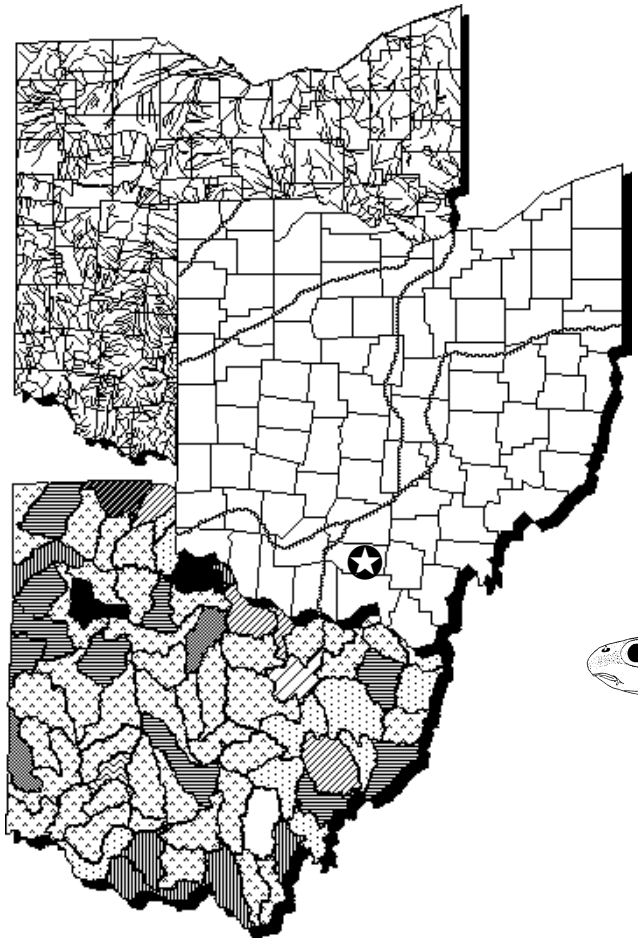
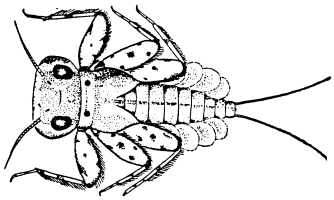
State of Ohio
Environmental Protection Agency

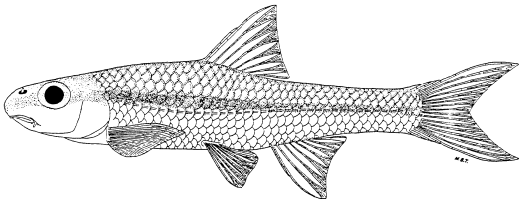
Ecological Assessment Section
Division of Water Quality
Planning & Assessment

Biological and Water Quality Study of Sevenmile Creek

Preble and Butler Counties (Ohio)







November 25, 1992

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-0149

Biological and Water Quality Study of Sevenmile Creek

Preble and Butler Counties, Ohio

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OEPA Technical Report EAS/1992-11-9

prepared by

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

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 - WQP&A
Ecological Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228
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Acknowledgements

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

Study Area Description - Hugh Trimble
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Kurt Chipps of the Water Quality Modeling Section provided (in part) chemical data used in this report. Major assistance with the preparation of the study area map was provided by Rich McClay.

Biological and Water Quality Survey of Sevenmile Creek (Preble and Butler Counties, Ohio)

Ohio Environmental Protection Agency
Division of Water Quality Planning and Assessment
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Introduction

The Sevenmile Creek study area extended from upstream from Gettysburg (RM 35.5) to the mouth with Fourmile Creek (RM 1.2) and included the municipal areas of Gettysburg, Eaton, Lake Lakengren, and Camden (Figure 1). Impacts of non-point source pollution were evaluated throughout the Sevenmile Creek mainstem along with point source dischargers.

Specific objectives of this evaluation were to:

1) Evaluate the potential impact from the Lake Lakengren, Eaton and Camden WWTPs.

2) Evaluate the existing Warmwater Habitat and Exceptional Warmwater Habitat use designations and attainment status.

3) Evaluate non-point source pollution impacts in the upper watershed.

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
Under the existing use designations, much of the lower portion of Sevenmile Creek (from RM 24.2 and downstream) is achieving the specified biological performance criteria for Exceptional Warmwater Habitat (EWH) and Warmwater Habitat (WWH). Ambient biological performance indicates that downstream from the confluence of Paint Creek (RM 15.18) Sevenmile Creek has the capability to attain EWH. When the EWH use designation is applied to this stream segment it results in partial attainment downstream of the Camden WWTP discharge. Partial attainment also occurred at RM 26.5/26.7 downstream of Parker Hannifan. Under the existing use designations Sevenmile Creek has 11.5 miles FULLY attaining, 14.1 miles PARTIALLY attaining and **2.9** miles **NON** attaining. Using the recommended use designation, 11.8 miles are FULLY attaining, 13.9 miles are PARTIALLY attaining and **2.3** miles are **NON** attaining. Changes in attainment miles are in part a result of changing the headwater areas from EWH to the more appropriate WWH use designation. Much of the headwater area designated EWH is in FULL attainment under the proposed new WWH use designation change. This larger area of attainment is off set though by a loss of attaining miles in Sevenmile Creek downstream of Camden's WWTP, where the use designation is proposed to change from WWH to EWH.

Exceedences of acute toxicity criteria for zinc levels were detected at RM 27.0 and 24.1. Phosphorus levels were elevated at four sites in the area downstream of Periwinkle Run at RMs 27.0, 25.94, 24.10, and 9.28. Dissolved oxygen violations occurred at the three most upstream

stations and six of the ten chemical sampling sites had elevated fecal coliform bacteria counts. Both of these latter parameters and the resultant violations were associated with agricultural activities in the basin and the unsewered area of Gettysburg at RM 35.5 (raw sewage was observed here).

Nonpoint source (NPS) impacts were evident throughout the study area although none of the areas impacted solely by NPS pollution had biological communities that departed from regional expectations (i.e. WWH biocriteria). The two sites at which biological performance was impaired were both located downstream of point source discharges (Camden WWTP and Parker Hannifan). The principal effect of NPS pollution on the biological community may be to prevent attainment of the EWH biocriteria in the reach from Periwinkle Run (RM 28.52) downstream to Paint Creek (RM 15.18). At present most sites in this area display higher levels of WWH performance.

Point source impacts in the study area consist of organic enrichment from the Camden WWTP and an unknown source of zinc in the Periwinkle Run area. The Camden WWTP is in frequent violation of NPDES permit limits and is in need of an upgrade. The population in Camden has increased 30% in the past ten years and ammonia-n loadings have increased five fold. The Camden WWTP contributed 93% of the point source derived ammonia load to the Sevenmile Creek study area (Figure 4). The current NPDES limitations for ammonia-n seem inadequate and should be reevaluated via the WQBEL process. The origin of zinc contamination could not be pinpointed from the available data. Follow-up monitoring of the general area around Periwinkle Run and the industries in that area will be needed to determine the source(s). Sediment samples downstream from Parker Hannifan and a history of spills indicate that the origin of a portion of the instream zinc may be this facility.

Conclusions

- Nonpoint source impacts were detected (chemically) throughout the basin although no violations of biological criteria based on the existing use designation were detected or can be ascribed to NPS pollution.
- The Camden WWTP is impacting Sevenmile Creek both chemically and biologically. Existing pollutant loadings must be reduced in order to achieve FULL use attainment.
- Heavy metals (primarily zinc) are entering Sevenmile Creek in the Periwinkle Run area. Parker Hannifan is suspected to be responsible in part for elevated levels of zinc.
- The unsewered area of Gettysburg is impacting Sevenmile Creek with discharges of untreated domestic sewage.
- The Lake Lakengren and Eaton WWTPs are having minimal impacts on Sevenmile Creek. None of the observed use impairments could be attributed to these sources.

Recommendations

Status of Aquatic Life Uses

Sevenmile Creek was originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Therefore, because this study represents a first use of this type of biological data to evaluate and establish aquatic life use designations, several revisions are recommended. While some of the changes may appear to constitute "downgrades" (*i.e.* EWH to WWH) or "upgrades" (*i.e.* WWH to EWH), these changes should not be construed

as an actual change in the true stream potential because this study constitutes the first use of an objective and robust use evaluation system and database in the Sevenmile Creek basin. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on existing, unverified use designations. Thus some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

- Sevenmile Creek was subdivided into three segments; an upper reach (segment 1) upstream of Periwinkle Run (confluence RM 28.5), a mid reach (segment 2) between the confluences of Periwinkle Run (RM 28.5) and Paint Creek (confluence RM 15.2) and a lower reach (segment 3) downstream of the Paint Creek confluence. The upper reach is dominated by nonpoint source impacts, the middle reach contains the principal point source discharges, and the lower reach is relatively undisturbed attaining the EWH community performance criteria through most of its length.
- The use designation of Sevenmile Creek should be EWH from the confluence of Paint Creek RM 15.2 to the mouth (segment 3) and WWH upstream of RM 15.2 (segments 1&2). Biological communities throughout segment 3 show a strong potential to achieve EWH levels outside of areas of impact (Table 1). All other communities in the basin remained at or below the WWH performance level.

Status of Non-Aquatic Life Uses

- All non-aquatic life uses should remain as presently designated in the Ohio water quality standards.

Other Recommendations

- The community of Gettysburg should be evaluated to determine if a sewage treatment system should be installed or if illegal connections have been made to a local storm drain. The priority ranking of this unsewered area should be reexamined for funding of WWTP construction via the State Revolving Loan Fund process.

Future Monitoring Needs

- The area around Parker Hannifan and Periwinkle Run should be investigated as soon as possible to determine the origin of the metals contamination.
- A follow up survey of the Sevenmile Creek basin will be needed, preferably after the Camden WWTP upgrade has been completed.
- The middle reach (segment 2) of the basin should be reviewed within five to ten years to determine if an EWH designation has become feasible for that area.
- The upper reach (segment 1) in the Gettysburg area should be surveyed for biological performance in unsewered areas and for the effects of habitat degradation and modifications.

