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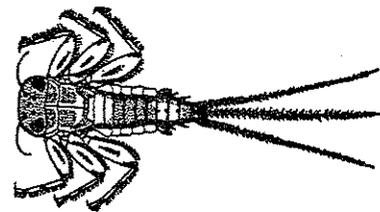
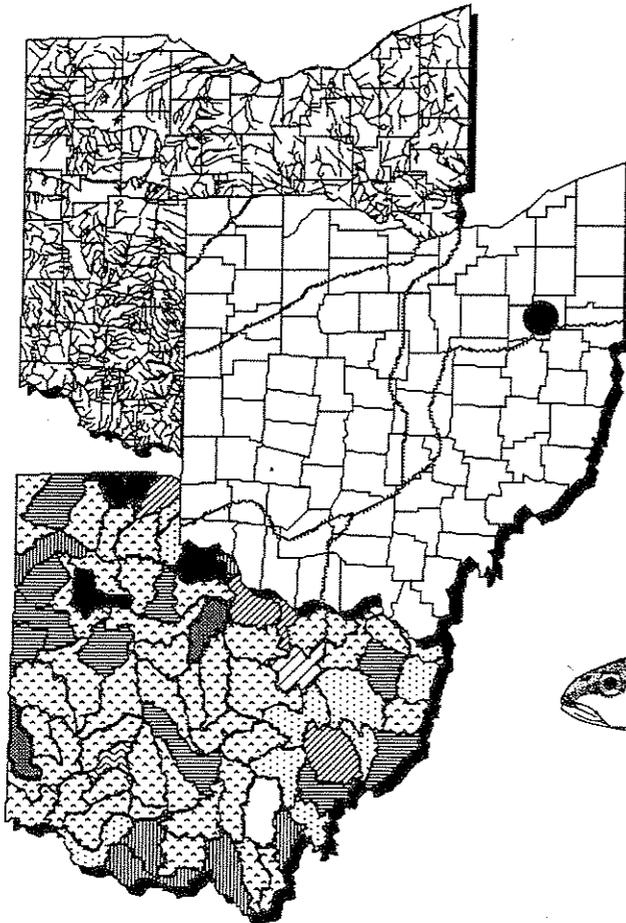


State of Ohio
Environmental Protection Agency

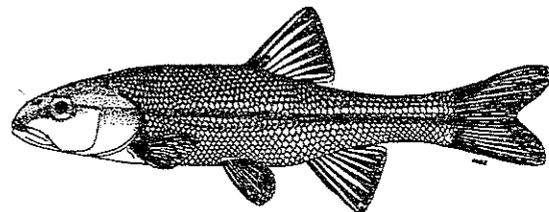
Northeast District Office
Ecological Assessment Section
Division of Surface Water

Biological and Water Quality Study of the East Branch Nimishillen Creek

Stark County (Ohio)



Mayfly (*Stenonema*)



Creek chub
(*Semotilus atromaculatus*)

July 15, 1994

**Biological and Water Quality Study
of the East Branch Nimishillen Creek**

Stark County, Ohio

July 15, 1994

OEPA Technical Report EAS/1994-6-6

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
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Appendix Tables *

* Appendix Tables will be furnished upon request. Available tables are chemistry, fish, macroinvertebrate, and spills data collected by the Ohio EPA.

NOTICE TO USERS

Ohio EPA adopted 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, and the Invertebrate Community Index (ICI), which is based on macroinvertebrates. Criteria for each index are specified for each of Ohio's five ecoregions, and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the chemical and whole effluent toxicity evaluation methods, figure prominently in the assessment of Ohio's surface water resources.

Several documents support the adoption of the biological criteria by outlining the rationale for using biological information, the specific methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results. These documents are:

- 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 Quality Monitoring & Assessment, 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 Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.
- Ohio Environmental Protection Agency. 1989a. 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 Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.
- Ohio Environmental Protection Agency. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.
- Ohio Environmental Protection Agency. 1990c. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.
- Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

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

Ohio EPA - DSW
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Acknowledgements

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

Study Area Description - Dan Halterman
Pollutant Loadings - Steve Tuckerman
Ambient Chemical Quality - Bob Davic
Sediment Chemical Quality - Bob Davic
Biological Assessment:
 Physical Habitat for Aquatic Life - Charles Boucher
 Macroinvertebrate Community - Marty Knapp
 Fish Community - Charles Boucher
Data Management - Dennis Mishne and Ed Rankin
TSD Coordinator - Marty Knapp
Reviewer(s) - Chris Yoder, Jeff DeShon

This evaluation and report would not have been possible without the additional assistance of the study team, many full and part time staff in the field, and the chemistry analyses provided by the Ohio EPA Division of Environmental Services. Acknowledgment is also given to the property owners that allowed Ohio EPA personnel access to the East Branch Nimishillen Creek and its tributaries.

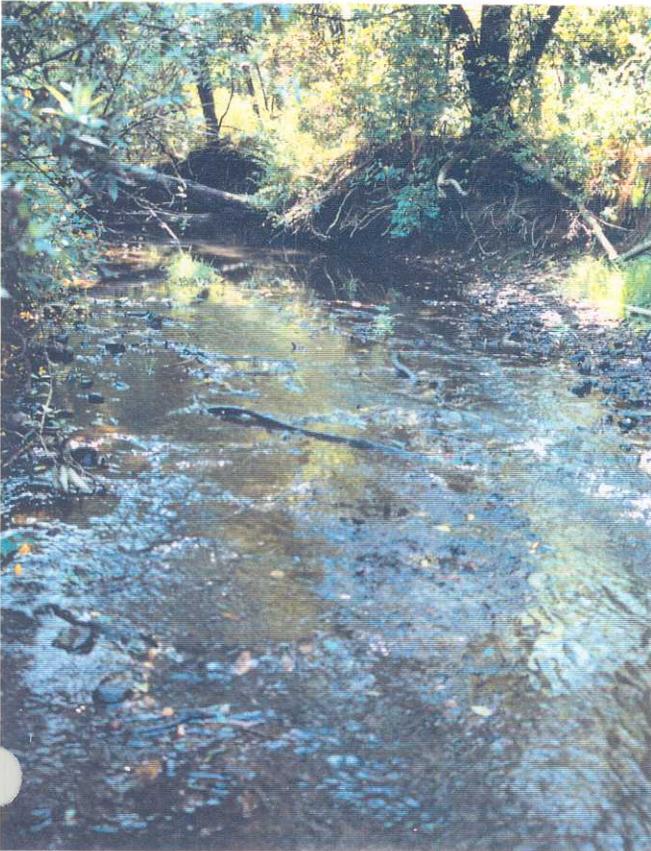
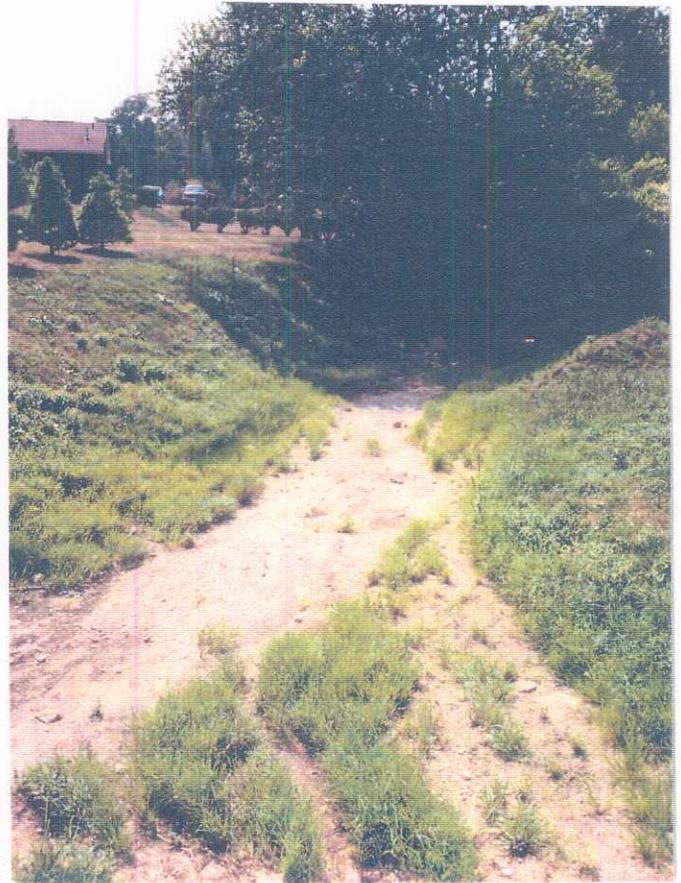


PLATE 1. Physical habitats in the upper East Branch Nimishillen Creek. *Top Left Photo:* The station at Meese Rd. (RM 8.6). This picture was taken on August 26, 1993 and shows flowing water upstream from the intermittent section of the stream (see bottom right) from RM 6.5 to 6.0. This segment of the stream has a predominantly agricultural land use. *Bottom Left Photo:* The stream bed of the East Branch Nimishillen Creek at State Route 153 (RM 6.4) on July 12, 1993. *Bottom Right Photo:* The stream bed of the East Branch Nimishillen Creek at State Route 153 (RM 6.4) on August 26, 1993. Note the dry stream bed. This picture shows the intermittency of the stream bed which occurs over the summer months on a regular basis.



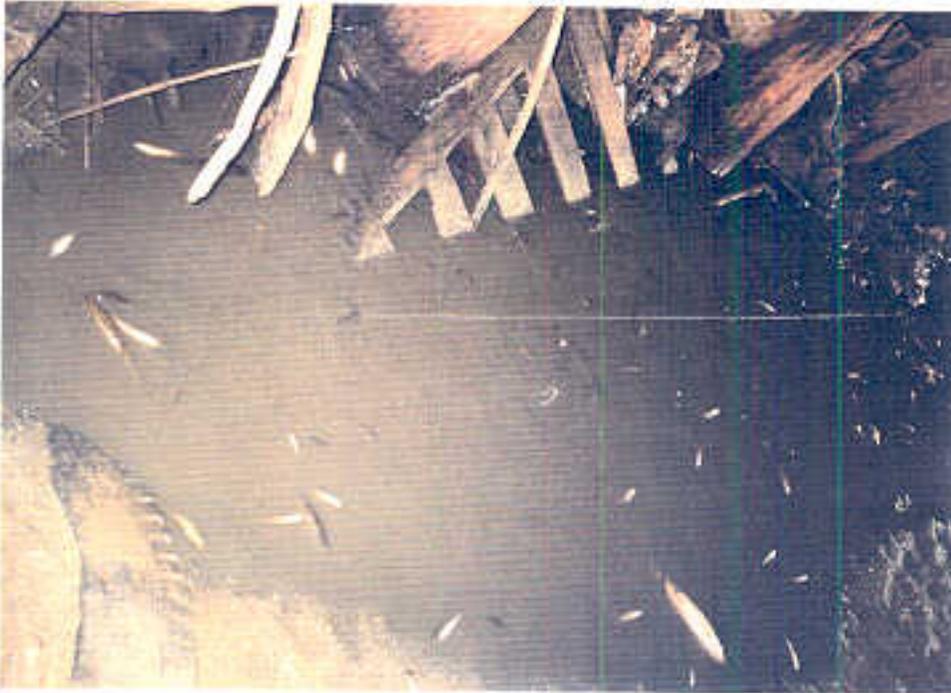


PLATE 2. Causes of impairment to biological communities. *Top Photo:* Fish kill under the State Route 153 bridge over the East Branch Nimishillen Creek in response to the creek drying up (most likely due to well water withdrawal by J&L Spec. Prod. and the City of Louisville). Photograph taken on August 22, 1993. *Bottom Photo:* Gray water (possibly oil and grease loadings) entering the East Branch main stem from the Conrail Railroad Yard tributary. An impact to the macroinvertebrate community was observed downstream from this tributary.

Biological and Water Quality Survey of the East Branch Nimishillen Creek

(Stark County, Ohio)
Ohio Environmental Protection Agency
Division of Surface Water
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Introduction

The 1993 East Branch Nimishillen Creek study area included the mainstem from river mile (RM) 8.6 to RM 0.1 near the confluence with the Middle Branch Nimishillen Creek. A number of smaller tributaries were also sampled to provide chemical data for wasteload allocation modeling. Specific objectives of this evaluation were to:

- 1) monitor and assess chemical, physical, and biological integrity of the East Branch Nimishillen Creek.
- 2) evaluate chemical, physical, and biological impacts to the East Branch Nimishillen Creek from industrial dischargers and municipal wastewater treatment plants (WWTPs) on their respective receiving streams,
- 3) determine the attainment status of current aquatic life use and non-aquatic use designations and recommend changes in use where appropriate, and
- 4) conduct a water resource trend assessment where historical data exist.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (e.g., NPDES permits, Director's Orders), the Ohio Water Quality Standards (OAC 3745-1), and 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

East Branch Nimishillen Creek, 1993 Survey

During the 1993 field sampling effort the East Branch Nimishillen Creek was evaluated at twelve fish and macroinvertebrate sampling stations. The mainstem had 1.7 miles (18%) in partial attainment of warmwater habitat (WWH) biocriteria and 7.5 miles (82%) in non attainment with no segment of the mainstem in full attainment of the WWH biocriteria in 1993. Upstream sites at RM 8.6 (Meese Rd.) and RM 6.9/6.8 (SR 44), and the station at the mouth (RM 0.1, Cook Rd.) demonstrated partial attainment of the Warmwater Habitat (WWH) biocriteria (Table 1). All other sites in the East Branch Nimishillen Creek did not attain the WWH biocriteria. Qualitative Habitat Evaluation Index (QHEI) values ranged between 45.0 at RM 0.1 (Cook Park) and 81.5 at RM 4.7 (Trump Rd.), with a mean reach value of 69.3. A mean QHEI score greater than 60 suggests that near and instream habitats of the East Branch Nimishillen Creek are of a sufficient quality to support and maintain a community of aquatic organisms consistent with the currently designated WWH aquatic life use designation (Rankin 1989).

Macroinvertebrate sampling at the two upstream stations RM 8.6 and RM 6.8 yielded Invertebrate Community Scores (ICI) scores within the nonsignificant departure of WWH biocriteria for the Erie/Ontario Lake Plain (EOLP) ecoregion. The stream reach between approximately RMs 6.0 and 6.5 becomes intermittent during dry weather periods, apparently in response to well water withdrawals by the City of Louisville and J&L Specialty Products during dry weather periods. This 0.4 mile reach of the East Branch Nimishillen Creek was effectively reduced to a few disjunct, shallow pools. A macroinvertebrate sample was collected at RM 6.0 during the week the stream bed was dry, but this sampling site was within the influence of the J&L Spec. Prod. outfall 003 discharge. The mixing zone (RM 5.9) of J&L Spec. Prod. outfall 003 appeared to be acutely toxic to macroinvertebrates - only four individual organisms comprising three separate taxa could be found inhabiting the natural substrates during qualitative sampling on August 23, 1993. The site below J&L Spec. Prod. at RM 4.7 (upstream from the Louisville WWTP) showed a decline in macroinvertebrate community quality (ICI of 30 (marginally good) at the most comparable upstream sites compared to an ICI score of 8 (poor) at RM 4.7). Macroinvertebrate community scores improved at the next two downstream stations (RMs 3.4 and 2.8) and did not show an impact from the Louisville WWTP. The ICI score decreased from 28 to 16 between RMs 2.8 and 1.9, apparently in response to oil and grease discharges from the Conrail Railroad Yard (via a tributary which enters the mainstem at RM 2.75). There was no additional impact discernible from the Republic Engineered Steel discharges. Data collected in 1985 and 1993 showed similar longitudinal trends in macroinvertebrate community performance.

The fish assemblage at the most upstream station (RM 8.6) demonstrated a significant decline in quality compared with results from the 1985 survey. Four sensitive species which were fairly common at this station in 1985, were absent in 1993. The fish community at RM 6.9 was considerably improved compared to the station at RM 8.6 and appeared to be the better arbiter to evaluate the sites downstream from the point source discharges. A significant decline was observed further downstream at RM 6.4 (SR 153) as a consequence of the intermittent flow conditions at this station. The poor performance of the fish assemblage at this site was most related to the observed intermittency, but represents a highly localized occurrence. As a result, for the purposes of assessing longitudinal performance, the station at RM 6.4 is an inappropriate reflection of the biological status upstream from J&L Spec. Prod. A distinct impact was evident within the J&L Spec. Prod. mixing zone (RM 5.9). The fish community demonstrated only a modest recovery further downstream at RM 4.7 (upstream from the Louisville WWTP). Downstream from the Louisville WWTP, the fish assemblage again declined and performed at a poor level. The remaining stations demonstrated little change, but a modest recovery was observed at the most downstream station (RM 0.1, Cook Park). No additional impact to the fish community was evident downstream from the Republic Engineered Steel and Republic Storage Systems outfalls.

Exceedences of chemical water quality criteria were not recorded at any sampling stations located upstream from the J&L Spec. Prod. outfalls (Table 2). Exceptionally high concentrations of nitrate-nitrite (as high as 170 mg/l) were recorded below the discharges of J&L Spec. Prod. well above the 90 mg/l concentration recommended by U.S. EPA for aquatic life (U.S. EPA 1986.). Thus, it would appear that toxic levels of nitrate-nitrite were present instream below J&L Spec. Prod. in 1993. Additionally, high concentrations of nitrite-N were recorded below J&L Spec. Prod. Violations of the dissolved oxygen (D.O.) criterion were recorded from RM 5.45 to RM 3.47 for a total of 1.98 river miles. Exceedences of the total dissolved solids criterion were recorded from RM 5.45 to RM 2.80 for a total of 2.65 river miles. The City of Louisville WWTP discharge at RM 4.64 may have contributed to the low D.O. at RMs 4.20 and 3.47. However, the

D.O. sag clearly begins above the city of Louisville discharge. Exceedences of the ammonia-N criterion were not recorded below the city of Louisville WWTP discharge nor were any exceedences of heavy metals criteria recorded at any location in the East Branch Nimishillen Creek in 1993. Detectable levels of total chromium, total nickel, and total cyanide were observed below J&L Spec. Prod. at times when these parameters were not detected at locations above the J&L property. No exceedences of chemical water quality criteria were observed at the mouth of the East Branch Nimishillen Creek at RM 0.13, which is below the numerous outfalls of Republic Engineered Steel and Republic Storage Systems.

Higher concentrations of zinc, chromium, and nickel were found in the sediments below J&L Spec. Prod. outfall 003 than at upstream sites. Concentrations of lead in the sediments increased longitudinally from RM 6.8 to RM 0.13. Results of organic sediment analyses in 1993 indicated no significant findings.

Table 1. Aquatic life use attainment status for the existing Warmwater Habitat (WWH) aquatic life use designation in the East Branch Nimishillen Creek based on data collected between June and September, 1985, 1986, and 1993.

RIVER MILE Fish/Invert.	Modified IBI	Iwb	ICI ^a	QHEI ^b	Attainment Status ^c	Comment
East Branch Nimishillen Creek						
<i>Erie Ontario Lake Plain- WWH Use Designation (Existing)</i>						
Year 1993						
8.6/8.6	27*	N/A	30 ^{ns}	68.5	PARTIAL	Reference site
6.9/6.8	35*	N/A	30 ^{ns}	78.5	PARTIAL	SR 44
6.4/ -	<u>22*</u>	<u>3.6*</u>		58.0	(NON)	Pumping impacted
- /6.0			<u>P</u>		(NON)	J&L backwater
5.9/5.9	<u>24*</u>	<u>5.0*</u>	<u>VP</u>	N/A	N/A	J&L Mix Zone
4.7/4.7	28*	<u>4.8*</u>	<u>8*</u>	80.0	NON	Upst. Louis. WWTP
4.2/4.2	<u>23*</u>	<u>4.3*</u>	F	74.0	NON	Beck Rd.
3.4/ 2.8	<u>23*</u>	<u>4.3*</u>	28*	60.0	NON	Dst. Broadway Rd.
1.9/1.9	28*	<u>4.3*</u>	16*	81.5	NON	Trump Rd.
0.49/0.5	33*	<u>7.3*</u>	<u>P</u>	N/A	N/A	Rep. Eng. Mix Zone
0.1/0.1	30*	7.9	18*	18	PARTIAL	Cook Park
Year 1986						
4.7/	<u>26*</u>	<u>5.4*</u>	-	72	(NON)	Upst Louis. WWTP
4.2/	<u>22*</u>	<u>3.9*</u>	-	64	(NON)	Beck Rd.
3.4/	<u>20*</u>	<u>2.4*</u>	-	60	(NON)	Broadway
Year 1985						
8.6/8.6	39	N/A	40	63	FULL	Reference site
6.4/6.3	33*	6.7*	26*	51	NON	SR153
4.7/4.7	29*	6.4*	<u>4*</u>	80	NON	Upst. Louis. WWTP
4.2/4.2	<u>23*</u>	<u>3.8*</u>	14*	66	NON	Beck Rd.
3.4/2.8	<u>24*</u>	<u>4.4*</u>	20*	64	NON	Dst. Broadway Rd.
1.9/1.9	<u>24*</u>	<u>5.1*</u>	20*	65	NON	Trump Rd.
0.1/0.1	31*	8.2	14*	58	PARTIAL	Cook Park

Ecoregion Biocriteria: Erie-Ontario Lake Plains (EOLP)

INDEX - Site Type	WWH	EWB	MWH ^d
IBI - Headwaters/Wading	40	50	20
IBI - Wading	38	50	22
Mod. Iwb - Wading	7.9	9.4	5.6
ICI	36	46	22

* - significant departure from biocriteria; poor and very poor results are underlined.

^{ns} - nonsignificant departure from biocriteria for WWH or EWB (4 IBI or ICI units; 0.5 Iwb units).

^a - Narrative evaluation used in lieu of ICI where quantitative sampling was not done (E=Exceptional; G=good; MG=Marginally good; F=Fair; P=Poor; VP=Very Poor).

^b - Qualitative Habitat Evaluation Index (QHEI) values based on the new version (Rankin 1989).

^c - Attainment status based on one organism group is parenthetically expressed.

^d - Modified Warmwater Habitat for channel modified areas.

Table 2. Exceedences of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical/physical parameters measured in the East Branch Nimishillen Creek study area, 1993 (units are mg/l for all parameters). All samples are grab samples unless otherwise indicated.

Stream Name River Mile	Violation: Parameter (value)
East Branch Nimishillen Creek	
2.80	Total Dissolved Solids (TDS) (1630#)*
3.47	TDS (1810, 1690#)* D.O. (3.86‡‡)#
4.20	TDS (2010, 1502, 1770#)* D.O. (4.0‡, 3.2‡‡)
4.70	TDS (2780, 1906, 1682)* D.O. (4.8‡, 4.2‡, 3.4‡‡, 2.2‡‡) D.O. (1.5 ‡‡)# NH ₃ -N† (1.80, 1.39)*
5.45	TDS (2910#)* NH ₃ -N (1.66#)†† D.O. (3.63‡)#

- * indicates an exceedence of numerical criterion for prevention of chronic toxicity (CAC).
 # 24-hour composite sample.
 ◇ indicates an exceedence of agricultural water supply criterion.
 ‡ Exceedence of average 24-hour criterion.
 ‡‡ Exceedence of minimum at any time criterion.
 † NH₃-N CAC exceedence at measured field pH and water temperature.
 †† NH₃-N CAC exceedence at minimum field pH and water temperature measured during 24-hour composite sampling.

