heterocloeon curiosum*	130	+
12200	*Isonychia sp*	378	+
13400	*Stenacron sp*	22	+
13510	*Stenonema exiguum*	101	+
13561	*Stenonema pulchellum*	498	+
13570	*Stenonema terminatum*	3	
15501	*Ephemerellidae*	24	
16700	*Tricorythodes sp*	37	+
17200	*Caenis sp*	17	
22300	*Argia sp*	0	+
25620	*Stylurus spiniceps*	0	+
27406	*Neurocordulia obsoleta*	0	+
30800	*Pteronarcys sp*	0	+
34410	*Paragnetina media*	9	
34700	*Agnetina capitata complex*	0	+
48410	*Corydalus cornutus*	3	+
52200	*Cheumatopsyche sp*	632	+
52430	*Ceratopsyche morosa group*	1281	+
52520	*Hydropsyche bidens*	0	+
52540	*Hydropsyche dicantha*	74	
52550	*Hydropsyche frisoni*	143	+
52560	*Hydropsyche orris*	283	+
52570	*Hydropsyche simulans*	231	+
52620	*Macrostemum zebratum*	1149	+
52801	*Potamyia flava*	404	+
53400	*Protoptila sp*	1	
53800	*Hydroptila sp*	0	+
59970	*Petrophila sp*	0	+
68901	*Macronychus glabratus*	18	
69400	*Stenelmis sp*	25	+
74100	*Simulium sp*	878	
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+
78750	*Rheopelopia paramaculipennis*	76	
82141	*Thienemanniella xena*	76	
82220	*Tvetenia discoloripes group*	686	+
82730	*Chironomus (C.) decorus group*	0	+
83000	*Dicrotendipes sp*	0	+
84060	*Parachironomus pectinatellae*	0	+
84450	*Polypedilum (P.) convictum*	305	+
84480	*Polypedilum (P.) laetum group*	0	+
84520	*Polypedilum (Tripodura) halterale group*	0	+
85625	*Rheotanytarsus exiguus group*	5641	+
85800	*Tanytarsus sp*	0	+
87540	*Hemerodromia sp*	160	
93900	*Elimia sp*	3	+
96900	*Ferrissia sp*	0	+
98600	*Sphaerium sp*	1	+

No. Quantitative Taxa:	35	Total Taxa:	55
No. Qualitative Taxa:	42	ICI:	**52**
Number of Organisms:	13754	Qual EPT:	**18**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/20/94 River Code: 17-800 River: Wills Creek RM: 5.20

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*	0	+
01200	*Cordylophora lacustris*	1	
01801	*Turbellaria*	50	+
03121	*Paludicella articulata*	1	
03221	*Pectinatella magnifica*	4	
03360	*Plumatella sp*	2	
03600	*Oligochaeta*	16	+
06201	*Hyalella azteca*	0	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0	+
08601	*Hydracarina*	16	
11130	*Baetis intercalaris*	629	+
11620	*Paracloeodes sp 2*	0	+
11670	*Procloeon irrubrum*	0	+
12200	*Isonychia sp*	1	+
13400	*Stenacron sp*	95	+
13561	*Stenonema pulchellum*	0	+
13570	*Stenonema terminatum*	347	+
16700	*Tricorythodes sp*	107	+
17200	*Caenis sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
23909	*Boyeria vinosa*	0	+
24900	*Gomphus sp*	0	+
26700	*Macromia sp*	0	+
27404	*Neurocordulia molesta*	1	
45100	*Palmacorixa sp*	0	+
47600	*Sialis sp*	0	+
48410	*Corydalus cornutus*	10	+
51206	*Cyrnellus fraternus*	135	
51300	*Neureclipsis sp*	272	+
51600	*Polycentropus sp*	68	+
52200	*Cheumatopsyche sp*	6247	+
52430	*Ceratopsyche morosa group*	2	
52520	*Hydropsyche bidens*	1509	+
52560	*Hydropsyche orris*	5842	+
52570	*Hydropsyche simulans*	2604	+
52620	*Macrostemum zebratum*	7	+
52801	*Potamyia flava*	13	+
53501	*Hydroptilidae*	4	
60300	*Dineutus sp*	1	+
68130	*Helichus sp*	0	+
68201	*Scirtidae*	0	+
68901	*Macronychus glabratus*	9	
69400	*Stenelmis sp*	4	+
71300	*Limonia sp*	0	+
77130	*Ablabesmyia rhamphe group*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	709	
81240	*Nanocladius (N.) distinctus*	79	
83300	*Glyptotendipes (Phytotendipes) sp*	276	+
84040	*Parachironomus frequens*	236	
84450	*Polypedilum (P.) convictum*	355	+
84470	*Polypedilum (P.) illinoense*	0	+
84480	*Polypedilum (P.) laetum group*	0	+
85625	*Rheotanytarsus exiguus group*	1497	+
87540	*Hemerodromia sp*	4	
89700	*Limnophora sp*	0	+
93900	*Elimia sp*	5	+
95100	*Physella sp*	0	+
97601	*Corbicula fluminea*	2	
98600	*Sphaerium sp*	1	+
99900	*Epioblasma triquetra*	0	+

No. Quantitative Taxa:	38	Total Taxa:	61
No. Qualitative Taxa:	46	ICI:	**44**
Number of Organisms:	21161	Qual EPT:	**17**

APPENDIX D

Fish Data

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

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
Muskingum River - (17-001)																	
Year: 94																	
110.00	A	07/26/94	4856	14(3)	2(3)	4(3)	1(1)	10(1)	11(1)	8(5)	9(5)	11(5)	76(5)	1.4(3)	262(3)	38	7.7
110.00	A	08/23/94	4856	15(3)	3(3)	5(3)	0(1)	30(3)	45(5)	8(5)	26(3)	12(5)	60(5)	9.4(1)	200(3)	40	8.7
110.00	A	09/21/94	4856	19(3)	4(5)	5(3)	2(3)	46(5)	50(5)	17(3)	24(3)	19(5)	57(5)	2.8(3)	210(3)	46	7.9
108.00	A	07/26/94	4861	21(5)	1(1)	6(5)	4(5)	29(3)	37(5)	11(5)	15(5)	14(5)	68(5)	4.3(1)	292(3)	48	8.8
108.00	A	08/23/94	4861	25(5)	0(1)	6(5)	7(5)	34(3)	45(5)	6(5)	16(3)	7(3)	74(5)	5.4(1)	478(5)	46	9.8
108.00	A	09/21/94	4861	21(5)	0(1)	7(5)	5(5)	59(5)	84(5)	4(5)	6(5)	5(1)	88(5)	2.9(3)	378(3)	48	9.4
107.00	A	07/26/94	4865	18(3)	0(1)	4(3)	2(3)	8(1)	26(3)	8(5)	14(5)	4(1)	78(5)	1.9(3)	478(5)	38	8.9
107.00	A	08/24/94	4865	14(3)	0(1)	4(3)	0(1)	29(3)	52(5)	5(5)	11(5)	13(5)	73(5)	4.2(1)	226(3)	40	8.4
107.00	A	09/22/94	4865	18(3)	0(1)	6(5)	5(5)	39(5)	68(5)	9(5)	13(5)	5(1)	80(5)	4.9(1)	364(3)	44	9.8
105.80	A	07/26/94	4870	9(1)	1(1)	2(1)	0(1)	3(1)	54(5)	13(5)	15(5)	18(5)	56(5)	0.0(5)	340(3)	38	7.3
105.80	A	08/24/94	4870	9(1)	2(3)	1(1)	0(1)	0(1)	0(1)	29(1)	50(1)	25(5)	13(1)	12.5(1)	170(1)	18	6.9
105.80	A	09/26/94	4870	8(1)	4(5)	1(1)	0(1)	10(1)	10(1)	40(1)	35(1)	25(5)	30(3)	0.0(5)	120(1)	26	7.0
105.70	A	07/26/94	4870	19(3)	0(1)	5(3)	5(5)	11(1)	71(5)	3(5)	9(5)	5(1)	85(5)	0.8(3)	516(5)	42	8.0
105.70	A	08/24/94	4870	20(3)	0(1)	6(5)	3(3)	30(3)	49(5)	11(5)	19(3)	15(5)	62(5)	5.1(1)	176(1) *	40	8.9
105.70	A	09/26/94	4870	19(3)	1(1)	5(3)	5(5)	38(3)	61(5)	3(5)	7(5)	16(5)	62(5)	8.2(1)	282(3)	44	9.2
105.00	A	09/26/94	0	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.0(0)	0(0) **	0	0.0
104.80	A	07/27/94	4875	14(3)	1(1)	5(3)	1(1)	7(1)	26(3)	2(5)	32(1)	3(1)	63(5)	1.3(3)	450(5)	32	8.1
104.80	A	08/24/94	4875	18(3)	1(1)	5(3)	4(5)	17(1)	68(5)	4(5)	5(5)	6(3)	80(5)	9.6(1)	316(3)	40	9.3
101.60	A	07/27/94	4883	21(5)	1(1)	4(3)	3(3)	7(1)	19(3)	10(5)	12(5)	7(3)	76(5)	2.0(3)	358(3)	40	8.4
101.60	A	08/24/94	4883	15(3)	2(3)	4(3)	2(3)	13(1)	34(5)	7(5)	12(5)	17(5)	65(5)	1.0(3)	194(1)	42	7.2
101.60	A	09/22/94	4883	21(5)	1(1)	6(5)	2(3)	19(3)	36(5)	17(3)	26(3)	7(3)	60(5)	1.8(3)	664(5)	44	9.7
98.30	A	07/27/94	5742	13(3)	2(3)	2(1)	1(1)	2(1)	7(1)	15(3)	14(5)	10(3)	66(5)	0.9(3)	188(1)	30	6.7

▲ - IBI is low end adjusted.

02/29/96

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

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
98.30	A	08/29/94	5742	16(3)	2(3)	3(3)	1(1)	5(1)	29(5)	15(5)	18(3)	12(5)	65(5)	4.7(1)	218(3)		38	7.5
98.30	A	09/22/94	5742	19(3)	3(3)	5(3)	1(1)	7(1)	22(3)	5(5)	8(5)	20(5)	64(5)	3.7(1)	204(3)		38	8.3
92.20	A	07/27/94	5993	13(3)	2(3)	4(3)	0(1)	11(1)	18(3)	17(3)	18(3)	10(5)	44(3)	1.9(3)	176(1)		32	8.7
92.20	A	08/29/94	5993	16(3)	3(3)	5(3)	0(1)	11(1)	51(5)	7(5)	11(5)	6(3)	76(5)	4.6(1)	322(3)		38	7.7
92.20	A	09/27/94	5993	14(3)	1(1)	5(3)	1(1)	28(3)	30(5)	15(5)	18(3)	21(5)	30(3)	12.4(1)	164(1)	*	34	8.3
Licking River - (17-200)																		
Year: 94																		
3.80	A	08/01/94	753	27(5)	6(5)	6(5)	2(3)	22(3)	35(3)	14(5)	19(3)	13(5)	62(5)	4.8(1)	286(3)		46	9.8
3.80	A	08/30/94	753	26(5)	8(5)	5(3)	1(1)	22(3)	33(3)	7(5)	38(1)	10(3)	45(3)	0.3(5)	590(5)		42	9.7
3.80	A	09/29/94	753	22(5)	5(5)	5(3)	1(1)	25(3)	58(5)	5(5)	18(3)	6(3)	71(5)	0.8(3)	750(5)		46	9.9
1.90	A	08/01/94	756	22(5)	3(3)	5(3)	2(3)	9(1)	14(1)	5(5)	6(5)	5(3)	86(5)	0.0(5)	3140(5)		44	9.6
1.90	A	08/30/94	756	17(3)	1(1)	3(3)	1(1)	6(1)	22(1)	11(5)	23(3)	8(3)	68(5)	0.0(5)	2400(5)		36	9.4
1.90	A	09/29/94	756	18(3)	1(1)	3(3)	3(3)	9(1)	24(3)	2(5)	7(5)	8(3)	84(5)	0.0(5)	1500(5)		42	9.0
1.70	A	08/01/94	756	21(5)	3(3)	5(3)	0(1)	26(3)	40(3)	6(5)	8(5)	9(3)	79(5)	1.1(3)	323(3)		42	8.4
1.70	A	08/30/94	756	28(5)	7(5)	4(3)	3(3)	15(1)	32(3)	9(5)	26(3)	8(3)	62(5)	1.0(3)	710(5)		44	9.5
1.70	A	09/29/94	756	28(5)	7(5)	6(5)	2(3)	26(3)	54(5)	6(5)	13(5)	15(5)	69(5)	0.4(5)	496(5)		56	9.2
0.80	A	08/01/94	779	23(5)	3(3)	4(3)	4(5)	27(3)	44(3)	6(5)	9(5)	11(5)	71(5)	1.5(3)	378(3)		48	9.2
0.80	A	08/30/94	779	27(5)	4(5)	6(5)	2(3)	17(1)	34(3)	6(5)	26(3)	7(3)	61(5)	0.7(3)	784(5)		46	9.6
0.80	A	09/29/94	779	27(5)	4(5)	5(3)	3(3)	25(3)	58(5)	6(5)	13(5)	11(5)	71(5)	0.0(5)	514(5)		54	9.5
Tuscarawas River - (17-500)																		
Year: 94																		
7.20	A	07/21/94	2576	13(3)	0(1)	4(3)	1(1)	15(1)	72(5)	10(5)	10(5)	2(1)	86(5)	1.0(3)	374(3)		36	8.1
7.20	A	08/24/94	2576	20(3)	2(3)	5(3)	2(3)	13(1)	43(5)	8(5)	44(1)	3(1)	50(3)	2.0(3)	558(5)		36	9.3
7.20	A	09/21/94	2576	14(3)	2(3)	4(3)	1(1)	36(3)	57(5)	16(3)	28(3)	2(1)	64(5)	0.6(3)	466(5)		38	8.3

▲ - IBI is low end adjusted.

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

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
3.60	A	07/21/94	2593	17(3)	1(1)	6(5)	0(1)	8(1)	40(5)	20(3)	26(3)	3(1)	70(5)	0.4(5)	410(3)	36	8.6
3.60	A	08/24/94	2593	22(5)	2(3)	4(3)	2(3)	12(1)	36(5)	6(5)	20(3)	4(1)	73(5)	0.7(3)	540(5)	42	9.0
3.60	A	09/21/94	2593	21(5)	1(1)	5(3)	2(3)	21(3)	43(5)	7(5)	6(5)	7(3)	86(5)	0.4(5)	472(5)	48	8.7
1.40	A	07/25/94	2595	19(3)	0(1)	5(3)	2(3)	28(3)	52(5)	11(5)	16(3)	3(1)	79(5)	1.5(3)	366(3)	38	9.2
1.40	A	08/23/94	2595	20(3)	2(3)	5(3)	2(3)	26(3)	43(5)	12(5)	32(1)	2(1)	62(5)	5.1(1)	526(5)	38	9.7
1.40	A	09/27/94	2595	18(3)	2(3)	4(3)	1(1)	41(5)	77(5)	8(5)	13(5)	5(1)	79(5)	1.1(3)	346(3)	42	9.0
1.00	A	07/25/94	2596	14(3)	0(1)	5(3)	3(3)	31(3)	50(5)	0(5)	2(5)	2(1)	92(5)	1.1(3)	900(5)	42	8.9
1.00	A	08/23/94	2596	8(1)	0(1)	2(1)	2(3)	25(3)	90(5)	0(5)	1(5)	7(3)	92(5)	3.5(1)	870(5)	38	7.7
1.00	A	09/27/94	2596	8(1)	0(1)	2(1)	1(1)	43(5)	89(5)	2(5)	2(5)	2(1)	96(5)	0.0(5)	520(5)	40	6.9
0.80	A	07/26/94	2596	15(3)	0(1)	6(5)	1(1)	21(3)	46(5)	4(5)	11(5)	5(1)	84(5)	2.1(3)	508(5)	42	9.2
0.80	A	08/23/94	2596	21(5)	1(1)	6(5)	2(3)	22(3)	47(5)	11(5)	33(1)	5(1)	61(5)	1.0(3)	4420(5)	42	11.8
0.80	A	09/27/94	2596	18(3)	1(1)	5(3)	2(3)	33(3)	51(5)	7(5)	15(5)	17(5)	63(5)	4.4(1)	214(3)	42	8.7
0.30	A	07/26/94	2596	16(3)	2(3)	5(3)	0(1)	27(3)	46(5)	8(5)	17(3)	13(5)	66(5)	1.8(3)	242(3)	42	8.2
0.30	A	08/23/94	2596	16(3)	1(1)	5(3)	0(1)	31(3)	33(3)	7(5)	49(1)	10(5)	34(3)	2.7(3)	222(3)	34	8.7
0.30	A	09/27/94	2596	19(3)	1(1)	6(5)	4(5)	39(5)	55(5)	14(5)	20(3)	20(5)	58(5)	3.6(1)	202(3)	46	8.1
Walhonding River - (17-600)																	
Year: 94																	
16.30	A	07/20/94	1505	22(5)	2(3)	6(5)	5(5)	49(5)	65(5)	2(5)	4(5)	7(3)	87(5)	0.0(5)	394(3)	54	9.8
16.30	A	08/25/94	1505	28(5)	3(3)	7(5)	8(5)	22(3)	60(5)	4(5)	7(5)	2(1)	85(5)	0.0(5)	926(5)	52	10.4
16.30	A	09/28/94	1505	36(5)	3(3)	7(5)	*(5)	31(3)	65(5)	5(5)	15(5)	4(1)	76(5)	0.2(5)	1150(5)	52	11.0
8.00	A	07/20/94	1576	27(5)	2(3)	6(5)	7(5)	33(3)	55(5)	8(5)	8(5)	9(3)	75(5)	1.9(3)	470(5)	52	10.1
8.00	A	08/25/94	1576	22(5)	1(1)	6(5)	6(5)	39(5)	62(5)	5(5)	7(5)	6(3)	83(5)	0.0(5)	254(3)	52	9.2
8.00	A	09/28/94	1576	30(5)	3(3)	4(3)	9(5)	22(3)	51(5)	5(5)	6(5)	3(1)	87(5)	1.4(3)	716(5)	48	10.0
1.10	A	07/20/94	2255	29(5)	2(3)	7(5)	7(5)	16(1)	34(3)	8(5)	9(5)	7(3)	80(5)	1.3(3)	552(5)	48	9.7

▲ - IBI is low end adjusted.