Study Area Description

The Sevenmile Creek drainage basin covers 138.4 square miles in Preble (109 mi^2) and Butler (29.4 mi^2) Counties (ODNR,1960). The mainstem of Sevenmile Creek is 36.6 miles in length with an average gradient of 16.5 feet per mile. It occupies the central portion of Preble Co. and the

north-central portion of Butler Co (Figure 1). Almost all of the stream was investigated during the summer of 1991 from the confluence with Fourmile (Talawanda) Creek to U.S. Rt. 40 (Rm 35.5). The current aquatic life use designation for most of Sevenmile Creek is warmwater habitat (WWH) exclusive of the reaches from the headwaters to Eaton (RM 26.5), and the Big Cave Run tributary to the mouth (RM 15.2-RM 0.0) which are exceptional warmwater habitat (EWH). All of the major tributaries are designated WWH except for Paint Creek which is EWH and a State Resource Water (SRW). All of the streams in the watershed are designated as agricultural and industrial water supply and primary contact recreation.

Land use in the Sevenmile watershed is rural/agricultural with limited areas of urban and residential development. Eaton (pop. 7400) is the only city in the watershed with villages of Camden (pop. 2,200), Somerville (pop. 279) and Seven Mile (pop. 804) providing the other areas of population concentration. Agriculture dominates land use with 78%, most of which is dedicated to row crop production for corn and soybeans (87%). Pasture makes up only 2% of the land use and woodlands account for 7% (USDA,1987). Sixteen livestock operations have been inventoried in the Sevenmile Creek watershed. Total animal units are 2,728 with hogs (45%) leading beef (32%) and dairy (23%) (MVRPC,1991). The few industries in the watershed are located in Eaton.

Sevenmile Creek lies entirely within the Eastern Cornbelt Plains Ecoregion. The landform has been shaped by glaciation which left flat to rolling terrain, glacial till, end and ground moraines, and boulders (USDA 1969). The upper reaches of the watershed are flat and the lower portions are more hilly with a well defined valley from Camden to the confluence with Fourmile Creek.

Table 1. Aquatic life use attainment status for the existing and proposed Exceptional//Warmwater Habitat (WWH/EWH) use designations in Sevenmile Creek based on data collected during June - September 1991.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI	Attainment Status[b]	Comment
Sevenmile Creek (1991)						
*Eastern Corn Belt Plain - **EWH /WWH** Use designation **(Existing/Proposed)***						
28.6/28.6	45*/45	N/A	42[ns/]	85.5	PART./FULL	Ust. Periwinkle Run
28.5/28.5	45*/45	8.2*/8.2[ns]	38*/	57.0	**NON**/FULL	Dst. Periwinkle Run
28.2/ -	46[ns]/46	9.2[ns]/9.2	- / -	80.5	(FULL)/(FULL)	
*Eastern Corn Belt Plain - **WWH /EWH** Use designation **(Existing/Proposed)***						
26.5/26.7	39[ns]/39*	7.5*/7.5*	VG/VG[ns]	68.0	PART./**NON**	Adj. Athletic Field
25.1/25.1	45/45	9.7/9.7	28/28	-	N/A	Mixing Zone
24.1/24.2	44/44*	8.6/8.6*	46/46	80.0	FULL/PART.	Dst. Eaton WWTP
18.8/20.2	43/43*	9.0/9.0[ns]	48/48	74.0	FULL/PART.	Ust. Camden WWTP
14.4/14.3	50/50	9.2/9.2[ns]	34[ns]/34*	81.0	FULL/PART.	Dst. Camden WWTP
9.2/9.2	55/55	10.1/10.1	52/52	85.0	FULL/FULL	Dst. Somerville
Eastern Corn Belt Plain - EWH Use designation (Existing)						
1.2/1.2	52	9.9	46	80.0	FULL	

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	WWH	EWH	MWH[d]
IBI - Headwaters/Wading	40	50	24
Mod. Iwb - Wading	8.3	9.4	5.8
ICI	36	46	22

[d] - Modified Warmwater Habitat for channel modified areas.

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

ns - Nonsignificant departure from interim biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 MIwb units).

a - Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor; VP=Very Poor).

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

NA - Headwater site; MIwb is not applicable.

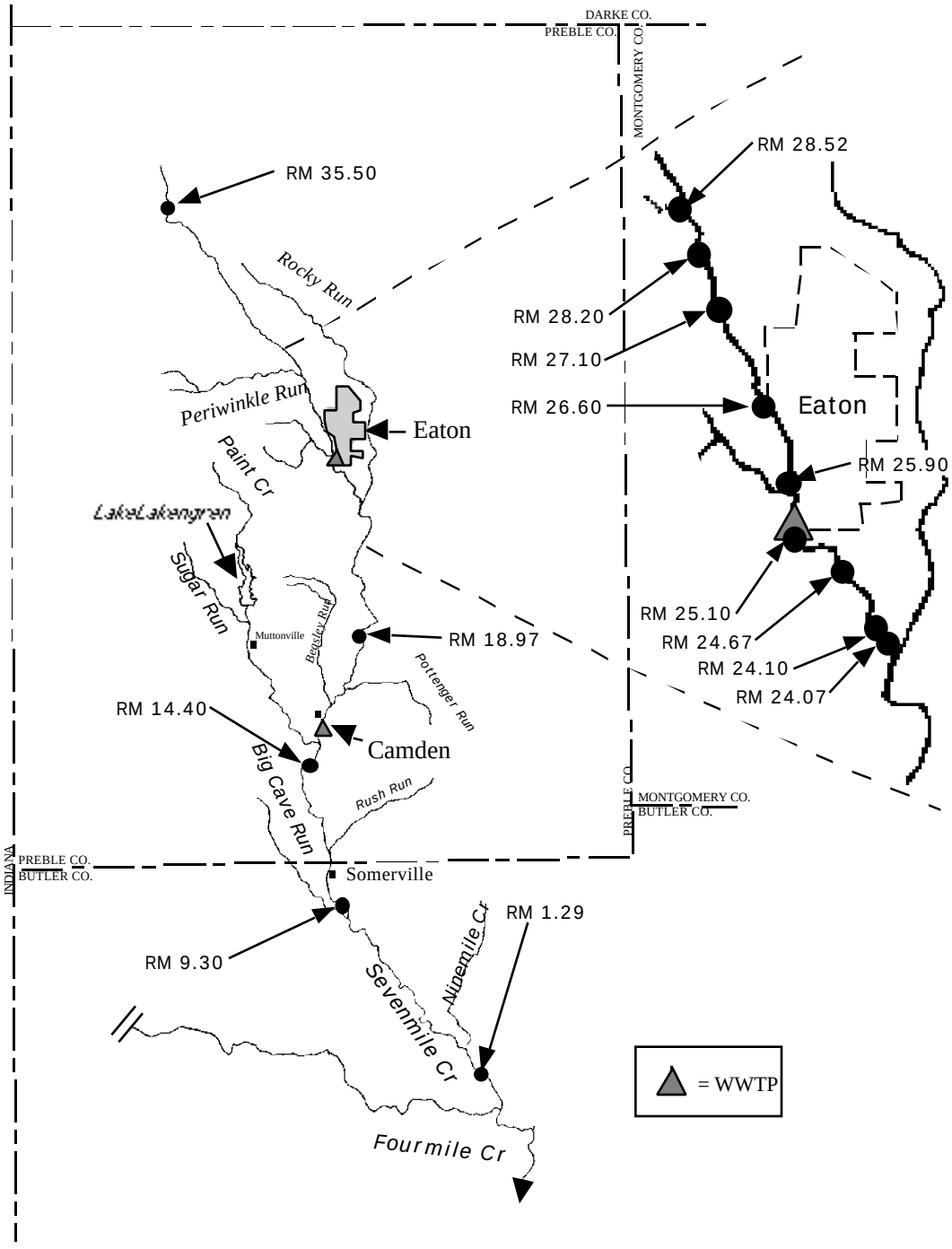

Figure 1. The Sevenmile Creek study area showing principal streams and tributaries, population centers, and pollution sources.

Table 2. Stream characteristics and significant identified pollution sources in the Sevenmile Creek study area.

Stream Name	Length (Miles)	Average Fall (Feet/Mile)	Drainage Area (Square Miles)	Nonpoint Source Pollution Categories	Point Sources Evaluated
Sevenmile Creek	32.5	16.5	138.4	Agriculture, urban runoff, land disposal, gravel mining	National Trail H.S. WWTP Eaton WWTP Camden WWTP
Ninemile Creek	3.6	35.0	7.94		
Big Cave Run	2.9	45.5	5.7	Agriculture	
Rush Run	3.3	76.9	4.6	Agriculture	
Paint Creek	10.0	28.0	22.44	Agriculture, urban runoff	
Opossum Run	0.5	72.0	1.34	Agriculture	
Sugar Run	1.7	54.0	2.96	Agriculture	
Beasley Run	3.6	42.2	5.86	Agriculture, urban runoff	
Pottenger Run	3.2	29.3	6.30	Agriculture, urban runoff	
Rocky Run	5.0	20.2	8.94	Agriculture, urban runoff	
Periwinkle Run	2.0	25.5	5.92	Agriculture	

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 1989a) Biological Criteria for the Protection of Aquatic Life, Volumes ll-llI (Ohio Environmental Protection Agency 1987, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989) for aquatic habitat assessment.

Attainment/non-attainment 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. The Invertebrate Community Index (ICI) 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] and Exceptional Warmwater Habitat [EWH]) 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. The exception was RM 26.7 where the artificial substrate samplers were lost (qualitative sampling only).

Fish were sampled 2 times at each site using the pulsed DC electrofishing wading methodology (150 meter zones). No tributary locations were electrofished. All chemical/physical and biological

sampling locations are listed in Table 3.

An Area Of Degradation Value (ADV; Rankin and Yoder 1991) 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 2). The magnitude 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.