*Evaluated Point Sources*J&L Specialty Products Corporation (East Branch Nimishillen Creek: RM 5.88)

All of the evidence from the 1993 survey (biological, chemical, toxicological) points to a toxic impact on the East Branch due to the J&L Spec. Prod. outfall 003 discharge. Biological survey results showed severe impacts to the fish and macroinvertebrate communities. Effluent toxicity data for outfall 003 indicated acute toxicity to *Ceriodaphnia*, and the effluent routinely had concentrations of nitrate+nitrite-N and nitrite-N that indicated acute toxicity in both the effluent and in the East Branch Nimishillen Creek.

Effluent from outfall 003 enters the East Branch Nimishillen Creek at RM 5.88. Results from two effluent bioassays on outfall 003 conducted by Ohio EPA personnel in May and August, 1993, indicated acute toxicity to *Ceriodaphnia* (Figure 1). Additionally, the 003 mixing zone sample and an instream sample at RM 4.7 (upstream from the Louisville WWTP) collected in August resulted in toxicity to *Ceriodaphnia*. These August samples were collected during the same time period that the stream bed was dry from RM 6.0 to 6.5 and indicated that the J&L 003 mixing zone and RM 4.7 samples were composed almost entirely of outfall 003 effluent.

Fish and macroinvertebrate index scores at stations upstream from J&L Spec. Prod. (RM 8.6 and RM 6.9/6.8) were in partial attainment of the ecoregional biocriteria. This was in sharp contrast to the instream biological communities observed downstream from the J&L outfall 003 discharge, which indicated severe toxic impacts. The instream macroinvertebrate community was virtually eliminated (only four individual organisms could be found on the natural substrates on August 22, 1993) in the mixing zone of J&L Spec. Prod. The site at RM 4.7 supported a poor macroinvertebrate community as evidenced by the ICI score of 8. This result showed no significant change compared to the ICI of 4 observed in 1985. A distinct near field impact was evident in the fish community downstream from J&L Spec. Prod. within the 003 mixing zone at RM 5.9. The station at RM 4.7 indicated a continued impact associated with the J&L 003 effluent.

Violations reported in J&L Spec. Prod. monthly operating report (MOR) data between 1988 and 1989 included minor exceedences for total chromium, oil and grease, and pH. No Ohio EPA compliance tracking data were available after 1989. On November 30, 1989, U.S. EPA, Region V assumed permitting authority for the J&L facility and all compliance tracking was transferred to that office.

J&L Spec. Prod. outfall 004 discharges to Kiems Run which enters the East Branch Nimishillen Creek at RM 4.2 (downstream from the Louisville WWTP, RM [4.64]). Kiems Run flows through a wetland area upstream from outfall 004, enters another wetland area downstream from outfall 004, then flows through a ditch-like channel to the East Branch Nimishillen Creek (confluence at approximately RM 4.2) upstream from Beck Rd. Macroinvertebrates collected at RM 4.2 (downstream from Beck Rd.) showed improvement compared to RM 4.7; this was most likely due to the dilutional effect of the Louisville WWTP effluent flow on the toxic J&L outfall 003 dominated flow upstream. The fish assemblage reflected an additional impact within the reach between RMs 4.2 and 3.4.

Louisville WWTP (East Branch Nimishillen Creek: RM 4.64)

Macroinvertebrates collected at RM 4.2 (downstream from Beck Rd.) showed improvement compared to RM 4.7. This was most likely due to the dilutional effect of the Louisville WWTP effluent flow on the toxic J&L outfall 003 which dominated flow upstream. The fish assemblage reflected an additional impact within the reach between RMs 4.2 and 3.4. This may indicate a combined impact from the Louisville WWTP effluent and the J&L outfall 003 effluent which is causing a secondary oxygen sag in this segment; a primary oxygen sag exists between the J&L outfall 003 and the Louisville WWTP (Figures 5, 9, and 10). No acute toxicity to either test organism was reported in May and August, 1993, bioassays conducted by Ohio EPA personnel on the Louisville WWTP effluent and mixing zone. This segment of the watershed should be investigated more thoroughly during future follow-up surveys.

NPDES permit limit exceedences for the Louisville WWTP over the past two years include one violation each for total suspended solids (June 1993) and oil and grease (September 1993). No violations were noted in 1992.

Conrail Railroad Yard (Tributary to East Branch Nimishillen Creek: RM 2.75)

An inspection at the Conrail RR yard in 1993 indicated an oily discharge from the 002 outfall to the RM 2.75 tributary of the East Branch Nimishillen Creek (Plate 2). Analysis of MOR data for the Conrail internal 601 station, which discharges via the 002 outfall, indicated 12 permit limit violations for oil and grease between January and July 1993. During the 1993 survey oily sediment was observed in the East Branch Nimishillen Creek at the RM 1.89 station below the discharge from the Conrail facility. ICI scores declined from 28 to 16 between RMs 2.8 and 1.9 upstream and downstream from Conrail. Qualitative sampling of the natural substrates reflected a shift to more tolerant organisms at the lower site. There was no additional impact apparent to the East Branch fish assemblages downstream from the Conrail facility.

Republic Engineered Steel (East Branch Nimishillen Creek: RM 1.1 to 0.45)

No significant additional impact was apparent to the fish community in the 010 mixing zone, but macroinvertebrates collected from natural substrates reflected poor conditions. Fish and macroinvertebrates were not sampled in the 008 mixing zone. No additional impact to fish and macroinvertebrate communities from the Republic Engineered Steel facility was observed at RM 0.1 in the 1993 survey. Bioassays conducted by Ohio EPA personnel in 1993 indicated that outfall 008 was acutely toxic to both *Ceriodaphnia* (LC₅₀s of 65.4% and 42.3%) and fathead minnows (30% and 50% adverse effects); and outfall 010 was acutely toxic to *Ceriodaphnia* (LC₅₀ = 83.5%). The mixing zone samples tested at each of these outfalls were not acutely toxic to either bioassay test organism.

The potential for future impairment is heightened by the toxicity data. The upstream effects are presently masking the impact of Republic Engineered Steel which should become evident if the upstream impacts lessen.

NPDES permit violations at the Republic Engineered Steel facility since 1985 have included sporadic exceedences of total suspended solids, oil and grease, and pH at outfalls 008 and internal outfall 601 (outfall 010 to the East Branch). Only limited monitoring is conducted at outfall 010 which discharges combined 601 process waste and non-contact cooling water.

Spills

A summary of reported spills within the East Branch Nimishillen Creek watershed reported in the Ohio EPA Emergency Response spill database between the years 1979 and 1993 is presented in the Appendix (available upon request). From 1979 through 1993, a total of 95,307 gallons of materials were reported to be spilled, of which 51,410 gallons (54%) were recovered. An analysis of the spills data indicates about 50% fewer spills reported during the past five years (1988-1993) as compared to the number of spills reported from 1983 to 1987. From 1989 to 1993, the total number reported ranged from one to six spills per year. Chemicals reported as spilled included diesel fuel, oily substances, paint, and gasoline. Republic Engineered Steel reported three spills of hydrochloric acid over the past ten years. Spills in conjunction with urban stormwater runoff have the potential to impact the biological communities in the East Branch Nimishillen Creek.

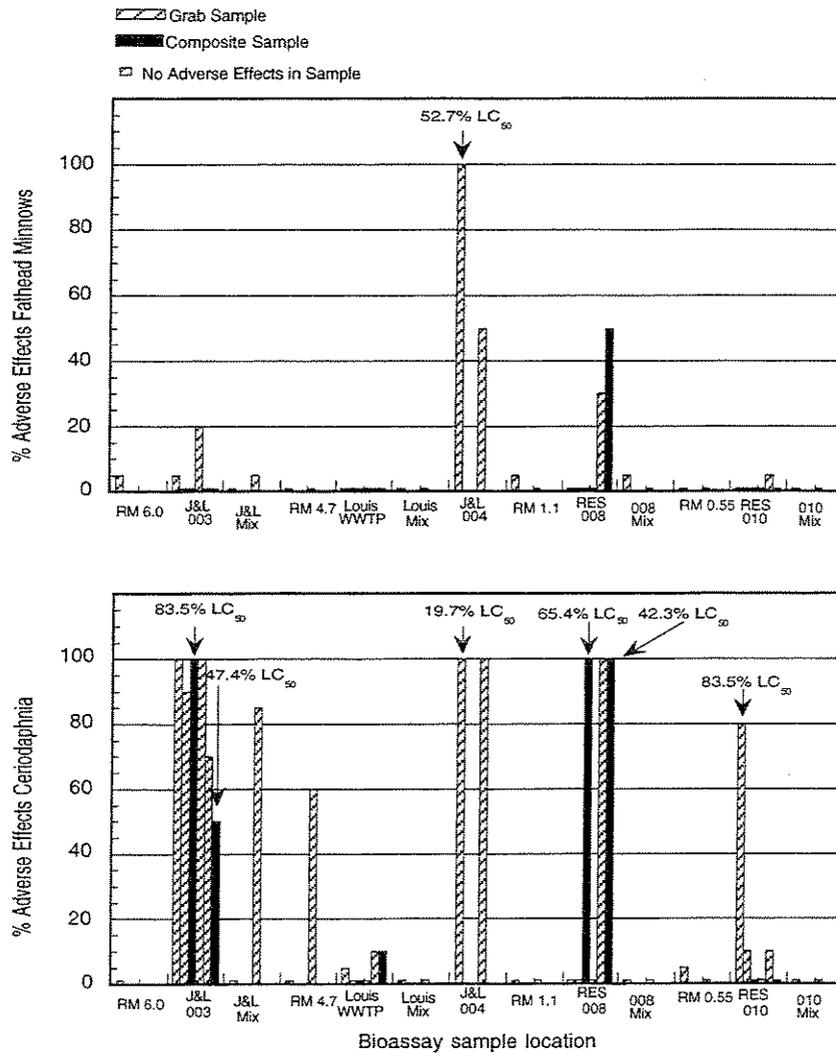


Figure 1. Bioassay test results (mortality + adverse effects) conducted by Ohio EPA personnel in 1993 on discharger effluents and instream sites in the East Branch Nimishillen Creek.

Conclusions

- Based on the performance of the biological communities and the ecoregional biocriteria, 10.4 miles of the East Branch Nimishillen Creek mainstem and selected tributaries were assessed as part of the 1993 sampling effort. Of the total miles assessed, no segment was in FULL attainment of the designated WWH aquatic life use (0% of the study area); 2.1 miles demonstrated PARTIAL attainment (24% of the study area) and 6.5 miles were in NON attainment of the WWH use (76% of the study area). Aquatic life use attainment status and biocriteria scores for all sampling locations are presented in Table 1.
- The impact of J&L Spec. Prod.outfall 003 was both detectable and fairly severe, particularly to the invertebrate community. This finding was similar to the results obtained by Ohio EPA in 1985. The evaluation of the impact of the major point sources is complicated somewhat by the anomalous flow conditions observed at RM 6.4. Because of the localized dessication (apparently caused by ground water withdrawals) the results at RM 6.4 do not adequately reflect the attainable biological performance downstream from the point sources. The sampling site at RM 6.8/6.9 suits this purpose much better. Although partial attainment of the WWH use designation was observed (due to the IBI falling just short of the biocriterion), the performance of the individual indices (IBI, MIwb, and the ICI) indicate a substantial decline downstream from the point source discharges and significant non-attainment of the WWH use.
- The results of the 1993 survey indicated relatively good chemical water quality in the East Branch Nimishillen Creek from station RM 8.56 downstream to RM 6.36. No exceedences of Ohio Water Quality Standards were recorded in this section of the stream. However, the stream was observed to be completely dry at RM 6.36.
- The results from the 1993 survey indicated that discharges from J&L Spec. Prod. have a significant negative impact on the chemical water quality of the East Branch Nimishillen Creek. Toxic levels of ammonia-N, nitrate+nitrite-N, nitrite-N, and total dissolved solids were measured immediately below the J&L discharges. Very low levels of dissolved oxygen (< 2.0 mg/l) were also measured immediately below this entity.
- No significant impact on chemical water quality could be attributed to the City of Louisville WWTP, with the possible exception of additional contributions to lowered dissolved oxygen concentrations which started above the WWTP point of discharge.
- No significant impact on chemical water quality could be attributed to the discharges of the Republic Engineered Steel (RES) complex and Republic Storage System located along the lower two river miles of the East Branch Nimishillen Creek. That is, no additional cumulative effects were discernable because extensive degradation existed upstream. Toxicity data showed acute toxicity in both RES outfalls 008 and 010. Potential future impacts may become apparent if upstream impacts are lessened.
- Higher concentrations of zinc, chromium, and nickel were found in the sediments below J&L Spec. Prod. oufall 003 than at upstream sites. Concentrations of lead in the sediments increased longitudinally from RM 6.8 to RM 0.13. Results of organic sediment analyses in 1993 indicated no significant findings.

Recommendations

Status of Aquatic Life Uses

- The current Warmwater Habitat aquatic life use that applies to the entire East Branch Nimishillen Creek watershed should be maintained for all stream segments surveyed in this study. Physical habitat conditions were not observed as being a problem; however, significant alteration of the flow regime has occurred in a 0.5 segment of the mainstem, apparently due to groundwater withdrawal by the City of Louisville and J&L Spec. Prod.

Status of Non-Aquatic Life Uses

- The existing Primary Contact Recreation (PCR) designation for the surveyed streams should be retained. The streams have pools with average depths of at least 3 feet covering an area of at least 100 square feet. These are the requisite physical dimensions to qualify a stream for the PCR use designation.

Nonpoint Sources

Urban Stormwater Runoff

- New industrial stormwater NPDES permits requiring Best Management Practices to minimize contaminated stormwater runoff from industrial facilities should be enforced.

Failing On-Site Sewage Systems

- A comprehensive program to educate the public about proper operation and maintenance of on-site sewage systems should be developed and implemented.
- Standards for on-site sewage system installation and maintenance, including pumping schedules and mandatory upgrading or replacement of failing systems should be developed and enforced.
- A water quality monitoring program for septic tank effluent impacts should be expanded to include the East Branch. (A project to monitor septic tank effluent impacts on the Middle Branch Nimishillen Creek includes some monitoring sites on the East Branch.)

Agricultural Pollution

- Continue promotion of conservation tillage and ongoing education of farmers. The Stark Soil and Water Conservation District rents no-till equipment to farmers, thus increasing the county's no-till cropland area. Ninety-eight percent of Stark County cropland is estimated to be under some form of conservation tillage.

Agricultural Pollution (continued)

- Maintenance of a high percentage of cropland under conservation tillage. A Stark Soil and Water Conservation District manure nutrient management program targeting the watershed has developed and implemented ten plans covering 2,500 acres. Cooperating farmers have been able to decrease purchases and use of other fertilizer, thereby lessening the amount of nutrients available to enter surface water and groundwater.
- Continue promotion, development, and implementation of manure nutrient management plans.

Other Recommendations

- Corrective actions should be taken at J&L Spec. Prod. to reduce the levels of total dissolved solids, ammonia-N, nitrate+nitrite-N, nitrite-N, and oxygen demanding substances that are being discharged from outfall 003. More parameters should be monitored including ammonia, nitrates, and nitrites is also recommended.
- Corrective actions should be taken at the Conrail Railroad Yard to reduce the amount of oil and grease being discharged. Increased frequency of monitoring is also recommended to ensure compliance.
- The City of Louisville and J&L Spec. Prod. should consider other options available to reduce the volume of well water withdrawal or augment stream flows between RM 6.5 and RM 6.0 during the months that this segment is prone to intermittency. An intensive hydrogeological survey of the East Branch Nimishillen Creek should be undertaken in the area of RM 6.36 to determine the cause(s) of intermittent stream flow during summer and fall.

Future Monitoring Needs

- Evaluation of the impacts from nonpoint source pollution in the upper mainstem of the East Branch Nimishillen Creek basin; potential impacts include unsewered communities and sporadic excessive nutrient loadings from agricultural fields during heavy rainfall events after spring fertilizer applications.
- Evaluation of possible impacts from J&L Spec. Prod. outfall 004 on the East Branch Nimishillen Creek and the flow characteristics of this outfall in relationship with Kiems Run.
- A similar biological and chemical study should be conducted in 1998 in accordance with the Five-Year Basin Approach strategy to document changes in the water resource and provide updated information for the reissuance of NPDES permits. In 1993, little or no change was observed in the East Branch Nimishillen Creek from the impaired conditions found in 1985.

Study Area

The East Branch Nimishillen Creek drains approximately 43.6 square miles (27,904 acres), all in Stark County. The 10.4 mile mainstem flows generally west-southwest, entering the Middle Branch Nimishillen Creek in Canton (Figure 2). Its waters eventually enter Nimishillen Creek, which drains into Sandy Creek, a tributary of the Tuscarawas River in the Muskingum River basin. The average gradient of the East Branch mainstem is 15.5 feet per mile.

The watershed is located in the Erie-Ontario Lake Plain ecoregion which is characterized by nearly level to strongly rolling terrain interspersed with glacial till ridges and outwash terraces. The watershed is nearly level to gently rolling except for the southern headwater area which is in unglaciated terrain. Approximately three-fourths of the soil types in the watershed have slopes less than or equal to six percent gradient; most of the area would be classified as prime farmland. Approximately one-fourth of the soils require artificial drainage for agricultural crops. Five soil associations are identified: Fitchville-Sebring, Chili-Wheeling-Shoals, Ravenna-Canfield, Canfield-Wooster, and Loudonville-Wooster. The soils, derived from glacial till or lake sediments, reflect the influence of continental glaciation.

Overall, the watershed is predominantly rural; the lower portion is heavily urban and industrial, while the upper reaches are rural and agricultural. The City of Louisville is entirely within the basin, and the City of Canton and the City of East Canton lie partially in the basin. Between 1988 and 1992, Stark County land used for agriculture decreased by 2.5 percent. A significant part of that land may be presumed to have been developed. Republic Storage Systems, Republic Engineered Steel, J&L Spec. Prod., and the Louisville Wastewater Treatment Plant (WWTP) discharge wastewater to the East Branch Nimishillen Creek mainstem (Table 3). The Conrail Railroad Yard and Molly Stark Hospital discharge wastewater to tributaries.

Water quality problems from nonpoint source pollution in the watershed are due to urban storm water runoff, failing septic systems, soil erosion, animal waste management (primarily from dairy farms), and, to a lesser extent, oil and gas production and construction site erosion.

The East Branch Nimishillen Creek between approximately RMs 6.0 and 6.5 becomes intermittent during dry weather periods, apparently in response to well water withdrawals by the City of Louisville and J&L Specialty Products (Figure 3).

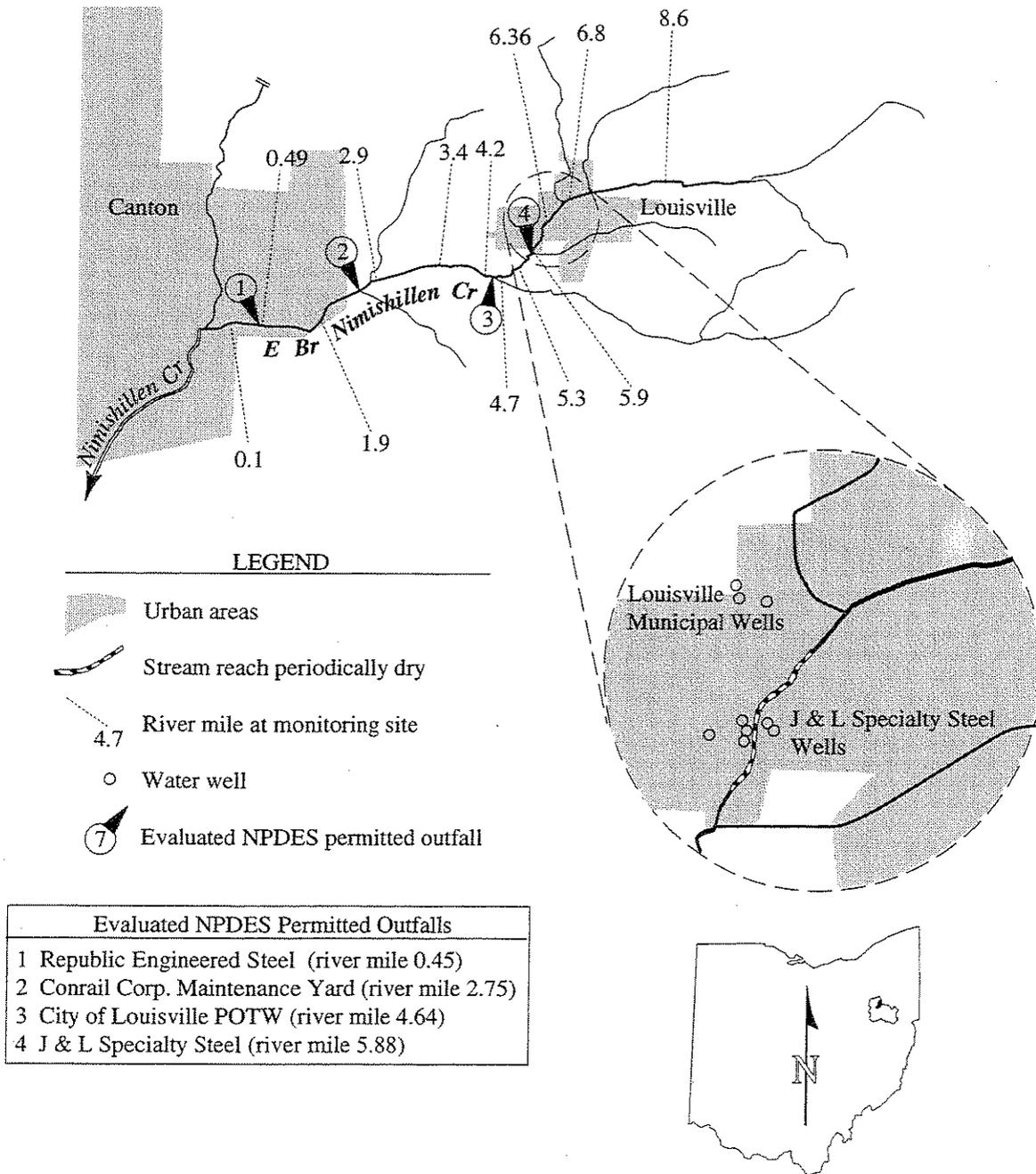


Figure 2. Study area map.

Table 3. NPDES Permitted Dischargers to the East Branch Nimishillen Creek.