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

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
1.10	A	08/25/94	2255	25(5)	2(3)	6(5)	5(5)	19(1)	39(5)	7(5)	14(5)	8(3)	70(5)	1.6(3)	456(5)	50	9.2
1.10	A	09/27/94	2255	28(5)	1(1)	7(5)	6(5)	32(3)	66(5)	2(5)	6(5)	10(3)	84(5)	1.7(3)	514(5)	50	10.1
Wills Creek - (17-800)																	
Year: 94																	
0.30	A	07/27/94	853	20(3)	3(3)	3(3)	1(1)	7(1)	11(1)	15(5)	15(5)	18(5)	58(5)	5.8(1)	234(3)	36	6.7
0.30	A	08/29/94	853	23(5)	4(5)	5(3)	1(1)	20(3)	26(3)	13(5)	25(3)	16(5)	52(3)	4.3(1)	290(3)	40	8.8
0.30	A	09/22/94	853	22(5)	3(3)	4(3)	2(3)	10(1)	16(1)	6(5)	15(5)	11(5)	63(5)	4.1(1)	452(5)	42	8.8

▲ - IBI is low end adjusted.

Index of Biotic Integrity (IBI) metrics and scores for the upper Muskingum River study area, 1994.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
Mill Creek - (17610)																	
Year: 94																	
0.70	D	08/26/94	51	33(5)	4(5)	7(5)	4(3)	7(5)	42(5)	5(5)	5(5)	5.3(5)	75(5)	0.0(5)	1110(5)	58	9.3
Wakatomika Creek - (17960)																	
Year: 94																	
14.80	D	07/25/94	140	33(5)	4(5)	5(5)	6(5)	8(5)	37(5)	7(5)	7(5)	2.7(3)	62(5)	0.0(5)	1130(5)	58	10.2
14.80	D	09/13/94	140	28(5)	1(1)	5(5)	6(5)	8(5)	31(3)	3(5)	6(5)	2.7(3)	45(3)	0.0(5)	965(5)	50	9.3
12.50	D	08/24/94	154	32(5)	4(5)	3(3)	5(3)	8(5)	49(5)	10(5)	10(5)	2.7(3)	84(5)	0.2(3)	602(3)	50	9.3
12.50	D	09/20/94	154	37(5)	3(3)	5(5)	9(5)	9(5)	45(5)	19(5)	21(3)	2.3(3)	72(5)	0.0(5)	747(3)	52	9.9
11.80	D	07/26/94	155	30(5)	3(3)	5(5)	4(3)	7(5)	44(5)	10(5)	6(5)	3.4(3)	66(5)	0.0(5)	899(5)	54	10.1
11.80	D	09/13/94	155	32(5)	3(3)	5(5)	5(3)	8(5)	47(5)	10(5)	9(5)	3.2(3)	77(5)	0.0(5)	839(5)	54	9.6
2.10	D	09/09/94	231	25(5)	2(3)	3(3)	4(3)	9(5)	58(5)	2(5)	2(5)	4.7(3)	89(5)	0.0(5)	804(5)	52	9.3

na - Qualitative data, Modified Iwb not applicable.
▲ - IBI is low-end adjusted.
● - One or more species excluded from IBI calculation.

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
Bucklew Run - (17-151)																
Year: 94																
0.10	E	08/16/94	8.1	24(5)	10(5)	1(1)	8(5)	3(3)	8(5)	31(5)	21(3)	35(3)	62(5)	0.0(5)	902(5)	50
Big Run - (17-157)																
Year: 94																
0.20	E	10/06/94	11.8	22(5)	9(5)	5(5)	7(5)	5(5)	8(5)	35(3)	24(3)	42(3)	43(3)	0.0(5)	906(5)	52
Beaver Run - (17-605)																
Year: 94																
5.00	E	08/16/94	5.2	13(5)	6(5)	6(5)	4(3)	3(3)	5(5)	61(1)	4(5)	10(5)	35(3)	0.0(5)	540(5)	50
Mill Creek - (17-610)																
Year: 94																
8.50	E	09/19/94	18.5	27(5)	10(5)	6(5)	8(5)	7(5)	12(5)	51(3)	37(1)	50(3)	42(3)	0.2(3)	791(5)	48
Spoon Creek - (17-611)																
Year: 94																
0.60	E	09/15/94	8.0	17(5)	9(5)	4(5)	4(3)	3(3)	8(5)	66(1)	36(1)	57(1)	30(3)	0.0(5)	716(3)	40
Turkey Run - (17-612)																
Year: 94																
0.20	E	08/03/94	5.5	20(5)	10(5)	5(5)	4(3)	5(5)	9(5)	46(3)	22(3)	55(3)	34(3)	0.0(5)	1534(5)	50
Little Mill Creek - (17-613)																
Year: 94																
0.10	E	08/03/94	8.6	22(5)	10(5)	5(5)	7(5)	6(5)	11(5)	30(5)	12(5)	51(3)	51(5)	0.4(3)	1548(5)	56
Wakatomika Creek - (17-960)																
Year: 94																

▲ - IBI is low end adjusted.

Index of Biotic Integrity (IBI)metrics and scores for the upper Muskingum River study area, 1994.

River Mile	Type	Date	Drainage area (sq mi)	Number of						Percent of Individuals					Rel.No. minus tolerants /(0.3km)	IBI
				Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies		
32.00	D	08/24/94	19.7	29(5)	12(5)	2(3)	*(5)	9(5)	15(5)	6(5)	5(5)	6(5)	44(3)	0.5(3)	1592(5)	54
32.00	D	09/20/94	19.7	31(5)	12(5)	2(3)	*(5)	7(5)	13(5)	2(5)	2(5)	1(5)	18(1)	0.0(5)	3417(5)	54
Moscow Brook - (17-963)																
Year: 94																
0.30	E	08/01/94	6.8	15(5)	9(5)	2(3)	2(1)	2(3)	7(5)	65(1)	6(5)	39(3)	9(1)	0.0(5)	364(3)	40
Fivemile Run - (17-969)																
Year: 94																
1.50	E	08/01/94	10.1	23(5)	9(5)	1(1)	6(5)	6(5)	11(5)	19(5)	11(5)	19(5)	49(5)	0.0(5)	988(5)	56
Brushy Fork - (17-971)																
Year: 94																
3.50	E	08/02/94	13.1	17(5)	8(5)	2(3)	4(3)	5(5)	7(5)	41(3)	2(5)	53(3)	43(3)	0.0(5)	840(5)	50
Winding Fork - (17-973)																
Year: 94																
1.80	E	07/29/94	19.1	31(5)	13(5)	5(5)	*(5)	8(5)	13(5)	18(5)	5(5)	31(3)	75(5)	0.0(5)	1028(5)	58

▲ - IBI is low end adjusted.