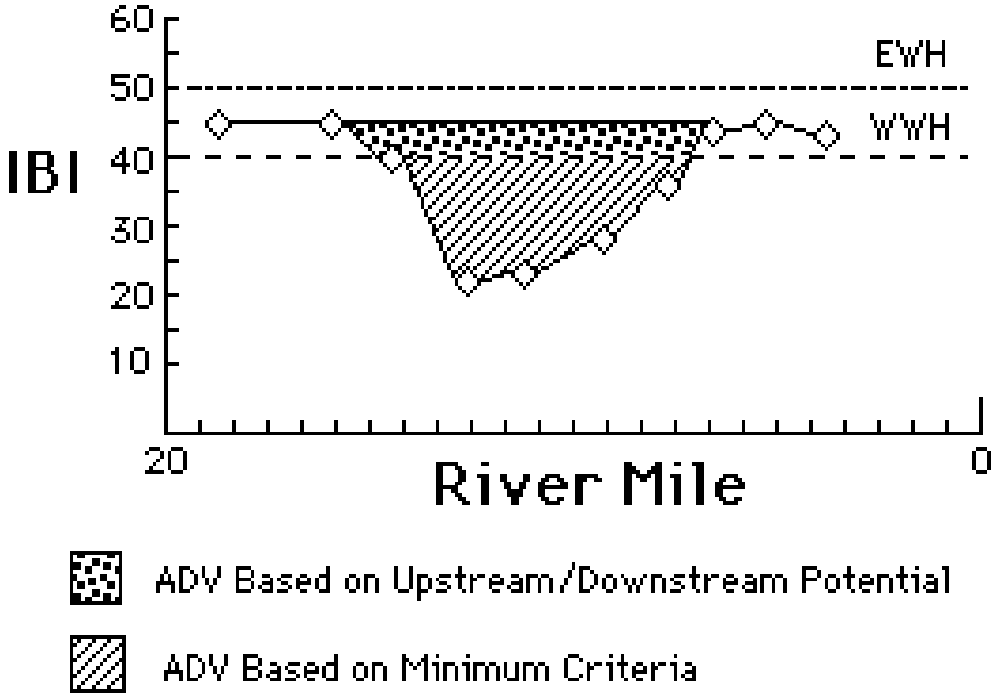

Figure 2. Graphic illustration of the calculation of Area of Degradation Values (ADV) based on upstream potential and the ecoregion warmwater habitat use or minimum criteria (WWH). Criteria for exceptional warmwater habitat use (EWH) is provided for reference.

Table 3. Sampling locations (effluent sample - E, water chemistry - C, sediment chemistry - S, benthos - B, fish - F) in the Sevenmile Creek study area, 1991.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Sevenmile Creek				
35.4	C,S	39º50'25"/84º43'32"	US Rt 40 bridge	Eaton North
28.6	C,F,B	39º46'17"/84º39'20"	ust. Periwinkle Run	Eaton North
28.5	F,B	39º46'09"/84º39'15"	dst. Periwinkle Run	Eaton North
28.2	F	39º38'29"/84º39'11"	ust.Washington-Jackson Rd	Eaton North
28.1	C	39º45'56"/8439'14"	Washington/Jackson Rd	Eaton North
27.0	C,S	39º45'04"/84º38'42"	adj. Water Works Park	Eaton North
26.7	B	39º44'48"/84º38'39"	adjacent Athletic Field	Eaton South
26.5	F	39º44'47"/84º38'34"	adjacent Athletic Field	Eaton South
25.9	C	39º44'38"/84º38'25"	Oh Rt 732/Hillcrest Rd	Eaton South
25.1	C,F,B	39º43'19"/84º38'04"	dst. Eaton WWTP(mz)	Eaton South
24.2	B	39º43'12"/84º37'40"	dst. Eaton WWTP	Eaton South
24.1	C,S,F	39º43'08"/84º37'30"	dst. Eaton WWTP	Eaton South
20.2	B	39º40'27"/84º37'22"	ust. Camden WWTP	W. Alexandria
18.8	F	39º39'34"/84º37'24"	ust. Camden WWTP	W. Alexandria
18.7	C	39º38'48"/84º37'46"	ust. Barnetts-Mill Rd	W. Alexandria
14.4	C,S,F	39º36'29"/84º39'16"	dst. Camden WWTP	Oxford
14.3	B	39º36'30"/84º39'21"	dst. Camden WWTP	Oxford
9.2	C,F,B	39º33'08"/84º38'04"	dst.Anthony Wayne Prkw	Oxford
1.2	C,S,F,B	39º28'44"/84º33'48"	dst. Taylor School Rd.	Hamilton

Results and Discussion

Nonpoint Source Pollution

Nonpoint source pollution in the Sevenmile Creek study area can be documented for only limited areas because of the locations of sampling sites although most sites in the study area at least showed some effects of nonpoint pollution. The site at Gettysburg on U.S. Route 40 was clearly impaired by sewage from inadequate or non-existent on-site sewage disposal systems which entered the stream through a collector pipe under the Route 40 bridge. Sewage was observed in the stream, low dissolved oxygen, high ammonia and high nitrates levels were recorded. *Tubifex* worms, mosquito larvae and algal mats were the principal biota observed. Periwinkle Run was investigated for possible nonpoint source inputs to Sevenmile Creek by bracketing the confluence with sites for chemical analysis and biological evaluation. Declines in the ICI and QHEI scores at the downstream site (RM 28.15) may indicate that Periwinkle run is causing a negative impact on Sevenmile Creek, but the downstream site also lacked the riparian forest cover that characterized the upstream site. Fecal coliform/fecal streptococcus bacteria results downstream of Periwinkle Run indicate the impact of a feedlot which is located on Periwinkle Run (Figure 8). The sampling location in Waterworks Park was selected because of a history of spills from the Parker Hannifan plant which entered Sevenmile Creek through a drainage ditch.

Pollutant Loadings

- **Eaton WWTP** (Figures 4 & 6) demonstrated steady reductions in BOD_5 loadings from 1981 until 1989. Ammonia-N level reductions of nearly 75% came about in 1985 due to a treatment plant upgrade. Eaton contributed 1% of the total ammonia-N load to Sevenmile Creek in the third quarter of 1991. On the average ammonia-N loadings for 1985-1991 remained 75-90% lower than in previous years (1978-1984) despite a steady increase in flow (MGD) from 1987-1991.

- Screening bioassay results for acute toxicity, conducted March and May 1988 (Eaton WWTP 001 effluent) resulted in no acute toxicity within 24 hrs. followed by chronic toxicity after 48hrs.

- NPDES permit limit violations at the Eaton WWTP (Figures 9 & 10, Table 5) from 1987-90 consisted mostly of exceedences for cadmium and cyanide. Reasons for the violations were traced to the metal finisher Parker Hannifan. In January, 1990 the City of Eaton (on behalf of Eaton's WWTP) sought from and were awarded "alternative justification" for NPDES metal limitations by the Environmental Board of Review. The case was dropped in September, 1991 after Eaton WWTP received a NPDES permit modification from the OEPA.

- **Camden WWTP** (Figures 4 & 5) ammonia-N loadings increased approximately 500% during a seven year span (1985-1991). Ammonia loadings from 1988-1991 averaged greater than 11.0 kg/day exceeding NPDES summer loading limitations. In the third quarter 1991, Camden contributed 93% of the total ammonia-N load to Sevenmile Creek. Frequent NPDES violations (Figure 8, Table 4) for fecal coliform, ammonia-N and chlorine transpired from May until October 1991. Ohio EPA has sent numerous notices of violation since 1983 to Camden for failure to submit monthly operating report (MOR) data. Discussions concerning a complete plant upgrade began in 1990. No major plant upgrade has occurred since plant establishment in 1936. Population increases over ten years reveals an additional 239 persons residing in Camden. This,

along with other factors, has resulted in an approximate 30% increase in flow during the period.

- **Lake Lakengren WWTP** (Figures 4 & 7) ammonia-N and BOD_5 loading data from 1978-1991 illustrate sporadic levels from year to year. NPDES permit limit violations of BOD_5 and ammonia-N have occurred one and two times per year since 1987. Lake Lakengren contributed 6% of the total load of ammonia-N to Sevenmile Creek in 1991. No WWTP plant upgrade has occurred since plant establishment in 1975.

Chemical Water Quality

- **Dissolved oxygen** (D.O.) levels generally attained Exceptional Warmwater and Warmwater Habitat (EWH/WWH) criteria excluding the unsewered community region of Gettysburg (RM 35.5-28.15). According to the Miami Valley Regional Planning Commission (MVRPC) on-site sewage systems, numbering over a thousand, exist from near the headwaters to north of Eaton (MVRPC 6-88). Sewage sludge accumulation, noted near the U.S. Rt 40 bridge, apparently emanates from a 12 inch drain tile beneath the bridge.

- Nonpoint source impacts (beef cattle, swine) along with on-site systems contributed to reduced D.O. levels downstream (RM 28.15) which approached EWH minimum criterion (6.0 mg/l).

- D.O. levels at RM 14.47 (downstream from the Camden WWTP, Beasley Cr., Pottenger Run and Paint Cr.) declined nearly two milligrams per liter (mg/l) demonstrating impacts from livestock, mobile home and on-site disposal systems. Camden WWTP monthly operating reports (MOR's) revealed fecal coliform and ammonia-N. NPDES permit limit violations the second, third and fourth quarters of 1991. Lake Lakengren WWTP (discharging to a tributary of Paint Cr.) has exhibited BOD_5 and ammonia-N violations since 1987.

- **Fecal Coliform** values near the headwaters (Gettysburg-RM 35.5) demonstrated on-site system impacts exceeding Secondary Contact Recreation criterion in 50% of the sampling events. Fecal coliform values exceeded Primary Contact Recreation Criterion (RM 24.10 & 25.17 excluded) at five of seven consecutive sampling stations (RM 28.15-14.47) with three of the five exceedences occurring on August 13, 1992. Mobile home parks, Camden WWTP and a few hundred on-site systems comprise the impacts to this reach.

- **Fecal streptococcus** counts in the headwaters reached concentrations greater than 10,000/100ml while descending sharply and later stabilizing the remainder of the segment . A slight increase in fecal streptococcus counts occurred downstream of Periwinkle Run where one small beef cattle operation (20-42 head) is known to exist.

- Elevated **ammonia-N** levels appeared at the headwaters on two of three sampling events. Values above detection limits developed downstream of the City of Eaton (RM 25.94) and again below Camden WWTP (RM 14.47). Water quality standard (WQS) violations were not detected within the study area nor were patterns of elevated levels exhibited.

- **Phosphorus** levels exceeding water quality guidelines (1 mg/l) appeared on three separate sampling occasions beginning at the City of Eaton (RM 27.0) to downstream of Eaton's WWTP. Several hundred on-site systems exist near RM 27.0 (MVRPC 6-88) and may be a source of these loadings.