Entity	Permit#	Outfall	RM	Type	Design Flow (mgd)
Republic Storage Systems	3ID00007	004	0.33	ST, NC	0.051
		001	0.35	ST, NC	0.063
Republic Engineered Steel	3ID00000	010	0.45	PW, ST, NC	1.166
		011	0.85	ST, NC	0.014
		009	0.9	ST, NC	0.140
		008	1.03	RW, ST	1.340
		003	1.1	ST, NC	0.072
Conrail Railroad Yard	3IT00014	002	2.75, trib	ST	
City of Louisville WWTP	3PD00033	001	4.64	SW	2.000
J & L Speciality Steel	3ID00018	004	4.2, trib	BW, ST	0.056
		003	5.88	PW, NC, ST	2.500
Molly Stark Hospital	3PG00108	001	7.1, trib	SW	0.060

NC = NON-CONTACT COOLING WATER
 SW = SANITARY WASTES
 ST = STORM WATER RUNOFF
 RW = RINSE WATER
 PW = PROCESS WATER
 BW = SOFTENER BACKWASH

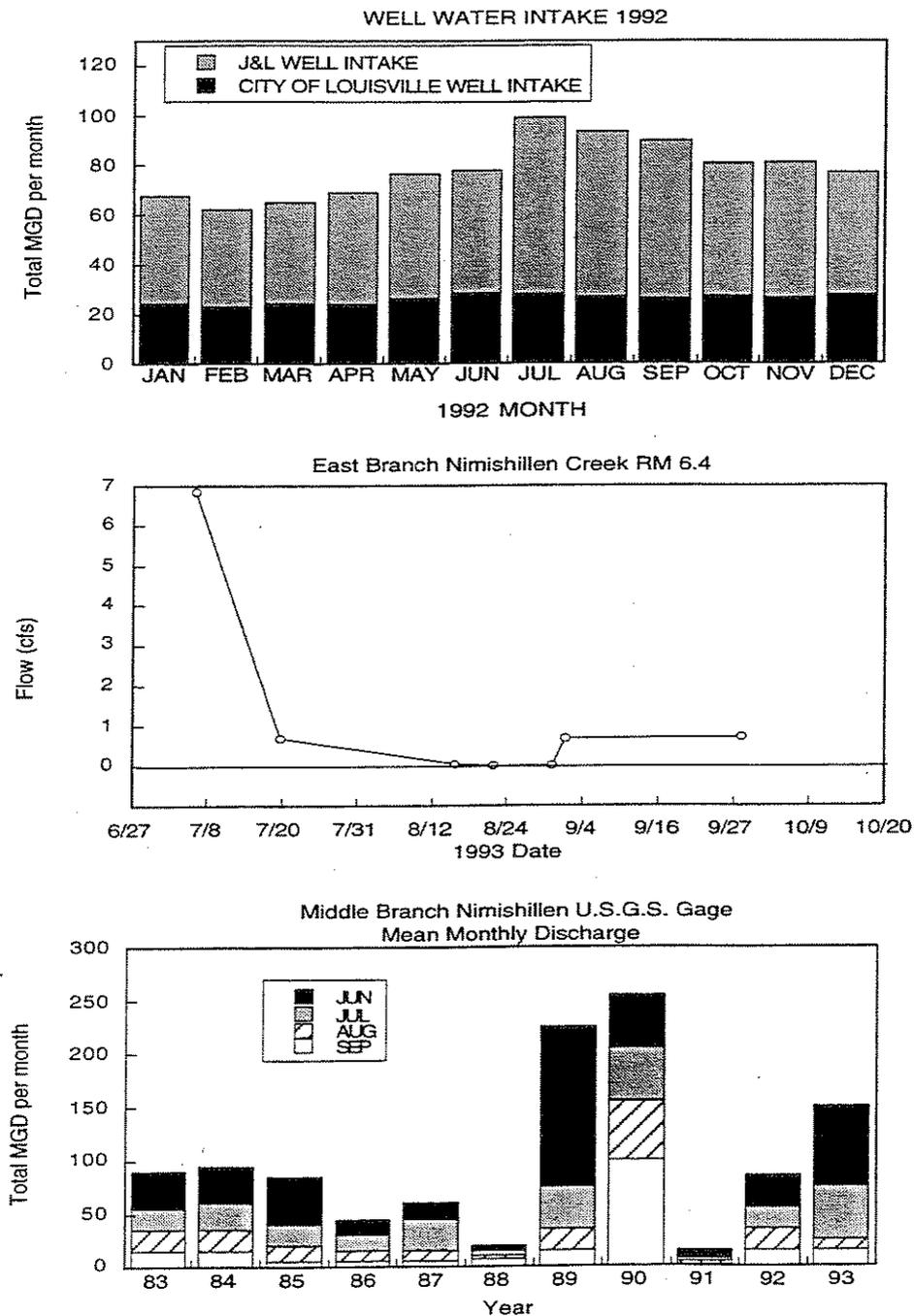


Figure 3. Water diagrams: typical monthly well water withdrawal by J&L Spec. Prod. and the City of Louisville (top), flow measurements at RM 6.4 in the summer of 1993, note dry stream bed (middle), and summer monthly flow measurements from 1983 to 1993 at the U.S. Geological Survey gage station on the Middle Branch Nimishillen Creek shown here to indicate wet/dry years (bottom).

Methods

All chemical, physical, and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989c) and Biological Criteria for the Protection of Aquatic Life, Volumes II-III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989) for aquatic habitat assessment.

Attainment/nonattainment of aquatic life uses is determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. The biological community performance measures that are used include the Index of Biotic Integrity (IBI) and the Modified Index of Well-being (MIwb), both of which are based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. IBI and ICI are multi-metric indices patterned after an original IBI described by Karr (1981) and Fausch et al. (1984). The MIwb is a measure of fish community abundance and diversity using numbers and weight information; it 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 basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is **FULL** if all three indices (or those available) meet the applicable criteria, **PARTIAL** if at least one of the indexes does not attain and performance does not fall below the fair category, and **NON** if all indices either fail to attain or any index indicates poor or very poor performance.

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among 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, not just the characteristics of a single sampling site. As such, individual sites may have much 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 higher than 60 are generally conducive to the establishment of warmwater faunas while those scores in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

During this survey, macroinvertebrates were sampled using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Exceptions included those locations where the artificial substrate samplers were buried or lost due to the extreme flows that occurred during the six week colonization period. At these locations, only qualitative samples were collected. A current velocity of 0.3 ft/sec across the artificial substrates is generally required for direct application of the resultant ICI score in determining aquatic life use attainment.

Macroinvertebrate sites in the study area were also evaluated using a new assessment tool which utilizes the qualitative, natural substrate collections available from each site. This method relies on tolerance values derived for each macroinvertebrate taxon collected. Unlike tolerance values used in other common indices (e.g., the Hilsenhoff Biotic Index), these tolerance values are based on abundance data for a given taxon collected using artificial substrates. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected with artificial substrates are weighted by the abundance data of that taxon at those sites. The mean of the weighted ICI scores for the taxon results in the tolerance value of that taxon. Thus, a taxon's tolerance value represents its relative level of tolerance on the ICI's 0 to 60 scale. High tolerance values are calculated for the more intolerant taxa which tend to reach their greatest abundance at undisturbed sites (i.e., sites with highest ICI scores). Conversely, more pollution tolerant taxa attain their greatest abundances at highly disturbed sites with low ICI scores, which results in a lower tolerance value. For the qualitative macroinvertebrate collections in the East Branch Nimishillen Creek study area, the median tolerance value, based on all tolerance values of the organisms collected at a site, resulted in what has been termed the Qualitative Community Tolerance Value (QCTV). Though only in the developmental stage, the QCTV shows potential as a method to supplement existing assessment methods using the qualitatively collected macroinvertebrate information. Its use in evaluating sites in the East Branch Nimishillen Creek study area was restricted to relative comparisons between sites with no attempt to interpret quality of the sites or aquatic life use attainment status.

Fish were sampled 2-3 times using pulsed DC electrofishing gear using either the wading method (150 meter zones) or boat method (500 meter zones). Chemical/physical and biological sampling locations are listed in Table :

One to five grab water samples were collected for chemical analyses from 11 mainstem stations along the East Branch Nimishillen Creek during the summer of 1993. All chemical, physical, and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989c).

An Area Of Degradation Value (ADV; Rankin and Yoder 1993) was calculated for the study area based on the longitudinal performance of the biological communities. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, and ICI) departs from the stream criterion or the upstream level of performance (Figure 4). The amount of impact refers to the vertical departure of each index below the criterion. The total ADV is the area beneath the ecoregional criterion when the results for each index are plotted against river mile. This is also expressed as ADV/mile to normalize comparisons between segments and other areas. For the purpose of generating the ADV, ICI values were assigned based on the narrative evaluation for sites that lacked valid quantitative data due to loss or disturbance of the artificial substrates.

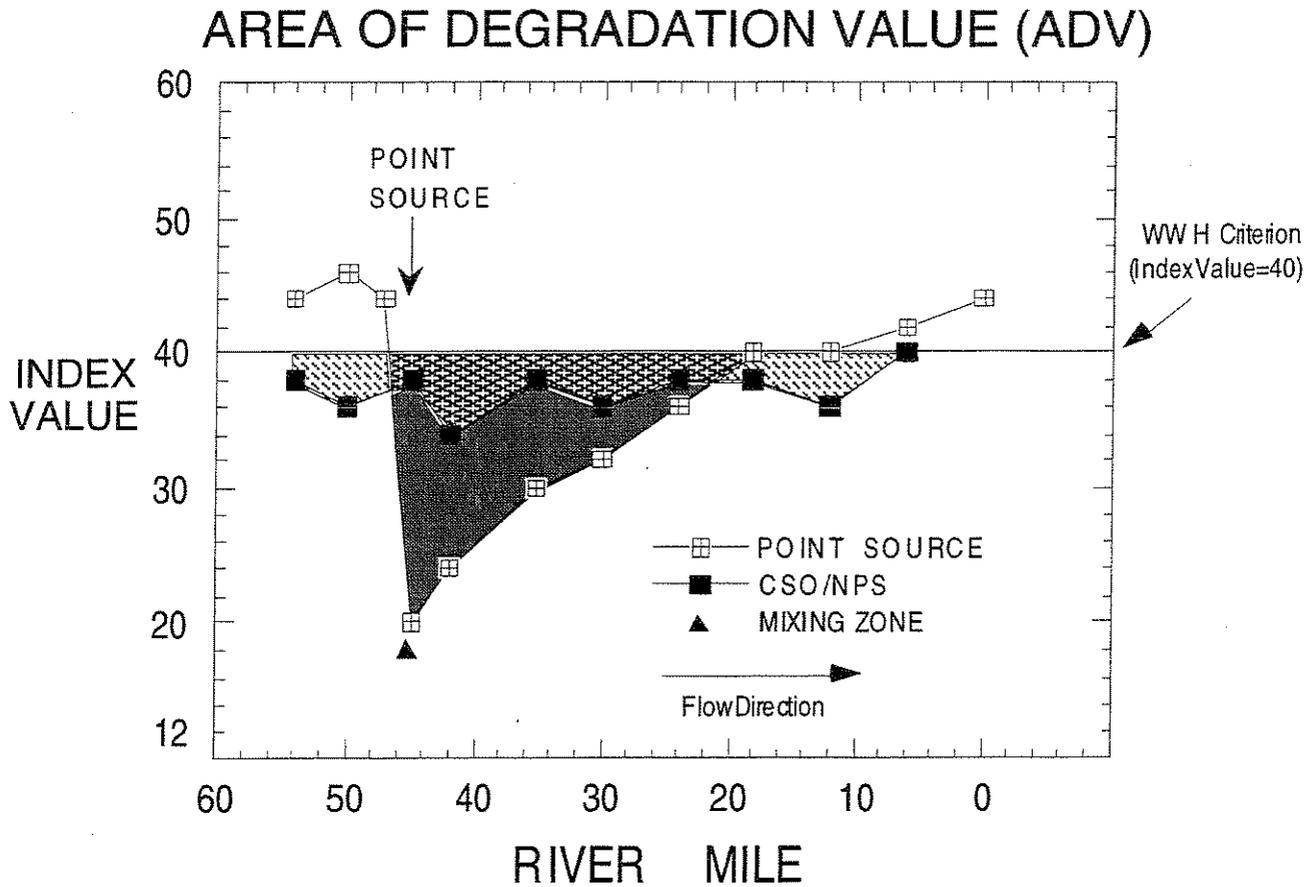


Figure 4. Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears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

Results and Discussion

East Branch Nimishillen Creek (1993 Survey)

Chemical Water Quality

- The 1993 East Branch Nimishillen study area included the mainstem from river mile (RM) 8.56 to RM 0.13 near the confluence with the Middle Branch Nimishillen Creek. A number of smaller tributaries were also sampled to provide chemical data for wasteload allocation modeling. A list of all 1993 sample stations is provided in Table 4.
- Exceedences/violations of water quality criteria (OAC 3745-1) were recorded for dissolved oxygen, total dissolved solids, and ammonia-nitrogen at RM stations 5.45 and 4.70 below the outfalls of the J&L Spec. Prod., but above the City of Louisville WWTP discharge (Table 2).
- Exceptionally high concentrations of nitrate+nitrite-N, as high as 170 mg/l, were recorded below outfall 003 of the J&L Spec. Prod. (Figure 5). Nitrate+nitrite-N concentrations were well above the 90 mg/l concentration recommended by US EPA as a level to be protective of aquatic life (US EPA 1986). Thus it would appear that potentially toxic levels of nitrate+nitrite-N were present in the stream below the J&L Spec. Prod. outfall 003 in 1993. Also, levels of nitrite-N were high enough to cause concern about toxic effects (>0.5 mg/l). No water quality criteria exceedences were recorded at three sample stations located above the J&L Spec. Prod. outfall 003.
- Violations of the dissolved oxygen criteria were recorded from RM 5.45 to 3.47 for a total of 1.98 river miles. Exceedences of the total dissolved solids criteria were recorded from RM 5.45 to RM 2.80 for a total of 2.65 river miles. The City of Louisville WWTP discharges at RM 4.64 may contribute to the low dissolved oxygen found at RMs 4.20 and 3.47, although the dissolved oxygen sag clearly begins above the discharge (Figure 10). Exceedences of the ammonia-nitrogen criteria were not recorded below the City of Louisville WWTP discharge.
- No exceedences of heavy metals criteria were recorded at any location along the East Branch of Nimishillen Creek in 1993. Detectable levels of total chromium, total nickel, and total cyanide were observed below the J&L Spec. Prod. outfall 003 at times when these parameters were not detected at stations located upstream (Figure 8).

Table 4. Sampling locations (effluent sample - E, water chemistry - C, sediment - S, benthos - B, fish - F, datasondes - D) in the East Branch Nimishillen Creek study area , 1993.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad	Storet #
East Branch Nimishillen Creek					
8.56	C, S, D, B, F	40°50'47"/81°14'03"	Meese Rd	Robertsville	R07S54
6.80	C, S, B, F	40°50'32"/81°15'34"	Rt 44	Canton East	R07P07
6.36	C, S, D, B, F	40°50'13"/81°15'51"	Rt 153	Canton East	R07S53
5.88	E	40°49'52"/81°16'03"	J&L Spec Prod 003	Canton East	R07W22
5.8	B, F, C		003 mix-zone	Canton East	
5.45	C	40°49'35"/81°16'14"	St Louis Cemetery	Canton East	R07W41
4.7	C, S, D, B, F	40°49'27"/81°16'19"	Upst Louisville WWTP	Canton East	R07S51
4.64	E	40°49'16"/81°16'48"	Louisville WWTP 001	Canton East	R07S50
4.6	B, F, C		WWTP 001 mix-zone	Canton East	
4.20	C, D, B, F	40°49'25"/81°17'07"	Beck Rd	Canton East	R07P06
3.47	C, D, B, F	40°49'14"/81°18'32"	Broadway Rd	Canton East	R07S49
2.80	C	40°49'12"/81°18'39"	Ford Rd	Canton East	R07W25
1.89	C, S, D, B, F	40°48'41"/81°19'24"	Harmont Rd	Canton East	R07P05
1.03	E	40°48'28"/81°20'05"	Rep Eng Steel 008	Canton East	R07W31
0.45	E	40°47'29"/81°20'48"	Rep Eng Steel 010	Canton East	R07W35
0.4	B, F		Rep Eng mix-zone	Canton East	
0.13	C, S, D, B, F	40°48'25"/81°21'14"	Cook Park	Canton East	R07P04
Kiems Run					
4.27 / 0.9	E	40°49'50"/81°16'28"	J&L Spec Prod 004	Canton East	R07W24
Unnamed Tributaries to East Branch Nimishillen Creek (single samples by modeling section)					
4.67 / 0.22	C	40°48'59"/81°16'31"	Just upst WWTP, RT 44	Canton East	R07W23
3.46 / 0.01	C	40°49'26"/81°17'55"	Just upst Broadway Rd	Canton East	R07W40
2.75 / 0.01	C	40°49'11"/81°18'42"	Conrail RR bridge	Canton East	R07S55
2.50 / 0.56	C	40°48'48"/81°18'18"	Klotz Rd	Canton East	R07W27

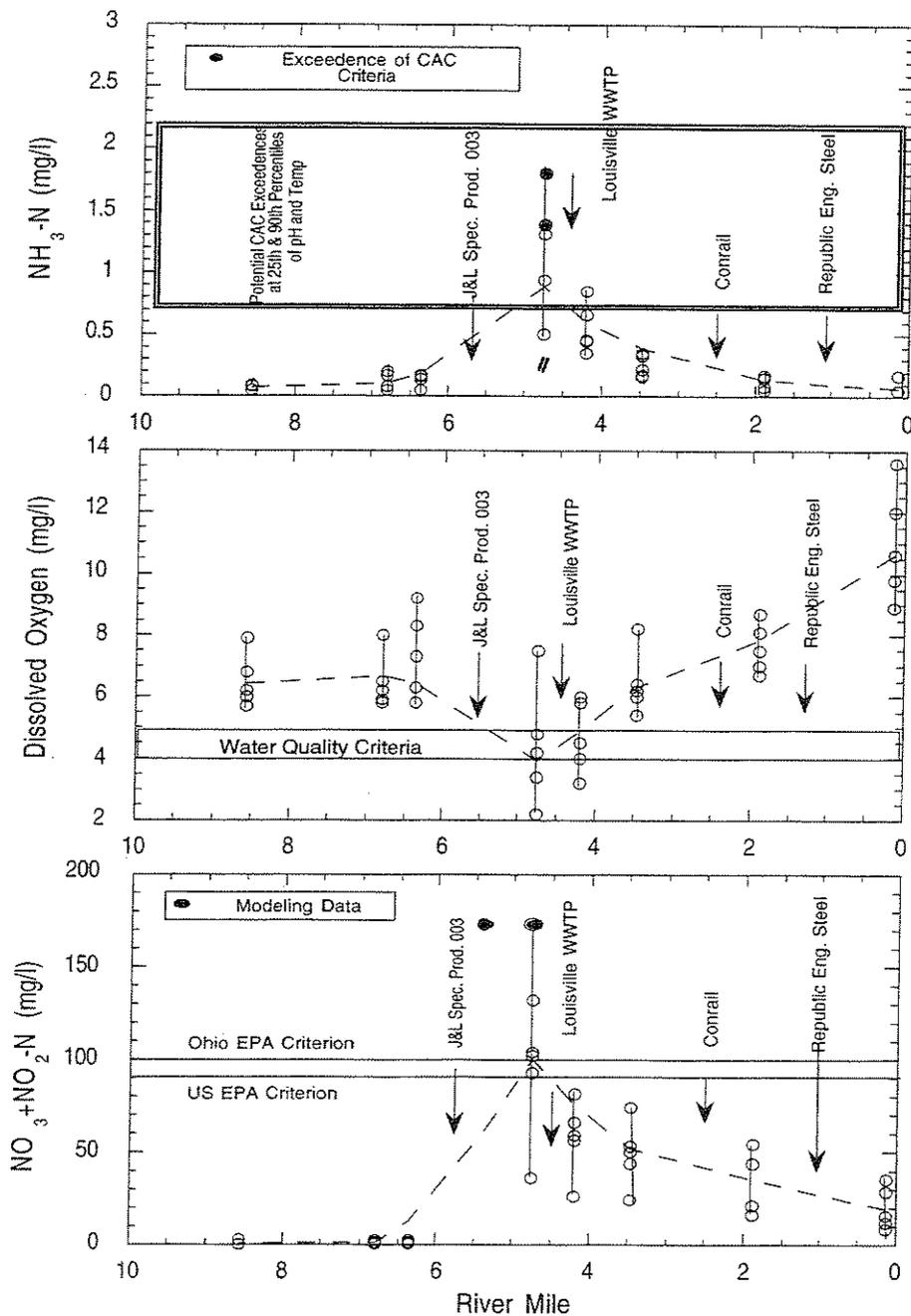


Figure 5 . Longitudinal concentrations of ammonia, dissolved oxygen, and nitrate+nitrate-N in the East Branch Nimishillen Creek during the summer of 1993.

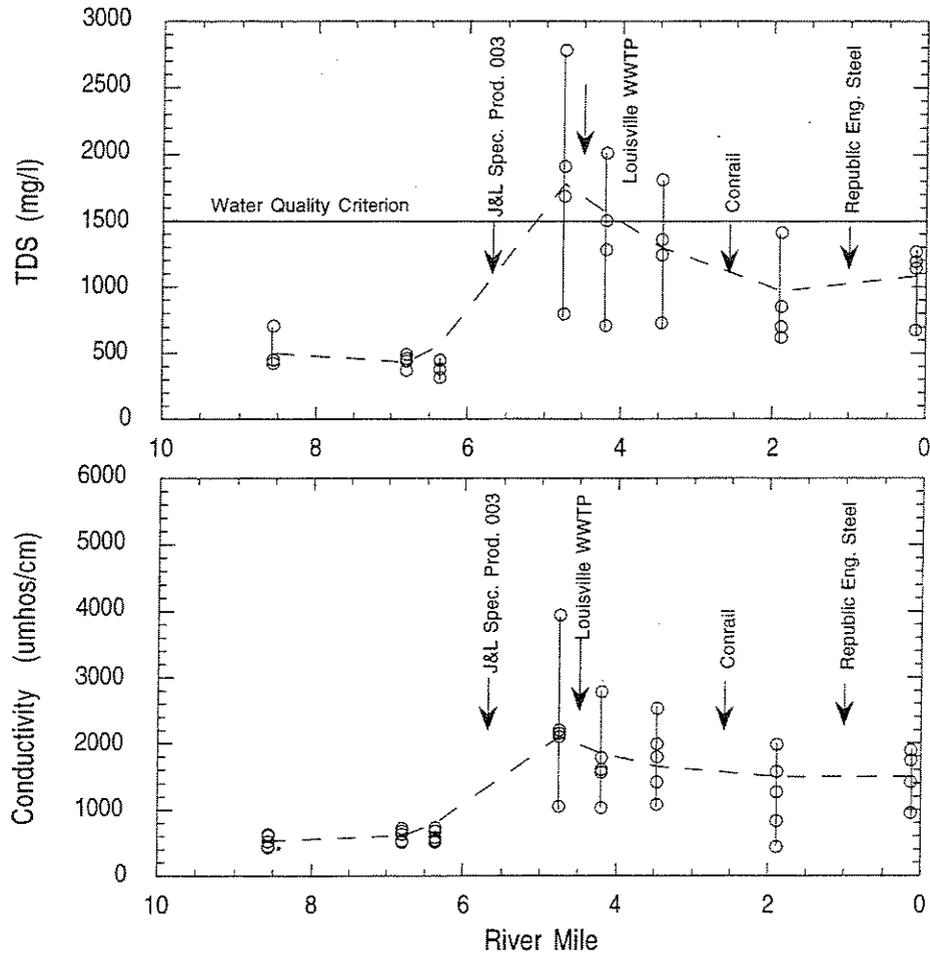


Figure 6 . Longitudinal instream concentrations of total dissolved solids and conductivity in the East Branch Nimishillen Creek in the summer of 1993.