Species List

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **110.00**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 6717 sec Drain Area: 4856.0 sq mi	Thru: 09/21/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.26	1.20	1.03	1,800.00
GIZZARD SHAD		O	M		15	10.00	3.97	0.10	0.09	10.40
QUILLBACK CARPSUCKER	C	O	M		2	1.33	0.53	1.39	1.19	1,040.00
HIGHFIN CARPSUCKER	C	O	M		11	7.33	2.91	3.90	3.35	531.64
SILVER REDHORSE	R	I	S	M	14	9.33	3.70	7.48	6.43	801.21
GOLDEN REDHORSE	R	I	S	M	83	55.33	21.96	28.99	24.92	524.00
SHORTHEAD REDHORSE	R	I	S	M	6	4.00	1.59	2.26	1.94	565.17
RIVER REDHORSE [S]	R	I	S	I	2	1.33	0.53	0.05	0.05	41.00
COMMON CARP	G	O	M	T	34	22.67	8.99	56.62	48.66	2,497.89
EMERALD SHINER	N	I	S		22	14.67	5.82	0.05	0.04	3.14
SPOTFIN SHINER	N	I	M		102	68.00	26.98	0.21	0.18	3.06
SAND SHINER	N	I	M	M	1	0.67	0.26	0.00	0.00	1.00
BULLHEAD MINNOW	N	O	C		1	0.67	0.26	0.00	0.00	2.00
BLUNTNOSE MINNOW	N	O	C	T	8	5.33	2.12	0.02	0.02	3.63
CHANNEL CATFISH	F		C		6	4.00	1.59	2.81	2.41	702.33
FLATHEAD CATFISH	F	P	C		3	2.00	0.79	5.08	4.37	2,542.00
BLACK CRAPPIE	S	I	C		3	2.00	0.79	0.29	0.25	145.33
ROCK BASS	S	C	C		10	6.67	2.65	0.33	0.29	49.80
SMALLMOUTH BASS	F	C	C	M	19	12.67	5.03	1.60	1.37	126.26
LARGEMOUTH BASS	F	C	C		1	0.67	0.26	0.15	0.13	230.00
WARMOUTH SF	S	C	C		1	0.67	0.26	0.05	0.04	70.00
BLUEGILL SUNFISH	S	I	C	P	11	7.33	2.91	0.08	0.07	11.36
BANDED DARTER	D	I	S	I	1	0.67	0.26	0.00	0.00	1.00
SAUGER X WALLEYE	E	P			18	12.00	4.76	1.28	1.10	106.78
FRESHWATER DRUM			M	P	3	2.00	0.79	2.39	2.06	1,196.67
Mile Total					378	252.00		116.35		
Number of Species					24					
Number of Hybrids					1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **108.00**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 5941 sec Drain Area: 4861.0 sq mi	Thru: 09/21/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.16	0.54	0.36	812.00
GIZZARD SHAD		O	M		35	23.33	5.70	0.34	0.23	14.71
QUILLBACK CARPSUCKER	C	O	M		1	0.67	0.16	0.37	0.24	555.00
HIGHFIN CARPSUCKER	C	O	M		1	0.67	0.16	0.38	0.25	566.00
SILVER REDHORSE	R	I	S	M	15	10.00	2.44	13.72	9.04	1,372.43
BLACK REDHORSE	R	I	S	I	2	1.33	0.33	0.30	0.20	223.00
GOLDEN REDHORSE	R	I	S	M	79	52.67	12.87	38.47	25.33	730.45
SHORTHEAD REDHORSE	R	I	S	M	88	58.67	14.33	51.65	34.01	880.46
RIVER REDHORSE [S]	R	I	S	I	10	6.67	1.63	9.21	6.07	1,382.20
NORTHERN HOG SUCKER	R	I	S	M	57	38.00	9.28	5.82	3.83	153.13
COMMON CARP	G	O	M	T	13	8.67	2.12	20.67	13.61	2,384.62
RIVER CHUB	N	I	N	I	3	2.00	0.49	0.02	0.01	8.00
STREAMLINE CHUB	N	I	S	R	6	4.00	0.98	0.03	0.02	7.50
GRAVEL CHUB	N	I	S	M	7	4.67	1.14	0.03	0.02	5.86
EMERALD SHINER	N	I	S		4	2.67	0.65	0.00	0.00	1.75
SPOTFIN SHINER	N	I	M		93	62.00	15.15	0.20	0.13	3.17
SAND SHINER	N	I	M	M	31	20.67	5.05	0.04	0.02	1.71
BULLHEAD MINNOW	N	O	C		1	0.67	0.16	0.00	0.00	3.00
BLUNTNOSE MINNOW	N	O	C	T	27	18.00	4.40	0.04	0.03	2.37
CENTRAL STONEROLLER	N	H	N		3	2.00	0.49	0.02	0.01	10.33
CHANNEL CATFISH	F		C		7	4.67	1.14	3.20	2.11	685.43
STONECAT MADTOM		I	C	I	1	0.67	0.16	0.00	0.00	4.00
ROCK BASS	S	C	C		1	0.67	0.16	0.05	0.04	80.00
SMALLMOUTH BASS	F	C	C	M	19	12.67	3.09	0.82	0.54	64.63
LOGPERCH	D	I	S	M	9	6.00	1.47	0.08	0.05	13.89
JOHNNY DARTER	D	I	C		4	2.67	0.65	0.01	0.00	2.00
GREENSIDE DARTER	D	I	S	M	13	8.67	2.12	0.03	0.02	3.69
BANDED DARTER	D	I	S	I	36	24.00	5.86	0.03	0.02	1.36
VARIEGATE DARTER	D	I	S	I	13	8.67	2.12	0.02	0.01	2.15
SAUGER X WALLEYE	E	P			28	18.67	4.56	3.89	2.56	208.43
FRESHWATER DRUM			M	P	6	4.00	0.98	1.90	1.25	474.83
	Mile Total				614	409.33		151.89		
	Number of Species				30					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **107.00**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 5966 sec Drain Area: 4865.0 sq mi	Thru: 09/22/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.17	0.65	0.62	974.00
GIZZARD SHAD		O	M		31	20.67	5.36	0.22	0.21	10.45
SILVER REDHORSE	R	I	S	M	11	7.33	1.90	11.92	11.42	1,625.00
BLACK REDHORSE	R	I	S	I	1	0.67	0.17	0.00	0.00	4.00
GOLDEN REDHORSE	R	I	S	M	37	24.67	6.40	20.26	19.41	821.28
SHORTHEAD REDHORSE	R	I	S	M	45	30.00	7.79	24.23	23.21	807.64
RIVER REDHORSE [S]	R	I	S	I	3	2.00	0.52	4.35	4.17	2,175.00
NORTHERN HOG SUCKER	R	I	S	M	35	23.33	6.06	2.34	2.24	100.31
COMMON CARP	G	O	M	T	14	9.33	2.42	27.17	26.03	2,910.71
RIVER CHUB	N	I	N	I	1	0.67	0.17	0.02	0.02	30.00
STREAMLINE CHUB	N	I	S	R	1	0.67	0.17	0.00	0.00	5.00
GRAVEL CHUB	N	I	S	M	44	29.33	7.61	0.16	0.15	5.36
EMERALD SHINER	N	I	S		62	41.33	10.73	0.13	0.12	3.08
SPOTFIN SHINER	N	I	M		105	70.00	18.17	0.26	0.24	3.65
SAND SHINER	N	I	M	M	78	52.00	13.49	0.07	0.07	1.44
BLUNTNOSE MINNOW	N	O	C	T	30	20.00	5.19	0.07	0.06	3.30
CHANNEL CATFISH	F		C		16	10.67	2.77	7.30	7.00	684.56
FLATHEAD CATFISH	F	P	C		1	0.67	0.17	0.55	0.52	820.00
SMALLMOUTH BASS	F	C	C	M	10	6.67	1.73	0.67	0.64	100.20
LOGPERCH	D	I	S	M	5	3.33	0.87	0.01	0.01	2.20
GREENSIDE DARTER	D	I	S	M	1	0.67	0.17	0.00	0.00	1.00
BANDED DARTER	D	I	S	I	19	12.67	3.29	0.01	0.01	1.16
VARIEGATE DARTER	D	I	S	I	1	0.67	0.17	0.00	0.00	1.00
SAUGER X WALLEYE	E	P			22	14.67	3.81	2.62	2.51	178.95
FRESHWATER DRUM			M	P	4	2.67	0.69	1.37	1.31	514.00
	Mile Total				578	385.33		104.37		
	Number of Species				24					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **105.80**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 1983 sec Drain Area: 4870.0 sq mi	Thru: 09/26/94
Purpose:	Dist Fished: 0.30 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LONGNOSE GAR		P	M		1	3.33	1.20	0.09	0.05	28.00
GIZZARD SHAD		O	M		2	6.67	2.41	0.04	0.02	6.00
HIGHFIN CARPSUCKER	C	O	M		3	10.00	3.61	4.98	2.45	498.33
SILVER REDHORSE	R	I	S	M	1	3.33	1.20	3.50	1.72	1,050.00
GOLDEN REDHORSE	R	I	S	M	2	6.67	2.41	2.35	1.15	352.00
COMMON CARP	G	O	M	T	19	63.33	22.89	165.70	81.30	2,616.32
EMERALD SHINER	N	I	S		20	66.67	24.10	0.12	0.06	1.80
SPOTFIN SHINER	N	I	M		3	10.00	3.61	0.04	0.02	3.67
BULLHEAD MINNOW	N	O	C		1	3.33	1.20	0.01	0.00	2.00
CHANNEL CATFISH	F		C		6	20.00	7.23	11.05	5.42	552.50
FLATHEAD CATFISH	F	P	C		1	3.33	1.20	0.76	0.37	229.00
WHITE BASS	F	P	M		1	3.33	1.20	0.46	0.23	138.00
WHITE CRAPPIE	S	I	C		1	3.33	1.20	0.30	0.15	90.00
BLACK CRAPPIE	S	I	C		2	6.67	2.41	1.38	0.68	207.50
ROCK BASS	S	C	C		7	23.33	8.43	0.62	0.30	26.57
SMALLMOUTH BASS	F	C	C	M	8	26.67	9.64	2.43	1.19	91.13
GREEN SUNFISH	S	I	C	T	1	3.33	1.20	0.09	0.05	28.00
BLUEGILL SUNFISH	S	I	C	P	1	3.33	1.20	0.00	0.00	1.00
FRESHWATER DRUM			M	P	3	10.00	3.61	9.88	4.85	988.00
Mile Total					83	276.67		203.81		
Number of Species					19					
Number of Hybrids					0					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **105.70**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 6614 sec Drain Area: 4870.0 sq mi	Thru: 09/26/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		24	16.00	4.69	0.20	0.20	12.67
QUILLBACK CARPSUCKER	C	O	M		1	0.67	0.20	0.83	0.83	1,250.00
HIGHFIN CARPSUCKER	C	O	M		1	0.67	0.20	0.20	0.20	300.00
SILVER REDHORSE	R	I	S	M	7	4.67	1.37	7.97	7.95	1,707.14
GOLDEN REDHORSE	R	I	S	M	24	16.00	4.69	7.57	7.55	472.96
SHORTHEAD REDHORSE	R	I	S	M	40	26.67	7.81	24.89	24.83	933.22
RIVER REDHORSE [S]	R	I	S	I	2	1.33	0.39	0.09	0.09	67.00
NORTHERN HOG SUCKER	R	I	S	M	42	28.00	8.20	2.90	2.90	103.62
COMMON CARP	G	O	M	T	12	8.00	2.34	28.85	28.79	3,606.25
RIVER CHUB	N	I	N	I	2	1.33	0.39	0.01	0.01	6.50
STREAMLINE CHUB	N	I	S	R	2	1.33	0.39	0.01	0.01	4.00
GRAVEL CHUB	N	I	S	M	10	6.67	1.95	0.04	0.04	5.70
EMERALD SHINER	N	I	S		151	100.67	29.49	0.18	0.18	1.76
STRIPED SHINER	N	I	S		1	0.67	0.20	0.00	0.00	3.00
SPOTFIN SHINER	N	I	M		30	20.00	5.86	0.08	0.08	4.03
SAND SHINER	N	I	M	M	16	10.67	3.13	0.02	0.02	2.00
BULLHEAD MINNOW	N	O	C		2	1.33	0.39	0.00	0.00	1.50
BLUNTNOSE MINNOW	N	O	C	T	13	8.67	2.54	0.03	0.03	2.92
CENTRAL STONEROLLER	N	H	N		2	1.33	0.39	0.02	0.02	15.00
CHANNEL CATFISH	F		C		26	17.33	5.08	21.65	21.61	1,249.13
FLATHEAD CATFISH	F	P	C		2	1.33	0.39	1.20	1.20	900.00
STONECAT MADTOM		I	C	I	3	2.00	0.59	0.01	0.01	3.67
ROCK BASS	S	C	C		2	1.33	0.39	0.01	0.01	5.00
SMALLMOUTH BASS	F	C	C	M	27	18.00	5.27	1.47	1.46	81.41
LOGPERCH	D	I	S	M	3	2.00	0.59	0.02	0.02	10.33
GREENSIDE DARTER	D	I	S	M	4	2.67	0.78	0.02	0.02	6.00
BANDED DARTER	D	I	S	I	32	21.33	6.25	0.03	0.03	1.53
VARIEGATE DARTER	D	I	S	I	10	6.67	1.95	0.02	0.02	2.40
SAUGER X WALLEYE	E	P			20	13.33	3.91	1.36	1.36	101.90
FRESHWATER DRUM			M	P	1	0.67	0.20	0.56	0.56	840.00
	Mile Total				512	341.33		100.21		
	Number of Species				29					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **104.80**	Basin: Muskingum River	Date Range: 07/27/94
Data Source: 01	Time Fished: 2912 sec Drain Area: 4875.0 sq mi	Thru: 08/24/94
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		68	68.00	17.26	0.39	0.49	5.74
QUILLBACK CARPSUCKER	C	O	M		3	3.00	0.76	2.95	3.72	983.33
SILVER REDHORSE	R	I	S	M	2	2.00	0.51	3.10	3.91	1,550.00
GOLDEN REDHORSE	R	I	S	M	15	15.00	3.81	7.76	9.79	517.40
SHORTHEAD REDHORSE	R	I	S	M	14	14.00	3.55	14.56	18.36	1,040.14
NORTHERN HOG SUCKER	R	I	S	M	13	13.00	3.30	3.45	4.35	265.54
COMMON CARP	G	O	M	T	9	9.00	2.28	22.74	28.67	2,526.11
RIVER CHUB	N	I	N	I	1	1.00	0.25	0.01	0.01	11.00
STREAMLINE CHUB	N	I	S	R	2	2.00	0.51	0.02	0.02	7.50
GRAVEL CHUB	N	I	S	M	19	19.00	4.82	0.13	0.17	7.05
EMERALD SHINER	N	I	S		94	94.00	23.86	0.26	0.33	2.78
SPOTFIN SHINER	N	I	M		98	98.00	24.87	0.47	0.59	4.76
SAND SHINER	N	I	M	M	4	4.00	1.02	0.01	0.01	1.25
BLUNTNOSE MINNOW	N	O	C	T	2	2.00	0.51	0.00	0.01	2.00
CHANNEL CATFISH	F		C		14	14.00	3.55	11.97	15.09	854.65
FLATHEAD CATFISH	F	P	C		3	3.00	0.76	4.52	5.70	1,506.67
STONECAT MADTOM		I	C	I	1	1.00	0.25	0.00	0.00	2.00
ROCK BASS	S	C	C		2	2.00	0.51	0.03	0.04	14.50
GREENSIDE DARTER	D	I	S	M	3	3.00	0.76	0.00	0.01	1.33
BANDED DARTER	D	I	S	I	8	8.00	2.03	0.01	0.01	0.75
VARIEGATE DARTER	D	I	S	I	1	1.00	0.25	0.00	0.00	2.00
SAUGER X WALLEYE	E	P			13	13.00	3.30	2.47	3.11	189.62
FRESHWATER DRUM			M	P	5	5.00	1.27	4.46	5.62	891.00
Mile Total					394	394.00		79.30		
Number of Species					22					
Number of Hybrids					1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **101.60**	Basin: Muskingum River	Date Range: 07/27/94
Data Source: 01	Time Fished: 6799 sec Drain Area: 4883.0 sq mi	Thru: 09/22/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.14	1.17	1.54	1,750.00
GIZZARD SHAD		O	M		26	17.33	3.70	0.24	0.31	13.66
QUILLBACK CARPSUCKER	C	O	M		3	2.00	0.43	0.85	1.12	423.67
SILVER REDHORSE	R	I	S	M	11	7.33	1.57	11.43	15.08	1,558.00
GOLDEN REDHORSE	R	I	S	M	45	30.00	6.41	10.81	14.28	360.49
SHORTHEAD REDHORSE	R	I	S	M	19	12.67	2.71	1.76	2.32	138.68
RIVER REDHORSE [S]	R	I	S	I	2	1.33	0.28	0.02	0.02	12.00
NORTHERN HOG SUCKER	R	I	S	M	26	17.33	3.70	1.35	1.79	78.00
COMMON CARP	G	O	M	T	13	8.67	1.85	31.15	41.13	3,594.23
RIVER CHUB	N	I	N	I	2	1.33	0.28	0.01	0.01	5.50
GRAVEL CHUB	N	I	S	M	13	8.67	1.85	0.04	0.06	5.08
EMERALD SHINER	N	I	S		70	46.67	9.97	0.18	0.23	3.76
SPOTFIN SHINER	N	I	M		140	93.33	19.94	0.28	0.36	2.96
SAND SHINER	N	I	M	M	78	52.00	11.11	0.06	0.07	1.08
MIMIC SHINER	N	I	M	I	10	6.67	1.42	0.01	0.02	1.90
BULLHEAD MINNOW	N	O	C		16	10.67	2.28	0.01	0.02	1.19
BLUNTNOSE MINNOW	N	O	C	T	81	54.00	11.54	0.13	0.17	2.44
CENTRAL STONEROLLER	N	H	N		7	4.67	1.00	0.03	0.04	6.43
CHANNEL CATFISH	F		C		31	20.67	4.42	9.09	12.00	439.77
ROCK BASS	S	C	C		5	3.33	0.71	0.02	0.03	6.40
SMALLMOUTH BASS	F	C	C	M	25	16.67	3.56	0.71	0.94	42.72
BLUEGILL SUNFISH	S	I	C	P	8	5.33	1.14	0.13	0.18	25.13
JOHNNY DARTER	D	I	C		7	4.67	1.00	0.01	0.01	1.71
GREENSIDE DARTER	D	I	S	M	2	1.33	0.28	0.00	0.00	2.50
BANDED DARTER	D	I	S	I	27	18.00	3.85	0.02	0.02	0.89
SAUGER X WALLEYE	E	P			29	19.33	4.13	3.70	4.89	191.52
FRESHWATER DRUM			M	P	5	3.33	0.71	2.54	3.36	763.40
	Mile Total				702	468.00		75.74		
	Number of Species				26					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **98.30**	Basin: Muskingum River	Date Range: 07/27/94
Data Source: 01	Time Fished: 9120 sec Drain Area: 5742.0 sq mi	Thru: 09/22/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		4	2.67	1.16	0.24	0.24	89.25
QUILLBACK CARPSUCKER	C	O	M		2	1.33	0.58	1.45	1.49	1,087.50
SILVER REDHORSE	R	I	S	M	8	5.33	2.31	10.12	10.41	1,896.88
GOLDEN REDHORSE	R	I	S	M	7	4.67	2.02	0.59	0.61	127.00
SHORTHEAD REDHORSE	R	I	S	M	1	0.67	0.29	0.38	0.39	568.00
NORTHERN HOG SUCKER	R	I	S	M	1	0.67	0.29	0.01	0.01	20.00
COMMON CARP	G	O	M	T	29	19.33	8.38	58.34	60.03	3,017.52
GRAVEL CHUB	N	I	S	M	2	1.33	0.58	0.01	0.01	7.00
EMERALD SHINER	N	I	S		48	32.00	13.87	0.07	0.07	2.19
SPOTFIN SHINER	N	I	M		130	86.67	37.57	0.35	0.36	4.00
SAND SHINER	N	I	M	M	17	11.33	4.91	0.02	0.02	1.93
MIMIC SHINER	N	I	M	I	2	1.33	0.58	0.00	0.00	1.50
BULLHEAD MINNOW	N	O	C		2	1.33	0.58	0.01	0.01	4.50
BLUNTNOSE MINNOW	N	O	C	T	11	7.33	3.18	0.02	0.02	2.64
GRASS CARP	E		M		1	0.67	0.29	6.67	6.86	10,000.00
CHANNEL CATFISH	F		C		17	11.33	4.91	10.32	10.62	910.71
FLATHEAD CATFISH	F	P	C		4	2.67	1.16	0.71	0.73	267.75
MOUNTAIN MADTOM [E]		I	C	R	1	0.67	0.29	0.00	0.00	4.00
BLACK CRAPPIE	S	I	C		1	0.67	0.29	0.19	0.20	290.00
ROCK BASS	S	C	C		1	0.67	0.29	0.00	0.00	2.00
SMALLMOUTH BASS	F	C	C	M	16	10.67	4.62	0.96	0.99	90.25
LARGEMOUTH BASS	F	C	C		1	0.67	0.29	0.01	0.01	18.00
WARMOUTH SF	S	C	C		1	0.67	0.29	0.00	0.00	6.00
GREEN SUNFISH	S	I	C	T	1	0.67	0.29	0.01	0.01	8.00
BLUEGILL SUNFISH	S	I	C	P	3	2.00	0.87	0.08	0.08	38.00
OR'GESPOTTED SUNFISH	S	I	C		1	0.67	0.29	0.00	0.00	2.00
BANDED DARTER	D	I	S	I	2	1.33	0.58	0.01	0.01	4.50
SAUGER X WALLEYE	E	P			24	16.00	6.94	2.03	2.08	126.58
FRESHWATER DRUM			M	P	8	5.33	2.31	4.58	4.72	859.13
	Mile Total				346	230.67		97.18		
	Number of Species				28					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **1994**
River Mile: **92.20**	Basin: Muskingum River	Date Range: 07/27/94
Data Source: 01	Time Fished: 8780 sec Drain Area:	Thru: 09/27/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		8	5.33	2.13	0.06	0.03	11.25
QUILLBACK CARPSUCKER	C	O	M		3	2.00	0.80	1.35	0.79	675.00
SILVER REDHORSE	R	I	S	M	2	1.33	0.53	1.54	0.90	1,155.00
GOLDEN REDHORSE	R	I	S	M	41	27.33	10.90	13.81	8.04	505.15
SHORTHEAD REDHORSE	R	I	S	M	12	8.00	3.19	5.74	3.34	717.33
RIVER REDHORSE [S]	R	I	S	I	1	0.67	0.27	0.78	0.46	1,175.00
NORTHERN HOG SUCKER	R	I	S	M	2	1.33	0.53	0.44	0.26	332.00
COMMON CARP	G	O	M	T	36	24.00	9.57	83.12	48.40	3,463.19
EMERALD SHINER	N	I	S		78	52.00	20.74	0.16	0.09	3.09
SPOTFIN SHINER	N	I	M		60	40.00	15.96	0.15	0.09	3.80
SAND SHINER	N	I	M	M	10	6.67	2.66	0.01	0.01	1.80
BULLHEAD MINNOW	N	O	C		1	0.67	0.27	0.00	0.00	2.00
BLUNTNOSE MINNOW	N	O	C	T	8	5.33	2.13	0.02	0.01	3.50
CHANNEL CATFISH	F		C		59	39.33	15.69	44.73	26.05	1,137.19
FLATHEAD CATFISH	F	P	C		6	4.00	1.60	8.76	5.10	2,190.83
BLACK CRAPPIE	S	I	C		1	0.67	0.27	0.11	0.06	160.00
ROCK BASS	S	C	C		9	6.00	2.39	0.40	0.23	66.11
SMALLMOUTH BASS	F	C	C	M	11	7.33	2.93	1.79	1.04	244.36
LARGEMOUTH BASS	F	C	C		1	0.67	0.27	0.01	0.00	10.00
WARMOUTH SF	S	C	C		1	0.67	0.27	0.02	0.01	35.00
GREEN SUNFISH	S	I	C	T	1	0.67	0.27	0.00	0.00	3.00
SAUGER X WALLEYE	E	P			13	8.67	3.46	1.44	0.84	166.38
FRESHWATER DRUM			M	P	12	8.00	3.19	7.27	4.23	908.50
	Mile Total				376	250.67		171.71		
	Number of Species				22					
	Number of Hybrids				1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **7.20**	Basin: Muskingum River	Date Range: 07/21/94
Data Source: 01	Time Fished: 6244 sec Drain Area: 2576.0 sq mi	Thru: 09/21/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		158	105.33	20.05	1.03	1.11	9.80
HIGHFIN CARPSUCKER	C	O	M		1	0.67	0.13	0.37	0.40	553.00
SILVER REDHORSE	R	I	S	M	17	11.33	2.16	9.54	10.28	841.73
GOLDEN REDHORSE	R	I	S	M	81	54.00	10.28	10.72	11.55	198.47
SHORTHEAD REDHORSE	R	I	S	M	48	32.00	6.09	27.95	30.13	873.44
NORTHERN HOG SUCKER	R	I	S	M	26	17.33	3.30	0.86	0.93	49.65
COMMON CARP	G	O	M	T	14	9.33	1.78	29.47	31.77	3,157.50
GRAVEL CHUB	N	I	S	M	31	20.67	3.93	0.06	0.07	3.00
CREEK CHUB	N	G	N	T	16	10.67	2.03	0.03	0.03	2.44
EMERALD SHINER	N	I	S		136	90.67	17.26	0.10	0.11	1.10
SILVER SHINER	N	I	S	I	2	1.33	0.25	0.00	0.00	2.50
SPOTFIN SHINER	N	I	M		50	33.33	6.35	0.09	0.10	2.68
SAND SHINER	N	I	M	M	14	9.33	1.78	0.02	0.03	2.57
BLUNTNOSE MINNOW	N	O	C	T	59	39.33	7.49	0.06	0.06	1.41
CHANNEL CATFISH	F		C		11	7.33	1.40	7.64	8.23	1,041.64
FLATHEAD CATFISH	F	P	C		1	0.67	0.13	0.31	0.34	472.00
WHITE CRAPPIE	S	I	C		4	2.67	0.51	0.43	0.47	162.00
ROCK BASS	S	C	C		2	1.33	0.25	0.04	0.05	32.50
SMALLMOUTH BASS	F	C	C	M	7	4.67	0.89	0.80	0.86	171.14
BLACKSIDE DARTER	D	I	S		1	0.67	0.13	0.00	0.00	1.00
LOGPERCH	D	I	S	M	1	0.67	0.13	0.00	0.01	7.00
JOHNNY DARTER	D	I	C		1	0.67	0.13	0.00	0.00	2.00
GREENSIDE DARTER	D	I	S	M	1	0.67	0.13	0.00	0.00	2.00
BANDED DARTER	D	I	S	I	95	63.33	12.06	0.08	0.09	1.26
SAUGER X WALLEYE	E	P			11	7.33	1.40	3.15	3.39	429.27
Mile Total					788	525.33		92.76		
Number of Species					24					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **3.60**	Basin: Muskingum River	Date Range: 07/21/94
Data Source: 01	Time Fished: 7647 sec Drain Area: 2593.0 sq mi	Thru: 09/21/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		51	34.00	6.41	0.24	0.34	7.10
QUILLBACK CARPSUCKER	C	O	M		3	2.00	0.38	0.01	0.02	7.33
HIGHFIN CARPSUCKER	C	O	M		3	2.00	0.38	0.95	1.34	472.67
SILVER REDHORSE	R	I	S	M	3	2.00	0.38	1.75	2.49	876.67
GOLDEN REDHORSE	R	I	S	M	41	27.33	5.15	12.62	17.90	461.54
SHORTHEAD REDHORSE	R	I	S	M	23	15.33	2.89	9.56	13.56	623.22
NORTHERN HOG SUCKER	R	I	S	M	40	26.67	5.03	0.93	1.32	34.90
COMMON CARP	G	O	M	T	16	10.67	2.01	31.71	44.98	2,972.44
RIVER CHUB	N	I	N	I	1	0.67	0.13	0.00	0.00	2.00
GRAVEL CHUB	N	I	S	M	18	12.00	2.26	0.04	0.05	3.11
CREEK CHUB	N	G	N	T	3	2.00	0.38	0.01	0.01	3.67
EMERALD SHINER	N	I	S		155	103.33	19.47	0.25	0.36	2.46
STRIPED SHINER	N	I	S		1	0.67	0.13	0.00	0.00	2.00
SPOTFIN SHINER	N	I	M		168	112.00	21.11	0.38	0.54	3.43
SAND SHINER	N	I	M	M	116	77.33	14.57	0.10	0.14	1.29
SILVERJAW MINNOW	N	I	M		1	0.67	0.13	0.00	0.00	2.00
BLUNTNOSE MINNOW	N	O	C	T	66	44.00	8.29	0.08	0.12	1.87
CENTRAL STONEROLLER	N	H	N		1	0.67	0.13	0.00	0.00	2.00
CHANNEL CATFISH	F		C		9	6.00	1.13	6.51	9.23	1,084.78
FLATHEAD CATFISH	F	P	C		3	2.00	0.38	0.23	0.33	114.67
MOUNTAIN MADTOM [E]		I	C	R	1	0.67	0.13	0.00	0.00	1.00
ROCK BASS	S	C	C		5	3.33	0.63	0.24	0.34	71.40
SMALLMOUTH BASS	F	C	C	M	23	15.33	2.89	2.64	3.74	172.13
BLUEGILL SUNFISH	S	I	C	P	1	0.67	0.13	0.01	0.02	17.00
BLACKSIDE DARTER	D	I	S		1	0.67	0.13	0.00	0.00	1.00
LOGPERCH	D	I	S	M	7	4.67	0.88	0.03	0.04	5.71
JOHNNY DARTER	D	I	C		6	4.00	0.75	0.01	0.01	1.67
GREENSIDE DARTER	D	I	S	M	1	0.67	0.13	0.00	0.00	4.00
BANDED DARTER	D	I	S	I	22	14.67	2.76	0.01	0.02	0.91
SAUGER X WALLEYE	E	P			5	3.33	0.63	1.18	1.67	352.60
FRESHWATER DRUM			M	P	2	1.33	0.25	1.00	1.41	747.50
	Mile Total				796	530.67		70.48		
	Number of Species				30					
	Number of Hybrids				1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **1.40**	Basin: Muskingum River	Date Range: 07/25/94
Data Source: 01	Time Fished: 6101 sec Drain Area: 2595.0 sq mi	Thru: 09/27/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		70	46.67	10.10	1.30	1.32	27.91
QUILLBACK CARPSUCKER	C	O	M		16	10.67	2.31	8.88	8.98	832.69
SILVER REDHORSE	R	I	S	M	13	8.67	1.88	12.26	12.38	1,414.08
GOLDEN REDHORSE	R	I	S	M	73	48.67	10.53	16.13	16.30	331.37
SHORTHEAD REDHORSE	R	I	S	M	47	31.33	6.78	23.48	23.73	749.50
RIVER REDHORSE [S]	R	I	S	I	1	0.67	0.14	0.02	0.02	27.00
NORTHERN HOG SUCKER	R	I	S	M	78	52.00	11.26	5.55	5.60	106.65
COMMON CARP	G	O	M	T	11	7.33	1.59	17.47	17.66	2,382.73
STREAMLINE CHUB	N	I	S	R	1	0.67	0.14	0.01	0.01	11.00
GRAVEL CHUB	N	I	S	M	20	13.33	2.89	0.08	0.08	6.20
BLACKNOSE DACE	N	G	S	T	1	0.67	0.14	0.00	0.00	1.00
CREEK CHUB	N	G	N	T	5	3.33	0.72	0.01	0.01	2.00
SUCKERMOUTH MINNOW	N	I	S		1	0.67	0.14	0.01	0.01	15.00
EMERALD SHINER	N	I	S		92	61.33	13.28	0.20	0.20	3.21
SPOTFIN SHINER	N	I	M		86	57.33	12.41	0.18	0.18	3.07
SAND SHINER	N	I	M	M	24	16.00	3.46	0.02	0.02	1.46
SILVERJAW MINNOW	N	I	M		1	0.67	0.14	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	57	38.00	8.23	0.11	0.11	2.89
CENTRAL STONEROLLER	N	H	N		3	2.00	0.43	0.00	0.00	1.67
CHANNEL CATFISH	F		C		11	7.33	1.59	8.83	8.92	1,204.00
ROCK BASS	S	C	C		2	1.33	0.29	0.17	0.17	128.50
SMALLMOUTH BASS	F	C	C	M	8	5.33	1.15	0.51	0.52	96.25
WARMOUTH SF	S	C	C		1	0.67	0.14	0.05	0.05	79.00
BLUEGILL SUNFISH	S	I	C	P	1	0.67	0.14	0.00	0.00	2.00
JOHNNY DARTER	D	I	C		4	2.67	0.58	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	3	2.00	0.43	0.00	0.00	1.67
BANDED DARTER	D	I	S	I	51	34.00	7.36	0.05	0.05	1.35
SAUGER X WALLEYE	E	P			11	7.33	1.59	2.80	2.83	382.00
FRESHWATER DRUM			M	P	1	0.67	0.14	0.83	0.84	1,250.00
	Mile Total				693	462.00		98.96		
	Number of Species				28					
	Number of Hybrids				1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **1.00**	Basin: Muskingum River	Date Range: 07/25/94
Data Source: 01	Time Fished: 778 sec Drain Area: 2596.0 sq mi	Thru: 09/27/94
Purpose:	Dist Fished: 0.30 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		1	3.33	0.43	0.04	0.05	12.00
QUILLBACK CARPSUCKER	C	O	M		1	3.33	0.43	3.47	3.93	1,040.00
SILVER REDHORSE	R	I	S	M	1	3.33	0.43	4.25	4.82	1,275.00
GOLDEN REDHORSE	R	I	S	M	1	3.33	0.43	1.35	1.53	404.00
SHORTHEAD REDHORSE	R	I	S	M	16	53.33	6.96	39.44	44.73	739.50
NORTHERN HOG SUCKER	R	I	S	M	55	183.33	23.91	12.88	14.61	70.27
COMMON CARP	G	O	M	T	1	3.33	0.43	7.00	7.94	2,100.00
GRAVEL CHUB	N	I	S	M	26	86.67	11.30	0.50	0.57	5.81
EMERALD SHINER	N	I	S		10	33.33	4.35	0.09	0.10	2.60
SPOTFIN SHINER	N	I	M		34	113.33	14.78	0.35	0.40	3.12
SAND SHINER	N	I	M	M	7	23.33	3.04	0.02	0.03	1.00
BULLHEAD MINNOW	N	O	C		1	3.33	0.43	0.01	0.01	2.00
CHANNEL CATFISH	F		C		3	10.00	1.30	3.87	4.38	386.67
STONECAT MADTOM		I	C	I	2	6.67	0.87	0.02	0.02	2.50
JOHNNY DARTER	D	I	C		1	3.33	0.43	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	4	13.33	1.74	0.03	0.03	2.00
BANDED DARTER	D	I	S	I	56	186.67	24.35	0.23	0.26	1.21
VARIEGATE DARTER	D	I	S	I	1	3.33	0.43	0.01	0.01	2.00
SAUGER X WALLEYE	E	P			9	30.00	3.91	14.63	16.59	487.78
Mile Total					230	766.67		88.18		
Number of Species					18					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **0.80**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 6954 sec Drain Area: 2596.0 sq mi	Thru: 09/27/94
Purpose:	Dist Fished: 1.05 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		61	340.67	17.94	4.17	1.04	11.52
QUILLBACK CARPSUCKER	C	O	M		18	42.00	2.21	38.33	9.60	869.06
HIGHFIN CARPSUCKER	C	O	M		4	8.67	0.46	5.13	1.28	615.50
SILVER REDHORSE	R	I	S	M	11	37.33	1.97	23.53	5.89	770.45
GOLDEN REDHORSE	R	I	S	M	53	161.33	8.49	71.48	17.90	514.85
SHORTHEAD REDHORSE	R	I	S	M	28	84.67	4.46	61.68	15.44	678.86
NORTHERN HOG SUCKER	R	I	S	M	56	145.33	7.65	16.71	4.19	127.25
COMMON CARP	G	O	M	T	15	58.00	3.05	136.01	34.06	2,772.53
GRAVEL CHUB	N	I	S	M	11	25.33	1.33	0.10	0.03	4.82
CREEK CHUB	N	G	N	T	1	6.67	0.35	0.03	0.01	4.00
EMERALD SHINER	N	I	S		76	188.67	9.93	0.56	0.14	2.67
SPOTFIN SHINER	N	I	M		65	145.33	7.65	0.41	0.10	2.23
SAND SHINER	N	I	M	M	79	130.67	6.88	0.12	0.03	1.13
BLUNTNOSE MINNOW	N	O	C	T	28	120.67	6.35	0.33	0.08	2.43
CENTRAL STONEROLLER	N	H	N		1	0.67	0.04	0.00	0.00	2.00
CHANNEL CATFISH	F		C		5	9.33	0.49	5.43	1.36	936.60
BLACK CRAPPIE	S	I	C		1	0.67	0.04	0.01	0.00	10.00
SMALLMOUTH BASS	F	C	C	M	24	64.00	3.37	10.51	2.63	145.21
BLUEGILL SUNFISH	S	I	C	P	3	20.00	1.05	0.17	0.04	8.67
JOHNNY DARTER	D	I	C		2	13.33	0.70	0.01	0.00	1.00
GREENSIDE DARTER	D	I	S	M	1	6.67	0.35	0.01	0.00	2.00
BANDED DARTER	D	I	S	I	51	214.00	11.27	0.22	0.06	1.12
VARIEGATE DARTER	D	I	S	I	8	23.33	1.23	0.09	0.02	2.31
SAUGER X WALLEYE	E	P			20	37.33	1.97	14.06	3.52	204.65
FRESHWATER DRUM			M	P	4	14.67	0.77	10.24	2.56	470.00
Mile Total					626	1,899.33		399.37		
Number of Species					24					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1994**
River Mile: **0.30**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 01	Time Fished: 6872 sec Drain Area: 2596.0 sq mi	Thru: 09/27/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.27	0.83	0.80	1,250.00
GIZZARD SHAD		O	M		57	38.00	15.49	0.15	0.14	3.96
QUILLBACK CARPSUCKER	C	O	M		8	5.33	2.17	5.39	5.15	1,010.63
HIGHFIN CARPSUCKER	C	O	M		4	2.67	1.09	1.56	1.49	585.50
SILVER REDHORSE	R	I	S	M	6	4.00	1.63	1.79	1.72	448.50
GOLDEN REDHORSE	R	I	S	M	57	38.00	15.49	16.25	15.54	427.70
SHORTHEAD REDHORSE	R	I	S	M	22	14.67	5.98	11.10	10.61	756.68
NORTHERN HOG SUCKER	R	I	S	M	34	22.67	9.24	2.37	2.27	104.56
COMMON CARP	G	O	M	T	29	19.33	7.88	53.33	50.98	2,758.45
RIVER CHUB	N	I	N	I	1	0.67	0.27	0.02	0.02	27.00
GRAVEL CHUB	N	I	S	M	7	4.67	1.90	0.03	0.03	7.29
EMERALD SHINER	N	I	S		22	14.67	5.98	0.03	0.03	2.05
SPOTFIN SHINER	N	I	M		24	16.00	6.52	0.05	0.04	2.88
SAND SHINER	N	I	M	M	3	2.00	0.82	0.00	0.00	1.33
BLUNTNOSE MINNOW	N	O	C	T	6	4.00	1.63	0.01	0.01	3.33
CENTRAL STONEROLLER	N	H	N		1	0.67	0.27	0.01	0.01	11.00
CHANNEL CATFISH	F		C		10	6.67	2.72	3.54	3.39	531.30
FLATHEAD CATFISH	F	P	C		1	0.67	0.27	0.28	0.27	420.00
STONECAT MADTOM		I	C	I	1	0.67	0.27	0.01	0.01	18.00
WHITE CRAPPIE	S	I	C		1	0.67	0.27	0.07	0.06	100.00
ROCK BASS	S	C	C		3	2.00	0.82	0.17	0.16	85.00
SMALLMOUTH BASS	F	C	C	M	25	16.67	6.79	3.33	3.18	199.84
WARMOUTH SF	S	C	C		1	0.67	0.27	0.02	0.02	32.00
YELLOW PERCH			M		2	1.33	0.54	0.01	0.01	10.50
LOGPERCH	D	I	S	M	4	2.67	1.09	0.01	0.01	4.50
GREENSIDE DARTER	D	I	S	M	1	0.67	0.27	0.00	0.00	2.00
BANDED DARTER	D	I	S	I	10	6.67	2.72	0.01	0.01	0.90
VARIEGATE DARTER	D	I	S	I	1	0.67	0.27	0.00	0.00	2.00
SAUGER X WALLEYE	E	P			22	14.67	5.98	1.86	1.78	127.09
FRESHWATER DRUM			M	P	4	2.67	1.09	2.35	2.25	882.25
	Mile Total				368	245.33		104.61		
	Number of Species				29					
	Number of Hybrids				1					