- **Zinc** values exceeding WQS maximum criteria (numerical criteria for prevention of acute toxicity) were noted at RM's 27.0 and 24.10. Toxic levels (exceedence of the Acute Aquatic Criteria [AAC] (1770, 1040 ug/l) were significant downstream of the storm drain receiving urban (Eaton) and metal finisher, Parker Hannifan, runoff (RM 27.0). Acute Aquatic Criteria exceedence (1040 ug/l) at RM 24.10 appeared approximately one river mile downstream of Eaton WWTP. Elevated zinc values transpired on September 3, 1991 at all sites from RM's 27.0-1.32.

- Presence of Organo-Chlorine **pesticides** and priority and non-priority volatile **organic** compounds were detected at 55% of the sampling sites. Detectable levels of pesticides appeared at all selected sampling sites (5 of 11 sites). Sample site #2 (RM 28.55) approached WQS "outside mixing zone -30-day average" for elevated concentrations of "Dieldrin". Elevated levels of volatile organic compounds appeared in Eaton WWTP's mixing zone and downstream of Camden WWTP.

Sediments

- Sediment chemistry results from five sites within the Sevenmile Creek mainstem demonstrated elevated to highly elevated metal concentrations at three of five sites.

- Sediment downstream from the Water Works Park storm drain (RM 27.0), containing urban (Eaton) and Parker Hannifan runoff, revealed elevated and highly elevated values of arsenic and cadmium. Reasons for the presence and elevated concentrations of these metals is unknown. Historically, metal finisher, Parker Hannifan in October of 1976 experienced a sodium cyanide and cadmium solution spill of 8-9 gallons resulting in a Sevenmile Creek fish kill lasting approximately 4-5 river miles. Punctured drums at the loading dock leaked into a storm drain exiting into Sevenmile Creek.

- Highly elevated lead levels were noted downstream of Camden WWTP (RM 14.47). Cadmium levels increased slightly downstream of Camden's WWTP.

- Iron levels reached "highly elevated" levels near the town of Seven Mile (RM 1.32). This enhanced concentration is most likely due to natural causes and possibly amplified by quarry operations conducted upstream.

Stream Flow

Historical data from the United States Geological Society (USGS) gage at Camden indicates May-Nov 1991 flows nearly equal flows of drought year, 1988. Comparison of flows at the Camden gage, retrogressing to 1981, reveal May-Nov. 1991 as having the second lowest flow year next to 1988. May 1991 flows exceed five other year's flows for that month while Sept. 1991 records the lowest flow in ten years. $Q7_{10}$ and 80% duration information is not available for Sevenmile Creek.

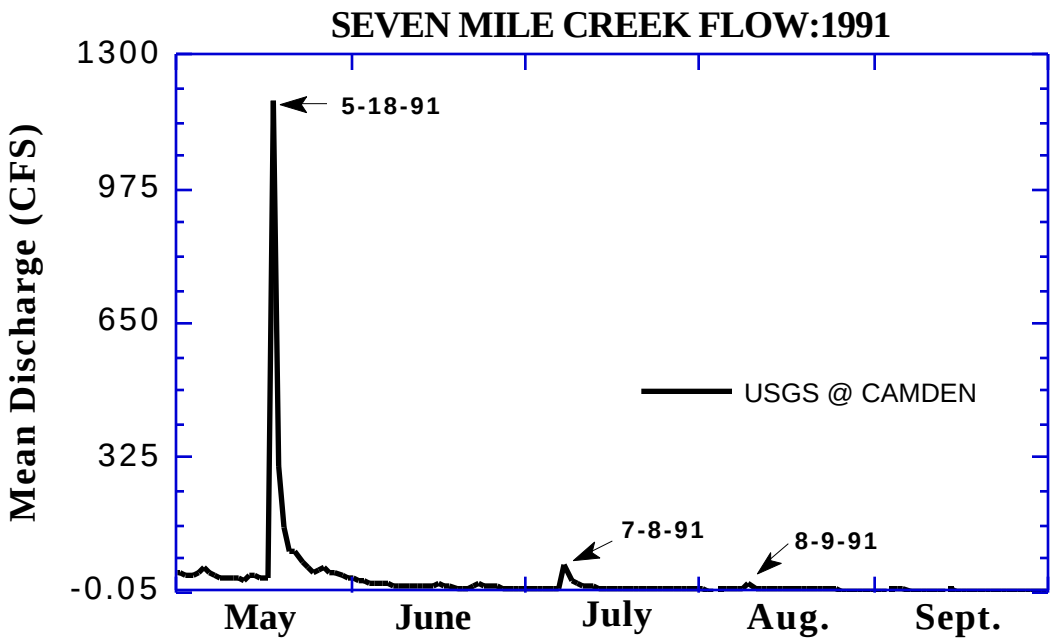

Figure 3. Flow hydrograph for Sevenmile Creek near Camden, Ohio (RM 16.05) May through September,1991 (period of record 1970 to 1991).

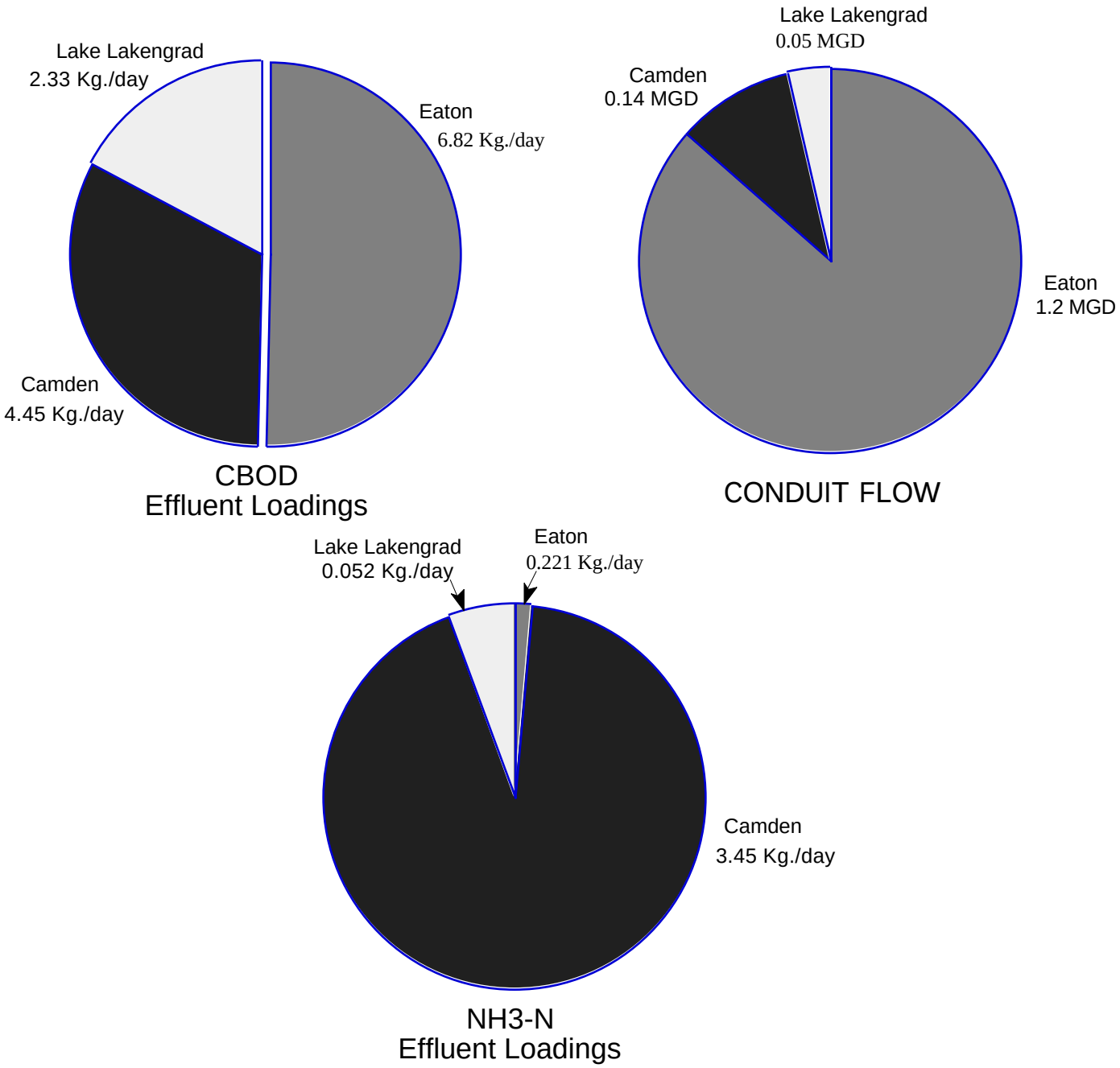

Figure 4. Third quarter loadings (kg/day) of $CBOD_5$, NH_3-N and conduit flow at the Eaton, Camden, and Lake Lakengren WWTPs in the Sevenmile Creek study area, 1991.