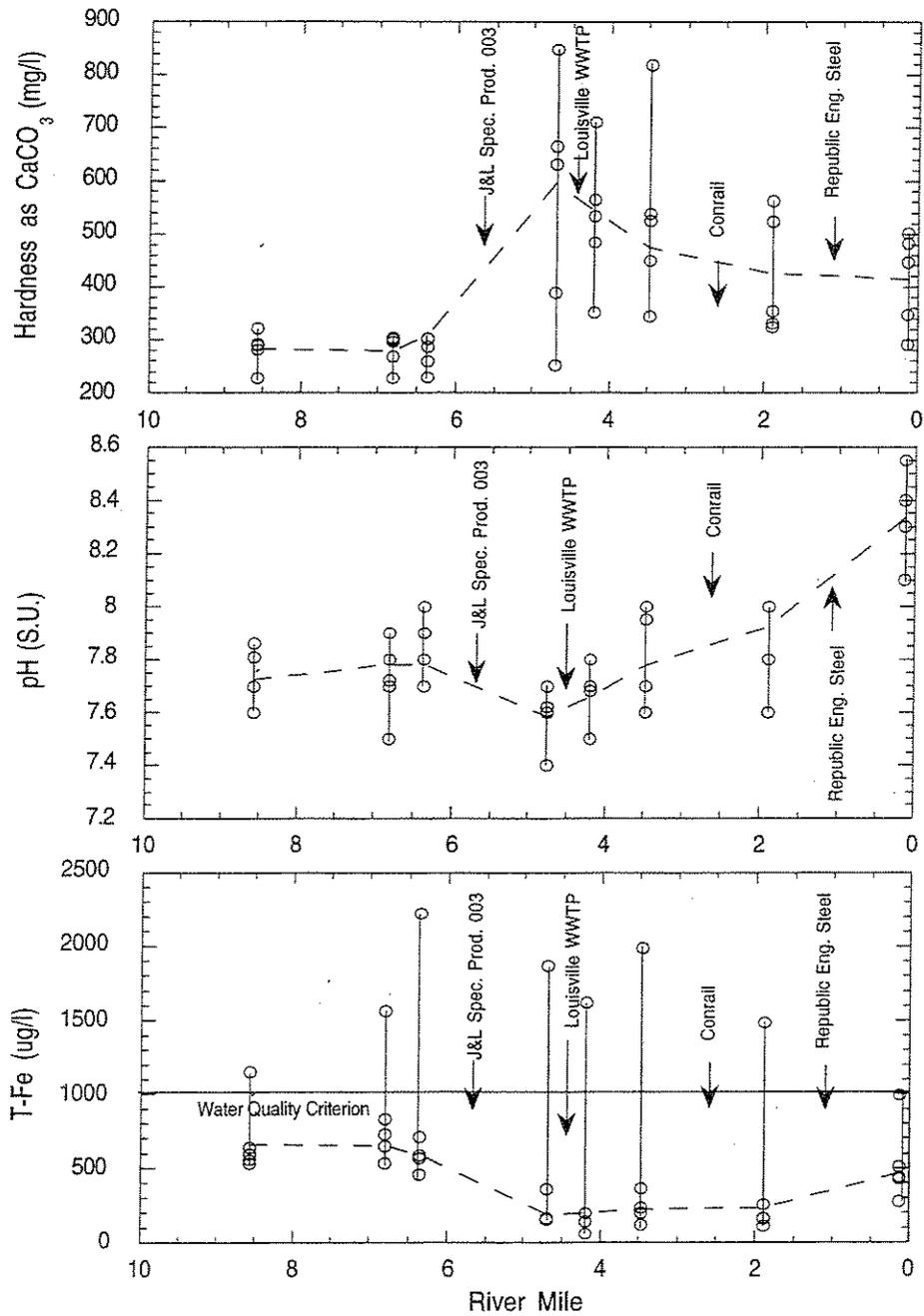


Figure 7. Longitudinal instream concentrations of hardness, pH, and iron in the East Branch Nimishillen Creek during the summer of 1993.

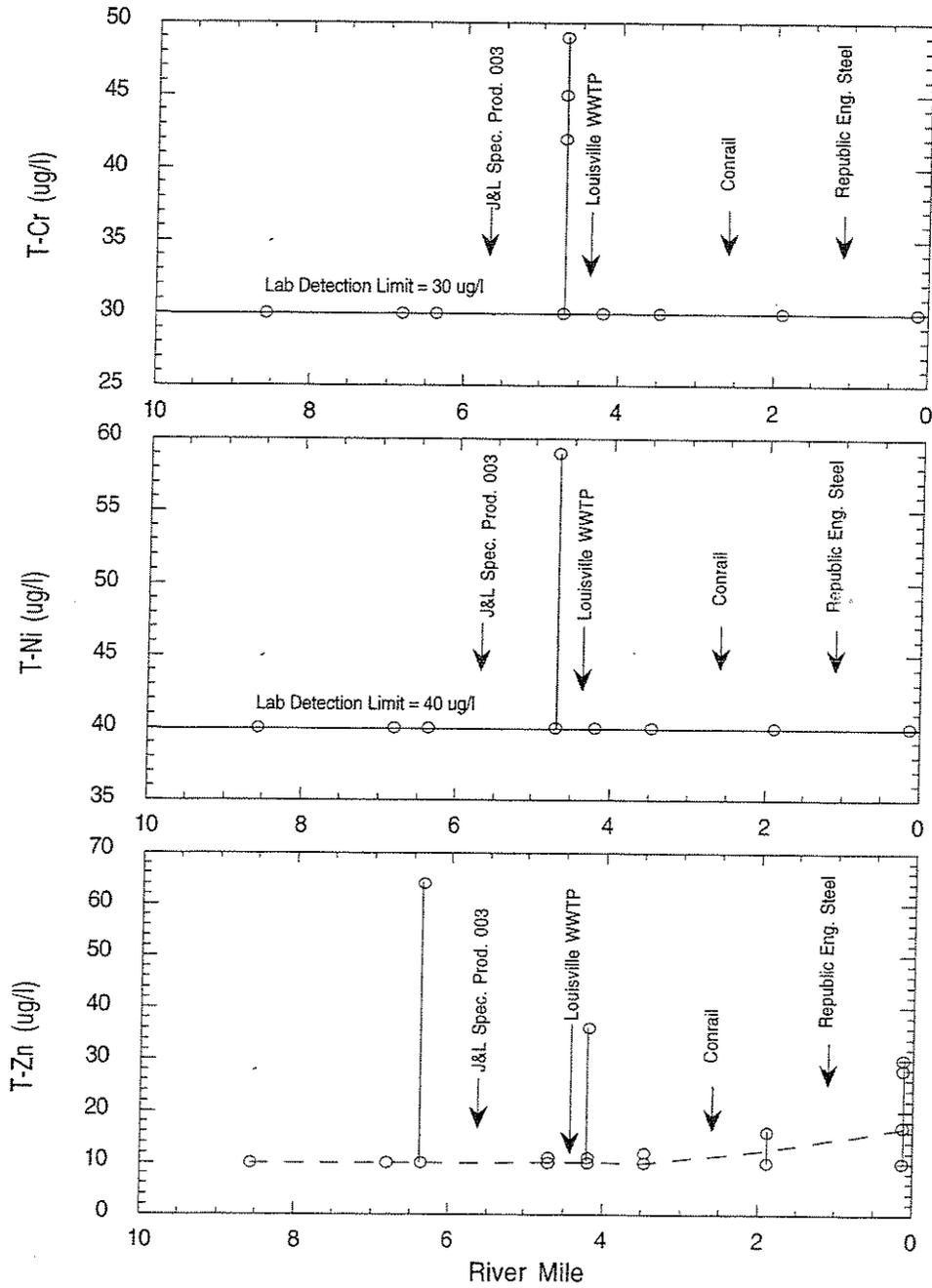


Figure 8. Longitudinal instream concentrations of chromium, nickel, and zinc in the East Branch Nimishillen Creek during the summer of 1993.

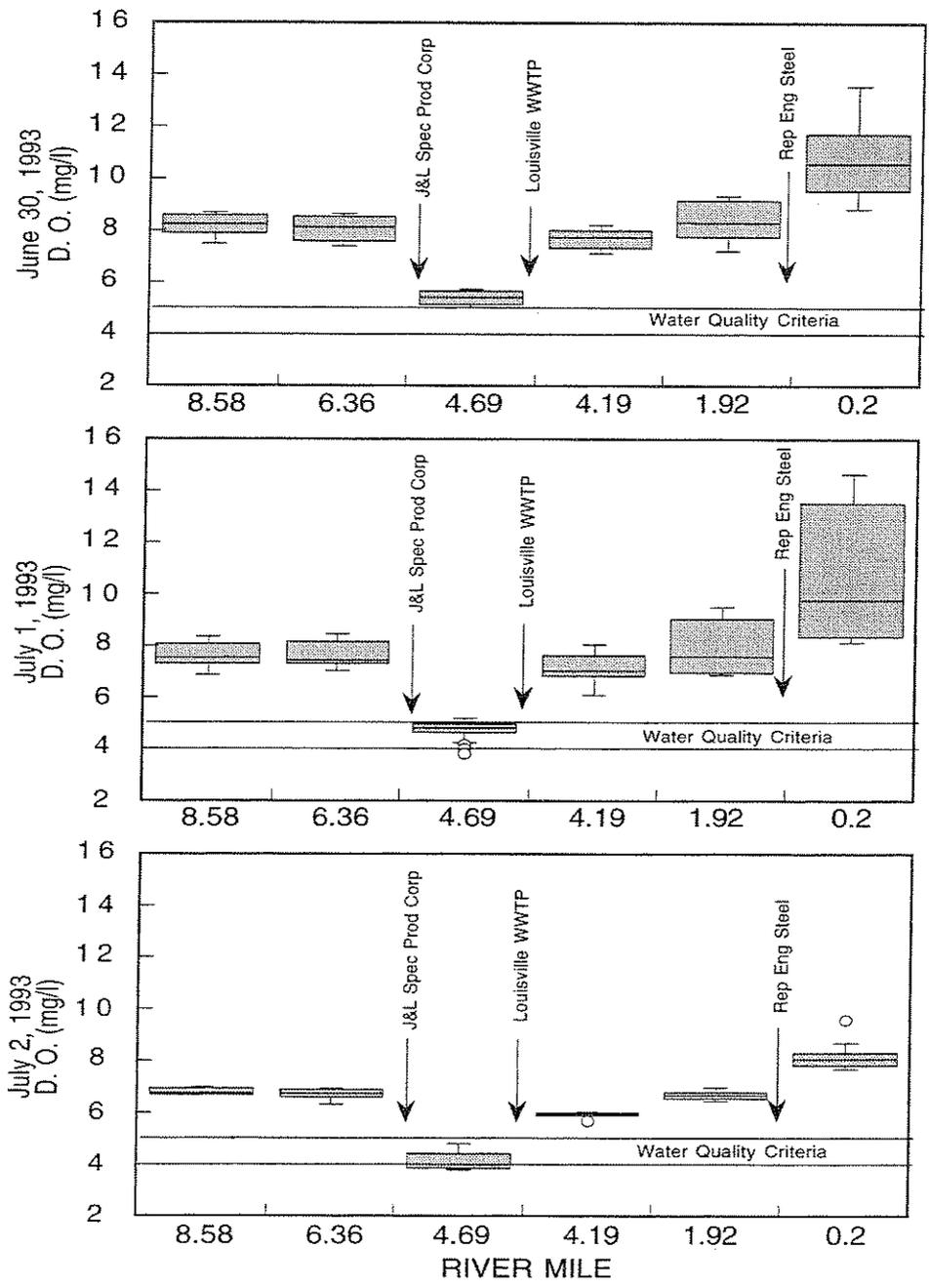


Figure 9. Dissolved oxygen (mg/l) concentrations from datasonde readings taken on June 30 to July 2, 1993.

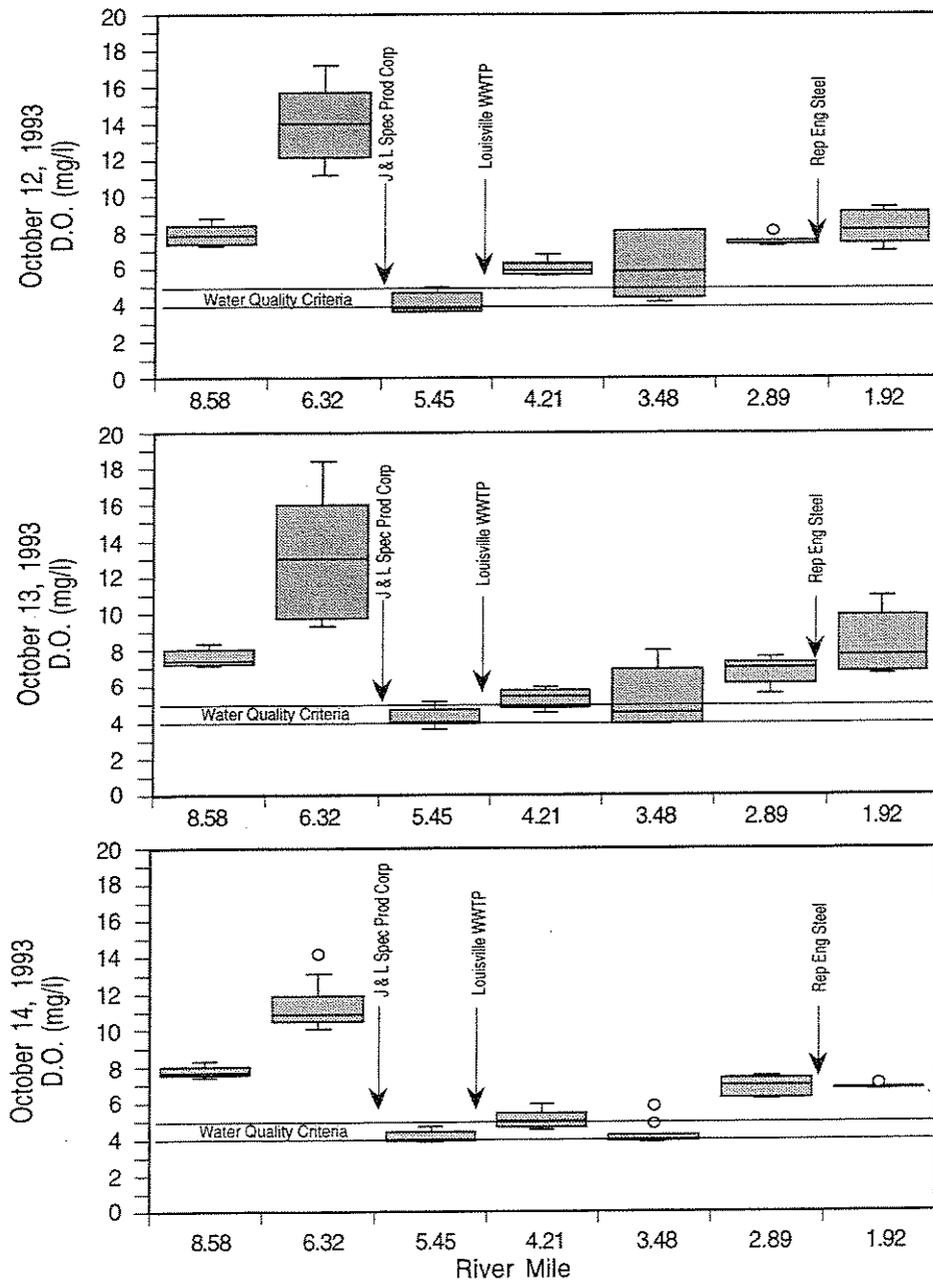


Figure 10. Dissolved oxygen (mg/l) concentrations from datasonde readings taken on October 12 to October 14, 1993.

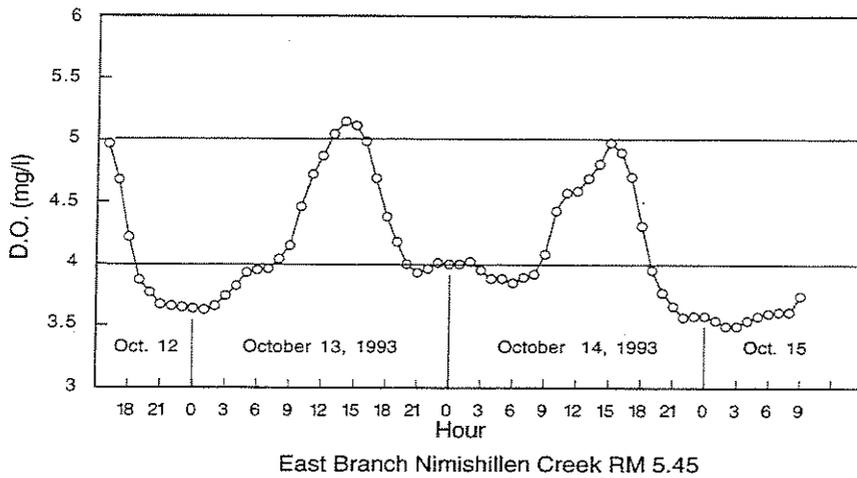
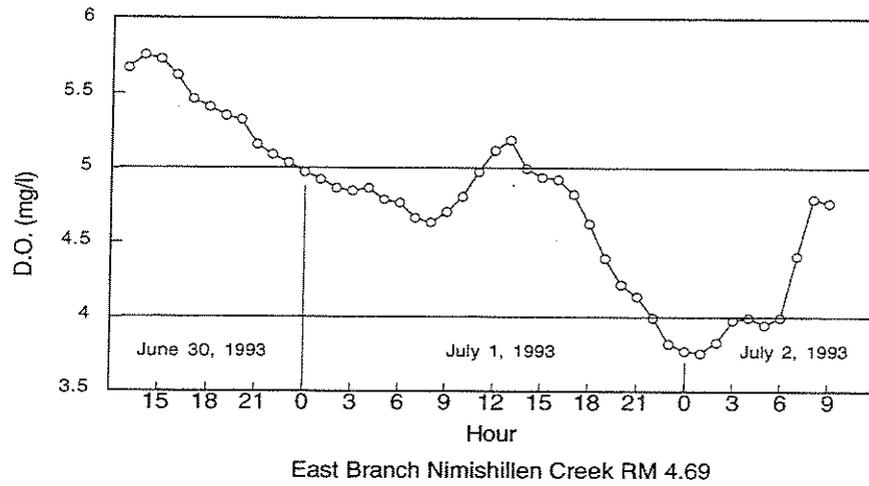


Figure 11. Hourly dissolved oxygen (mg/l) concentrations from datasonde readings in the East Branch Nimishillen Creek downstream from J&L Spec. Prod. outfall 003.

- No exceedences of chemical water quality criteria were observed near the mouth of the East Branch Nimishillen at RM 0.13, which is below the numerous outfalls of Republic Engineered Steel and Republic Storage Systems. However, total zinc levels increased below these dischargers.
- Although no violations of the primary or secondary contact fecal coliform bacteria criteria were measured during limited sampling (two samples/station) in 1993, two fecal coliform samples were elevated at RM 4.75, (1800 and 1050 /100 ml). Although elevated, these values are below the 2000/100 ml primary contact recreational 10% criterion. Sufficient samples were not collected over a 30 day period to evaluate potential violations of the 1000/100 ml fecal coliform primary contact criterion. The source of these bacteria at RM station 4.75 is presently unknown.
- Stream flow measurements were taken at State Rt. 153 (RM 6.36) when grab surface water samples were collected. Five measurements at State Rt. 153 (RM 6.36) ranged from 6.847 cfs to 0.034 cfs. No permanent stream flow gaging stations are located on the East Branch Nimishillen Creek. The U.S.G.S. maintains continuous daily flow records on the Middle Branch of Nimishillen Creek at Martindale Road (RM 2.4). The period of record is from 1941 to present.
- The East Branch Nimishillen Creek at the RM 6.36 station was observed to be completely dry from August 22 to August 31, 1993. A similar observation was made on October 3, 1985. In 1993, the stream was dry down to the J&L Spec. Prod. 003 discharge. A likely cause of the loss of stream water is the combined groundwater well removal in the general area of RM 6.36 by three City of Louisville drinking water wells and six J&L Spec. Prod. process water wells. During the summer of 1992 (July, August, September) the City of Louisville wells removed an average of 0.886 mgd (1.371 cfs) and the J&L Spec. Prod. wells removed an average of 2.187 mgd (3.384 cfs). These removal rates are well above the estimated $Q_{7,10}$ for the East Branch Nimishillen Creek of 1.73 cfs (December 1990, WLA Report). Well water pumping rates have been relatively similar from 1985 to the present, which suggests that the East Branch of Nimishillen Creek has experienced intermittent flow at RM 6.36 on an annual basis for several consecutive years. This type of habitat alteration (i.e., lack of water) could have a significant local impact on the chronic health of the biological communities in the East Branch of Nimishillen Creek near RM 6.36.
- The discharge from the City of Louisville North WWTP was tied into the Louisville South WWTP in late 1987. Improvements to the Louisville South WWTP, completed in 1988, have resulted in a significant decrease in the loadings of oxygen demanding substances and ammonia (Figure 14). There has also been a significant decrease in the 95th percentile loading of TSS from the City of Louisville South WWTP since 1988.
- In addition to the City of Louisville North WWTP, three other NPDES permitted dischargers were eliminated between 1988 and 1992: Liquid Carbonic (April, 1990); WCI Drainage Products (May 1992); Ford Motor Company (December 1988).

- During the 1993 survey, an oily discharge was observed leaving the property of Conrail. This entity has two NPDES outfalls to a tributary that empties into the East Branch of Nimishillen Creek at RM 2.75. Loadings of oil and grease reported by Conrail since 1990 indicate a significant increase over time (Figure 12). Oil was observed in the sediments of the East Branch at RM station 1.89, which is downstream from the Conrail discharge tributary. Oil contaminated sediments pose a potential impact to biological communities at stream stations below the RM 2.75 tributary.

Sediment Quality

- Stream sediment samples were collected from six stations along the East Branch Nimishillen Creek mainstem in October of 1993 (Table 5). Compared to upstream samples, much higher concentrations of zinc, chromium, and nickel were found in the sediments at RM 4.7, which is downstream from the J&L Sped. Prod. outfall 003 (RM 5.9). Levels of cadmium and copper were also higher at this station (Figure 16). Using the sediment criteria of Kelly and Hite (1984) highly elevated to extremely elevated levels of chromium, lead, and zinc were detected at RM 4.7. Sediment metals at these highly elevated concentrations may be toxic to benthic invertebrates and other aquatic life.
- The concentration of lead in the sediments increased longitudinally from RM 6.8 to RM 0.13 (Figure 16). This pattern suggests effects from urban runoff.
- The results of volatile, semi-volatile, pesticide and PCB sediment analyses in 1993 indicated no significant findings. No PCBs were detected at any of the six sample stations. Mirex was detected at a very low concentration (4.86 ug/kg) at one location (RM 6.36). The highest number of semi-volatile compounds detected was eight at RM 6.36, but the total concentration for all the compounds was less than 12 mg/kg.