River Code: **17-600**	Stream: **Walhonding River**	Sample Date: **1994**
River Mile: **16.30**	Basin: Muskingum River	Date Range: 07/20/94
Data Source: 01	Time Fished: 7207 sec Drain Area: 1505.0 sq mi	Thru: 09/28/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		81	54.00	6.30	1.00	0.58	18.60
NORTHERN PIKE	F	P	M		2	1.33	0.16	1.17	0.67	874.50
QUILLBACK CARPSUCKER	C	O	M		4	2.67	0.31	1.15	0.66	431.00
SILVER REDHORSE	R	I	S	M	36	24.00	2.80	19.31	11.15	804.74
BLACK REDHORSE	R	I	S	I	34	22.67	2.64	4.76	2.75	209.85
GOLDEN REDHORSE	R	I	S	M	179	119.33	13.92	39.27	22.67	329.09
SHORTHEAD REDHORSE	R	I	S	M	43	28.67	3.34	8.09	4.67	282.27
RIVER REDHORSE [S]	R	I	S	I	36	24.00	2.80	34.87	20.13	1,452.79
NORTHERN HOG SUCKER	R	I	S	M	63	42.00	4.90	6.61	3.81	157.29
COMMON CARP	G	O	M	T	23	15.33	1.79	38.15	22.03	2,488.04
RIVER CHUB	N	I	N	I	19	12.67	1.48	0.17	0.10	13.47
BIGEYE CHUB	N	I	S	I	6	4.00	0.47	0.02	0.01	4.17
STREAMLINE CHUB	N	I	S	R	37	24.67	2.88	0.14	0.08	5.57
GRAVEL CHUB	N	I	S	M	21	14.00	1.63	0.07	0.04	4.81
SUCKERMOUTH MINNOW	N	I	S		2	1.33	0.16	0.01	0.00	6.00
EMERALD SHINER	N	I	S		1	0.67	0.08	0.00	0.00	2.00
SILVER SHINER	N	I	S	I	13	8.67	1.01	0.03	0.02	3.62
ROSYFACE SHINER	N	I	S	I	26	17.33	2.02	0.06	0.03	3.31
STRIPED SHINER	N	I	S		149	99.33	11.59	0.73	0.42	7.37
SPOTFIN SHINER	N	I	M		123	82.00	9.56	0.21	0.12	2.54
SAND SHINER	N	I	M	M	60	40.00	4.67	0.07	0.04	1.75
MIMIC SHINER	N	I	M	I	6	4.00	0.47	0.01	0.00	1.33
BLUNTNOSE MINNOW	N	O	C	T	28	18.67	2.18	0.07	0.04	4.00
CENTRAL STONEROLLER	N	H	N		52	34.67	4.04	0.68	0.39	19.62
CHANNEL CATFISH	F		C		4	2.67	0.31	2.78	1.60	1,041.25
FLATHEAD CATFISH	F	P	C		1	0.67	0.08	2.13	1.23	3,200.00
TROUT-PERCH		I	M		1	0.67	0.08	0.00	0.00	4.00
BLACK CRAPPIE	S	I	C		6	4.00	0.47	1.06	0.61	264.17
ROCK BASS	S	C	C		7	4.67	0.54	0.36	0.21	77.29
SMALLMOUTH BASS	F	C	C	M	20	13.33	1.56	1.67	0.96	125.10
LARGEMOUTH BASS	F	C	C		5	3.33	0.39	0.36	0.21	107.20
BLUEGILL SUNFISH	S	I	C	P	11	7.33	0.86	0.30	0.17	40.55
REDEAR SUNFISH	E	I	C		1	0.67	0.08	0.07	0.04	111.00
YELLOW PERCH			M		1	0.67	0.08	0.04	0.02	59.00
BLACKSIDE DARTER	D	I	S		1	0.67	0.08	0.00	0.00	4.00
LOGPERCH	D	I	S	M	8	5.33	0.62	0.04	0.02	7.88
JOHNNY DARTER	D	I	C		2	1.33	0.16	0.00	0.00	0.50
GREENSIDE DARTER	D	I	S	M	22	14.67	1.71	0.04	0.02	2.73
BANDED DARTER	D	I	S	I	86	57.33	6.69	0.05	0.03	0.88
VARIEGATE DARTER	D	I	S	I	27	18.00	2.10	0.06	0.03	3.33
BLUEBREAST DARTER [T]	D	I	S	R	19	12.67	1.48	0.02	0.01	1.74
RAINBOW DARTER	D	I	S	M	4	2.67	0.31	0.00	0.00	0.75

River: **17-600 Walhonding River** River Mile: **16.30** Sample Date: **1994**

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
SAUGER X WALLEYE	E		P		16	10.67	1.24	7.58	4.38	711.06
Mile Total					1,286	857.33		173.21		
Number of Species					42					
Number of Hybrids					1					

River Code: **17-600**	Stream: **Walhonding River**	Sample Date: **1994**
River Mile: **8.00**	Basin: Muskingum River	Date Range: 07/20/94
Data Source: 01	Time Fished: 7802 sec Drain Area: 1576.0 sq mi	Thru: 09/28/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		2	1.33	0.26	0.99	0.87	739.00
GIZZARD SHAD		O	M		8	5.33	1.05	0.41	0.36	77.13
NORTHERN PIKE	F	P	M		1	0.67	0.13	1.13	1.00	1,700.00
SILVER REDHORSE	R	I	S	M	2	1.33	0.26	1.41	1.25	1,060.00
BLACK REDHORSE	R	I	S	I	13	8.67	1.70	2.18	1.93	251.62
GOLDEN REDHORSE	R	I	S	M	76	50.67	9.95	16.02	14.16	316.25
SHORTHEAD REDHORSE	R	I	S	M	73	48.67	9.55	20.62	18.21	423.60
RIVER REDHORSE [S]	R	I	S	I	14	9.33	1.83	8.88	7.85	951.71
NORTHERN HOG SUCKER	R	I	S	M	42	28.00	5.50	6.14	5.42	219.27
COMMON CARP	G	O	M	T	28	18.67	3.66	31.44	27.77	1,684.05
RIVER CHUB	N	I	N	I	4	2.67	0.52	0.04	0.04	16.50
STREAMLINE CHUB	N	I	S	R	22	14.67	2.88	0.10	0.09	6.95
GRAVEL CHUB	N	I	S	M	14	9.33	1.83	0.05	0.04	4.86
EMERALD SHINER	N	I	S		55	36.67	7.20	0.10	0.09	2.84
SILVER SHINER	N	I	S	I	25	16.67	3.27	0.05	0.05	3.20
ROSYFACE SHINER	N	I	S	I	5	3.33	0.65	0.00	0.00	1.40
STRIPED SHINER	N	I	S		8	5.33	1.05	0.01	0.01	2.38
SPOTFIN SHINER	N	I	M		177	118.00	23.17	0.31	0.28	2.65
SAND SHINER	N	I	M	M	13	8.67	1.70	0.01	0.01	1.31
MIMIC SHINER	N	I	M	I	6	4.00	0.79	0.01	0.00	1.33
BLUNTNOSE MINNOW	N	O	C	T	15	10.00	1.96	0.03	0.02	2.67
CENTRAL STONEROLLER	N	H	N		4	2.67	0.52	0.04	0.03	14.00
CHANNEL CATFISH	F		C		38	25.33	4.97	17.46	15.42	689.02
BLACK CRAPPIE	S	I	C		1	0.67	0.13	0.02	0.02	36.00
ROCK BASS	S	C	C		2	1.33	0.26	0.06	0.05	43.00
SMALLMOUTH BASS	F	C	C	M	26	17.33	3.40	1.57	1.39	90.81
GREEN SUNFISH	S	I	C	T	1	0.67	0.13	0.07	0.06	105.00
BLUEGILL SUNFISH	S	I	C	P	7	4.67	0.92	0.15	0.14	33.14
LOGPERCH	D	I	S	M	9	6.00	1.18	0.10	0.08	16.00
JOHNNY DARTER	D	I	C		1	0.67	0.13	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	4	2.67	0.52	0.01	0.01	3.00
BANDED DARTER	D	I	S	I	27	18.00	3.53	0.02	0.02	1.00
VARIEGATE DARTER	D	I	S	I	17	11.33	2.23	0.05	0.04	4.24
BLUEBREAST DARTER [T]	D	I	S	R	9	6.00	1.18	0.02	0.02	3.33
FANTAIL DARTER	D	I	C		5	3.33	0.65	0.01	0.01	2.00
SAUGER X WALLEYE	E	P			9	6.00	1.18	2.45	2.16	407.67
FRESHWATER DRUM			M	P	1	0.67	0.13	1.23	1.09	1,850.00
	Mile Total				764	509.33		113.19		
	Number of Species				36					
	Number of Hybrids				1					