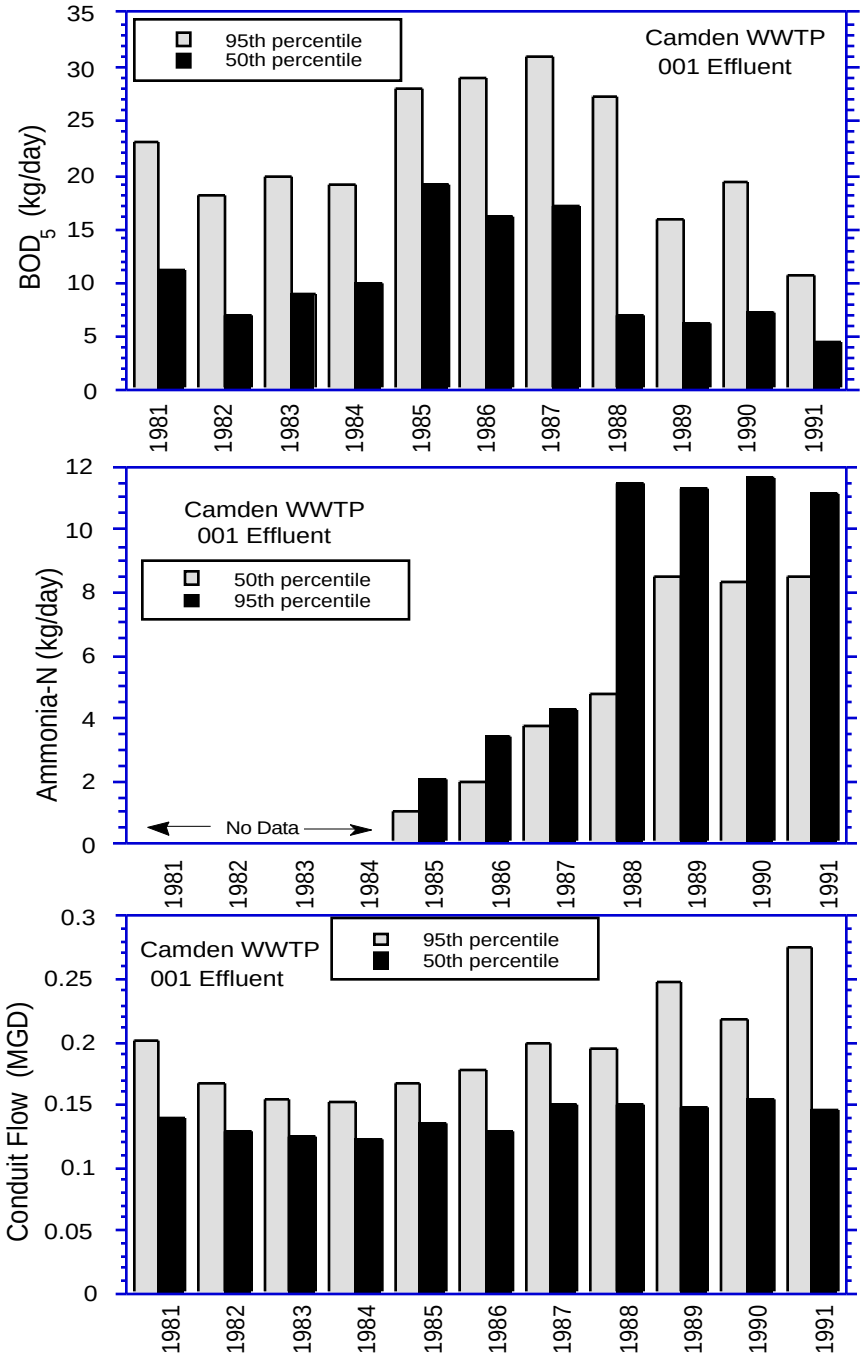

Figure 5 Annual loadings (kg/day) of BOD5 and NH3-N and conduit flow at the Camden WWTP in the Sevenmile Creek study area, 1981 - 1991.

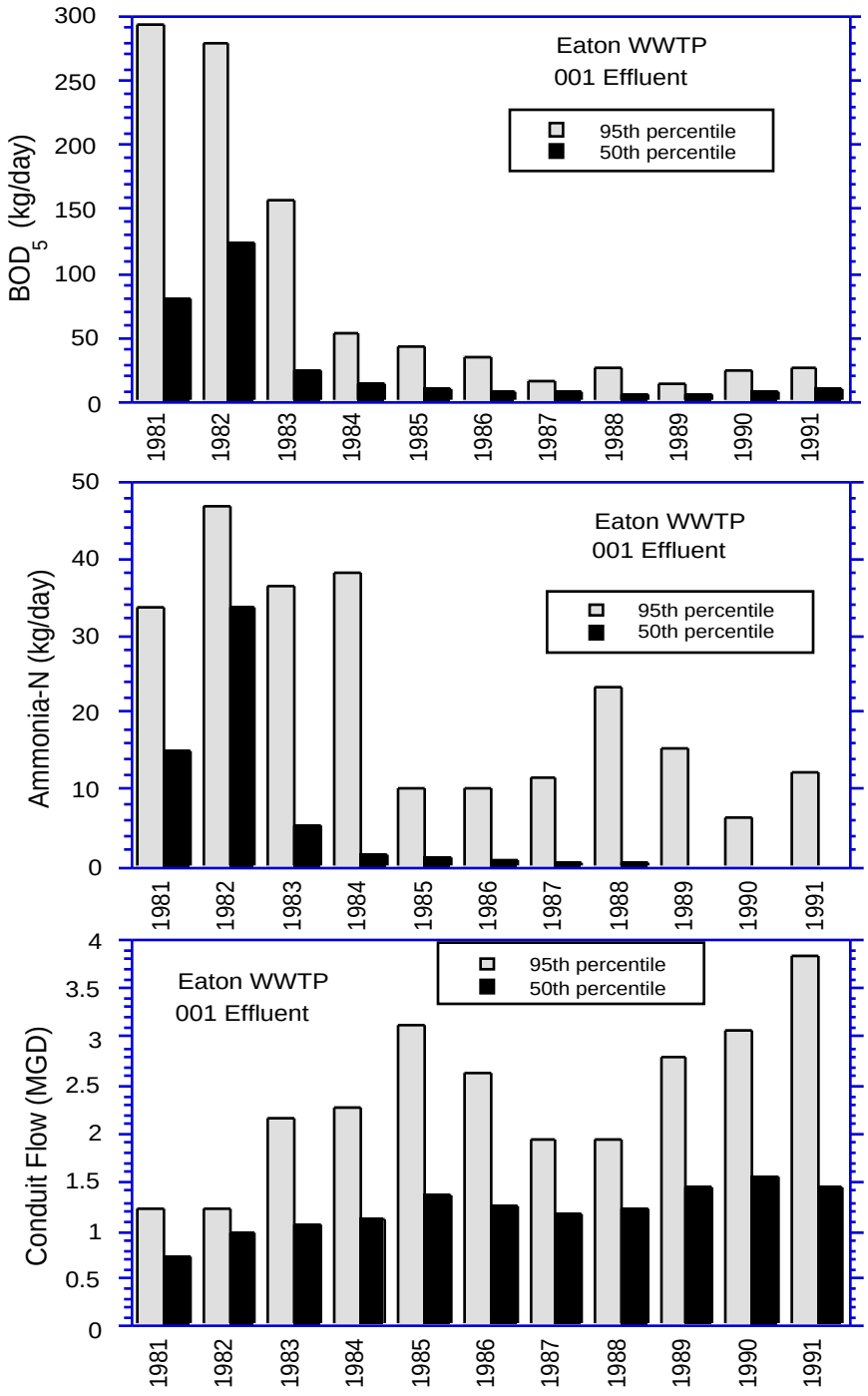

Figure 6 Annual loadings (kg/day) of BOD_5 and NH_3-N and conduit flow at the Eaton WWTP in the Sevenmile Creek study area, 1981 - 1991.

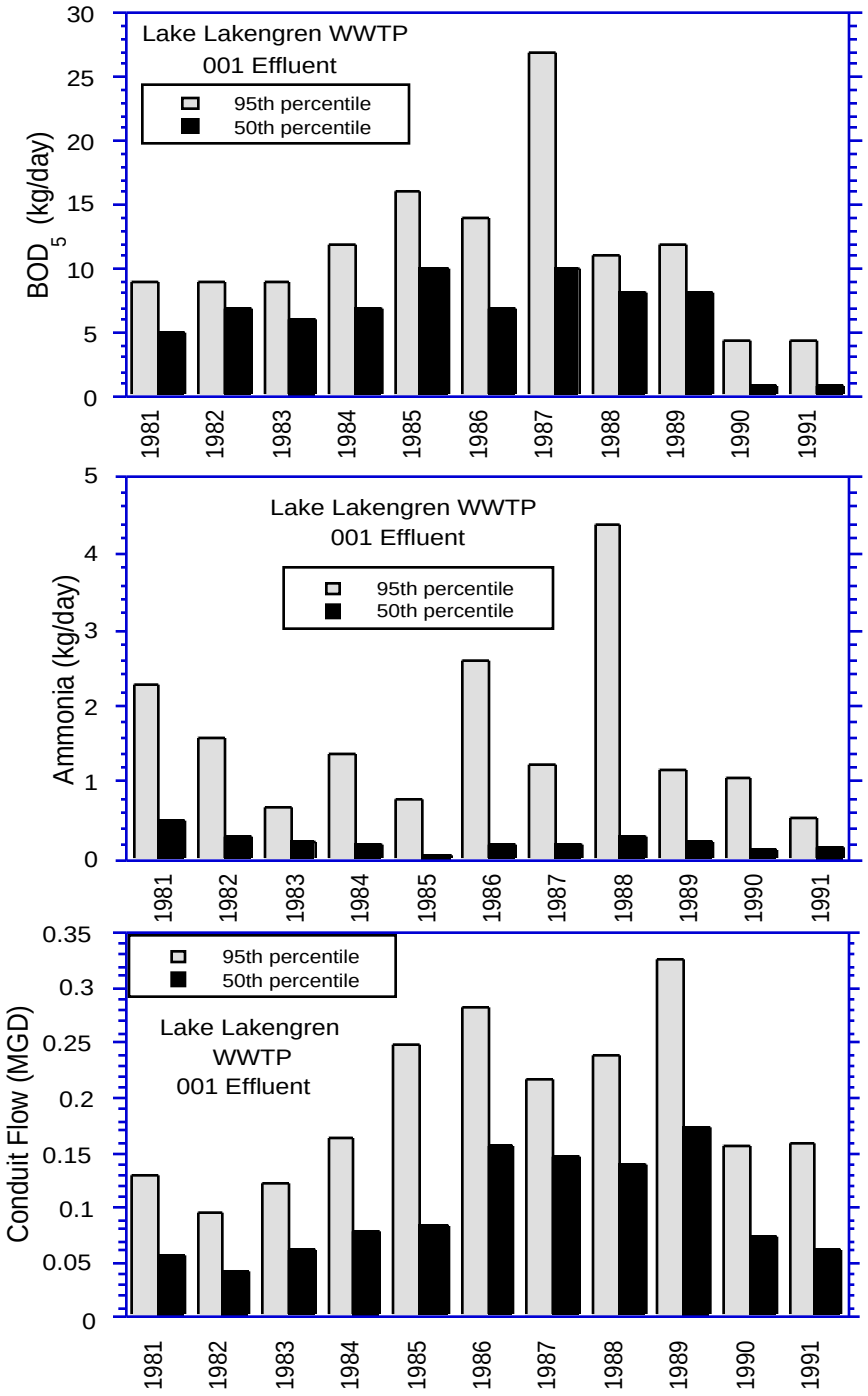

Figure 7 Annual loadings (kg/day) of BOD_5 and NH_3-N and conduit flow at the Eaton WWTP in the Sevenmile Creek study area, 1981 - 1991.