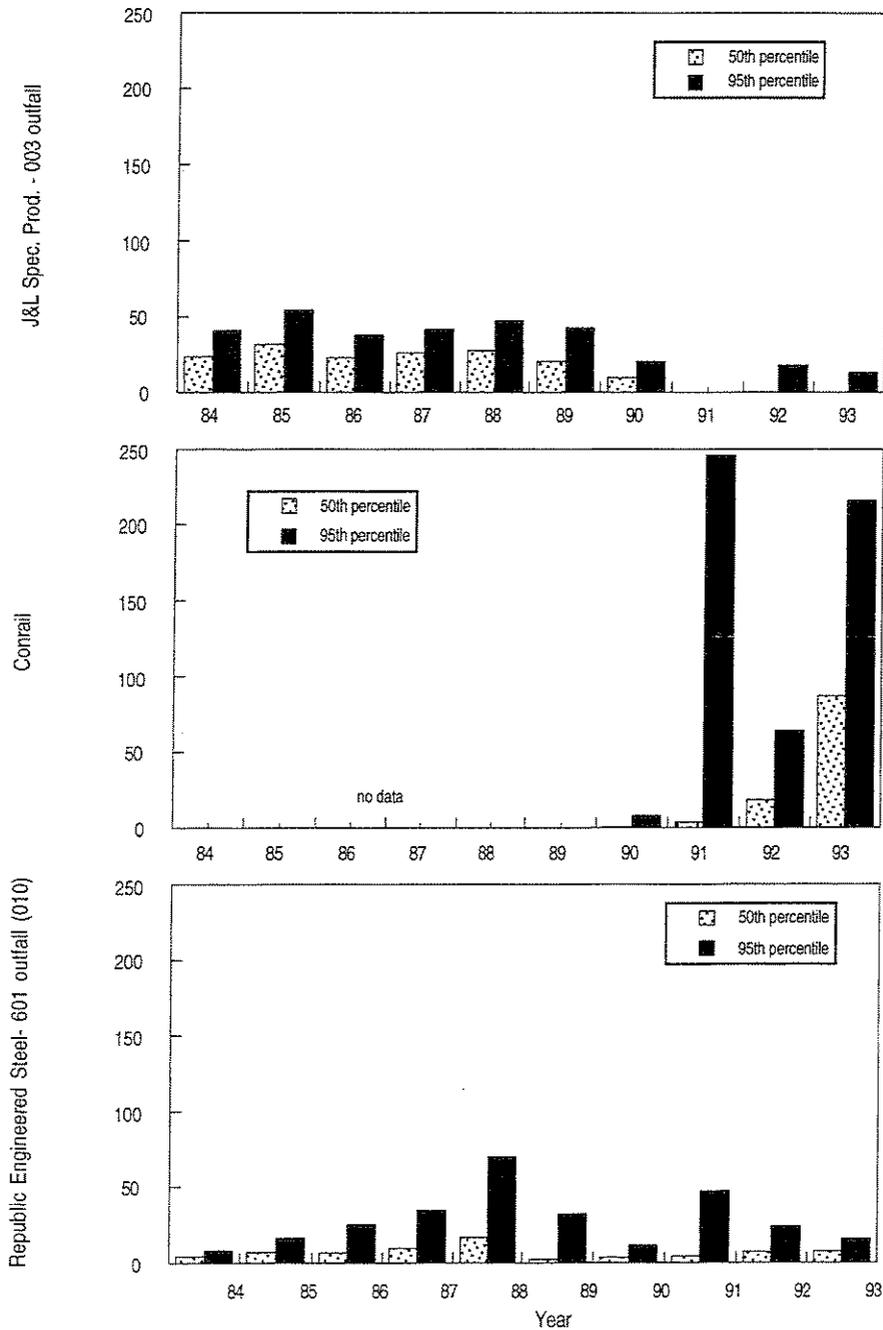


Figure 12 . Loadings of oil and grease (kg/day) of dischargers to the East Branch Nimishillen

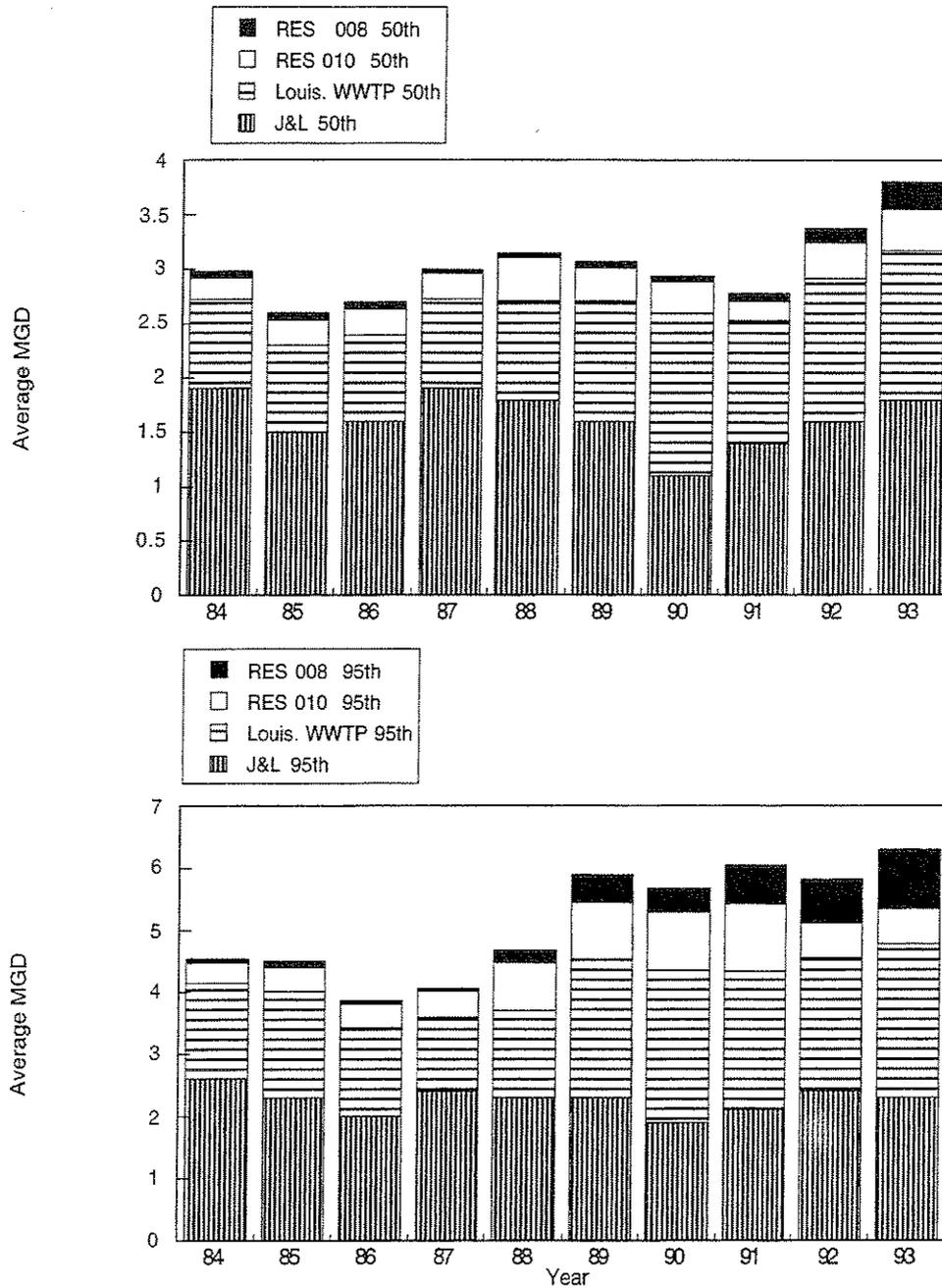


Figure 13 . Trends in 50th and 95th percentile flows of major dischargers in the East Branch Nimishillen Creek.

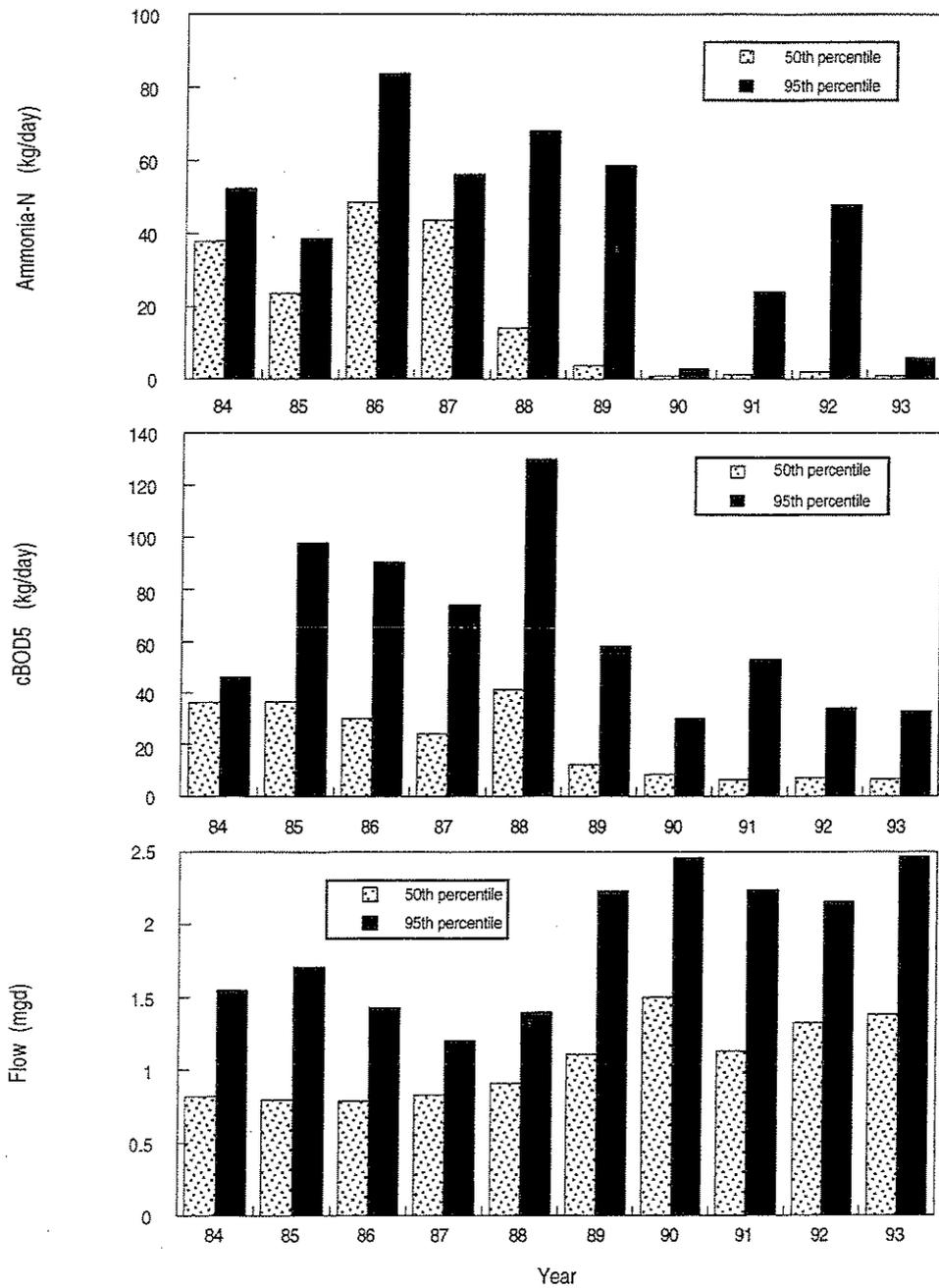


Figure 14. Louisville WWTP 50th and 95th percentile trend analyses for ammonia, CBOD, and flow.

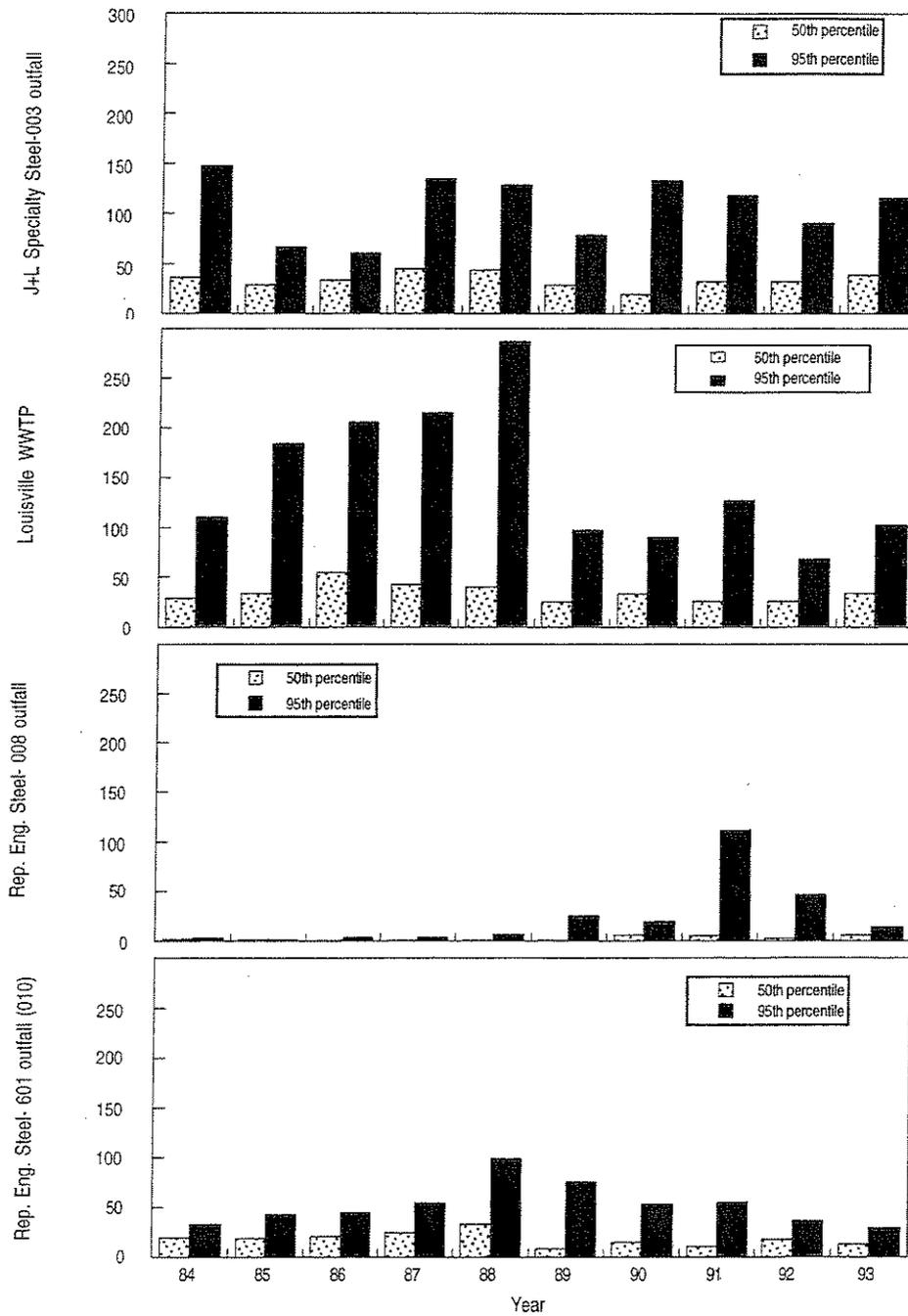


Figure 15. Total Suspended Solids (kg/day) of dischargers to the East Branch Nimishillen Creek.

Table 5. Dry weight concentrations of heavy metals (mg/kg or ppm) in sediments of the East Branch Nimishillen Creek study area during 1993. All parameter concentrations (excluding nickel) were ranked based on a stream sediment classification system described by Kelly and Hite (1984).

River Mile	As	Cd	Cr	Cu	Fe	Pb	Ni	Zn
<i>East Branch Nimishillen Creek (1993)</i>								
8.56	9.38 ^b	0.18 ^a	10.5 ^a	10.3 ^a	25100 ^c	12.0 ^a	9.19	60.8 ^a
6.8	6.58 ^a	0.185 ^a	16.1 ^b	9.16 ^a	16100 ^a	13.4 ^a	6.78	61.1 ^a
6.36	9.38 ^b	0.324 ^a	18.1 ^b	16.6 ^a	21700 ^b	45.4 ^c	9.12	120 ^c
<i>J&L Spec. Prod.</i>								
4.7	9.24 ^b	1.64 ^c	793 ^e	43.2 ^b	27600 ^c	60.9 ^d	210	749 ^e
<i>Louisville WWTP</i>								
1.89	16.5 ^c	1.18 ^c	242 ^e	56.8 ^b	32900 ^d	119 ^e	82.5	615 ^e
<i>Republic Engineered Steel</i>								
0.13	35.6 ^e	0.935 ^b	223 ^e	43.2 ^b	27900 ^c	134 ^e	70.2	281 ^d
<i>East Branch Nimishillen Creek (1985)</i>								
6.36	6.56 ^a	0.164 ^a	1180 ^e	10.0 ^a		33.2 ^b	14.0	65.0 ^a
4.2	2.67 ^a	0.325 ^a	59.9 ^d	12.0 ^a		7.0 ^a	78.0	91.0 ^b
0.1	11.0 ^b	0.865 ^b	52.1 ^d	37.0 ^a		50.1 ^c	71.0	302 ^e

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

Note: The Kelly and Hite (1984) classification system addresses relative concentrations but did not directly assess toxicity.

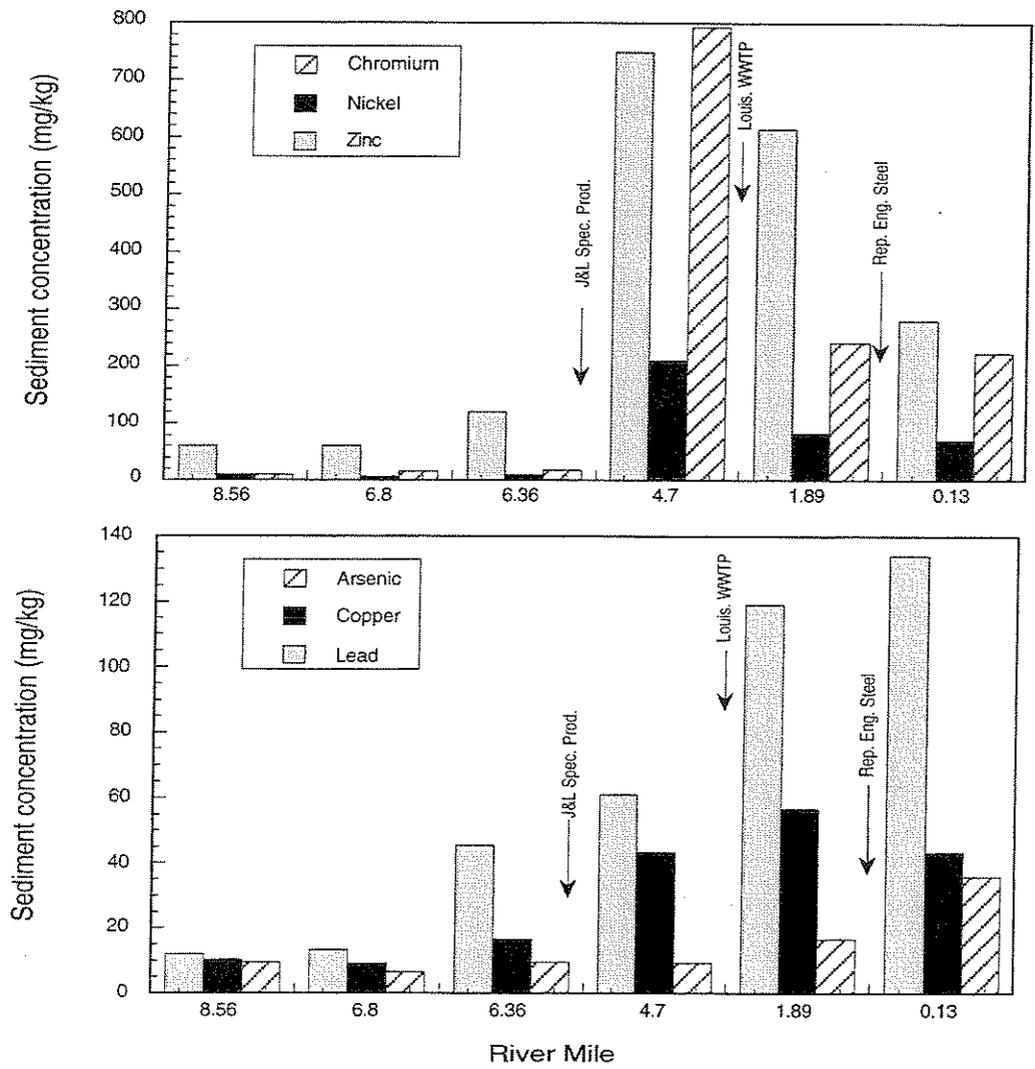


Figure 16. Longitudinal sediment concentrations (mg/kg) in the East Branch Nimishillen Creek, 1993.

Physical Habitat for Aquatic Life

- During the 1993 field sampling effort the macrohabitats of the East Branch Nimishillen Creek were evaluated at eight fish sampling stations. Qualitative Habitat Evaluation Index (QHEI) values ranged between 45.0 at RM 0.1 (Cook Park) and 81.5 at RM 4.7 (Trump Rd.), with a mean reach value of 69.3. A mean QHEI score greater than 60 suggests that near and instream physical habitats of the East Branch Nimishillen Creek are of a sufficient quality to support and maintain a community of aquatic organisms consistent with the WWH aquatic life use designation (Rankin 1989).
- Warmwater habitat attributes were encountered throughout the study area, becoming predominant at four of the eight stations evaluated. Components of quality habitat generally found within the study area included: abundant coarse (glacial and native) substrates, pooled areas greater than 40 cm in depth, moderate/high functional sinuosity, and a fairly persistent wooded riparian corridor (Table 6). The low incidence of high influence modified habitat attributes and the predominance of moderate influence modified habitat attributes at three of the stations evaluated suggested that segments of the East Branch Nimishillen Creek are in the process of physical recovery from urban encroachment and direct modifications to the active and wetted channel. Limiting aspects of instream habitats included moderate/high embeddedness of coarse substrates, fair/poor channel development, and lack of a sustained, swift current.
- Three sampling stations demonstrated evidence of past channelization: RM 6.4 (SR 153), RM 3.4 (Broadway Ave.), and RM 0.1 (Cook Park). Though moderate influence modified habitat attributes were predominant at these sites, QHEI values at or near 60.0 were maintained. These values demonstrated that minimum habitat quality has been conserved and/or re-established through natural fluvial processes since modification. The only station that appeared habitat altered was RM 6.4 (SR 153). During the 1993 sampling effort it was evident that the stream reach between approximately RM 6.5 and RM 6.0 had intermittent flow. During the period between August 23 and August 26, 1993 Ohio EPA field staff observed that this reach of the East Branch Nimishillen Creek was effectively dry, reduced to a few disjunct, shallow pools. The dewatering of this segment contributed to a documented fish kill on August 22, 1993. The lack of consistent flow during typical summer low flow conditions limits the biological potential of this segment. However, this event appeared localized and relatively short-lived, for intermittency was not observed elsewhere within the study area. Moreover, during the fish community survey continuous stream flow was observed during both sampling efforts (July 13 and September 27, 1993).
- An additional aspect of physical habitat that likely influenced biological performance within the East Branch Nimishillen Creek, though not directly measured by the QHEI, included the urban and suburban character of the watershed. Urbanization of a watershed leads to increased total runoff (and attendant urban nonpoint source pollution), higher peak discharge, and shorter duration of peak discharge (Grodon *et al.* 1992). The pervasive disturbances to the flow regime of impervious and well-drained urbanized catchments can adversely affect the ability of a river system to create and maintain habitats typically associated with less developed systems. Significant relationships have been found to exist between extent of urban land use and biological performance within rivers and streams (Steedman 1988). In these situations maintenance and restoration of the riparian vegetation becomes of paramount importance. Thus any restoration efforts, aimed at either point or nonpoint sources, needs to include attention to ensuring an adequate riparian buffer zone.