River Code: **17-600**	Stream: **Walhonding River**	Sample Date: **1994**
River Mile: **1.10**	Basin: Muskingum River	Date Range: 07/20/94
Data Source: 01	Time Fished: 7474 sec Drain Area: 2255.0 sq mi	Thru: 09/27/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		27	18.00	3.35	1.37	1.31	76.11
QUILLBACK CARPSUCKER	C	O	M		2	1.33	0.25	0.54	0.52	408.00
HIGHFIN CARPSUCKER	C	O	M		4	2.67	0.50	1.33	1.27	497.75
SILVER REDHORSE	R	I	S	M	29	19.33	3.60	11.26	10.78	582.38
BLACK REDHORSE	R	I	S	I	5	3.33	0.62	0.74	0.71	223.20
GOLDEN REDHORSE	R	I	S	M	65	43.33	8.06	11.85	11.35	273.55
SHORTHEAD REDHORSE	R	I	S	M	52	34.67	6.45	26.37	25.24	760.58
RIVER REDHORSE [S]	R	I	S	I	2	1.33	0.25	0.85	0.81	635.00
NORTHERN HOG SUCKER	R	I	S	M	25	16.67	3.10	4.23	4.05	253.78
COMMON CARP	G	O	M	T	15	10.00	1.86	25.26	24.18	2,525.87
RIVER CHUB	N	I	N	I	5	3.33	0.62	0.05	0.05	14.60
STREAMLINE CHUB	N	I	S	R	5	3.33	0.62	0.01	0.01	4.20
GRAVEL CHUB	N	I	S	M	16	10.67	1.99	0.05	0.04	4.31
SUCKERMOUTH MINNOW	N	I	S		1	0.67	0.12	0.01	0.01	10.00
EMERALD SHINER	N	I	S		115	76.67	14.27	0.25	0.24	3.25
SILVER SHINER	N	I	S	I	3	2.00	0.37	0.01	0.01	3.33
STRIPED SHINER	N	I	S		7	4.67	0.87	0.01	0.01	1.43
SPOTFIN SHINER	N	I	M		126	84.00	15.63	0.24	0.23	2.84
SAND SHINER	N	I	M	M	117	78.00	14.52	0.09	0.09	1.16
MIMIC SHINER	N	I	M	I	6	4.00	0.74	0.00	0.00	1.17
BLUNTNOSE MINNOW	N	O	C	T	29	19.33	3.60	0.04	0.04	2.17
CENTRAL STONEROLLER	N	H	N		20	13.33	2.48	0.12	0.11	9.00
COM. CARP X GOLDFISH	G	O		T	1	0.67	0.12	0.13	0.12	190.00
CHANNEL CATFISH	F		C		11	7.33	1.36	4.78	4.57	651.64
FLATHEAD CATFISH	F	P	C		2	1.33	0.25	7.90	7.56	5,925.00
TROUT-PERCH		I	M		2	1.33	0.25	0.00	0.00	2.50
WHITE BASS	F	P	M		1	0.67	0.12	0.21	0.20	320.00
BLACK CRAPPIE	S	I	C		1	0.67	0.12	0.05	0.05	76.00
ROCK BASS	S	C	C		2	1.33	0.25	0.05	0.05	41.00
SMALLMOUTH BASS	F	C	C	M	38	25.33	4.71	1.85	1.77	72.95
LARGEMOUTH BASS	F	C	C		2	1.33	0.25	0.62	0.60	467.00
WARMOUTH SF	S	C	C		1	0.67	0.12	0.03	0.02	38.00
BLUEGILL SUNFISH	S	I	C	P	3	2.00	0.37	0.00	0.00	2.00
BLACKSIDE DARTER	D	I	S		1	0.67	0.12	0.00	0.00	1.00
LOGPERCH	D	I	S	M	1	0.67	0.12	0.03	0.03	40.00
JOHNNY DARTER	D	I	C		1	0.67	0.12	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	11	7.33	1.36	0.01	0.01	1.27
BANDED DARTER	D	I	S	I	12	8.00	1.49	0.00	0.00	0.58
VARIEGATE DARTER	D	I	S	I	18	12.00	2.23	0.03	0.03	2.56
FANTAIL DARTER	D	I	C		1	0.67	0.12	0.00	0.00	1.00
SAUGER X WALLEYE	E	P			18	12.00	2.23	3.06	2.93	254.72
FRESHWATER DRUM			M	P	3	2.00	0.37	1.05	1.00	523.33
Mile Total					806	537.33		104.48		
Number of Species					40					
Number of Hybrids					2					

River Code: **17-800**	Stream: **Wills Creek**	Sample Date: **1994**
River Mile: **0.30**	Basin: Muskingum River	Date Range: 07/27/94
Data Source: 01	Time Fished: 6682 sec Drain Area: 853.0 sq mi	Thru: 09/22/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		34	22.67	6.24	0.58	0.57	25.41
HIGHFIN CARPSUCKER	C	O	M		3	2.00	0.55	0.89	0.88	444.00
SILVER REDHORSE	R	I	S	M	9	6.00	1.65	3.42	3.38	569.44
GOLDEN REDHORSE	R	I	S	M	38	25.33	6.97	6.60	6.52	260.38
SHORTHEAD REDHORSE	R	I	S	M	13	8.67	2.39	1.35	1.34	156.00
NORTHERN HOG SUCKER	R	I	S	M	7	4.67	1.28	0.08	0.08	17.57
COMMON CARP	G	O	M	T	29	19.33	5.32	51.05	50.45	2,640.52
GRAVEL CHUB	N	I	S	M	2	1.33	0.37	0.01	0.01	7.50
CREEK CHUB	N	G	N	T	2	1.33	0.37	0.00	0.00	1.00
EMERALD SHINER	N	I	S		19	12.67	3.49	0.05	0.05	4.00
SPOTFIN SHINER	N	I	M		123	82.00	22.57	0.24	0.23	2.87
SAND SHINER	N	I	M	M	32	21.33	5.87	0.03	0.03	1.56
MIMIC SHINER	N	I	M	I	46	30.67	8.44	0.05	0.05	1.59
BULLHEAD MINNOW	N	O	C		6	4.00	1.10	0.00	0.00	1.17
BLUNTNOSE MINNOW	N	O	C	T	25	16.67	4.59	0.02	0.02	1.36
CHANNEL CATFISH	F		C		45	30.00	8.26	23.63	23.35	787.68
FLATHEAD CATFISH	F	P	C		4	2.67	0.73	0.65	0.64	242.50
BLACK CRAPPIE	S	I	C		4	2.67	0.73	0.53	0.52	197.75
ROCK BASS	S	C	C		11	7.33	2.02	0.63	0.62	85.27
SMALLMOUTH BASS	F	C	C	M	11	7.33	2.02	0.17	0.17	22.82
LARGEMOUTH BASS	F	C	C		2	1.33	0.37	0.23	0.23	175.50
GREEN SUNFISH	S	I	C	T	1	0.67	0.18	0.01	0.01	10.00
BLUEGILL SUNFISH	S	I	C	P	8	5.33	1.47	0.28	0.27	51.75
DUSKY DARTER	D	I	S	M	1	0.67	0.18	0.01	0.01	10.00
LOGPERCH	D	I	S	M	6	4.00	1.10	0.03	0.03	6.67
JOHNNY DARTER	D	I	C		4	2.67	0.73	0.00	0.00	1.00
BANDED DARTER	D	I	S	I	3	2.00	0.55	0.00	0.00	0.67
SAUGER X WALLEYE	E	P			50	33.33	9.17	7.69	7.60	230.62
FRESHWATER DRUM			M	P	7	4.67	1.28	2.97	2.94	637.29
	Mile Total				545	363.33		101.18		
	Number of Species				28					
	Number of Hybrids				1					

Species List

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1993**
River Mile: **5.50**	Basin: Muskingum River	Date Range: 07/26/93
Data Source: 01	Time Fished: 6120 sec Drain Area: 742.0 sq mi	Thru: 09/07/93
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LONGNOSE GAR		P	M		1	1.00	0.13	0.05	0.03	50.00
GIZZARD SHAD		O	M		51	51.00	6.39	2.33	1.54	45.61
SMALLMOUTH BUFFALO	C	I	M		4	4.00	0.50	1.62	1.07	404.00
QUILLBACK CARPSUCKER	C	O	M		8	8.00	1.00	2.60	1.72	324.75
HIGHFIN CARPSUCKER	C	O	M		1	1.00	0.13	0.54	0.36	540.00
SILVER REDHORSE	R	I	S	M	2	2.00	0.25	1.80	1.19	900.00
BLACK REDHORSE	R	I	S	I	1	1.00	0.13	0.20	0.14	204.00
GOLDEN REDHORSE	R	I	S	M	26	26.00	3.26	7.60	5.04	292.33
SHORTHEAD REDHORSE	R	I	S	M	2	2.00	0.25	0.33	0.22	165.00
NORTHERN HOG SUCKER	R	I	S	M	7	7.00	0.88	1.11	0.74	159.14
COMMON CARP	G	O	M	T	55	55.00	6.89	73.33	48.63	1,333.31
GOLDFISH	G	O	M	T	5	5.00	0.63	1.19	0.79	238.60
EMERALD SHINER	N	I	S		78	78.00	9.77	0.05	0.04	0.69
SPOTFIN SHINER	N	I	M		13	13.00	1.63	0.03	0.02	2.08
SAND SHINER	N	I	M	M	3	3.00	0.38	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	6	6.00	0.75	0.01	0.00	0.83
CHANNEL CATFISH	F		C		39	39.00	4.89	10.40	6.89	266.55
YELLOW BULLHEAD		I	C	T	1	1.00	0.13	0.02	0.01	16.00
FLATHEAD CATFISH	F	P	C		1	1.00	0.13	12.30	8.16	12,300.00
BROOK SILVERSIDE		I	M	M	2	2.00	0.25	0.00	0.00	1.00
BLACK CRAPPIE	S	I	C		12	12.00	1.50	0.75	0.50	62.83
ROCK BASS	S	C	C		1	1.00	0.13	0.01	0.01	10.00
SMALLMOUTH BASS	F	C	C	M	8	8.00	1.00	0.27	0.18	33.88
SPOTTED BASS	F	C	C		34	34.00	4.26	4.26	2.82	125.21
LARGEMOUTH BASS	F	C	C		53	53.00	6.64	7.92	5.25	149.51
WARMOUTH SF	S	C	C		19	19.00	2.38	0.32	0.21	16.63
GREEN SUNFISH	S	I	C	T	16	16.00	2.01	0.26	0.17	16.44
BLUEGILL SUNFISH	S	I	C	P	232	232.00	29.07	12.81	8.49	55.20
OR'GESPOTTED SUNFISH	S	I	C		17	17.00	2.13	0.15	0.10	8.76
PUMPKINSEED SUNFISH	S	I	C	P	21	21.00	2.63	0.43	0.28	20.33
GREEN SF X BLUEGILL					1	1.00	0.13	0.03	0.02	30.00
GR'N SF X PUMPKINS'D					2	2.00	0.25	0.04	0.02	18.00
BLUEGILL X ORANGESPT					1	1.00	0.13	0.04	0.03	40.00
GREEN SF X WARMOUTH					1	1.00	0.13	0.07	0.05	68.00
LARGEMOUTH X SPOTTED	F	C	C		1	1.00	0.13	0.17	0.11	166.00
LOGPERCH	D	I	S	M	16	16.00	2.01	0.08	0.05	5.13
SAUGER X WALLEYE	E	P			38	38.00	4.76	2.22	1.47	58.39
FRESHWATER DRUM			M	P	19	19.00	2.38	5.47	3.63	287.89
	Mile Total				798	798.00		150.79		
	Number of Species				32					
	Number of Hybrids				6					

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1994**
River Mile: **3.80**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 01	Time Fished: 5672 sec Drain Area: 753.0 sq mi	Thru: 09/29/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		150	100.00	17.10	1.15	0.67	11.47
QUILLBACK CARPSUCKER	C	O	M		13	8.67	1.48	5.16	3.00	595.62
HIGHFIN CARPSUCKER	C	O	M		2	1.33	0.23	0.89	0.52	668.50
SILVER REDHORSE	R	I	S	M	8	5.33	0.91	6.12	3.55	1,148.00
GOLDEN REDHORSE	R	I	S	M	119	79.33	13.57	37.03	21.49	466.76
SHORTHEAD REDHORSE	R	I	S	M	66	44.00	7.53	26.66	15.47	605.81
NORTHERN HOG SUCKER	R	I	S	M	12	8.00	1.37	1.96	1.14	244.56
COMMON CARP	G	O	M	T	47	31.33	5.36	41.44	24.05	1,322.40
GOLDFISH	G	O	M	T	4	2.67	0.46	0.61	0.35	227.50
RIVER CHUB	N	I	N	I	1	0.67	0.11	0.01	0.00	12.00
GRAVEL CHUB	N	I	S	M	1	0.67	0.11	0.00	0.00	6.00
EMERALD SHINER	N	I	S		158	105.33	18.02	0.15	0.09	1.44
SPOTFIN SHINER	N	I	M		33	22.00	3.76	0.06	0.04	2.82
SAND SHINER	N	I	M	M	1	0.67	0.11	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	1	0.67	0.11	0.00	0.00	2.00
COM. CARP X GOLDFISH	G	O		T	6	4.00	0.68	2.13	1.24	533.17
CHANNEL CATFISH	F		C		27	18.00	3.08	6.48	3.76	360.15
FLATHEAD CATFISH	F	P	C		5	3.33	0.57	19.27	11.18	5,780.00
WHITE BASS	F	P	M		1	0.67	0.11	0.19	0.11	286.00
WHITE PERCH	E		M		2	1.33	0.23	0.42	0.24	312.50
STR. BASS X WH. BASS	E				4	2.67	0.46	2.54	1.47	951.25
WHITE CRAPPIE	S	I	C		7	4.67	0.80	0.73	0.42	156.43
BLACK CRAPPIE	S	I	C		8	5.33	0.91	0.85	0.49	158.88
ROCK BASS	S	C	C		5	3.33	0.57	0.28	0.16	83.60
SMALLMOUTH BASS	F	C	C	M	10	6.67	1.14	2.00	1.16	299.90
SPOTTED BASS	F	C	C		13	8.67	1.48	1.59	0.92	183.15
LARGEMOUTH BASS	F	C	C		7	4.67	0.80	0.41	0.24	87.71
WARMOUTH SF	S	C	C		2	1.33	0.23	0.04	0.02	27.50
GREEN SUNFISH	S	I	C	T	6	4.00	0.68	0.09	0.05	21.67
BLUEGILL SUNFISH	S	I	C	P	66	44.00	7.53	0.38	0.22	8.68
OR'GESPOTTED SUNFISH	S	I	C		3	2.00	0.34	0.01	0.01	5.33
LONGEAR SUNFISH	S	I	C	M	3	2.00	0.34	0.00	0.00	2.00
REDEAR SUNFISH	E	I	C		1	0.67	0.11	0.05	0.03	76.00
PUMPKINSEED SUNFISH	S	I	C	P	5	3.33	0.57	0.02	0.01	5.00
B'GILL X PUMPKINSEED					1	0.67	0.11	0.01	0.01	18.00
GREEN SF X HYBRID					2	1.33	0.23	0.04	0.02	29.50
HYBRID X SUNFISH					1	0.67	0.11	0.04	0.02	57.00
YELLOW PERCH			M		1	0.67	0.11	0.01	0.00	8.00
LOGPERCH	D	I	S	M	7	4.67	0.80	0.09	0.05	19.29
GREENSIDE DARTER	D	I	S	M	5	3.33	0.57	0.01	0.00	2.40
BANDED DARTER	D	I	S	I	16	10.67	1.82	0.01	0.01	1.25
SAUGER X WALLEYE	E	P			34	22.67	3.88	7.46	4.33	328.90

River: **17-200 Licking River** River Mile: **3.80** Sample Date: **1994**

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
FRESHWATER DRUM			M	P	13	8.67	1.48	5.94	3.45	685.92
Mile Total					877	584.67		172.31		
Number of Species					37					
Number of Hybrids					6					

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1993**
River Mile: **3.40**	Basin: Muskingum River	Date Range: 07/27/93
Data Source: 01	Time Fished: 5180 sec Drain Area: 753.0 sq mi	Thru: 09/13/93
Purpose:	Dist Fished: 0.95 km No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		52	56.33	9.50	1.79	1.10	32.54
NORTHERN PIKE	F	P	M		1	1.00	0.17	2.60	1.61	2,600.00
SMALLMOUTH BUFFALO	C	I	M		2	2.00	0.34	0.78	0.48	388.00
QUILLBACK CARPSUCKER	C	O	M		11	11.67	1.97	5.00	3.09	420.82
HIGHFIN CARPSUCKER	C	O	M		1	1.00	0.17	0.15	0.09	152.00
SILVER REDHORSE	R	I	S	M	5	5.11	0.86	2.72	1.68	540.20
GOLDEN REDHORSE	R	I	S	M	90	94.78	15.99	28.50	17.61	302.14
SHORTHEAD REDHORSE	R	I	S	M	69	73.56	12.41	34.06	21.04	464.64
NORTHERN HOG SUCKER	R	I	S	M	20	21.33	3.60	5.24	3.23	244.40
COMMON CARP	G	O	M	T	38	39.22	6.62	37.96	23.45	964.98
GOLDFISH	G	O	M	T	2	2.11	0.36	0.62	0.38	294.00
GRAVEL CHUB	N	I	S	M	2	2.22	0.37	0.01	0.01	5.00
EMERALD SHINER	N	I	S		57	63.22	10.66	0.05	0.03	0.72
SPOTFIN SHINER	N	I	M		2	2.22	0.37	0.00	0.00	2.00
MIMIC SHINER	N	I	M	I	1	1.11	0.19	0.00	0.00	2.00
BULLHEAD MINNOW	N	O	C		1	1.11	0.19	0.00	0.00	1.00
CENTRAL STONEROLLER	N	H	N		1	1.00	0.17	0.00	0.00	2.00
CHANNEL CATFISH	F		C		79	83.67	14.11	11.80	7.29	142.64
FLATHEAD CATFISH	F	P	C		1	1.00	0.17	1.45	0.90	1,450.00
WHITE CRAPPIE	S	I	C		2	2.00	0.34	0.08	0.05	42.00
BLACK CRAPPIE	S	I	C		2	2.11	0.36	0.16	0.10	75.00
ROCK BASS	S	C	C		2	2.11	0.36	0.19	0.12	89.50
SMALLMOUTH BASS	F	C	C	M	11	11.78	1.99	1.32	0.82	113.27
SPOTTED BASS	F	C	C		28	29.89	5.04	2.43	1.50	81.82
LARGEMOUTH BASS	F	C	C		3	3.22	0.54	0.43	0.26	131.33
GREEN SUNFISH	S	I	C	T	5	5.56	0.94	0.17	0.10	29.80
BLUEGILL SUNFISH	S	I	C	P	16	17.22	2.90	0.94	0.58	54.19
OR'GESPOTTED SUNFISH	S	I	C		1	1.11	0.19	0.02	0.01	18.00
LOGPERCH	D	I	S	M	3	3.33	0.56	0.02	0.02	7.33
BANDED DARTER	D	I	S	I	6	6.44	1.09	0.01	0.01	1.67
SAUGER X WALLEYE	E	P			21	22.22	3.75	5.53	3.42	245.62
FRESHWATER DRUM			M	P	21	22.22	3.75	17.85	11.03	792.89
Mile Total					556	592.89		161.88		
Number of Species					31					
Number of Hybrids					1					