Table 4. Exceedences of Ohio EPA Warmwater/Modified/Exceptional Warmwater/Cold Water Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Sevenmile Creek study area, 1991 (units are µg/l for metals, S.U. for pH, and mg/l for all other parameters).

Stream Name	River Mile	Violation: Parameter (value)
Sevenmile Creek	35.5	D.O. (5.1‡‡, 3.0‡‡); Fecal coliform (24,000◊◊ , >60,000◊◊)
	28.55	D.O. (5.7‡‡ , 5.7‡‡)
	28.15	D.O . (4.9‡‡, 5.7‡‡), Fecal Coliform (1,060◊)
	27.0	Zinc (1770**), Phos. (2.97††); Fecal Coliform (1,200◊, 1,800◊)
	25.94	Phos. (3.74††); Fecal Coliform (1,050◊)
	25.17	Pesticide-Endrin (.007 ug/l †)
	24.10	Zinc (1,040**); Phos.(1.72†† , 3.44 ††)
	17.79	Fecal Coliform (1,500◊)
	14.47	Fecal Coliform (1,600◊)
	9.28	Phos. (1.40††)

* indicates an exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** indicates an exceedence of numerical criteria for prevention of acute toxicity (AAC).
*** indicates an exceedence of numerical criteria for prevention of lethality (FAV).
‡ violation of the average dissolved oxygen (D.O.) criterion.
‡‡ violation of the minimum dissolved oxygen (D.O.) criterion.
‡‡‡ violation of the "nuisance prevention" minimum dissolved oxygen (D.O.) criterion.
◊ exceedence of the Primary Contact Recreation criterion.
◊◊ exceedence of the Secondary Contact Recreation criterion.
† exceedence of the "outside mixing zone-30 day average" criterion.
†† exceedence of WQS guideline for daily average Phosphorus (1mg/l)

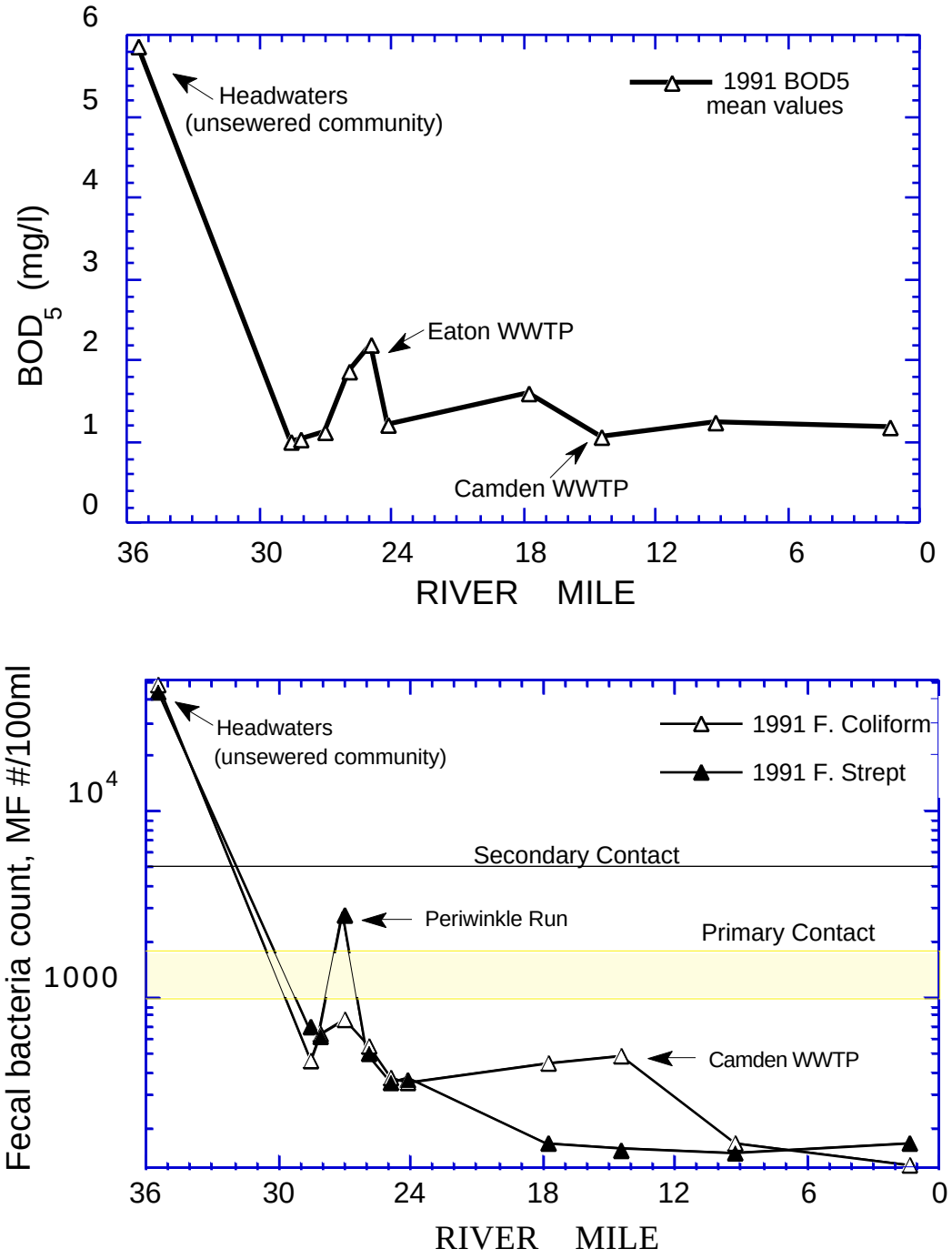

Figure 8. Longitudinal trend of BOD_5 and fecal coliform and fecal streptococcus bacteria counts in the Sevenmile Creek study area, 1991.

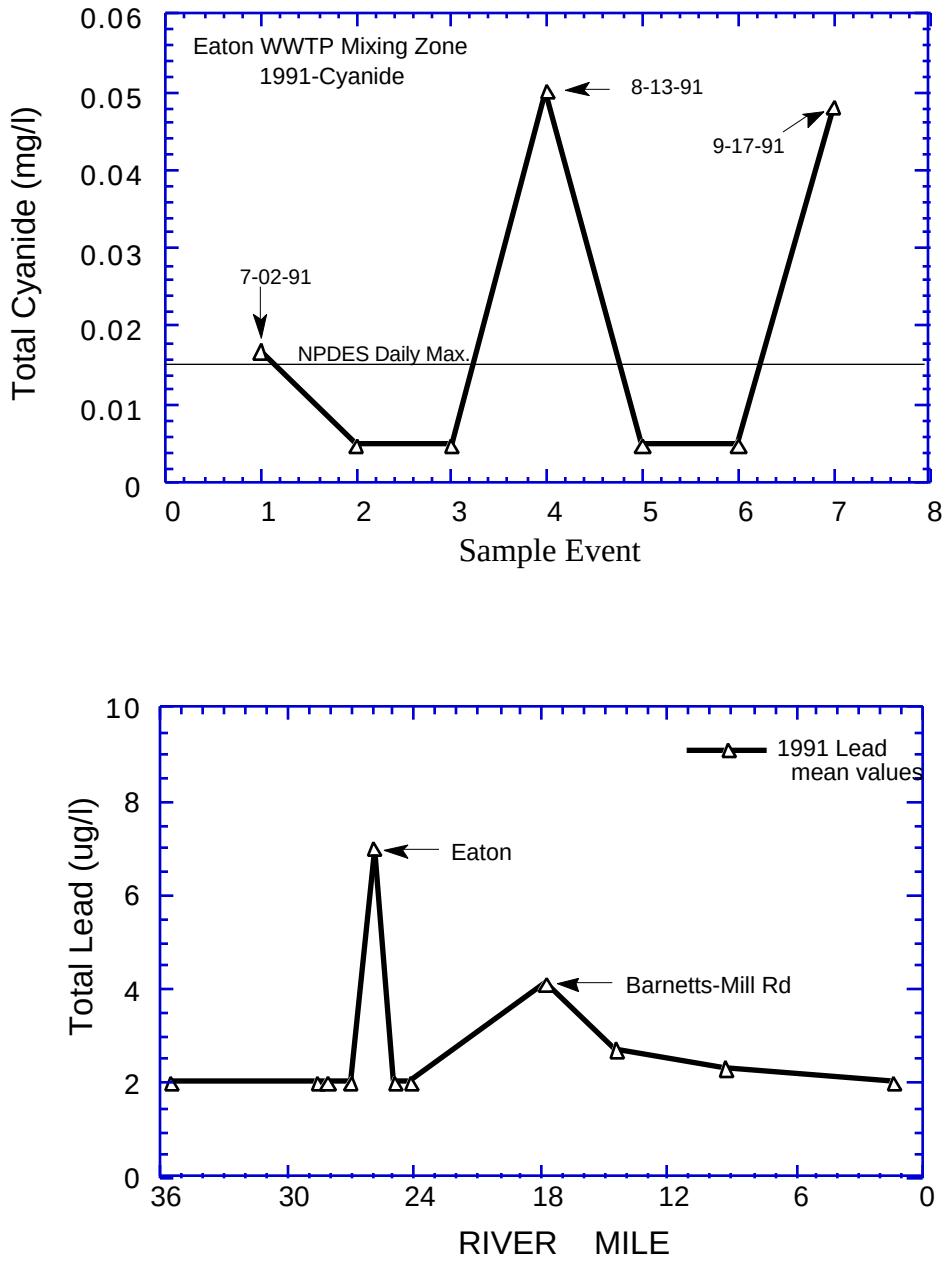

Figure 9. Total cyanide in seven mixing zone samples and longitudinal trend of total lead in the Sevenmile Creek study area, 1991.