Biological Assessment: Macroinvertebrate Community

- Quantitative and qualitative data were collected from six East Branch Nimishillen Creek mainstem stations between RM 8.6 and RM 0.1 (Table 7). Flow over the quantitative artificial substrate samplers ranged from 0.35 ft/sec to 0.60 ft/sec on July 12-13, 1993, when they were set, and from 0.05 ft/sec to 0.25 ft/sec on August 23-24, 1993, when they were collected. Qualitative data only were collected from an additional four mainstem stations at RMs 6.0, 5.9, 4.2, and 0.5. Narrative evaluations at all sites ranged from marginally good at the two most upstream stations, RMs 8.6 and 6.8 (ICI = 30, both stations), to poor and fair at the rest of the mainstem stations. The mixing zones of J&L Specialty Products outfall 003 RM 5.9 and Republic Engineered Steel outfall 010 RM 0.5 were evaluated as very poor and poor, respectively.
- Macroinvertebrate samples at the upstream stations, RMs 8.6 and RM 6.8, yielded ICI scores (30) within the nonsignificant departure range of the WWH biocriterion (ICI = 34) for the Erie/Ontario Lake Plain (EOLP) ecoregion (Figure 17). QCTV scores were 35.6 at both sites and samples included seven EPT (mayfly, stonefly, and caddisfly) taxa at RM 8.6 and four EPT taxa at RM 6.8. By comparison, sites in the Erie/Ontario Lake Plain ecoregion that achieve the ICI biocriterion generally have QCTV scores that exceed 35.7. These ICI and QCTV scores reflect marginally good conditions. Agricultural nonpoint source impacts in the upper watershed may be depressing community performance slightly below full ecoregional expectations.
- Quantitative artificial substrate samplers were set at SR 153 (RM 6.4); however, the stream bed was dry (Photo Plate 1) on August 23, 1993, when they were scheduled to be collected, and, therefore, a macroinvertebrate sample was not collected from this site. The stream bed was dry from approximately RMs 6.0 to 6.5. Shallow pools (<1 foot deep) with stranded fish were observed under the SR 153 bridge (Photo Plate 2). When Ohio EPA personnel returned to the site on August 26, 1993, these pools were completely desiccated. Only one pool with standing water, at approximately RM 6.3, was observed in this dry reach on August 23, 1993. This stream reach of the East Branch Nimishillen Creek apparently becomes intermittent due to well water withdrawal by the City of Louisville and J&L Spec. Prod. during dry weather periods.
- The J&L Spec. Prod. outfall 003 discharges to the East Branch Nimishillen Creek at RM 5.9. On August 23, 1993, water in the stream bed existed for approximately 50 to 75 yards. This area was qualitatively sampled since the planned upstream site for J&L Spec. Prod. at RM 6.4 was dry. Macroinvertebrates collected reflected poor conditions. Eighteen total taxa, including only one EPT taxa, resulted in a QCTV score of 30.6. Because this station represented backwater from the 003 effluent, the results at this station did not adequately reflect the attainable biological performance downstream from J&L Spec. Prod. It was determined that the sampling site at RM 6.8 best suited this purpose.

- The most toxic effect to macroinvertebrates in the East Branch Nimishillen Creek was observed in the mixing zone of the J&L Spec. Prod. outfall 003. For 20 minutes, two Ohio EPA personnel sampled the mixing zone and found a total of four individual organisms. This impairment was not due to habitat conditions because pool, riffle, and run habitats were available. The very poor conditions were due to the toxic nature of the J&L Spec. Prod. outfall 003 effluent, which dominated the stream flow since little or no upstream flow existed for dilution. Bioassays conducted by Ohio EPA personnel in May and August 1993, resulted in acute toxicity to *Ceriodaphnia* in all effluent samples collected. On May 17, 1993, the stream segment from RMs 6.0 to 6.5 had flowing water and, consequently, there was flow upstream from outfall 003. A mixing zone sample collected on this date resulted in no toxicity to test organisms. On August 30, 1993, the stream bed was dry from RMs 6.0 to 6.5 with little or no flow upstream from outfall 003. A mixing zone sample collected on this date resulted in acute toxicity to *Ceriodaphnia*.
- Poor conditions attributed to the toxic impact of the J&L Spec. Prod. outfall 003 effluent continued to affect the macroinvertebrate community at RM 4.7. The lowest ICI score (8) of the 1993 survey was recorded at this site. On the same day that macroinvertebrate samples were collected at RM 4.7, an instream water sample for toxicity testing was collected at RM 4.68 (upstream from the Louisville WWTP). This instream sample was acutely toxic to *Ceriodaphnia*. Another sample collected at the same time from the Louisville WWTP mixing zone resulted in no acute toxicity. Apparently the Louisville WWTP effluent diluted the impact of the J & L Spec. Prod. discharge.
- The Louisville WWTP discharges to the East Branch at RM 4.64. The macroinvertebrate community qualitatively collected at RM 4.2 reflected fair conditions. The QCTV score showed an increase from 20.2 at RM 4.7 to 31.3 at this site, total qualitative taxa increased from 13 (RM 4.7) to 31 (RM 4.2), and two EPT taxa were collected at RM 4.2 (compared to 0 EPT taxa at RM 4.7). These higher scores and numbers of taxa probably reflected a positive response to dilutional effects that the Louisville WWTP effluent exerts on the toxic effluent dominated flow upstream from the plant. Bioassay results conducted on the Louisville WWTP effluent in 1993 by Ohio EPA personnel reported no acute toxicity to test organisms.
- Macroinvertebrate scores and numbers of taxa from RM 2.8 further increased compared to those collected upstream at RMs 4.2 and 4.7. The ICI score of 28 indicated only fair conditions but was near the nonsignificant departure range of the WWH biocriterion and was only two points below the scores at RMs 8.6 and 6.8.
- Macroinvertebrate community performance again declined at the next downstream station (RM 1.9). From RM 2.8 to RM 1.9, the ICI score declined from 28 to 16, and the QCTV score declined from 34.3 to 29.2. Although the total numbers of quantitative and qualitative taxa were the same, more tolerant organisms were collected at RM 1.9 (reflected by the lower QCTV score). Three EPT taxa were collected from RM 2.8 while none were observed at RM 1.9. Ohio EPA personnel observed a change in community structure inhabiting natural substrates between these sites. The disappearance of caddisflies in the riffle at RM 1.9 (compared to a moderate density of caddisflies in the riffle at RM 2.8), accompanied by moderate densities of amphipods (*Crangonyx* sp) and midges (*Cricotopus trifascia*), indicated a toxic response.

- Ohio EPA personnel investigated a possible toxic source between RM 2.8 and RM 1.9. On August 26, 1993, a plume of gray colored water (Photo Plate 2) was observed in the East Branch Nimishillen Creek entering from a tributary at RM 2.75. Further investigation identified the probable source as oil contamination from the Conrail Railroad Yard.
- The mixing zone of Republic Engineered Steel outfall 010 (RM 0.5) was qualitatively sampled for macroinvertebrates. A total of ten taxa (no EPT taxa) with a QCTV score of 23.2 was collected. The narrative evaluation considered the macroinvertebrate community to reflect poor conditions. Bioassays conducted by Ohio EPA personnel in 1993 resulted in acutely toxic effects to *Ceriodaphnia* in some of the outfall 008 and 010 tests, but the mixing zone samples were not acutely toxic to test organisms. Unlike the toxic effluent dominated (J&L Spec. Prod.) section of the East Branch Nimishillen Creek (RMs 5.9 to 4.64), the Republic Engineered Steel outfalls did not appear to further negatively impact the creek.
- Macroinvertebrates at the East Branch Nimishillen Creek mouth site (RM 0.1) showed signs of improvement compared to RM 1.9, but still reflected only fair conditions. The ICI score increased from 16 to 18, the QCTV score increased from 29.2 to 32.2, and the EPT taxa increased from no taxa to five taxa from RM 1.9 to RM 0.1, respectively.

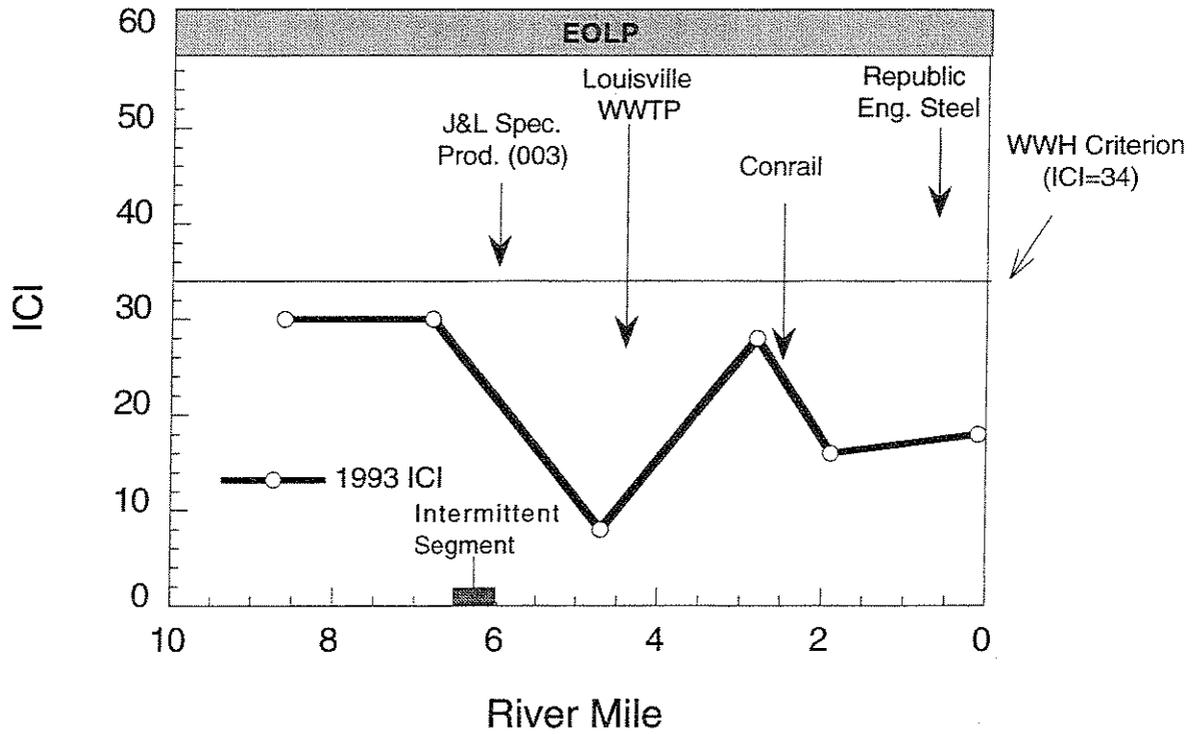


Figure 17. Longitudinal trend of the Invertebrate Community Index (ICI) in the East Branch Nimishillen Creek study area, 1993

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the East Branch Nimishillen Creek, 1993. Mixing zones sites are italicized. Stream uses indicated are those currently designated in the Ohio Water Quality Standards.

<i>Quantitative Evaluation</i>							
<i>Stream</i>	Relative	Quant.	Qual.	Qual.			
River Mile	Density	Taxa	Taxa	EPT ^a	QCTV ^b	ICI	Evaluation
<i>East Branch Nimishillen Creek (WWH)</i>							
8.6	338	35	45	7	35.6	30 ^{ns}	Marg. Good
6.8	195	29	29	4	35.6	30 ^{ns}	Marg. Good
6.0		Qual only	18	1	30.6	P*	Poor
5.9		Qual only	3	0	20.1	<u>VP</u>	<u>Very Poor</u>
4.7	73	19	13	0	20.2	8*	Poor
4.2		Qual only	31	2	31.3	F*	Fair
2.8	371	28	22	3	34.3	28*	Fair
1.9	132	28	22	0	29.2	16*	Fair
0.5		Qual only	10	0	23.2	<u>P</u>	<u>Poor</u>
0.1	246	26	26	5	32.2	18*	Fair
<i>Qualitative Evaluation</i>							
<i>Stream</i>	No. Qual.		Qual.	Relative		Predominant	Narrative
River Mile	Taxa	QCTV ^b	EPT ^a	Density		Organisms	Evaluation ^c
<i>East Branch Nimishillen Creek (WWH)</i>							
6.0	18	30.6	1	Low		Red midges	Poor
5.9	3	20.1	0	Low		<i>Midges</i>	<u>Very Poor</u>
4.2	31	31.3	2	Mod.		Caddisflies, red midges	Fair
0.5	10	23.2	0	Low		<i>Midges</i>	<u>Poor</u>
Ecoregional Biocriteria: Erie-OntarioLake Plain (EOLP)							
	<u>INDEX</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^d</u>			
	ICI	34	46	22			
a	EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies).						
b	Qualitative Community Tolerance Value (QCTV) derived as the median of the tolerance values calculated for each qualitative taxon present (see discussion in text).						
c	A qualitative narrative evaluation is based on best professional judgement utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate the Invertebrate Community Index (ICI) scores.						
d	Modified Warmwater Habitat for channel modified areas.						
*	Significant departure from ecoregional biocriterion (>4 ICI units); poor and very poor results are underlined.						
ns	Nonsignificant departure from ecoregional biocriterion (≤4 ICI units).						

Biological Assessment: Fish Community

- A total of 10,358 fish comprised of 30 species and five hybrids were collected from the East Branch Nimishillen Creek between July 12 and September 28, 1993. The sampling effort included 3.42 km at 10 sampling stations between RM 8.6 (Meese Rd.) and RM 0.1 (Cook Park).
- The numerically predominant fish species were: creek chub (29.8%), white sucker (18.0%), bluntnose minnow (13.1%), blacknose dace (9.36%), and central stoneroller (7.89%). Species that predominated in terms of biomass were white sucker (79.7%) and creek chub (8.77%). The fish assemblage was predominated by tolerant, omnivorous, and generalist feeding species both in terms of relative abundance and biomass.
- Fish community indices and narrative evaluations within the East Branch Nimishillen Creek ranged between fair (IBI=35) at RM 6.9 and very poor/poor (MIwb=4.3; IBI=23) at RM 3.4/4.2 (Table 8). Viewed in the aggregate (all stations) the overall fish community performance was characterized as poor. Community performance consistent with instream habitats and ecoregional expectations was not observed within the study area. The fish assemblage demonstrated many characteristics commonly associated with the following degraded aquatic conditions: diminished species richness, predominance by species tolerant of water quality disturbances, while intolerant forms were nearly absent from the study area. Longitudinal performance of the fish community portrayed fairly distinct impacts associated with both J&L Spec. Prod. and Louisville WWTP (Figure 18).
- The fish assemblage within the upper portion of the study area (RM 8.6 and RM 6.9) performed at poor and fair levels respectively. These stations represented the headwater reach of the East Branch Nimishillen Creek study area (*i.e.*, drainage area <20 sq. mi.). The station at RM 8.6 (Meese Rd.) was predominated by tolerant and omnivorous species. Cumulative species richness and biomass were low, the mean percent occurrence of pioneering species was over 50 % and sensitive species were lacking. The structural and functional attributes of the assemblage suggested that a recent episodic event likely impacted the upper portion of the East Branch Nimishillen Creek. Pioneering species are typically the first component of the fish community to reinvade a stream segment that has been affected by temporal desiccation and/or anthropogenic stresses (Schlosser 1990; Smith 1979). The abundance of pioneering species coupled with the low mean relative weight (12.7 kg/0.3 km) suggested that significant components of the community consisted of young pioneering species that likely reinvaded after a recent disturbance. Moreover, the loss of sensitive species reinforces the hypothesis of a recent episodic impact to the headwaters of study area. A more detailed analysis of the historic biological condition of this station can be found in the trend assessment.
- Community performance was considerably improved at RM 6.9 (SR 44). Though tolerant and pioneering species remained predominant, cumulative species richness, biomass, and relative abundance increased substantially in comparison with the upstream station. Community performance as measured by the IBI was considered fair (IBI=35).
- Longitudinal performance within the fish assemblage was significantly reduced at RM 6.4 (SR 153) upstream of J&L Spec. Prod.. Community performance as measured by the MIwb and IBI indicated a very poor/poor condition (MIwb=3.6; IBI=22). The primary cause of the observed decline appeared related to the intermittent stream flow observed during the 1993 field sampling effort. During late August, the segment of the East Branch Nimishillen Creek between RM 6.5 and RM 6.0 was observed to be effectively dry, reduced to a few disjunct

pools. Though stream flow was present during both fish sampling efforts (July and September), the fish assemblage integrated the disruptive effects of dessication on this reach. The effects of the intervening lack of aqueous habitat was evident upon examination of the results of individual fish sampling efforts. The sample collected on July 13, prior to the reported intermittency, demonstrated several significant differences when compared with the sample collected on September 27, after the documented intermittency (Figure 24). Species richness was reduced from 13 (in July) to 7 (in September). Relative abundance and relative weight were 852/0.3 km and 68.7 kg/0.3 km respectively in July; while in September, relative abundance and relative weight were 188/0.3 km and 2.14 kg/0.3 km respectively. These result coupled with index values within the poor and very poor range indicated impairment as a result of intermittent flow. For the purposes of assessing longitudinal performance the station at RM 6.4 did not appear to be an appropriate reflection of ambient biological condition upstream from J&L Spec. Prod. Instead, the station upstream at RM 6.9 was deemed more appropriate for this purpose.

- A distinct near-field impact was evident downstream of J&L Spec. Prod. within the 003 mixing zone at RM 5.9 (Figure 18). The station at RM 4.7 (downstream J&L Specialty Products; upstream Louisville WWTP) was improved in comparison with the mixing zone; however community performance in comparison with the station at RM 6.9 indicated a continued impact associated with J&L Spec. Prod. (Figure 18). The fish assemblage delineated an additional impact downstream of the Louisville WWTP within the reach between RM 4.2. and RM 3.4. Community performance within this segment as measured by the MIwb and IBI was characterized as very poor/poor (MIwb=4.3; IBI=23), and represented the most biologically degraded conditions found within the 1993 study area. The very poor/poor condition of the fish community likely reflected the combined influences of J&L Spec. Prod., Louisville WWTP, and perhaps urban nonpoint source runoff. An additional factor that likely contributed to the diminished performance of the fish community was the episodic intermittency observed at RM 6.4 (upstream of J&L Spec. Prod.). The lack of consistent stream flow during typically low flow summer conditions would greatly limit or temporarily eliminate the beneficial effects of outfall dilution by the receiving water and the availability of a localized refuge immediately upstream from a major impact. As a result, the river segment downstream of J&L Spec. Prod. was effluent dominated.
- A modest recovery of the fish community was evident further downstream within the lower segment of the study area (Figure 18). No significant additional impacts were in evidence downstream of the Conrail discharge at RM 1.9 (Trump Rd) and Republic Engineered Steel at RM 0.49 (mixing zone)/RM 0.1 (Cook Park). The station at RM 0.1 demonstrated improved functional and structural organization, and performed at a level just below the upstream station at RM 6.9 (Table 8). In addition, four sensitive species, one classified as intolerant (hornyhead chub), were represented within the fish assemblage, providing additional evidence of biological recovery.

Table 8. Fish community indices based on pulse D.C. electrofishing samples at eight locations sampled by Ohio EPA in the East Branch Nimishillen Creek study area during July and September, 1993. All stations sampled by the wading method.

Stream River Mile	Mean Number Species	Cumulative Species	Mean Rel.No. (No./0.3Km)	Mean Rel.Wt. (Wt./0.3Km)	QHEI	Mean Index of Well-Being	Mean Biotic Integrity	Narrative Evaluation ^a
East Branch Nimishillen Creek (1993)								
<i>Erie Ontario Lake Plain - WWH Use Designation (Existing)</i>								
8.6	14.5	16	807	12.7	68.5	N/A	27*	Poor
6.9	18.5	21	2894	85.7	78.5	N/A	35*	Fair
6.4	10.0	15	520	35.4	58.0	<u>3.6*</u>	<u>22*</u>	V.Poor/Poor
5.9 ^{mz}	8.5	10	255	2.6	-	<u>5.0*</u>	<u>24*</u>	Poor
4.7	16.5	19	381	36.6	80.0	<u>4.8*</u>	28*	Poor/Fair
4.2	14.5	16	788	72.5	74.0	<u>4.3*</u>	<u>23*</u>	V.Poor/Poor
3.4	13.0	15	479	55.3	60.0	<u>4.3*</u>	<u>23*</u>	V.Poor/Poor
1.9	11.0	13	376	5.0	81.5	<u>5.2*</u>	28*	Poor/Fair
0.49 ^{mz}	10.5	14	261	11.4	-	<u>7.3*</u>	33*	Fair
0.1	18.0	19	1382	28.3	54.0	7.9	30*	Good/Fair
East Branch Nimishillen Creek (1986)								
4.7	14.0	14	640	12.3	72.0	<u>5.4*</u>	<u>26*</u>	Poor
4.2	12.0	12	343	17.5	64.0	<u>3.9*</u>	<u>22*</u>	V.Poor/Poor
3.4	9.0	9	195	15.3	60.0	<u>2.4*</u>	<u>20*</u>	V.Poor/Poor
East Branch Nimishillen Creek (1985)								
8.6	18.7	22	2483	48.6	63.0	N/A	39 ^{ns}	M. Good
6.4	18.3	21	1438	13.0	51.0	6.7*	33*	Fair
4.7	15.3	19	912	18.8	80.0	6.4*	29*	Fair
4.2	12.7	18	773	45.4	66.0	<u>3.8*</u>	<u>23*</u>	V.Poor/Poor
3.4	15.3	20	956	112.4	64.0	<u>4.4*</u>	<u>24*</u>	V.Poor/Poor
1.9	13.3	17	1225	25.4	65.0	<u>5.1*</u>	<u>24*</u>	Poor
0.1	17.0	23	1943	23.7	58.0	8.2	31*	Good/Fair

* - Significant departure from applicable criteria (>4 IBI units or >0.5 MIwb units); underlined values were in the poor or very poor range.

ns - Nonsignificant departure from biocriteria (<4 IBI units or <0.5 MIwb units).

a - Narrative evaluation is based on both MIwb and IBI.

N/A - Headwater station, MIwb is not applicable.

mz - Mixing zone station.

Ecoregion Biocriteria: Erie Ontario Lake Plain

Index - Site Type	WWH	EWI	MWH ^d
IBI - Headwaters	40	50	24
IBI - Wading	38	50	24
MIwb - Wading	7.9	9.4	5.8

d - Modified Warmwater Habitat for channel modified areas.