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1994**
River Mile: **1.90**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 01	Time Fished: 2566 sec Drain Area: 756.0 sq mi	Thru: 09/29/94
Purpose:	Dist Fished: 0.30 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		43	143.33	5.70	1.41	1.31	9.84
QUILLBACK CARPSUCKER	C	O	M		1	3.33	0.13	0.01	0.01	3.00
SILVER REDHORSE	R	I	S	M	1	3.33	0.13	1.04	0.97	312.00
GOLDEN REDHORSE	R	I	S	M	26	86.67	3.44	22.65	21.07	261.35
SHORTHEAD REDHORSE	R	I	S	M	6	20.00	0.79	6.39	5.94	319.33
NORTHERN HOG SUCKER	R	I	S	M	27	90.00	3.58	5.97	5.55	66.30
COMMON CARP	G	O	M	T	11	36.67	1.46	36.92	34.35	1,006.91
GRAVEL CHUB	N	I	S	M	3	10.00	0.40	0.05	0.04	4.50
EMERALD SHINER	N	I	S		45	150.00	5.96	0.21	0.20	1.42
STRIPED SHINER	N	I	S		1	3.33	0.13	0.01	0.01	4.00
SPOTFIN SHINER	N	I	M		144	480.00	19.07	1.29	1.20	2.69
SAND SHINER	N	I	M	M	283	943.33	37.48	1.26	1.17	1.34
MIMIC SHINER	N	I	M	I	5	16.67	0.66	0.03	0.02	1.60
GHOST SHINER	N	I	M		1	3.33	0.13	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	39	130.00	5.17	0.22	0.21	1.72
CENTRAL STONEROLLER	N	H	N		3	10.00	0.40	0.04	0.04	4.33
CHANNEL CATFISH	F		C		6	20.00	0.79	2.16	2.01	107.83
STONECAT MADTOM		I	C	I	1	3.33	0.13	0.10	0.09	29.00
SMALLMOUTH BASS	F	C	C	M	10	33.33	1.32	0.76	0.70	22.70
SPOTTED BASS	F	C	C		3	10.00	0.40	0.32	0.29	31.67
LARGEMOUTH BASS	F	C	C		32	106.67	4.24	12.86	11.96	120.53
GREEN SUNFISH	S	I	C	T	1	3.33	0.13	0.00	0.00	1.00
BLUEGILL SUNFISH	S	I	C	P	18	60.00	2.38	0.25	0.23	4.10
OR'GESPOTTED SUNFISH	S	I	C		1	3.33	0.13	0.02	0.02	5.00
REDEAR SUNFISH	E	I	C		1	3.33	0.13	0.35	0.32	104.00
GREEN SF X BLUEGILL					1	3.33	0.13	0.03	0.03	9.00
GREEN SF X HYBRID					1	3.33	0.13	0.06	0.05	17.00
LOGPERCH	D	I	S	M	7	23.33	0.93	0.38	0.35	16.14
GREENSIDE DARTER	D	I	S	M	15	50.00	1.99	0.10	0.10	2.07
BANDED DARTER	D	I	S	I	13	43.33	1.72	0.04	0.04	0.92
SAUGER X WALLEYE	E	P			6	20.00	0.79	12.58	11.70	628.83
Mile Total					755	2,516.67		107.48		
Number of Species					28					
Number of Hybrids					3					

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1994**
River Mile: **1.70**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 01	Time Fished: 6582 sec Drain Area: 756.0 sq mi	Thru: 09/29/94
Purpose:	Dist Fished: 1.52 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN		P	C		1	0.67	0.12	0.70	0.96	1,050.00
GIZZARD SHAD		O	M		89	59.23	10.74	0.77	1.06	13.05
QUILLBACK CARPSUCKER	C	O	M		1	0.64	0.12	0.21	0.29	330.00
HIGHFIN CARPSUCKER	C	O	M		1	0.67	0.12	0.21	0.29	312.00
SILVER REDHORSE	R	I	S	M	19	12.62	2.29	2.98	4.10	236.18
BLACK REDHORSE	R	I	S	I	1	0.67	0.12	0.29	0.40	440.00
GOLDEN REDHORSE	R	I	S	M	136	89.56	16.24	27.89	38.27	310.52
SHORTHEAD REDHORSE	R	I	S	M	8	5.31	0.96	1.82	2.50	343.25
NORTHERN HOG SUCKER	R	I	S	M	8	5.31	0.96	0.62	0.85	118.00
COMMON CARP	G	O	M	T	26	17.23	3.12	18.01	24.71	1,043.62
GOLDFISH	G	O	M	T	1	0.67	0.12	0.28	0.38	420.00
GRAVEL CHUB	N	I	S	M	1	0.64	0.12	0.00	0.00	5.00
EMERALD SHINER	N	I	S		149	98.80	17.92	0.11	0.15	1.09
SPOTFIN SHINER	N	I	M		98	64.21	11.64	0.11	0.16	1.78
SAND SHINER	N	I	M	M	64	42.33	7.68	0.05	0.07	1.16
MIMIC SHINER	N	I	M	I	7	4.67	0.85	0.00	0.01	0.86
GHOST SHINER	N	I	M		2	1.33	0.24	0.00	0.00	1.00
BULLHEAD MINNOW	N	O	C		1	0.67	0.12	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	30	19.85	3.60	0.03	0.04	1.43
CHANNEL CATFISH	F		C		21	13.95	2.53	2.62	3.60	187.90
FLATHEAD CATFISH	F	P	C		4	2.62	0.47	1.06	1.46	400.50
BLACK CRAPPIE	S	I	C		2	1.31	0.24	0.10	0.13	74.00
ROCK BASS	S	C	C		4	2.67	0.48	0.17	0.24	65.50
SMALLMOUTH BASS	F	C	C	M	9	5.95	1.08	0.68	0.94	114.44
SPOTTED BASS	F	C	C		30	19.95	3.62	1.47	2.01	73.90
LARGEMOUTH BASS	F	C	C		8	5.28	0.96	0.35	0.48	67.63
WARMOUTH SF	S	C	C		2	1.33	0.24	0.06	0.08	43.50
GREEN SUNFISH	S	I	C	T	6	3.97	0.72	0.03	0.05	8.50
BLUEGILL SUNFISH	S	I	C	P	32	21.05	3.82	0.32	0.43	15.22
OR'GESPOTTED SUNFISH	S	I	C		3	2.00	0.36	0.00	0.01	2.00
LONGEAR SUNFISH	S	I	C	M	10	6.67	1.21	0.05	0.06	6.80
REDEAR SUNFISH	E	I	C		1	0.67	0.12	0.06	0.08	85.00
PUMPKINSEED SUNFISH	S	I	C	P	2	1.33	0.24	0.02	0.02	12.50
YELLOW PERCH			M		2	1.33	0.24	0.01	0.01	6.00
DUSKY DARTER	D	I	S	M	1	0.67	0.12	0.01	0.01	8.00
SLENDERHEAD DARTER [S]	D	I	S	R	1	0.67	0.12	0.00	0.00	4.00
LOGPERCH	D	I	S	M	7	4.62	0.84	0.06	0.08	12.71
GREENSIDE DARTER	D	I	S	M	5	3.33	0.60	0.01	0.01	2.00
BANDED DARTER	D	I	S	I	2	1.33	0.24	0.00	0.00	1.00
SAUGER X WALLEYE	E	P			29	19.13	3.47	7.57	10.39	394.28
FRESHWATER DRUM			M	P	10	6.54	1.19	4.13	5.67	630.20
	Mile Total				834	551.41		72.88		
	Number of Species				40					
	Number of Hybrids				1					

River Code: **17-200**	Stream: **Licking River**	Sample Date: **1994**
River Mile: **0.80**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 01	Time Fished: 7035 sec Drain Area: 779.0 sq mi	Thru: 09/29/94
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		102	68.00	11.41	0.86	0.98	12.62
QUILLBACK CARPSUCKER	C	O	M		1	0.67	0.11	0.14	0.16	211.00
SILVER REDHORSE	R	I	S	M	4	2.67	0.45	2.23	2.54	836.50
BLACK REDHORSE	R	I	S	I	1	0.67	0.11	0.13	0.15	198.00
GOLDEN REDHORSE	R	I	S	M	110	73.33	12.30	23.76	27.06	324.01
SHORTHEAD REDHORSE	R	I	S	M	35	23.33	3.91	10.70	12.18	458.46
RIVER REDHORSE [S]	R	I	S	I	3	2.00	0.34	1.33	1.51	664.67
NORTHERN HOG SUCKER	R	I	S	M	40	26.67	4.47	1.61	1.83	60.38
SPOTTED SUCKER	R	I	S		1	0.67	0.11	0.00	0.00	5.00
COMMON CARP	G	O	M	T	39	26.00	4.36	28.78	32.78	1,107.05
GRAVEL CHUB	N	I	S	M	5	3.33	0.56	0.01	0.01	3.40
SUCKERMOUTH MINNOW	N	I	S		3	2.00	0.34	0.01	0.02	7.33
EMERALD SHINER	N	I	S		143	95.33	16.00	0.15	0.17	1.55
SPOTFIN SHINER	N	I	M		137	91.33	15.32	0.21	0.24	2.30
SAND SHINER	N	I	M	M	37	24.67	4.14	0.03	0.03	1.05
BULLHEAD MINNOW	N	O	C		3	2.00	0.34	0.00	0.00	1.67
BLUNTNOSE MINNOW	N	O	C	T	17	11.33	1.90	0.01	0.01	0.94
CENTRAL STONEROLLER	N	H	N		12	8.00	1.34	0.04	0.04	4.75
CHANNEL CATFISH	F		C		33	22.00	3.69	3.61	4.11	163.88
FLATHEAD CATFISH	F	P	C		1	0.67	0.11	0.13	0.15	198.00
BLACK CRAPPIE	S	I	C		1	0.67	0.11	0.02	0.03	35.00
ROCK BASS	S	C	C		2	1.33	0.22	0.25	0.29	191.00
SMALLMOUTH BASS	F	C	C	M	21	14.00	2.35	2.76	3.15	197.48
SPOTTED BASS	F	C	C		26	17.33	2.91	1.67	1.91	96.58
LARGEMOUTH BASS	F	C	C		4	2.67	0.45	0.02	0.02	7.25
BLUEGILL SUNFISH	S	I	C	P	13	8.67	1.45	0.04	0.05	5.08
OR'GESPOTTED SUNFISH	S	I	C		6	4.00	0.67	0.02	0.02	4.67
LONGEAR SUNFISH	S	I	C	M	5	3.33	0.56	0.04	0.04	11.60
PUMPKINSEED SUNFISH	S	I	C	P	1	0.67	0.11	0.00	0.00	4.00
GREEN SF X HYBRID					1	0.67	0.11	0.00	0.00	1.00
YELLOW PERCH			M		1	0.67	0.11	0.01	0.01	10.00
SLENDERHEAD DARTER [S]	D	I	S	R	9	6.00	1.01	0.03	0.03	5.11
LOGPERCH	D	I	S	M	22	14.67	2.46	0.23	0.26	15.55
EASTERN SAND DARTER [S]	D	I	S	R	1	0.67	0.11	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	6	4.00	0.67	0.01	0.01	1.83
BANDED DARTER	D	I	S	I	8	5.33	0.89	0.01	0.01	1.00
SAUGER X WALLEYE	E	P			28	18.67	3.13	3.69	4.20	197.50
FRESHWATER DRUM			M	P	12	8.00	1.34	5.26	6.00	658.08
Mile Total					894	596.00		87.81		
Number of Species					36					
Number of Hybrids					2					

River Code: **17-610**	Stream: **Mill Creek**	Sample Date: **1994**
River Mile: **8.50**	Basin: Muskingum River	Date Range: 09/19/94
Data Source: 05	Time Fished: 5400 sec Drain Area: 18.5 sq mi	
Purpose:	Dist Fished: 0.19 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
AMER BROOK LAMPREY		F	N	R	2	3.16	0.19	0.04	0.33	14.00
QUILLBACK CARPSUCKER	C	O	M		2	3.16	0.19	0.02	0.14	6.00
GOLDEN REDHORSE	R	I	S	M	8	12.63	0.78	0.33	2.48	26.00
NORTHERN HOG SUCKER	R	I	S	M	22	34.74	2.14	1.08	8.12	30.93
WHITE SUCKER	W	O	S	T	145	228.95	14.11	5.87	44.33	25.65
BLACKNOSE DACE	N	G	S	T	1	1.58	0.10	0.00	0.02	2.00
CREEK CHUB	N	G	N	T	146	230.53	14.20	2.51	18.93	10.88
SOUTH. REDBELLY DACE	N	H	S		3	4.74	0.29	0.00	0.02	0.67
REDSIDE DACE	N	I	S	I	9	14.21	0.88	0.02	0.12	1.11
EMERALD SHINER	N	I	S		6	9.47	0.58	0.01	0.10	1.33
COMMON SHINER	N	I	S		129	203.68	12.55	0.90	6.79	4.42
SPOTFIN SHINER	N	I	M		11	17.37	1.07	0.05	0.41	3.09
SILVERJAW MINNOW	N	I	M		44	69.47	4.28	0.10	0.78	1.48
BLUNTNOSE MINNOW	N	O	C	T	229	361.58	22.28	0.85	6.39	2.34
CENTRAL STONEROLLER	N	H	N		57	90.00	5.54	0.28	2.10	3.09
TROUT-PERCH		I	M		50	78.95	4.86	0.46	3.49	5.85
ROCK BASS	S	C	C		3	4.74	0.29	0.14	1.02	28.67
SMALLMOUTH BASS	F	C	C	M	4	6.32	0.39	0.03	0.20	4.25
GREEN SUNFISH	S	I	C	T	6	9.47	0.58	0.23	1.75	24.50
BLUEGILL SUNFISH	S	I	C	P	2	3.16	0.19	0.04	0.26	11.00
BLACKSIDE DARTER	D	I	S		18	28.42	1.75	0.10	0.72	3.39
LOGPERCH	D	I	S	M	1	1.58	0.10	0.01	0.11	9.00
JOHNNY DARTER	D	I	C		93	146.84	9.05	0.12	0.89	0.80
GREENSIDE DARTER	D	I	S	M	15	23.68	1.46	0.03	0.25	1.40
BANDED DARTER	D	I	S	I	6	9.47	0.58	0.01	0.05	0.60
FANTAIL DARTER	D	I	C		12	18.95	1.17	0.01	0.09	0.64
MOTTLED SCULPIN		I	C		4	6.32	0.39	0.01	0.11	2.25
Mile Total					1,028	1,623.16		13.25		
Number of Species					27					
Number of Hybrids					0					

River Code: **17-610**	Stream: **Mill Creek**	Sample Date: **1994**
River Mile: **0.70**	Basin: Muskingum River	Date Range: 08/26/94
Data Source: 05	Time Fished: 6240 sec Drain Area: 51.0 sq mi	
Purpose:	Dist Fished: 0.28 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		16	17.14	1.47	0.34	2.15	19.69
SILVER REDHORSE	R	I	S	M	6	6.43	0.55	0.16	1.03	25.17
BLACK REDHORSE	R	I	S	I	3	3.21	0.28	0.10	0.64	31.33
GOLDEN REDHORSE	R	I	S	M	64	68.57	5.88	5.20	33.10	75.87
SHORTHEAD REDHORSE	R	I	S	M	3	3.21	0.28	0.08	0.48	23.33
NORTHERN HOG SUCKER	R	I	S	M	32	34.29	2.94	0.91	5.82	26.67
WHITE SUCKER	W	O	S	T	1	1.07	0.09	0.00	0.01	1.00
SPOTTED SUCKER	R	I	S		1	1.07	0.09	0.00	0.01	2.00
COMMON CARP	G	O	M	T	1	1.07	0.09	0.48	3.08	452.00
CREEK CHUB	N	G	N	T	8	8.57	0.73	0.01	0.06	1.00
EMERALD SHINER	N	I	S		250	267.86	22.96	0.76	4.81	2.82
STRIPED SHINER	N	I	S		4	4.29	0.37	0.03	0.21	7.75
SPOTFIN SHINER	N	I	M		248	265.71	22.77	0.66	4.23	2.50
SAND SHINER	N	I	M	M	32	34.29	2.94	0.04	0.23	1.05
SILVERJAW MINNOW	N	I	M		1	1.07	0.09	0.00	0.01	1.00
BLUNTNOSE MINNOW	N	O	C	T	34	36.43	3.12	0.09	0.60	2.59
CENTRAL STONEROLLER	N	H	N		151	161.79	13.87	0.93	5.90	5.73
YELLOW BULLHEAD		I	C	T	1	1.07	0.09	0.00	0.02	3.00
STONECAT MADTOM		I	C	I	1	1.07	0.09	0.03	0.17	25.00
TROUT-PERCH		I	M		7	7.50	0.64	0.01	0.06	1.14
ROCK BASS	S	C	C		18	19.29	1.65	1.56	9.95	81.04
SMALLMOUTH BASS	F	C	C	M	31	33.21	2.85	3.31	21.06	99.62
LARGEMOUTH BASS	F	C	C		1	1.07	0.09	0.00	0.03	4.00
GREEN SUNFISH	S	I	C	T	8	8.57	0.73	0.09	0.59	10.75
BLUEGILL SUNFISH	S	I	C	P	17	18.21	1.56	0.21	1.32	11.40
OR'GESPOTTED SUNFISH	S	I	C		1	1.07	0.09	0.03	0.17	25.00
YELLOW PERCH			M		1	1.07	0.09	0.04	0.25	36.00
BLACKSIDE DARTER	D	I	S		3	3.21	0.28	0.00	0.01	0.67
LOGPERCH	D	I	S	M	2	2.14	0.18	0.00	0.01	1.00
EASTERN SAND DARTER [S]	D	I	S	R	1	1.07	0.09	0.00	0.01	2.00
JOHNNY DARTER	D	I	C		45	48.21	4.13	0.03	0.20	0.66
GREENSIDE DARTER	D	I	S	M	52	55.71	4.77	0.10	0.66	1.85
BANDED DARTER	D	I	S	I	31	33.21	2.85	0.02	0.13	0.61
FANTAIL DARTER	D	I	C		6	6.43	0.55	0.00	0.02	0.50
SAUGER X WALLEYE	E	P			8	8.57	0.73	0.47	2.99	54.88
	Mile Total				1,089	1,166.79		15.72		
	Number of Species				34					
	Number of Hybrids				1					