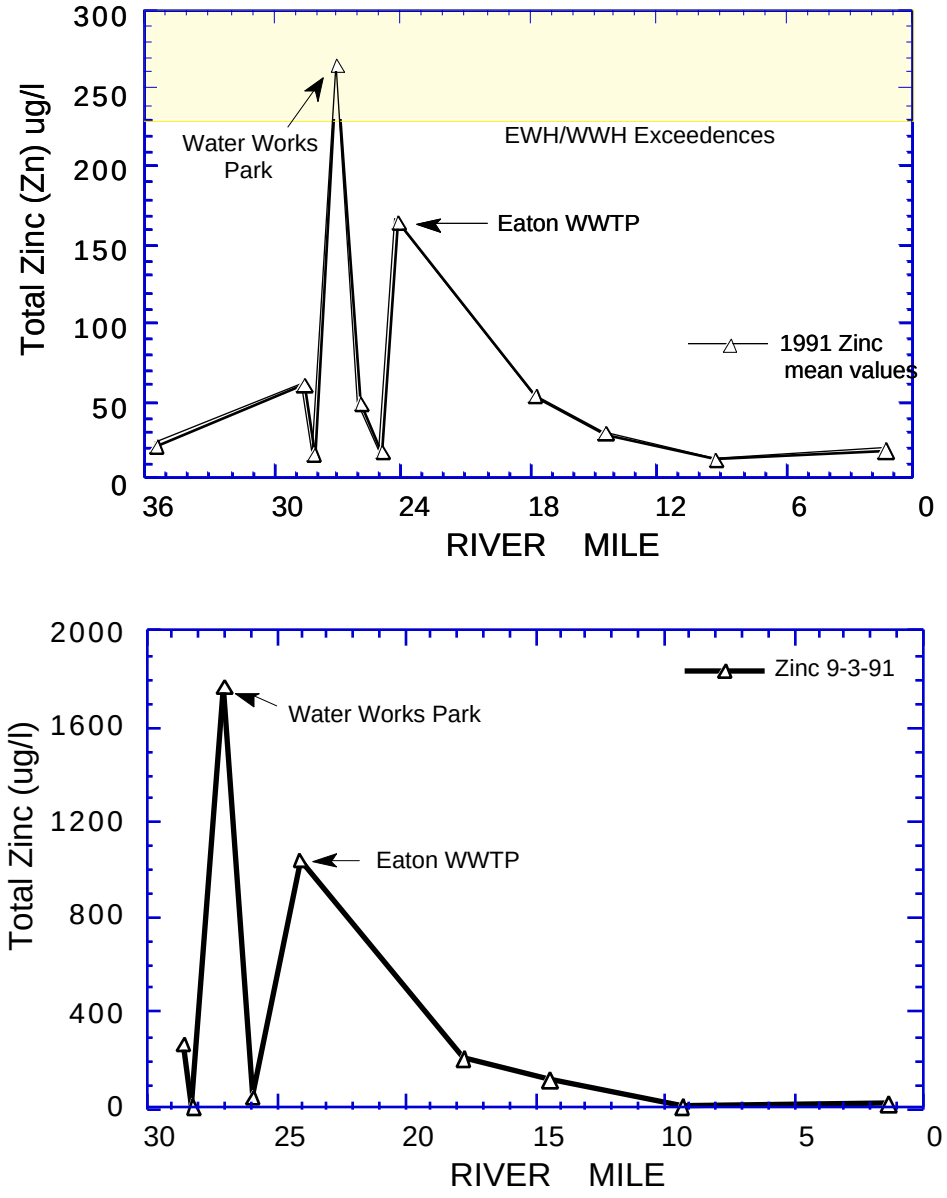

Figure 10. Longitudinal trends of total mean zinc (upper figure) and total zinc concentrations on September 3rd in the Sevenmile Creek study area, 1991.

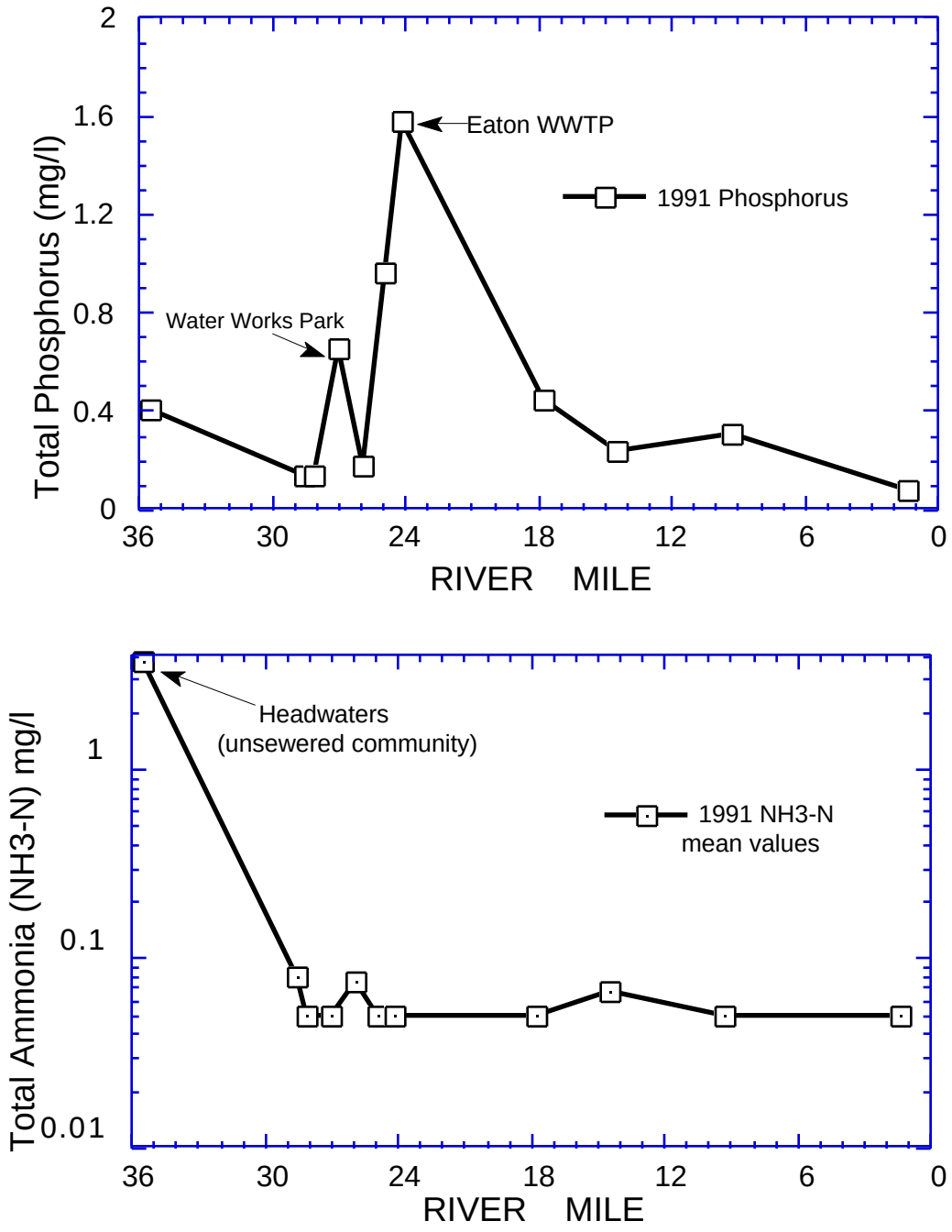

Figure 11. Longitudinal trend of total phosphorus and ammonia-N in the Sevenmile Creek study area, 1991.

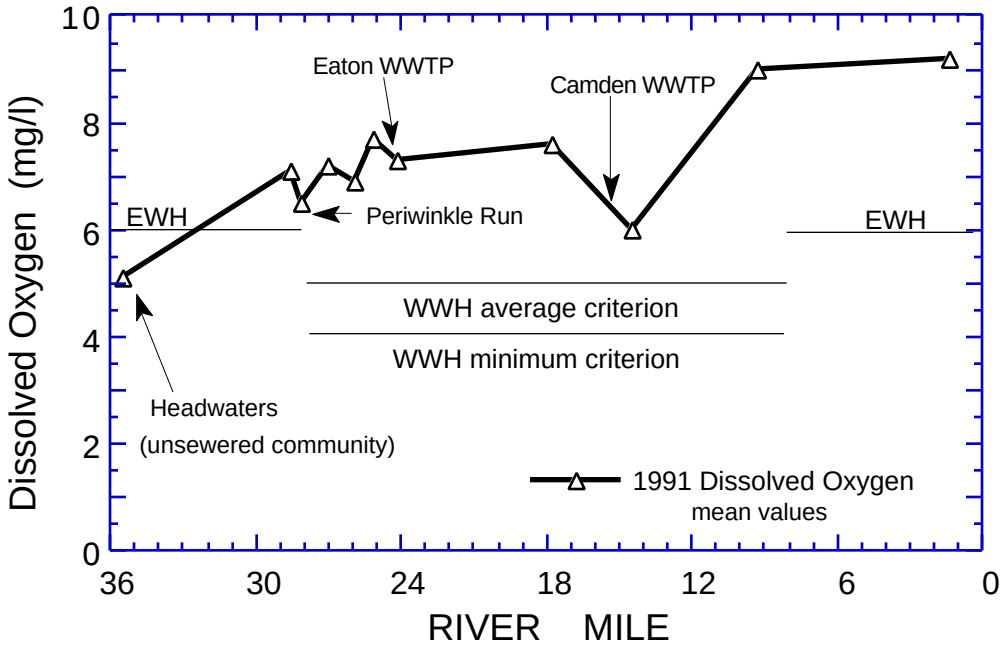

Figure 12. Longitudinal trend of daytime dissolved oxygen in the Sevenmile Creek study area, 1991.