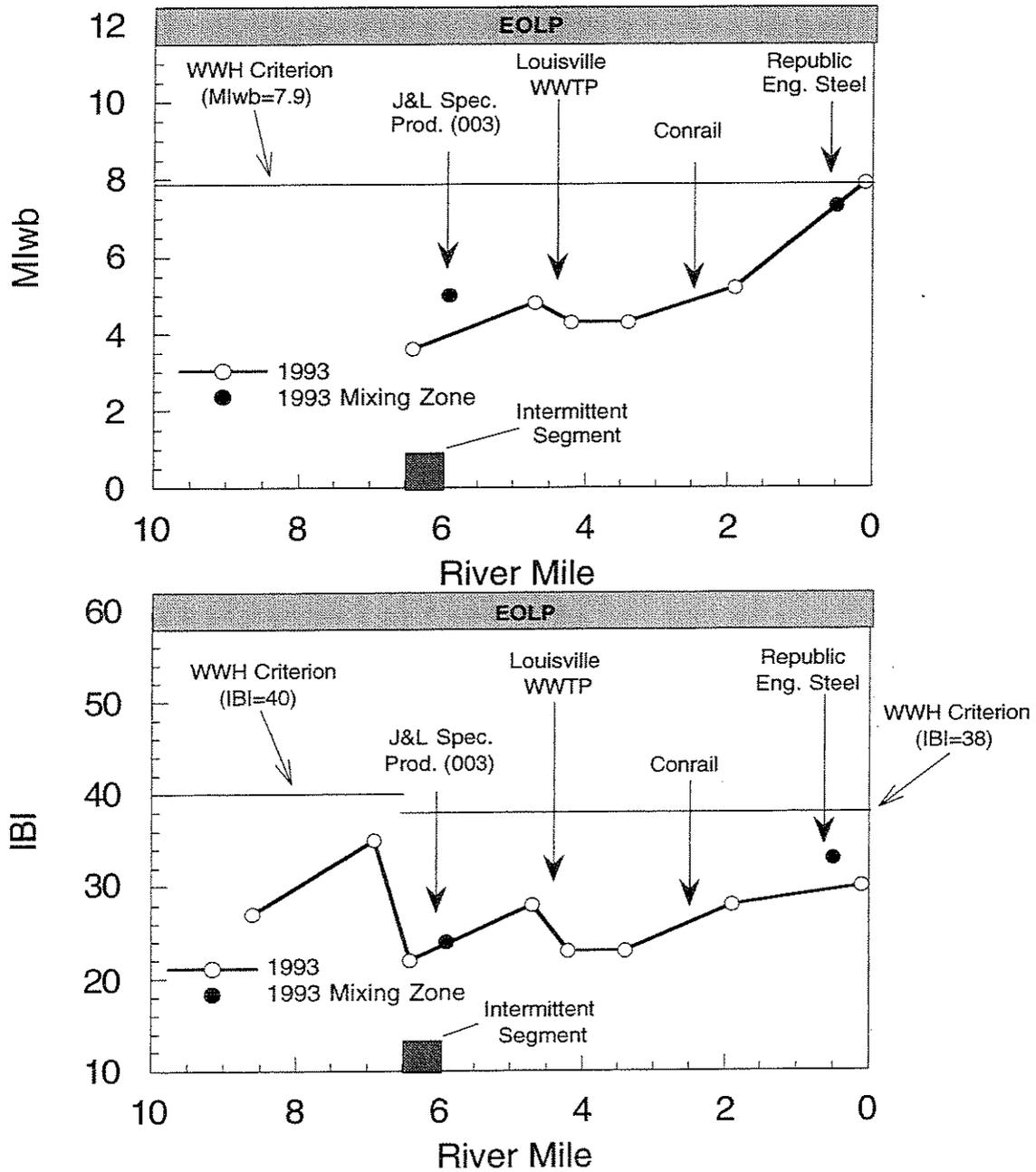


Figure 18 . Longitudinal trend of the Modified Index of Well-Being (MIwb), and the Index Biotic Integrity (IBI) in the 1993 East Branch Nimishillen Creek study area.

Trend Assessment

East Branch Nimishillen Creek

Chemical Water Quality Changes: 1985-1993.

- The city of Louisville North WWTP discharge was tied into the Louisville South WWTP sometime in late 1987. Improvements to the Louisville South WWTP, completed in 1988, have resulted in a significant decrease in the loadings of oxygen demanding substances and ammonia to the East Branch Nimishillen Creek (Figure 19). There has also been a significant decrease in the 95th percentile loading of TSS from the City of Louisville South WWTP since 1988.
- In addition to the Louisville North WWTP, three other NPDES permitted dischargers were eliminated between 1988 and 1992: Liquid Carbonic (April, 1990); WCI Drainage Products (May 1992); Ford Motor Company (December 1988).
- Comparison of grab surface water samples collected in the East Branch between 1985 and 1993 indicates the following trends in chemical water quality over time (Figures 16 and 17): (1) as compared to background levels significantly higher amounts of nitrate+nitrite-N and total dissolved solids continue to be present below the J&L Spec. Prod. discharges; (2) there continues to be a significant decline in instream dissolved oxygen levels below the J&L Spec. Prod. discharges down to RM 3.47; (3) since 1985, ammonia-N levels have significantly decreased immediately below the Louisville South WWTP; (4) ammonia-N has significantly increased in 1993 immediately below the J&L Spec. Prod. discharges; (5) concentrations of COD have increased slightly in the mainstem; and (6) concentrations of total phosphorus have decreased in the mainstem.
- During the 1985 survey elevated levels of total arsenic were measured in the East Branch Nimishillen Creek below the J&L Spec. Prod. 003 outfall. Between 1986 and 1987 the company isolated and removed a source of arsenic. Survey results in 1993 indicate that no arsenic was detected in the stream below the 003 discharge. It would appear that the source of arsenic has been virtually eliminated.

Sediment Chemistry Changes: 1985-1993.

- Only two stations at RMs 0.1 and 6.36 were sampled in both 1985 and 1993 for sediment contamination. The analysis of these trend data indicate higher concentrations of arsenic, chromium, and lead at RM 0.1 in 1993, and much lower concentrations at RM 6.36 in 1993 (Figures 21 and 22).
- PCBs were not found in the sediment at RM 6.36 (Rt. 153) in 1993; however, PCB-1242 (21 ug/kg) and PCB-1260 (48 ug/kg) were found during the 1985 survey. PCB spills were reported in 1982 and 1983 at the Ohio Transformer Company, with releases of 210 gallons of oil contaminated with PCBs. It is possible that the PCBs detected in 1985 were the result of these spills.

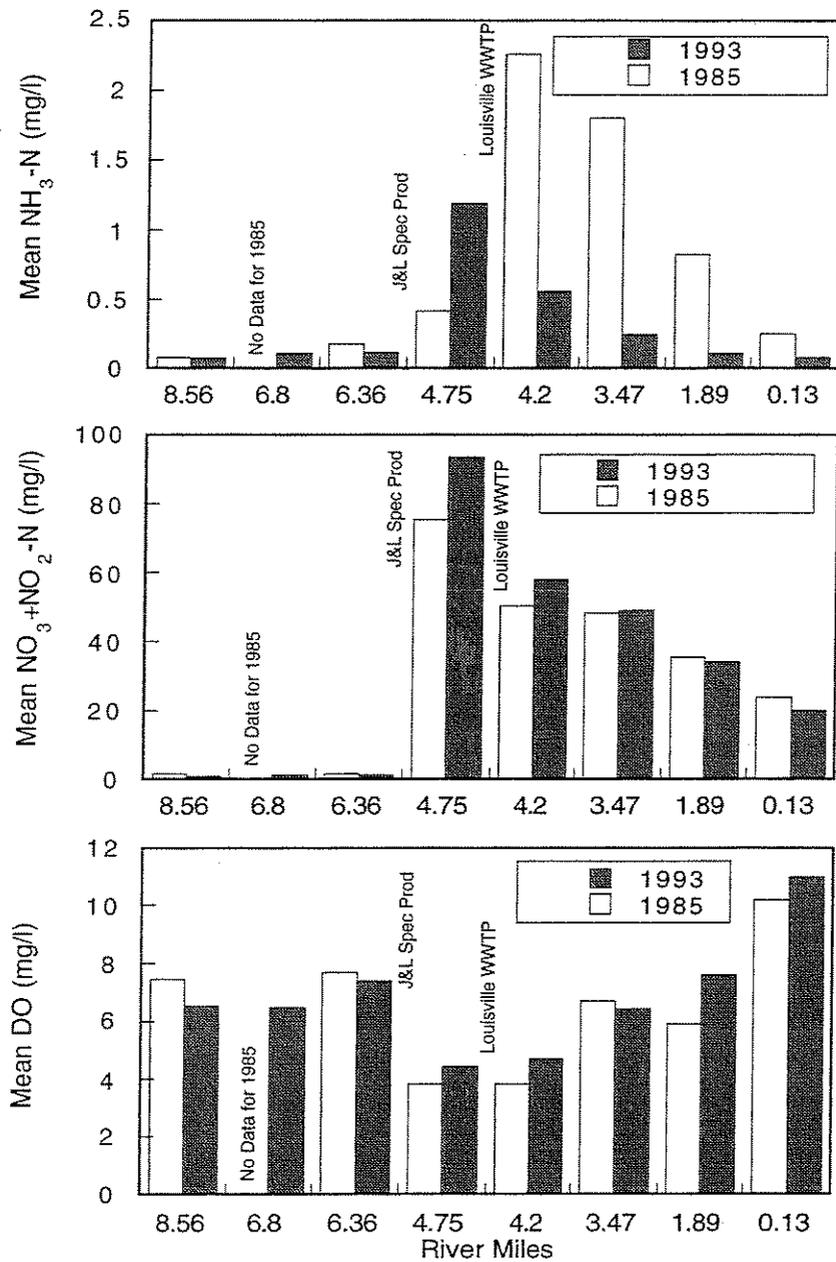


Figure 19. Longitudinal instream trends of ammonia, nitrate+nitrate-N, and dissolved oxygen for 1985 and 1993 in the East Branch Nimishillen Creek.

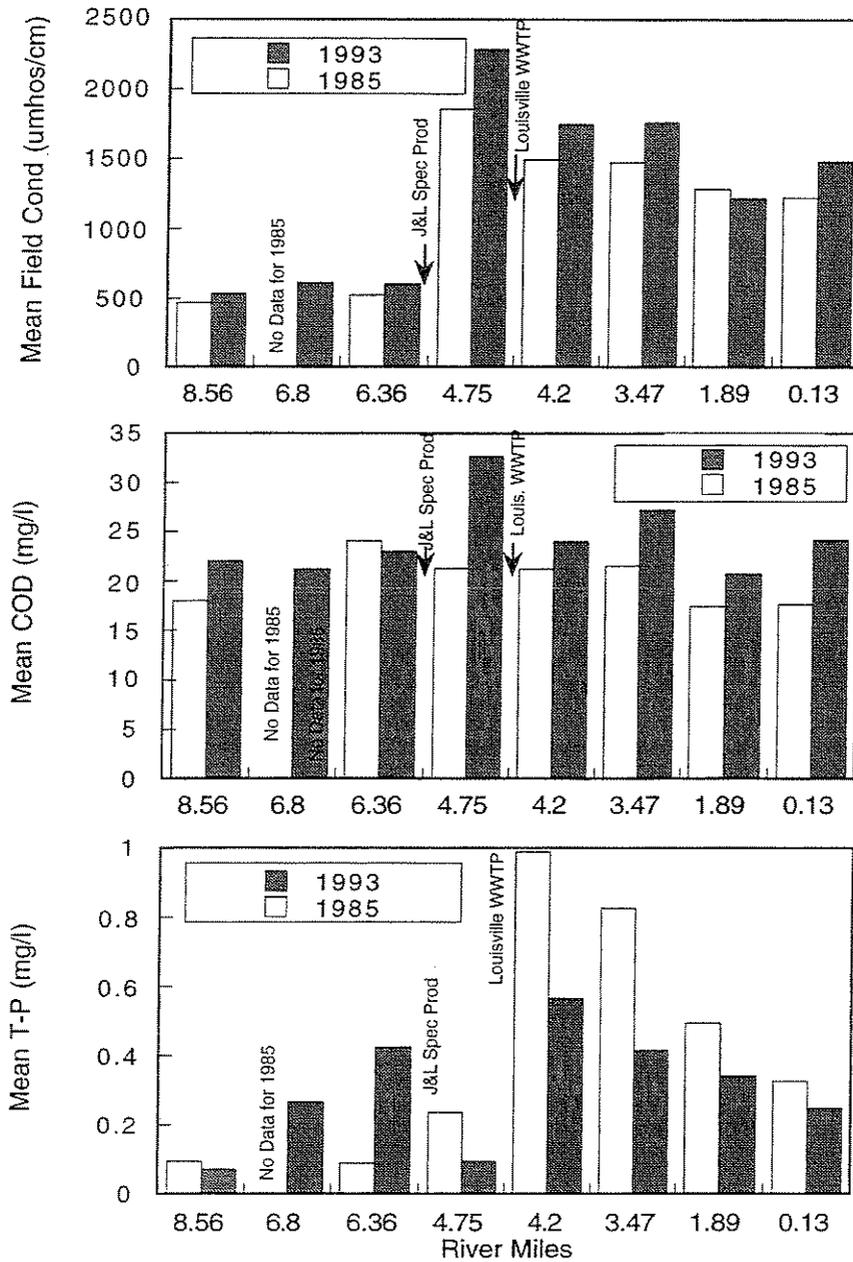


Figure 20. Longitudinal instream trends of conductivity, chemical oxygen demand, and phosphorous for 1985 and 1993 in the East Branch Nimishillen Creek.

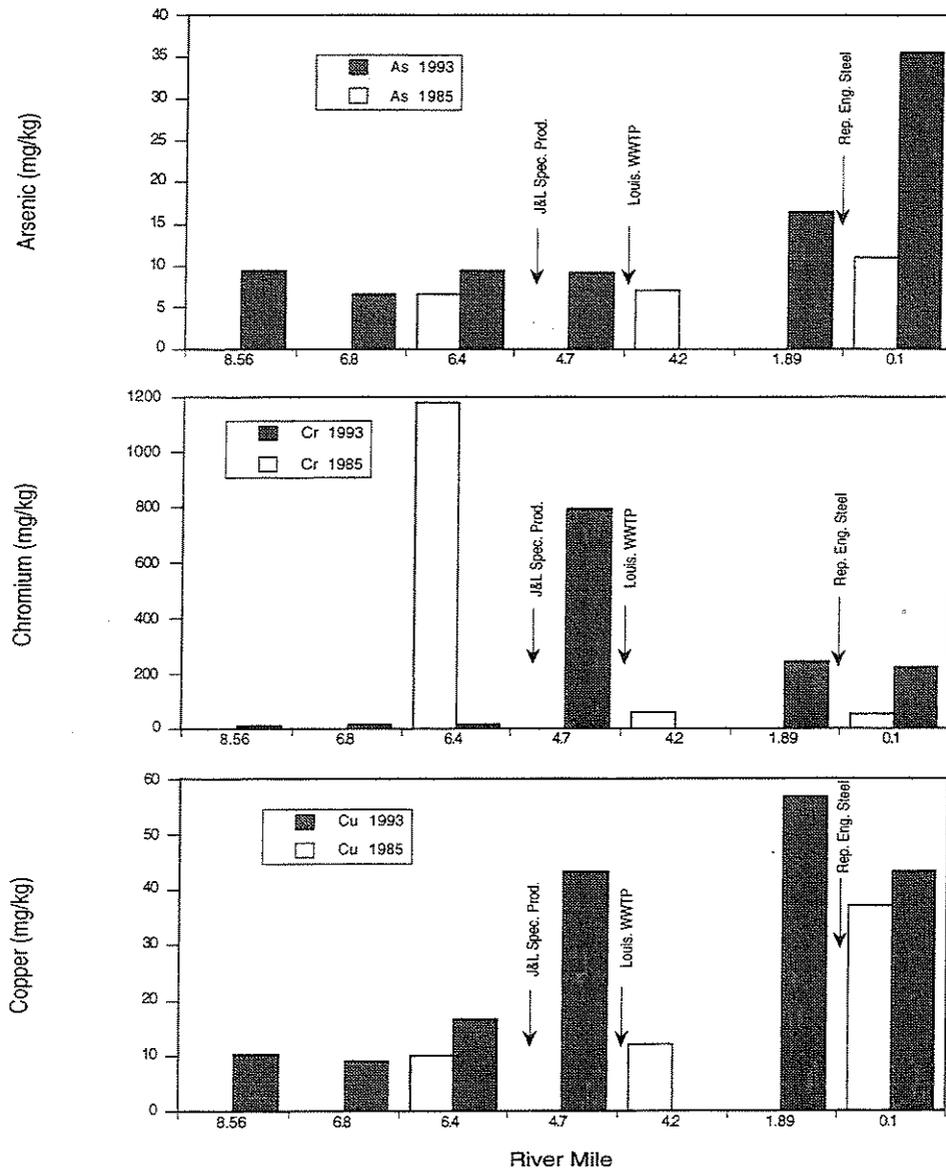


Figure 21. Sediment chemistry trends in the East Branch Nimishillen Creek in 1985 and 1993 for arsenic, chromium, and copper.

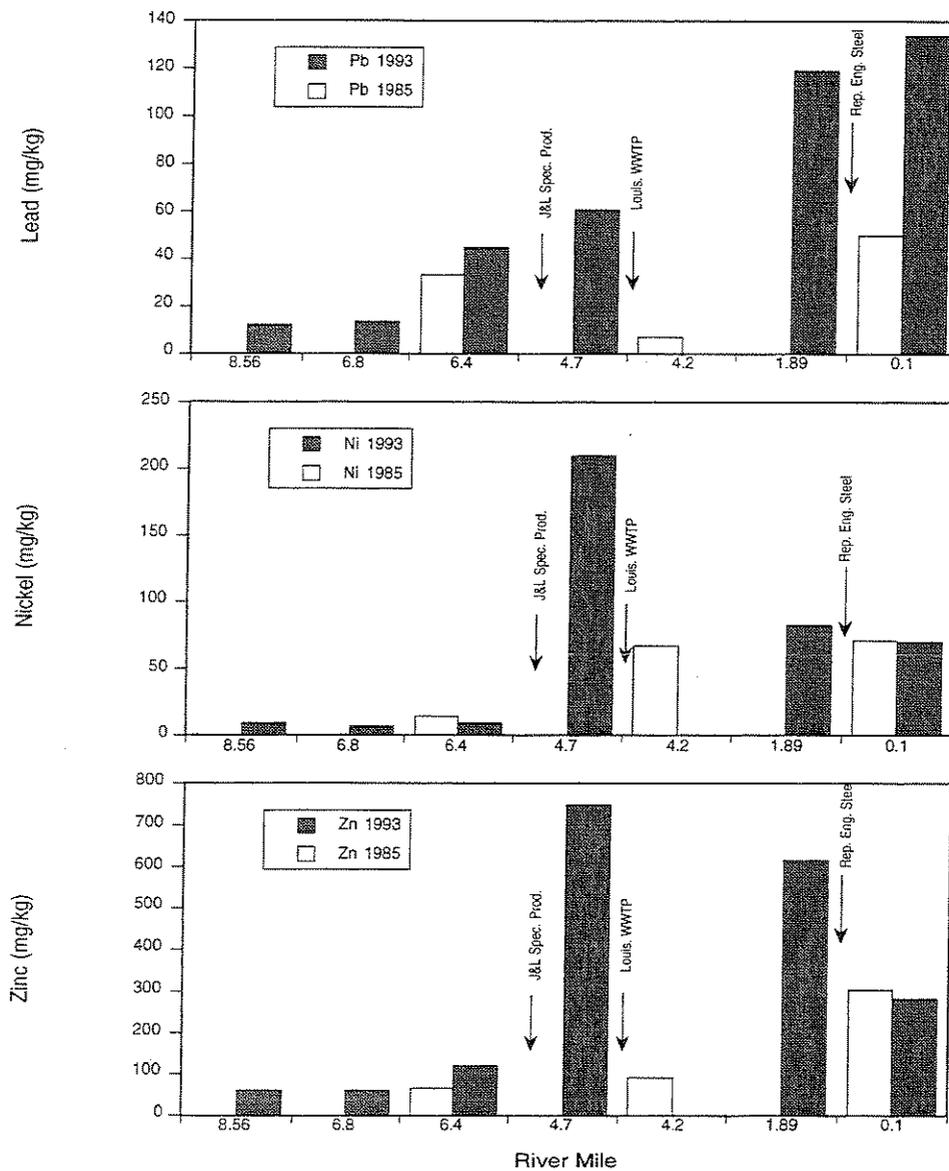


Figure 22. Sediment chemistry trends in the East Branch Nimishillen Creek in 1985 and 1993 for lead, nickel, and zinc.

Changes in Biological Community Performance: 1985-1993

Macroinvertebrate Community: 1985-1993

Overall Trends/Area of Degradation Value (ADV)

- Macroinvertebrates were collected from the East Branch Nimishillen Creek in 1985 and 1993 from RM 8.6 (Meese Rd.) to RM 0.1 (Cook Park). Longitudinal performance of ICI scores showed comparable trends between both survey years from good and marginally good conditions (upstream from RMs 8.6 and 6.8) to poor (below J&L Spec. Prod. at RM 4.7) and fair (RMs 4.2, 2.8, 1.9, and 0.1) conditions (Figure 23). No site achieved the WWH biocriterion in the lower 5.9 miles of the stream below J&L Spec. Prod. during either year.
- Area of Degradation Values (ADV) for the 1985 and 1993 surveys (Table 9) provide a relative measure of performance of the ICI in the East Branch Nimishillen Creek. The ICI ADV/mile value for the entire mainstem was lower in 1993 (28% lower than 1985) indicating an improvement in this indicator. The ADV/mile value for the ICI in the lower 4.7 miles of the mainstem declined by 45% in 1993. This decline was most likely caused by the improvements made at the Louisville WWTP between 1985 and 1993. However, the ADV/mile value for the ICI in the upper mainstem increased by 50% in 1993. This change was due to the changes which took place at RM 8.6.

Local/Site-Specific Trends

- In 1985, the most upstream station at RM 8.6 (Meese Rd.) had an ICI score of 40. Community composition included 33 total taxa with 9 EPT taxa and indicated good conditions. Macroinvertebrate data from 1993 was of lesser quality (ICI = 30, total taxa = 35, 7 EPT taxa) and was evaluated as marginally good (Figure 23). The macroinvertebrate community at this station these two may have been responding to differing levels of nonpoint sources of pollution in the upper part of the watershed.
- Downstream from J&L Spec. Prod. at RM 4.7, macroinvertebrate communities indicated poor conditions both survey years (ICI = 4 in 1985, and ICI = 8 in 1993). No EPT taxa were collected from the artificial substrate quantitative samples or from natural substrates either survey year at this station. In 1985, one of the possible sources for the poor conditions at RM 4.7 was attributed to arsenic in the J&L Spec. Prod. outfall 003 effluent. The arsenic problem has since been alleviated. In 1993, the poor conditions reflected by the macroinvertebrate community were again attributed to the outfall 003 effluent which dominated the stream flow and, in fact, represented the total flow in the East Branch at the outfall 003 during some dry weather periods. The likely cause of these poor conditions were toxic levels of ammonia-N, nitrate+nitrite-N, nitrite-N, and TDS which were measured immediately below outfall 003. Very low levels of dissolved oxygen (below 2.0 mg/l) were also measured immediately downstream.
- The only macroinvertebrate community improvements observed in the East Branch Nimishillen Creek from 1985 to 1993 were at RM 4.2 and RM 2.8. The ICI score increased from 20 to 28 at RM 2.8 during these years. At RM 4.2, qualitative sampling indicated a predominance of more tolerant organisms (blackflies) in 1985 compared to 1993 (caddisflies) and this was also reflected in the QCTV scores (26.1 in 1985 compared to 31.3 in 1993). Still, both sites were evaluated as fair both years, although the 1993 ICI score of 28 at RM 2.8 was within two of from the insignificant departure range of the EOLP ecoregional biocriterion.