River Code: **17-611**	Stream: **Spoon Creek**	Sample Date: **1994**
River Mile: **0.60**	Basin: Muskingum River	Date Range: 09/15/94
Data Source: 05	Time Fished: 3180 sec Drain Area: 8.0 sq mi	
Purpose:	Dist Fished: 0.16 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY		F	N		1	1.88	0.09			
GOLDEN REDHORSE	R	I	S	M	1	1.88	0.09			
NORTHERN HOG SUCKER	R	I	S	M	1	1.88	0.09			
WHITE SUCKER	W	O	S	T	219	410.63	19.28			
BLACKNOSE DACE	N	G	S	T	39	73.13	3.43			
CREEK CHUB	N	G	N	T	294	551.25	25.88			
REDSIDE DACE	N	I	S	I	54	101.25	4.75			
SILVER SHINER	N	I	S	I	1	1.88	0.09			
COMMON SHINER	N	I	S		106	198.75	9.33			
SPOTFIN SHINER	N	I	M		5	9.38	0.44			
SILVERJAW MINNOW	N	I	M		23	43.13	2.02			
BLUNTNOSE MINNOW	N	O	C	T	188	352.50	16.55			
CENTRAL STONEROLLER	N	H	N		51	95.63	4.49			
GREEN SUNFISH	S	I	C	T	14	26.25	1.23			
BLACKSIDE DARTER	D	I	S		2	3.75	0.18			
JOHNNY DARTER	D	I	C		129	241.88	11.36			
FANTAIL DARTER	D	I	C		8	15.00	0.70			
Mile Total					1,136	2,130.00				
Number of Species					17					
Number of Hybrids					0					

River Code: **17-612**	Stream: **Turkey Run**	Sample Date: **1994**
River Mile: **0.20**	Basin: Muskingum River	Date Range: 08/03/94
Data Source: 05	Time Fished: 3600 sec Drain Area: 5.5 sq mi	
Purpose:	Dist Fished: 0.17 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	67	118.24	4.13			
WHITE SUCKER	W	O	S	T	48	84.71	2.96			
BLACKNOSE DACE	N	G	S	T	106	187.06	6.53			
CREEK CHUB	N	G	N	T	290	511.77	17.87			
SOUTH. REDBELLY DACE	N	H	S		58	102.35	3.57			
REDSIDE DACE	N	I	S	I	53	93.53	3.27			
STRIPED SHINER	N	I	S		1	1.77	0.06			
COMMON SHINER	N	I	S		31	54.71	1.91			
SPOTFIN SHINER	N	I	M		1	1.77	0.06			
SILVERJAW MINNOW	N	I	M		81	142.94	4.99			
BLUNTNOSE MINNOW	N	O	C	T	309	545.29	19.04			
CENTRAL STONEROLLER	N	H	N		257	453.53	15.83			
YELLOW BULLHEAD		I	C	T	1	1.77	0.06			
ROCK BASS	S	C	C		1	1.77	0.06			
SMALLMOUTH BASS	F	C	C	M	1	1.77	0.06			
BLACKSIDE DARTER	D	I	S		8	14.12	0.49			
JOHNNY DARTER	D	I	C		208	367.06	12.82			
GREENSIDE DARTER	D	I	S	M	3	5.29	0.18			
FANTAIL DARTER	D	I	C		59	104.12	3.64			
MOTTLED SCULPIN		I	C		40	70.59	2.46			
Mile Total					1,623	2,864.12				
Number of Species					20					
Number of Hybrids					0					

Species List

River Code: **17-151**	Stream: **Bucklew Run**	Sample Date: **1994**
River Mile: **0.10**	Basin: Muskingum River	Date Range: 08/16/94
Data Source: 05	Time Fished: 3900 sec Drain Area: 8.1 sq mi	
Purpose:	Dist Fished: 0.16 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		1	1.88	0.14			
SILVER REDHORSE	R	I	S	M	20	37.50	2.85			
GOLDEN REDHORSE	R	I	S	M	3	5.63	0.43			
NORTHERN HOG SUCKER	R	I	S	M	47	88.13	6.70			
WHITE SUCKER	W	O	S	T	3	5.63	0.43			
CREEK CHUB	N	G	N	T	71	133.13	10.13			
EMERALD SHINER	N	I	S		54	101.25	7.70			
ROSYFACE SHINER	N	I	S	I	2	3.75	0.29			
STRIPED SHINER	N	I	S		53	99.38	7.56			
SPOTFIN SHINER	N	I	M		18	33.75	2.57			
SAND SHINER	N	I	M	M	164	307.50	23.40			
MIMIC SHINER	N	I	M	I	2	3.75	0.29			
SILVERJAW MINNOW	N	I	M		4	7.50	0.57			
BLUNTNOSE MINNOW	N	O	C	T	143	268.13	20.40			
CENTRAL STONEROLLER	N	H	N		35	65.63	4.99			
YELLOW BULLHEAD		I	C	T	2	3.75	0.29			
ROCK BASS	S	C	C		2	3.75	0.29			
SMALLMOUTH BASS	F	C	C	M	14	26.25	2.00			
LARGEMOUTH BASS	F	C	C		1	1.88	0.14			
GREEN SUNFISH	S	I	C	T	1	1.88	0.14			
BLUEGILL SUNFISH	S	I	C	P	28	52.50	3.99			
JOHNNY DARTER	D	I	C		28	52.50	3.99			
GREENSIDE DARTER	D	I	S	M	1	1.88	0.14			
FANTAIL DARTER	D	I	C		4	7.50	0.57			
Mile Total					701	1,314.38				
Number of Species					24					
Number of Hybrids					0					

River Code: **17-157**	Stream: **Big Run**	Sample Date: **1994**
River Mile: **0.20**	Basin: Muskingum River	Date Range: 10/06/94
Data Source: 05	Time Fished: 5700 sec Drain Area: 11.8 sq mi	
Purpose:	Dist Fished: 0.16 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY		F	N		1	1.88	0.13			
AMER BROOK LAMPREY		F	N	R	58	108.75	7.75			
GRASS PICKEREL		P	M	P	4	7.50	0.53			
GOLDEN REDHORSE	R	I	S	M	1	1.88	0.13			
NORTHERN HOG SUCKER	R	I	S	M	4	7.50	0.53			
WHITE SUCKER	W	O	S	T	43	80.63	5.75			
BLACKNOSE DACE	N	G	S	T	2	3.75	0.27			
CREEK CHUB	N	G	N	T	77	144.38	10.29			
ROSEFIN SHINER	N	I	S	M	4	7.50	0.53			
STRIPED SHINER	N	I	S		39	73.13	5.21			
SPOTFIN SHINER	N	I	M		121	226.88	16.18			
SAND SHINER	N	I	M	M	8	15.00	1.07			
SILVERJAW MINNOW	N	I	M		23	43.13	3.07			
BLUNTNOSE MINNOW	N	O	C	T	137	256.88	18.32			
CENTRAL STONEROLLER	N	H	N		107	200.63	14.30			
YELLOW BULLHEAD		I	C	T	3	5.63	0.40			
GREEN SUNFISH	S	I	C	T	3	5.63	0.40			
JOHNNY DARTER	D	I	C		71	133.13	9.49			
GREENSIDE DARTER	D	I	S	M	2	3.75	0.27			
RAINBOW DARTER	D	I	S	M	7	13.13	0.94			
FANTAIL DARTER	D	I	C		19	35.63	2.54			
MOTTLED SCULPIN		I	C		14	26.25	1.87			
Mile Total					748	1,402.50				
Number of Species					22					
Number of Hybrids					0					

River Code: **17-605**	Stream: **Beaver Run**	Sample Date: **1994**
River Mile: **5.00**	Basin: Muskingum River	Date Range: 08/16/94
Data Source: 05	Time Fished: 3300 sec Drain Area: 5.2 sq mi	
Purpose:	Dist Fished: 0.13 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY		F	N		22	50.77	3.69			
NORTHERN HOG SUCKER	R	I	S	M	20	46.15	3.36			
WHITE SUCKER	W	O	S	T	24	55.39	4.03			
BLACKNOSE DACE	N	G	S	T	277	639.23	46.48			
CREEK CHUB	N	G	N	T	61	140.77	10.23			
SOUTH. REDBELLY DACE	N	H	S		3	6.92	0.50			
REDSIDE DACE	N	I	S	I	24	55.39	4.03			
SPOTFIN SHINER	N	I	M		8	18.46	1.34			
MIMIC SHINER	N	I	M	I	2	4.62	0.34			
LONGEAR SUNFISH	S	I	C	M	1	2.31	0.17			
JOHNNY DARTER	D	I	C		1	2.31	0.17			
FANTAIL DARTER	D	I	C		2	4.62	0.34			
MOTTLED SCULPIN		I	C		151	348.46	25.34			
Mile Total					596	1,375.39				
Number of Species					13					
Number of Hybrids					0					

River Code: **17-613**	Stream: **Little Mill Creek**	Sample Date: **1994**
River Mile: **0.10**	Basin: Muskingum River	Date Range: 08/03/94
Data Source: 05	Time Fished: 2700 sec Drain Area: 8.6 sq mi	
Purpose:	Dist Fished: 0.10 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY		F	N		2	6.00	0.27			
GOLDEN REDHORSE	R	I	S	M	20	60.00	2.70			
NORTHERN HOG SUCKER	R	I	S	M	33	99.00	4.45			
WHITE SUCKER	W	O	S	T	12	36.00	1.62			
BLACKNOSE DACE	N	G	S	T	1	3.00	0.13			
CREEK CHUB	N	G	N	T	135	405.00	18.19			
REDSIDE DACE	N	I	S	I	2	6.00	0.27			
SILVER SHINER	N	I	S	I	1	3.00	0.13			
STRIPED SHINER	N	I	S		28	84.00	3.77			
COMMON SHINER	N	I	S		16	48.00	2.16			
SPOTFIN SHINER	N	I	M		3	9.00	0.40			
SILVERJAW MINNOW	N	I	M		66	198.00	8.89			
BLUNTNOSE MINNOW	N	O	C	T	78	234.00	10.51			
CENTRAL STONEROLLER	N	H	N		131	393.00	17.65			
ROCK BASS	S	C	C		1	3.00	0.13			
SMALLMOUTH BASS	F	C	C	M	7	21.00	0.94			
BLACKSIDE DARTER	D	I	S		4	12.00	0.54			
JOHNNY DARTER	D	I	C		100	300.00	13.48			
GREENSIDE DARTER	D	I	S	M	14	42.00	1.89			
BANDED DARTER	D	I	S	I	1	3.00	0.13			
FANTAIL DARTER	D	I	C		71	213.00	9.57			
MOTTLED SCULPIN		I	C		16	48.00	2.16			
Mile Total					742	2,226.00				
Number of Species					22					
Number of Hybrids					0					

Species List

River Code: **17-960**	Stream: **Wakatomika Creek**	Sample Date: **1994**
River Mile: **32.00**	Basin: Muskingum River	Date Range: 08/24/94
Data Source: 05	Time Fished: 12300 sec Drain Area: 19.7 sq mi	Thru: 09/20/94
Purpose:	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BLACK REDHORSE	R	I	S	I	72	54.00	2.08	7.94	23.97	147.03
GOLDEN REDHORSE	R	I	S	M	67	50.25	1.94	4.59	13.85	91.32
NORTHERN HOG SUCKER	R	I	S	M	116	87.00	3.36	6.26	18.91	72.01
WHITE SUCKER	W	O	S	T	51	38.25	1.48	2.38	7.18	62.15
RIVER CHUB	N	I	N	I	89	66.75	2.58	0.63	1.92	9.51
BIGEYE CHUB	N	I	S	I	2	1.50	0.06	0.01	0.02	3.00
CREEK CHUB	N	G	N	T	21	15.75	0.61	0.52	1.56	32.81
EMERALD SHINER	N	I	S		21	15.75	0.61	0.03	0.08	1.62
SILVER SHINER	N	I	S	I	34	25.50	0.98	0.06	0.17	2.15
ROSYFACE SHINER	N	I	S	I	35	26.25	1.01	0.03	0.10	1.23
STRIPED SHINER	N	I	S		210	157.50	6.08	1.77	5.33	11.22
SPOTFIN SHINER	N	I	M		36	27.00	1.04	0.05	0.16	1.97
SAND SHINER	N	I	M	M	9	6.75	0.26	0.01	0.04	2.00
MIMIC SHINER	N	I	M	I	30	22.50	0.87	0.03	0.10	1.43
SILVERJAW MINNOW	N	I	M		17	12.75	0.49	0.04	0.11	2.94
BLUNTNOSE MINNOW	N	O	C	T	40	30.00	1.16	0.09	0.29	3.16
CENTRAL STONEROLLER	N	H	N		650	487.50	18.81	3.11	9.40	6.39
YELLOW BULLHEAD		I	C	T	1	0.75	0.03	0.14	0.42	184.00
TROUT-PERCH		I	M		1	0.75	0.03	0.00	0.01	3.00
ROCK BASS	S	C	C		39	29.25	1.13	1.79	5.39	61.02
SMALLMOUTH BASS	F	C	C	M	1,741	1,305.75	50.38	3.14	9.48	2.40
LARGEMOUTH BASS	F	C	C		1	0.75	0.03	0.05	0.14	60.00
GREEN SUNFISH	S	I	C	T	4	3.00	0.12	0.05	0.16	17.75
BLUEGILL SUNFISH	S	I	C	P	5	3.75	0.14	0.09	0.29	25.20
LONGEAR SUNFISH	S	I	C	M	3	2.25	0.09	0.07	0.22	31.67
BLACKSIDE DARTER	D	I	S		3	2.25	0.09	0.01	0.02	3.00
LOGPERCH	D	I	S	M	11	8.25	0.32	0.12	0.35	13.91
JOHNNY DARTER	D	I	C		14	10.50	0.41	0.01	0.02	0.46
GREENSIDE DARTER	D	I	S	M	35	26.25	1.01	0.05	0.15	1.91
BANDED DARTER	D	I	S	I	12	9.00	0.35	0.01	0.03	1.00
VARIEGATE DARTER	D	I	S	I	1	0.75	0.03	0.00	0.01	3.00
RAINBOW DARTER	D	I	S	M	33	24.75	0.95	0.02	0.07	0.97
FANTAIL DARTER	D	I	C		48	36.00	1.39	0.04	0.11	1.02
MOTTLED SCULPIN		I	C		4	3.00	0.12	0.00	0.01	1.00
Mile Total					3,456	2,592.00		33.13		
Number of Species					34					
Number of Hybrids					0					

River Code: **17-960**	Stream: **Wakatomika Creek**	Sample Date: **1994**
River Mile: **14.80**	Basin: Muskingum River	Date Range: 07/25/94
Data Source: 05	Time Fished: 10920 sec Drain Area: 140.0 sq mi	Thru: 09/13/94
Purpose:	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		26	19.50	1.76	0.47	2.19	24.00
SILVER REDHORSE	R	I	S	M	2	1.50	0.14	0.01	0.03	4.00
BLACK REDHORSE	R	I	S	I	20	15.00	1.36	2.51	11.72	167.35
GOLDEN REDHORSE	R	I	S	M	22	16.50	1.49	1.68	7.84	101.82
NORTHERN HOG SUCKER	R	I	S	M	53	39.75	3.59	4.20	19.61	105.66
WHITE SUCKER	W	O	S	T	3	2.25	0.20	0.14	0.67	63.67
COMMON CARP	G	O	M	T	1	0.75	0.07	0.40	1.86	530.00
RIVER CHUB	N	I	N	I	32	24.00	2.17	0.56	2.60	23.20
CREEK CHUB	N	G	N	T	6	4.50	0.41	0.02	0.08	3.67
EMERALD SHINER	N	I	S		50	37.50	3.39	0.07	0.33	1.86
SILVER SHINER	N	I	S	I	4	3.00	0.27	0.01	0.04	3.00
ROSYFACE SHINER	N	I	S	I	70	52.50	4.75	0.06	0.28	1.14
STRIPED SHINER	N	I	S		65	48.75	4.41	0.66	3.10	13.62
SPOTFIN SHINER	N	I	M		108	81.00	7.32	0.16	0.76	2.01
SAND SHINER	N	I	M	M	49	36.75	3.32	0.05	0.23	1.35
SILVERJAW MINNOW	N	I	M		1	0.75	0.07	0.00	0.00	1.00
BLUNTNOSE MINNOW	N	O	C	T	61	45.75	4.14	0.09	0.44	2.07
CENTRAL STONEROLLER	N	H	N		534	400.50	36.20	4.57	21.33	11.41
CHANNEL CATFISH	F		C		2	1.50	0.14	1.30	6.06	865.00
YELLOW BULLHEAD		I	C	T	7	5.25	0.47	0.46	2.17	88.29
TROUT-PERCH		I	M		3	2.25	0.20	0.00	0.02	1.67
ROCK BASS	S	C	C		25	18.75	1.69	1.58	7.38	84.32
SMALLMOUTH BASS	F	C	C	M	13	9.75	0.88	1.77	8.27	181.54
LARGEMOUTH BASS	F	C	C		2	1.50	0.14	0.00	0.01	1.50
GREEN SUNFISH	S	I	C	T	1	0.75	0.07	0.01	0.04	10.00
BLUEGILL SUNFISH	S	I	C	P	6	4.50	0.41	0.05	0.23	10.83
LONGEAR SUNFISH	S	I	C	M	4	3.00	0.27	0.07	0.34	24.25
BLACKSIDE DARTER	D	I	S		15	11.25	1.02	0.02	0.09	1.73
LOGPERCH	D	I	S	M	12	9.00	0.81	0.11	0.53	12.58
JOHNNY DARTER	D	I	C		19	14.25	1.29	0.01	0.03	0.37
GREENSIDE DARTER	D	I	S	M	65	48.75	4.41	0.12	0.56	2.44
BANDED DARTER	D	I	S	I	46	34.50	3.12	0.04	0.21	1.27
VARIEGATE DARTER	D	I	S	I	80	60.00	5.42	0.15	0.69	2.48
RAINBOW DARTER	D	I	S	M	5	3.75	0.34	0.01	0.03	1.40
FANTAIL DARTER	D	I	C		63	47.25	4.27	0.06	0.27	1.22
	Mile Total				1,475	1,106.25		21.42		
	Number of Species				35					
	Number of Hybrids				0					