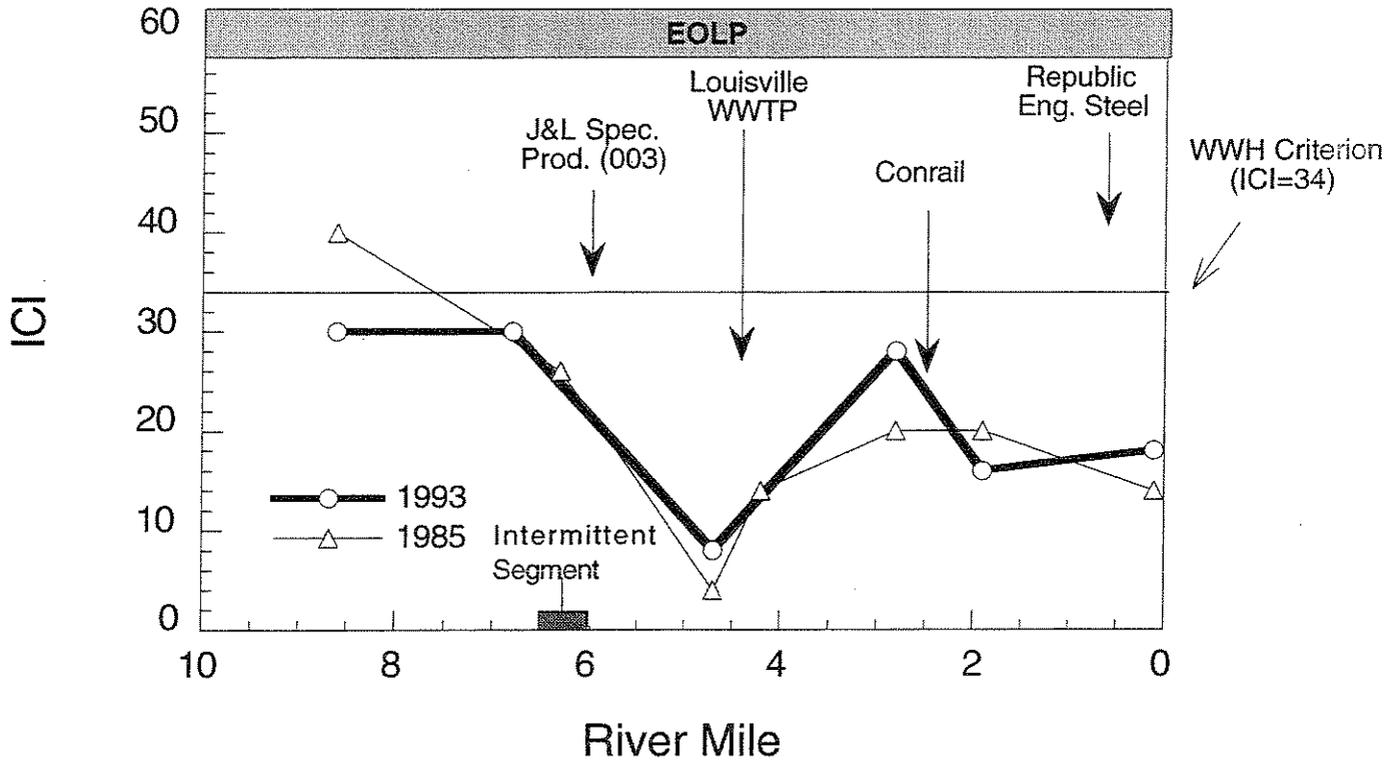


Figure 23. Longitudinal trend of the Invertebrate Community Index (ICI) in the East Branch Nimishillen Creek study area, 1985 and 1993.

- From 1985 to 1993 the macroinvertebrate community at RM 1.9 showed a slight decline in the ICI score (20 to 16) and in numbers of taxa. Four EPT taxa were collected from the natural substrates in 1985, but no EPT taxa were collected in 1993. The probable cause for the disappearance of these taxa may have been the observed oil contamination from the Conrail Railroad Yards.
- The site near the mouth in Cook Park (RM 0.1) had similar ICI scores and numbers of taxa in 1985 and 1993, and, as such, indicated little overall change in macroinvertebrate condition or quality; both years were evaluated as fair and not meeting ecoregional expectations..

Fish Community: 1985-1993

Overall Trends/Area of Degradation Value (ADV)

- Fish community data were collected from the East Branch Nimishillen Creek study area in 1985, 1986, and 1993. Both the 1985 and 1993 surveys evaluated the stream reach between RM 8.6 (Meese Rd.) and RM 0.1 (Cook Park). Data collection in 1986 consisted of a much smaller sampling effort including the reach between RM 4.7 and RM 3.4 and is not included here. Longitudinal performance of recent and historic fish community data delineated several areas of significant decline (Figure 25).
- Area of Degradation Values (ADV) for the 1985 and 1993 surveys (Table 9) provide a relative measure of performance of the IBI and MIwb in the East Branch Nimishillen Creek. The IBI ADV/mile value for the entire mainstem was higher in 1993 which could have signified an overall decline in community performance since 1985 (Table 9). However, this change was due to the changes which took place at RM 8.6. The MIwb ADV value in 1993 was slightly lower than in 1985 indicating a slight improvement in this indicator.
- ADV statistics compiled for the lower 4.7 miles of the mainstem provide a clearer picture of the changes downstream from the major point sources between 1985 and 1993. The ADV/mile values for IBI and MIwb declined by 18% and 37%, respectively in 1993 (signifying a lessened impact). Other ADV statistics such as the poor/very poor ADV have improved markedly for both indices since 1985. However, the overall use attainment status (Table 9) has not changed. These results indicate that while the overall severity of impairment to the fish community has lessened, the extent of the overall impairment remains at similar levels to those observed in 1985.

Local/Site-Specific Trends

- The fish assemblage at RM 8.6 (Meese Rd.) demonstrated a substantial decline in 1993 compared with the results from the 1985 survey. Performance as measured by the IBI was reduced from 39 in 1985 to 27 in 1993 which is a significant departure from WWH biological criteria. Nearly every attribute of the fish assemblage was diminished in 1993 (Figure 26). Mean species richness was reduced from 18.7 in 1985 to 14.5 in 1991. The percent occurrence of tolerant, omnivorous, and pioneering species demonstrated significant increases when compared with the 1985 survey results. Additional evidence of recent degradation within the assemblage included the loss of sensitive and headwater species. In 1985, hog sucker, rainbow darter, smallmouth bass, and southern red-bellied dace were well represented within the fish assemblage. The results from the 1993 survey indicated that these species have either been eliminated or displaced within the headwaters of the study area. The high percentage of pioneering species coupled with the loss of sensitive and typical headwater species suggested a recent episodic event likely impacted this reach of the East Branch Nimishillen Creek. No information was available from the Ohio DNR documenting fish and wildlife kills within the upper portion of the study area. However, a significant episodic impact was evident from the condition of the fish assemblage. The ultimate cause(s) were not clear, but were likely associated with agricultural nonpoint source(s). Given the agricultural land use within the headwaters, poorly managed fertilizers, herbicides, or livestock wastes may have entered the stream in sufficient quantity to significantly disturb the fish community prior to the 1993 sampling effort. Fish assemblages associated with headwater stream systems typically exhibit rapid post-disturbance (desiccation and/or other anthropogenic stresses) recovery, provided that refugia exist within tributaries and/or adjacent segments, and that the particular stressing agent is not chronic (Bayley and Osborne 1993). It is likely that recovery within the upper segment of the study area will be forthcoming if the perturbation was indeed an isolated event.

- The fish community at RM 6.4 (SR 153) portrayed a significant decline when compared to the results from 1985. Community index values and narrative evaluation at this station were reduced from fair (IBI=33; MIwb=6.7) in 1985 to very poor/poor (IBI=22; MIwb=3.6) in 1993. The poor performance documented in 1993 was a result of the intermittent stream flow observed during August 1993. The intermittent condition at this station appeared related to ground water withdrawals by the City of Louisville and J&L Spec. Prod., and a markedly dry August. Precipitation within the state and particularly within the Central Hills hydrologic region during the summer of 1993 was below average with a Palmer Drought Severity Index that ranged between -1.1 and -3.0 (mild to severe drought conditions; Ohio DNR 1993). It is likely that the dry conditions observed during the summer of 1993 coupled with ground water withdrawals caused the localized intermittency. The lack of consistent stream flow at this station would likely preclude the establishment of a diverse and functionally organized fish assemblage within this reach. Though intermittency was observed in 1985, this segment was not desiccated until early October, well after the fish sampling efforts of that year. In addition, precipitation in 1985 within the Central Hills hydrologic region was nearly 10% above average (Ohio DNR 1985). Given the hydrologic data and performance of the fish community near WWH levels, it appeared as though the reach in 1985 retained flow through the summer months, and/or for a period long enough to support a temporal community of fishes more diverse and organized than that encountered in 1993. Provided sufficient flow was maintained in 1985, headwater fish communities have demonstrated the ability to rapidly invade and repopulate decimated areas within one year's time (Bayley and Osborne 1993).
- The fish community at RM 4.7 (downstream J&L Spec. Prod.) demonstrated an incremental decline from 1985 levels. The MIwb portrayed diminished community structure between 1985 and 1993. The IBI indicated little difference at this station between 1985 and 1993, which suggested that minimal functional organization within the assemblage was maintained in the intervening eight year period.
- The fish community demonstrated a modest recovery from impacts likely associated with the Louisville WWTP at RM 3.4 in 1986 (Figure 25). Despite the improvement observed at this station in 1993, the assemblage still remained degraded and performance better than poor/very poor was not observed at RM 3.4. Performance of the fish community within the lower reach of the study (RM 1.9 to RM 0.1) area demonstrated little change between 1985 and 1993. Both the 1993 and 1985 fish community samples indicated modest biological recovery at RM 0.1 (Cook Park).

Summary of Fish Community Performance: 1985 to 1993

- The overall performance of the fish community within the East Branch Nimishillen Creek study area has substantially worsened at specific sites over the past eight years. Declines in community performance indicators were most evident at RM 8.6 and RM 6.4. The headwater station at RM 8.6 was likely impacted by an episodic event, possibly associated with agricultural nonpoint source pollution (*i.e.*, pesticides, fertilizer, and/or livestock wastes). The station at RM 6.4 was significantly impacted by localized intermittent flows during the 1993 sampling efforts. Though modest fluctuations of index values were evident within the middle and lower segment of the study area, the fish community remained at poor and very poor range performance levels in 1993.

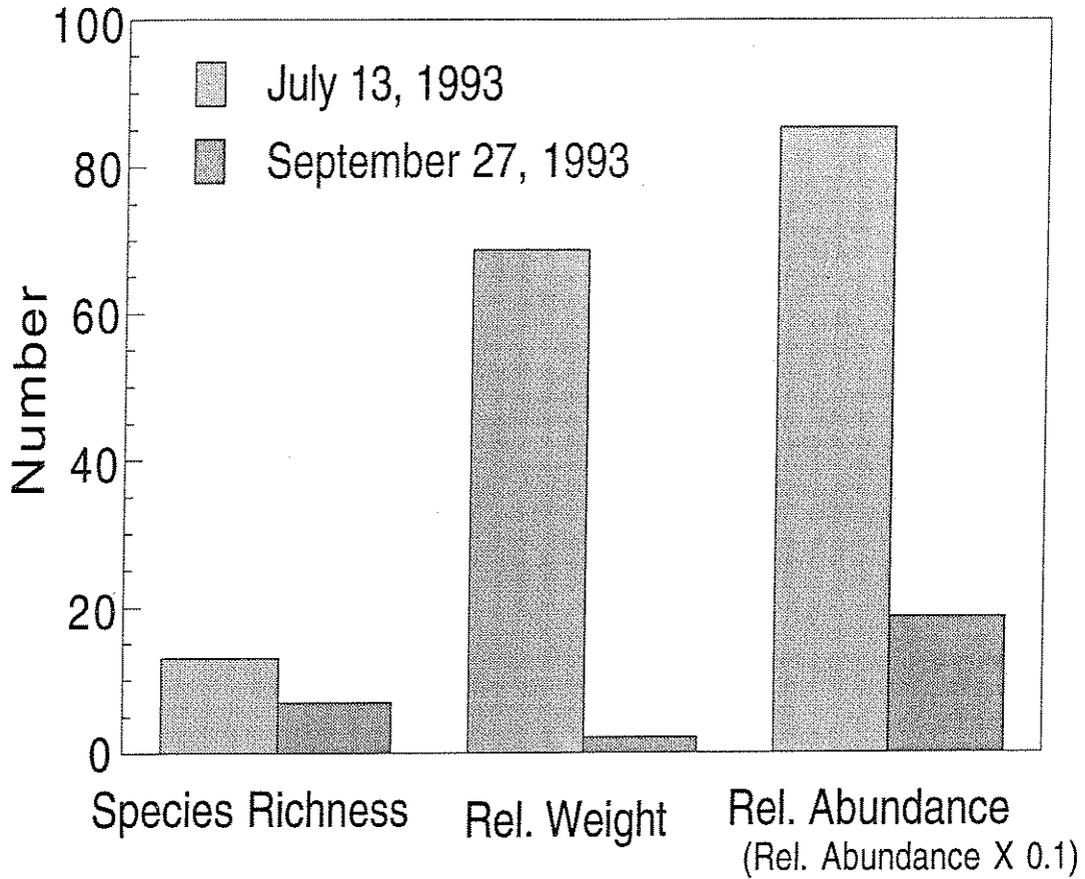


Figure 24. Comparison of structural attributes of individual fish sampling efforts at RM 6.4 (SR 153). Fish community data collected in July represented pre-intermittent condition. The data collected in September represented post intermittent condition.

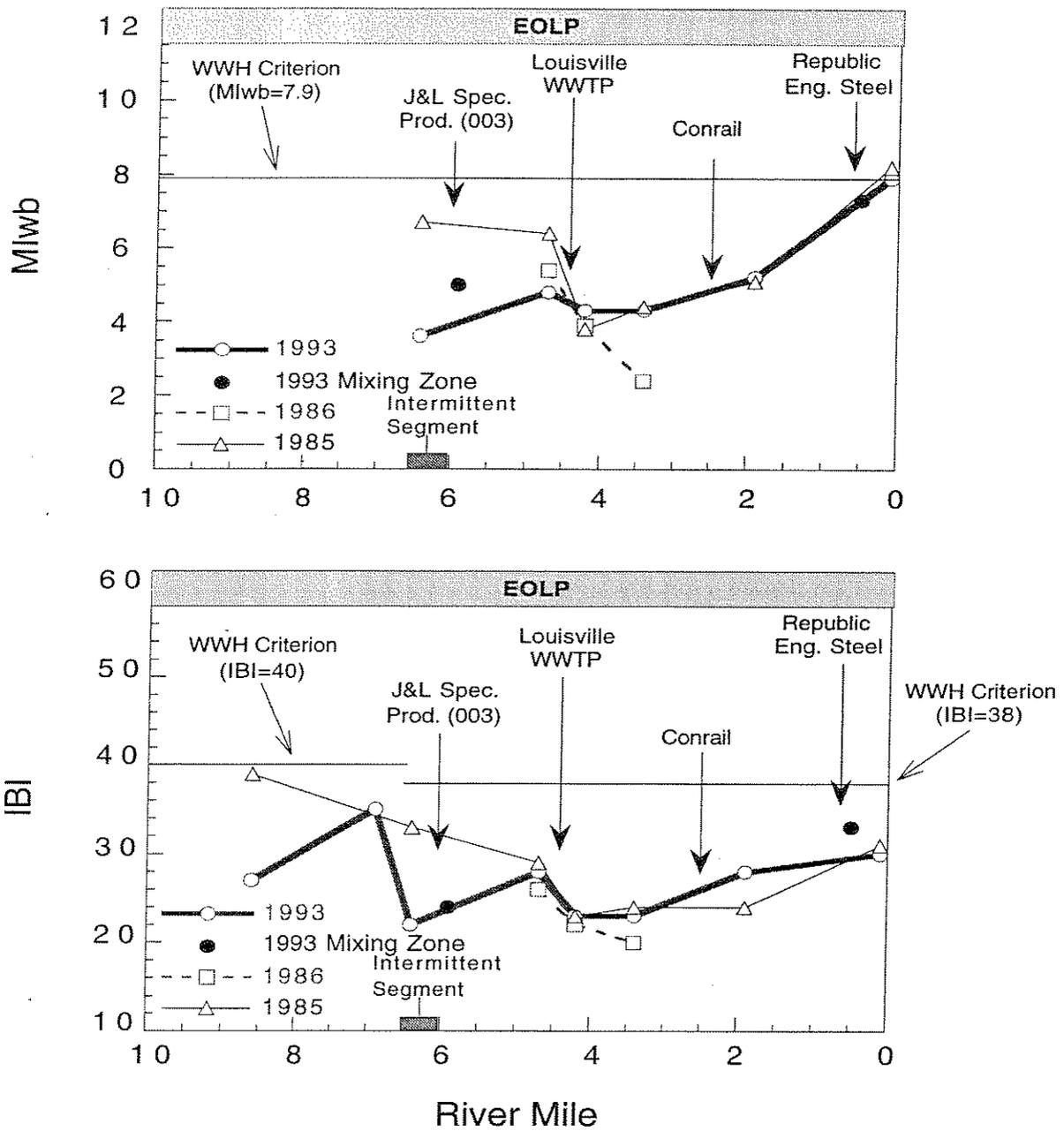


Figure 25. Longitudinal trend of the Modified Index of Well-Being (MIwb), and the Index of Biotic Integrity (IBI) in the 1985, 1986, and 1993 East Branch Nimishillen Creek study area.

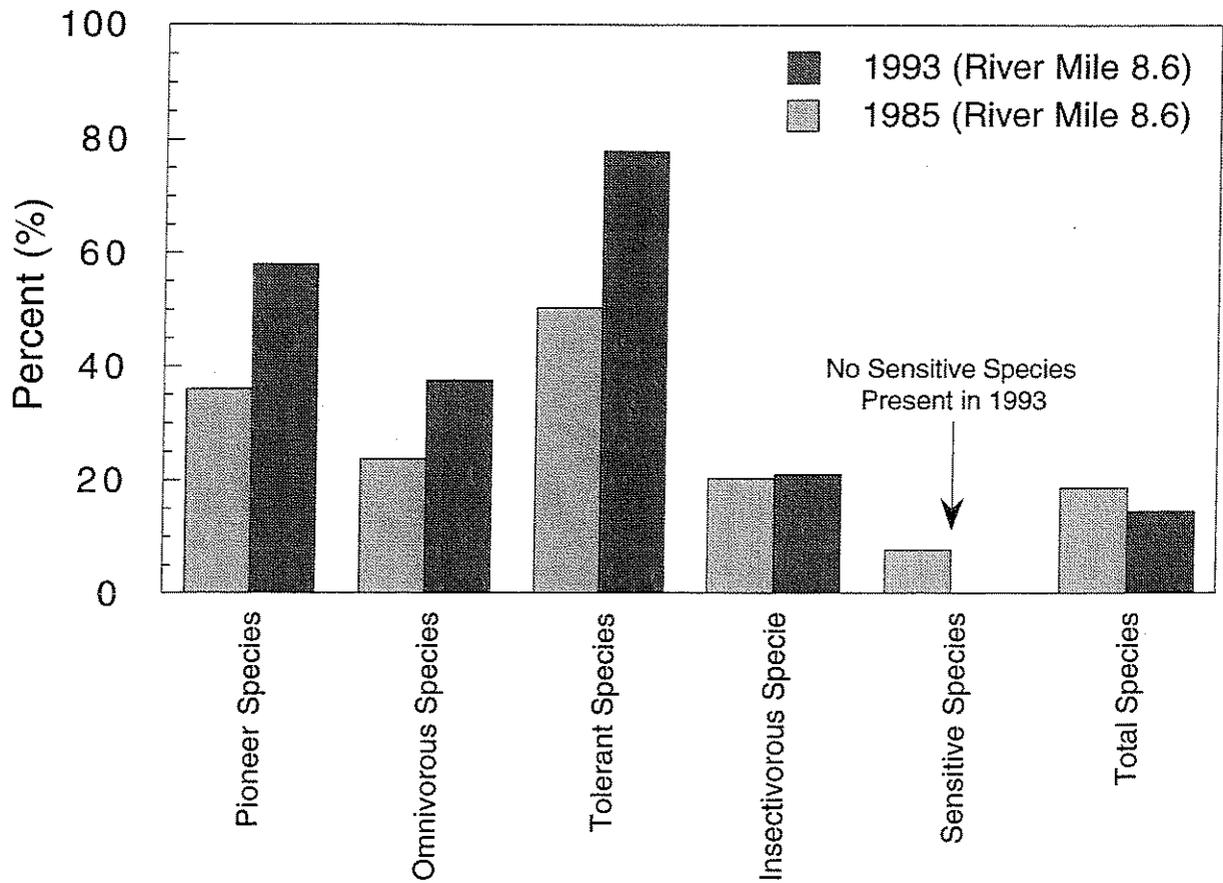


Figure 26. Comparison of functional and structural attributes of the fish assemblage at RM 8.6 between 1985 and 1993. (Note: the mean species values presented are not percentages)

Table 9. Area of Degradation (ADV) statistics for the entire East Branch Nimishillen Creek mainstem (RM 8.6 - 0.1) and the segment downstream from J&L Spec. Prod. (RM 4.7 - 0.1) during 1985 and 1993. The 1985 and 1993 ADV values were calculated using the ecoregion biocriteria as the background community performance.

<i>Stream</i> Index	Biological Index Scores				ADV Statistics			Attainment Status (miles) ^a			
	Upper RM	Lower RM	Mini- mum	Maxi- mum	ADV	ADV/ Mile	Poor/VP ADV	FULL	PARTIAL	NON	Poor/VP
<i>East Branch Nimishillen Creek (1993): RM 8.6 - 0.1</i>											
IBI	8.6	0.1	23	35	611	72	71				
MIwb	6.9	0.1	3.6	7.2	500	74	34	0	1.7	7.5	4.4
ICI	8.6	0.1	8	30	641	75	15				
<i>East Branch Nimishillen Creek (1985): RM 8.6 - 0.1</i>											
IBI	8.6	0.1	23	39	459	54	91				
MIwb	6.4	0.1	3.8	8.2	545	87	36	1.8	1.1	6.3	4.3
ICI	8.6	0.1	4	40	888	104	39				
<i>East Branch Nimishillen Creek (1993): RM 4.7- 0.1</i>											
IBI	4.7	0.1	23	33	345	75	63				
MIwb	4.7	0.1	4.3	7.9	315	68	20	0	0.5	4.3	2.7
ICI	4.7	0.1	8	28	421	92	9				
<i>East Branch Nimishillen Creek (1985): RM 4.7- 0.1</i>											
IBI	4.7	0.1	23	31	422	92	91				
MIwb	4.7	0.1	3.8	7.9	495	108	36	0	0.6	4.2	4.2
ICI	4.7	0.1	4	20	778	169	60				

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