River Code: **17-960**	Stream: **Wakatomika Creek**	Sample Date: **1994**
River Mile: **12.50**	Basin: Muskingum River	Date Range: 08/24/94
Data Source: 05	Time Fished: 12300 sec Drain Area: 154.0 sq mi	Thru: 09/20/94
Purpose:	Dist Fished: 0.41 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
AMER BROOK LAMPREY		F	N	R	2	1.43	0.18	0.03	0.26	17.50
GIZZARD SHAD		O	M		52	37.68	4.75	0.57	6.06	15.27
NORTHERN PIKE	F	P	M		1	0.71	0.09	1.33	14.07	1,860.00
BLACK REDHORSE	R	I	S	I	1	0.71	0.09	0.01	0.07	9.00
GOLDEN REDHORSE	R	I	S	M	84	61.21	7.71	1.90	20.12	30.87
NORTHERN HOG SUCKER	R	I	S	M	69	50.25	6.33	0.88	9.33	17.27
WHITE SUCKER	W	O	S	T	8	5.82	0.73	0.14	1.48	23.38
SPOTTED SUCKER	R	I	S		1	0.71	0.09	0.00	0.01	1.00
RIVER CHUB	N	I	N	I	2	1.43	0.18	0.01	0.14	9.00
CREEK CHUB	N	G	N	T	18	13.18	1.66	0.04	0.38	2.78
EMERALD SHINER	N	I	S		101	74.18	9.34	0.17	1.81	2.29
SILVER SHINER	N	I	S	I	7	5.11	0.64	0.01	0.15	2.86
ROSYFACE SHINER	N	I	S	I	22	16.25	2.05	0.02	0.20	1.18
STRIPED SHINER	N	I	S		66	48.00	6.05	0.15	1.57	3.08
COMMON SHINER	N	I	S		3	2.25	0.28	0.01	0.06	2.67
SPOTFIN SHINER	N	I	M		199	146.18	18.41	0.25	2.67	1.73
SAND SHINER	N	I	M	M	21	15.36	1.93	0.02	0.25	1.52
MIMIC SHINER	N	I	M	I	11	7.96	1.00	0.01	0.10	1.09
SILVERJAW MINNOW	N	I	M		7	5.07	0.64	0.01	0.10	1.71
BLUNTNOSE MINNOW	N	O	C	T	124	89.57	11.28	0.16	1.73	1.83
CENTRAL STONEROLLER	N	H	N		17	12.21	1.54	0.08	0.84	6.40
CHANNEL CATFISH	F		C		4	2.89	0.36	1.01	10.73	347.75
YELLOW BULLHEAD		I	C	T	7	5.07	0.64	0.47	4.98	91.86
TROUT-PERCH		I	M		30	21.71	2.74	0.08	0.85	3.63
ROCK BASS	S	C	C		22	16.07	2.02	1.17	12.40	72.68
SMALLMOUTH BASS	F	C	C	M	3	2.21	0.28	0.59	6.30	268.67
LARGEMOUTH BASS	F	C	C		1	0.71	0.09	0.02	0.17	23.00
GREEN SUNFISH	S	I	C	T	8	5.86	0.74	0.05	0.58	9.38
BLUEGILL SUNFISH	S	I	C	P	4	2.89	0.36	0.06	0.58	18.75
LONGEAR SUNFISH	S	I	C	M	1	0.75	0.09	0.01	0.10	12.00
DUSKY DARTER	D	I	S	M	3	2.18	0.27	0.01	0.13	5.67
BLACKSIDE DARTER	D	I	S		48	35.00	4.41	0.06	0.61	1.67
LOGPERCH	D	I	S	M	2	1.46	0.18	0.01	0.12	7.50
EASTERN SAND DARTER [S]	D	I	S	R	2	1.46	0.18	0.00	0.03	1.50
JOHNNY DARTER	D	I	C		36	26.21	3.30	0.01	0.13	0.44
GREENSIDE DARTER	D	I	S	M	48	34.96	4.40	0.05	0.52	1.42
BANDED DARTER	D	I	S	I	31	22.50	2.83	0.02	0.22	0.90
VARIEGATE DARTER	D	I	S	I	11	7.86	0.99	0.01	0.05	0.64
FANTAIL DARTER	D	I	C		12	8.71	1.10	0.01	0.13	1.42
Mile Total					1,089	793.82		9.44		
Number of Species					39					
Number of Hybrids					0					

River Code: **17-960**	Stream: **Wakatomika Creek**	Sample Date: **1994**
River Mile: **11.80**	Basin: Muskingum River	Date Range: 07/26/94
Data Source: 05	Time Fished: 12900 sec Drain Area: 155.0 sq mi	Thru: 09/13/94
Purpose:	Dist Fished: 0.41 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
AMER BROOK LAMPREY		F	N	R	4	2.89	0.30	0.03	0.11	10.63
GIZZARD SHAD		O	M		3	2.25	0.23	0.03	0.11	14.00
GRASS PICKEREL		P	M	P	6	4.29	0.45	0.14	0.50	32.67
SILVER REDHORSE	R	I	S	M	20	14.36	1.49	1.36	4.84	94.55
BLACK REDHORSE	R	I	S	I	11	7.96	0.83	1.13	4.02	142.00
GOLDEN REDHORSE	R	I	S	M	78	56.61	5.88	7.47	26.54	133.19
SHORTHEAD REDHORSE	R	I	S	M	1	0.75	0.08	0.11	0.38	143.00
NORTHERN HOG SUCKER	R	I	S	M	104	75.54	7.85	2.20	7.81	29.35
WHITE SUCKER	W	O	S	T	8	5.71	0.59	0.80	2.86	140.75
COMMON CARP	G	O	M	T	2	1.43	0.15	4.68	16.62	3,275.00
RIVER CHUB	N	I	N	I	3	2.25	0.23	0.01	0.03	3.33
BLACKNOSE DACE	N	G	S	T	1	0.75	0.08	0.00	0.00	1.00
CREEK CHUB	N	G	N	T	24	17.32	1.80	0.05	0.16	2.66
EMERALD SHINER	N	I	S		190	140.50	14.60	0.33	1.18	2.36
REDFIN SHINER	N	I	N		1	0.71	0.07	0.00	0.01	2.00
STRIPED SHINER	N	I	S		56	40.39	4.20	0.13	0.47	3.26
COMMON SHINER	N	I	S		1	0.75	0.08	0.00	0.01	3.00
SPOTFIN SHINER	N	I	M		163	120.75	12.55	0.29	1.04	2.42
SAND SHINER	N	I	M	M	92	66.71	6.93	0.12	0.42	1.78
SILVERJAW MINNOW	N	I	M		16	11.46	1.19	0.02	0.06	1.53
BLUNTNOSE MINNOW	N	O	C	T	86	63.25	6.57	0.11	0.40	1.79
CENTRAL STONEROLLER	N	H	N		201	145.71	15.15	1.04	3.70	7.12
CHANNEL CATFISH	F		C		6	4.43	0.46	3.50	12.43	792.50
YELLOW BULLHEAD		I	C	T	5	3.61	0.37	0.17	0.59	46.20
TROUT-PERCH		I	M		15	10.71	1.11	0.05	0.16	4.29
ROCK BASS	S	C	C		27	19.82	2.06	1.31	4.66	66.00
SMALLMOUTH BASS	F	C	C	M	11	8.04	0.84	2.72	9.67	338.27
GREEN SUNFISH	S	I	C	T	2	1.46	0.15	0.05	0.18	34.50
LONGEAR SUNFISH	S	I	C	M	5	3.61	0.37	0.12	0.41	31.80
DUSKY DARTER	D	I	S	M	2	1.50	0.16	0.01	0.02	3.50
BLACKSIDE DARTER	D	I	S		26	19.18	1.99	0.02	0.08	1.21
LOGPERCH	D	I	S	M	3	2.14	0.22	0.02	0.07	9.00
JOHNNY DARTER	D	I	C		33	24.39	2.54	0.02	0.08	0.91
GREENSIDE DARTER	D	I	S	M	46	33.82	3.52	0.06	0.20	1.65
BANDED DARTER	D	I	S	I	41	30.14	3.13	0.03	0.09	0.85
VARIEGATE DARTER	D	I	S	I	9	6.57	0.68	0.01	0.05	2.06
RAINBOW DARTER	D	I	S	M	1	0.75	0.08	0.00	0.01	2.00
FANTAIL DARTER	D	I	C		13	9.54	0.99	0.01	0.04	1.23
Mile Total					1,316	962.07		28.15		
Number of Species					38					
Number of Hybrids					0					

River Code: **17-960**	Stream: **Wakatomika Creek**	Sample Date: **1994**
River Mile: **2.10**	Basin: Muskingum River	Date Range: 09/09/94
Data Source: 05	Time Fished: 7140 sec Drain Area: 231.0 sq mi	
Purpose:	Dist Fished: 0.24 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GOLDEN REDHORSE	R	I	S	M	23	28.75	3.50	1.63	7.56	56.61
SHORTHEAD REDHORSE	R	I	S	M	10	12.50	1.52	2.46	11.40	196.40
NORTHERN HOG SUCKER	R	I	S	M	92	115.00	14.00	7.49	34.77	65.13
GRAVEL CHUB	N	I	S	M	5	6.25	0.76	0.04	0.17	5.80
SUCKERMOUTH MINNOW	N	I	S		10	12.50	1.52	0.06	0.28	4.90
EMERALD SHINER	N	I	S		51	63.75	7.76	0.07	0.32	1.08
SPOTFIN SHINER	N	I	M		127	158.75	19.33	0.20	0.92	1.24
SAND SHINER	N	I	M	M	28	35.00	4.26	0.06	0.28	1.71
BLUNTNOSE MINNOW	N	O	C	T	14	17.50	2.13	0.04	0.17	2.07
CENTRAL STONEROLLER	N	H	N		15	18.75	2.28	0.40	1.88	21.54
CHANNEL CATFISH	F		C		13	16.25	1.98	5.59	25.93	343.69
STONECAT MADTOM		I	C	I	4	5.00	0.61	0.12	0.55	23.50
TROUT-PERCH		I	M		8	10.00	1.22	0.02	0.09	2.00
ROCK BASS	S	C	C		16	20.00	2.44	1.15	5.35	57.63
SMALLMOUTH BASS	F	C	C	M	9	11.25	1.37	1.28	5.94	113.78
BLUEGILL SUNFISH	S	I	C	P	1	1.25	0.15	0.00	0.02	3.00
DUSKY DARTER	D	I	S	M	6	7.50	0.91	0.04	0.17	4.83
BLACKSIDE DARTER	D	I	S		18	22.50	2.74	0.05	0.25	2.33
LOGPERCH	D	I	S	M	5	6.25	0.76	0.07	0.32	10.80
JOHNNY DARTER	D	I	C		13	16.25	1.98	0.01	0.06	0.77
GREENSIDE DARTER	D	I	S	M	55	68.75	8.37	0.15	0.69	2.17
BANDED DARTER	D	I	S	I	91	113.75	13.85	0.12	0.54	1.02
VARIEGATE DARTER	D	I	S	I	15	18.75	2.28	0.04	0.18	2.07
BLUEBREAST DARTER [T]	D	I	S	R	1	1.25	0.15	0.00	0.00	1.00
FANTAIL DARTER	D	I	C		21	26.25	3.20	0.02	0.09	0.76
SAUGER X WALLEYE	E	P			6	7.50	0.91	0.45	2.09	60.00
Mile Total					657	821.25		21.54		
Number of Species					25					
Number of Hybrids					1					

River Code: **17-963**	Stream: **Moscow Brook**	Sample Date: **1994**
River Mile: **0.30**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 05	Time Fished: 4200 sec Drain Area: 6.8 sq mi	
Purpose:	Dist Fished: 0.17 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	7	12.35	1.18			
WHITE SUCKER	W	O	S	T	7	12.35	1.18			
BLACKNOSE DACE	N	G	S	T	176	310.59	29.58			
CREEK CHUB	N	G	N	T	171	301.77	28.74			
SOUTH. REDBELLY DACE	N	H	S		16	28.24	2.69			
STRIPED SHINER	N	I	S		4	7.06	0.67			
COMMON SHINER	N	I	S		1	1.77	0.17			
SPOTFIN SHINER	N	I	M		6	10.59	1.01			
SILVERJAW MINNOW	N	I	M		5	8.82	0.84			
BLUNTNOSE MINNOW	N	O	C	T	31	54.71	5.21			
CENTRAL STONEROLLER	N	H	N		140	247.06	23.53			
YELLOW BULLHEAD		I	C	T	2	3.53	0.34			
GREEN SUNFISH	S	I	C	T	2	3.53	0.34			
JOHNNY DARTER	D	I	C		25	44.12	4.20			
RAINBOW DARTER	D	I	S	M	2	3.53	0.34			
Mile Total					595	1,050.00				
Number of Species					15					
Number of Hybrids					0					

River Code: **17-969**	Stream: **Fivemile Run**	Sample Date: **1994**
River Mile: **1.50**	Basin: Muskingum River	Date Range: 08/01/94
Data Source: 05	Time Fished: 5520 sec Drain Area: 10.1 sq mi	
Purpose:	Dist Fished: 0.16 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GOLDEN REDHORSE	R	I	S	M	1	1.88	0.15			
NORTHERN HOG SUCKER	R	I	S	M	66	123.75	10.20			
WHITE SUCKER	W	O	S	T	17	31.88	2.63			
CREEK CHUB	N	G	N	T	45	84.38	6.96			
EMERALD SHINER	N	I	S		12	22.50	1.85			
ROSEFIN SHINER	N	I	S	M	3	5.63	0.46			
STRIPED SHINER	N	I	S		48	90.00	7.42			
COMMON SHINER	N	I	S		33	61.88	5.10			
SPOTFIN SHINER	N	I	M		22	41.25	3.40			
SILVERJAW MINNOW	N	I	M		2	3.75	0.31			
BLUNTNOSE MINNOW	N	O	C	T	51	95.63	7.88			
CENTRAL STONEROLLER	N	H	N		215	403.13	33.23			
YELLOW BULLHEAD		I	C	T	5	9.38	0.77			
TROUT-PERCH		I	M		27	50.63	4.17			
LARGEMOUTH BASS	F	C	C		1	1.88	0.15			
GREEN SUNFISH	S	I	C	T	2	3.75	0.31			
BLUEGILL SUNFISH	S	I	C	P	7	13.13	1.08			
BLACKSIDE DARTER	D	I	S		7	13.13	1.08			
LOGPERCH	D	I	S	M	1	1.88	0.15			
JOHNNY DARTER	D	I	C		22	41.25	3.40			
GREENSIDE DARTER	D	I	S	M	9	16.88	1.39			
RAINBOW DARTER	D	I	S	M	2	3.75	0.31			
FANTAIL DARTER	D	I	C		49	91.88	7.57			
Mile Total					647	1,213.13				
Number of Species					23					
Number of Hybrids					0					

River Code: **17-971**	Stream: **Brushy Fork**	Sample Date: **1994**
River Mile: **3.50**	Basin: Muskingum River	Date Range: 08/02/94
Data Source: 05	Time Fished: 2880 sec Drain Area: 13.1 sq mi	
Purpose:	Dist Fished: 0.17 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	69	121.77	8.52			
BLACKNOSE DACE	N	G	S	T	57	100.59	7.04			
CREEK CHUB	N	G	N	T	259	457.06	31.98			
ROSEFIN SHINER	N	I	S	M	4	7.06	0.49			
COMMON SHINER	N	I	S		19	33.53	2.35			
SPOTFIN SHINER	N	I	M		5	8.82	0.62			
SILVERJAW MINNOW	N	I	M		51	90.00	6.30			
BLUNTNOSE MINNOW	N	O	C	T	17	30.00	2.10			
CENTRAL STONEROLLER	N	H	N		127	224.12	15.68			
YELLOW BULLHEAD		I	C	T	1	1.77	0.12			
ROCK BASS	S	C	C		1	1.77	0.12			
BLUEGILL SUNFISH	S	I	C	P	1	1.77	0.12			
BLACKSIDE DARTER	D	I	S		2	3.53	0.25			
JOHNNY DARTER	D	I	C		99	174.71	12.22			
GREENSIDE DARTER	D	I	S	M	35	61.77	4.32			
RAINBOW DARTER	D	I	S	M	1	1.77	0.12			
FANTAIL DARTER	D	I	C		62	109.41	7.65			
Mile Total					810	1,429.41				
Number of Species					17					
Number of Hybrids					0					

River Code: **17-973**	Stream: **Winding Fork**	Sample Date: **1994**
River Mile: **1.80**	Basin: Muskingum River	Date Range: 07/29/94
Data Source: 05	Time Fished: 4800 sec Drain Area: 19.1 sq mi	
Purpose:	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY		F	N		5	10.00	0.79			
AMER BROOK LAMPREY		F	N	R	1	2.00	0.16			
GOLDEN REDHORSE	R	I	S	M	1	2.00	0.16			
NORTHERN HOG SUCKER	R	I	S	M	79	158.00	12.56			
WHITE SUCKER	W	O	S	T	9	18.00	1.43			
RIVER CHUB	N	I	N	I	1	2.00	0.16			
CREEK CHUB	N	G	N	T	85	170.00	13.51			
REDSIDE DACE	N	I	S	I	9	18.00	1.43			
EMERALD SHINER	N	I	S		9	18.00	1.43			
ROSYFACE SHINER	N	I	S	I	9	18.00	1.43			
REDFIN SHINER	N	I	N		2	4.00	0.32			
STRIPED SHINER	N	I	S		22	44.00	3.50			
COMMON SHINER	N	I	S		25	50.00	3.97			
SPOTFIN SHINER	N	I	M		26	52.00	4.13			
MIMIC SHINER	N	I	M	I	1	2.00	0.16			
SILVERJAW MINNOW	N	I	M		21	42.00	3.34			
BLUNTNOSE MINNOW	N	O	C	T	19	38.00	3.02			
CENTRAL STONEROLLER	N	H	N		29	58.00	4.61			
TROUT-PERCH		I	M		22	44.00	3.50			
ROCK BASS	S	C	C		8	16.00	1.27			
GREEN SUNFISH	S	I	C	T	2	4.00	0.32			
BLUEGILL SUNFISH	S	I	C	P	2	4.00	0.32			
LONGEAR SUNFISH	S	I	C	M	1	2.00	0.16			
BLACKSIDE DARTER	D	I	S		9	18.00	1.43			
LOGPERCH	D	I	S	M	1	2.00	0.16			
JOHNNY DARTER	D	I	C		65	130.00	10.33			
GREENSIDE DARTER	D	I	S	M	65	130.00	10.33			
BANDED DARTER	D	I	S	I	16	32.00	2.54			
RAINBOW DARTER	D	I	S	M	19	38.00	3.02			
FANTAIL DARTER	D	I	C		47	94.00	7.47			
MOTTLED SCULPIN		I	C		19	38.00	3.02			
Mile Total					629	1,258.00				
Number of Species					31					
Number of Hybrids					0					