Table 5. Concentrations of heavy metals in sediments of the Sevenmile Creek study area, 1991. All parameter concentrations, excluding aluminum and nickel, were ranked based on a stream sediment classification system described by Kelly and Hite (1984)

River Mile	Sediment Concentration (mg/kg. dry weight) As	Cu	Cd	Cr	Fe	Pb	Ni	Zn
Sevenmile Creek								
35.43	6.07[a]	11.9[a]	0.318[a]	7.82[a]	13400[a]	27.00[a]	9.22	41.8[a]
27.00	13.7[c]							
	32.0[a]	**6.94[d]**	14.00[a]	13900[a]	19.20[a]	11.60	85.6[b]	
25.17	3.30[a]	6.50[a]	0.398[a]	3.94[a]	8520[a]	6.94[a]	5.29	31.2[a]
14.47	3.97[a]	5.11[a]	0.949[b]	5.51[a]	7600[a]	**66.8[d]**	4.68	24.0[a]
1.32	4.27[a]	14.6[a]	0.831[b]	2.56[a]	**36800**[d]	11.9[a]	14.1	34.1[a]

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

Note: The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

Physical Habitat for Aquatic Life

Macrohabitats of Sevenmile Creek (Tables 6 & 7) were evaluated at a total of nine fish sampling locations. QHEI values ranged from 85.5 at RM 28.6 to 57.0 at RM 28.5. The abundance of quality habitat found throughout the study area was reflected in a mean QHEI value of 76.7. A mean QHEI score greater than 60 suggests that the habitats throughout the study area are capable of supporting a biological community achieving WWH and EWH biological criteria (Rankin 1989).

Throughout the study area Warmwater Habitat attributes predominate, occurring at a significantly higher frequency than moderate and high influence modified habitat attributes (Table 7). Generally, Sevenmile Creek can be characterized as possessing numerous pool/riffle/run

complexes, substrates of native and glacial origin, good channel development, mixed current velocities, and pools commonly greater than 40 cm in depth.

The only limiting aspects of instream habitat observed during the 1991 field sampling effort were moderately embedded substrates and the lack of a complete wooded riparian corridor. The majority of the sampling stations did possess a vegetated riparian zone extending 10 to 50 meters from each bank, but locations adjacent to land currently under cultivation possessed a narrow (<10m) or nonexistent riparian corridor. Consequently, at sites where riparian and near stream vegetation have been removed, localized bank erosion has occurred. The introduced sediments, primarily sand, have moderately embedded the coarse glacial substrates. Though the problem of embeddedness was evident at most sampling locations, it presently does not appear to be a significant limiting factor in biological community performance.

Overall the habitat heterogeneity observed within the Sevenmile Creek study area indicates that the stream is capable of supporting a diverse and highly organized community of aquatic organisms, achieving both WWH and EWH biological criteria in many areas.

Table 6. Average QHEI scores for 3 relatively homogenous segments of Sevenmile Creek based on sampling conducted during July - October, 1991.

Sample Location: Segment Description			Sample	Segment
Upstream River Mile	Downstream River Mile	River Mile	Location QHEI	Average QHEI
Segment 1: Upstream Periwinkle Run				
28.6	28.5	28.6	85.5	71.3
		28.5	57.0	
Segment 2: Periwinkle Run to Paint Creek				
28.2	18.8	28.2	80.5	75.8
		26.5	68.0	
		25.5	76.5	
		24.1	80.0	
		18.8	74.0	
Segment 3: Paint Creek to the mouth				
14.4	1.2	14.4	81.0	82.0
		9.2	85.0	
		1.2	80.0	

Table 7. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Sevenmile Creek study area, July - September, 1991.

Biological assessment: Macroinvertebrate Community

Macroinvertebrate communities sampled upstream from Eaton scored in the very good (ust. Eaton New Hope Rd.) to good (dst. Periwinkle Run) range (Figure 13, Table 9). The small size of the stream at these sites resulted in the artificial substrates being placed in slow current which resulted in the virtual absence of caddisflies in the quantitative samples. Under optimal current conditions at least the upstream station (RM 18.6) would achieve the EWH criterion. The qualitative sample supports this view with six caddisfly taxa collected at each site. Several taxa which were present at these sites but disappeared downstream from Eaton were the mayfly *Stenonema mediopunctatum* (McDunnough), the caddisfly *Chimarra aterrima* Hagen, and the midges *Parametriocnemus* sp. and *Paratanytarsus* n. sp. 1. These two midge taxa are usually associated with cool water which is an indication of groundwater recharge at these sites. Structural changes in the community downstream from Periwinkle Run resulted in a four point drop in the Invertebrate Community Index (ICI) which may be the result of mild organic enrichment and/or metals from Periwinkle Run.

Qualitative sampling within Eaton (RM 26.7) downstream from Parker Hannifan Manufacturing yielded a very good community with no apparent impact.

The Eaton WWTP had a localized impact on the macroinvertebrate community. Structural and, to a lesser extent, composition changes within the mixing zone (RM 25.1) resulted in a fair ICI score of 28. Mayfly and caddisfly diversity remained fairly high (Qual. EPT = 10) even though a few of the more sensitive taxa disappeared. The percentage of the midge tribe Tanytarsini, a more pollution sensitive group, also remained high (26.6%). These community attributes indicate the WWTP impact was primarily organic enrichment in nature. The community recovered rapidly downstream and improved to the exceptional range at RM 24.2 and RM 20.2.

The macroinvertebrate community downstream from Camden (RM 14.3) declined to the marginally good range (ICI=34). Compositionally the community was similar to upstream stations, but structurally there were large increases in primarily facultative organisms Turbellaria (flatworms), Oligochaeta (segmented worms), and the midges *Hayesomyia senata* (Walley) and *Polypedilum (P.) convictum* (Walker). Overall density increased at this site to 1408 organisms/sq. ft. compared to 481 organisms/sq. ft. at RM 20.2. These community changes were the result of organic enrichment from the Camden area. Another indication of enrichment at this site was the thick covering of the green algae *Hydrodictyon* sp. on all substrates. The community recovered to the exceptional range at RM 9.2 (ICI=52) and RM 1.2 (ICI=46). The organism density remained relatively high at these sites (2014 orgs./sq ft at RM 9.2 and 1401 orgs./sq. ft. at RM 1.2) indicating some continued enrichment.

Table 8. Summary of macroinvertebrate data collected from artificial substrate samplers (quantitative) and natural substrates (qualitative sampling) in the Sevenmile Creek study area, August 6 to September 17, 1991.

Quantitative Evaluation

Stream River Mile	Density No./sq ft	Quant. Taxa	Qual. Taxa	Qual. EPT[b]	QCTV[c]	ICI	Narrative Evaluation
Sevenmile Creek							
			WWH Use Designation (Recommended)				
28.6	262	34	39	13	38.7	42	V. Good
28.5	199	41	42	10	37.8	38	Good
			WWH Use Designation (Existing)				
25.1	516	33	45	10	36.0	28*	Fair
24.2	524	43	40	10	37.4	46	Exceptional
20.2	481	35	45	16	38.7	48	Exceptional
			EWH Use Designation (Recommended)				
14.3	1408	45	40	14	38.4	34*	Marg. Good
9.2	2014	54	44	15	38.3	52	Exceptional
			EWH Use Designation (Existing)				
1.2	1401	36	34	16	40.5	46	Exceptional

Qualitative Evaluation

Stream River Mile	No. Qual. Taxa	QCTV[c]	Qual. EPT[b]	Relative Density	Predominant Organisms	Narrative Evaluation[a]
Sevenmile Creek : *WWH Use Designation (Existing)*						
26.7	39	38.4	13	Moderate	*Chimarra*, Riffle beetles, Water pennies, *Petrophila*	V. Good

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX	WWH	EWH	MWH[d]
ICI	36	46	22

[a] A qualitative narrative evaluation is based on best professional judgement is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.

[b] EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies).

[c] Qualitative Community Tolerance Value calculated as the median of the weighted ICI for each taxa.

[d] Modified Warmwater Habitat for channel modified areas.

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

[ns] Nonsignificant departure from biocriterion (<4 ICI units).

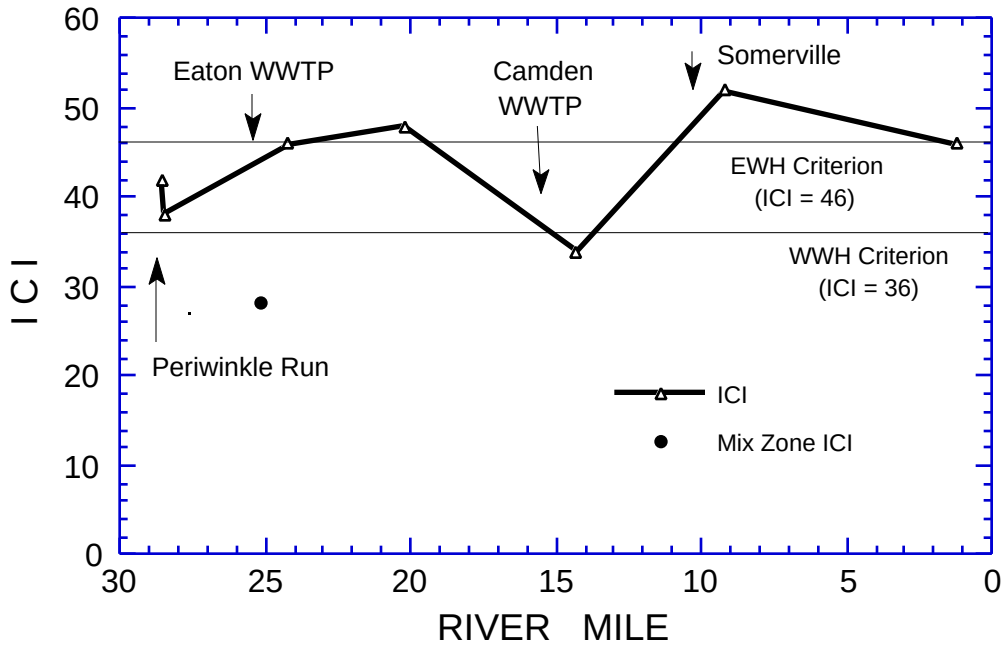

Figure 13. Longitudinal trend of the Invertebrate Community Index (ICI) in the Sevenmile Creek study area, 1991.

Fish Community

A total of 16,124 fish comprised of 40 species and three hybrids were collected from Sevenmile Creek between July 7 and September 23, 1991. The sampling effort included 44.1 km at 10 sampling locations between RM 28.6, upstream of the city of Eaton and RM 1.2, downstream of the village of Somerville.

The fish community was predominated by numbers by central stoneroller (36%), striped shiner (15%), creek chub (8%), northern hog sucker (6%), bluntnose minnow (5%) and blacknose dace (4%). Species that predominated in terms of biomass were northern hog sucker (29%), black redhorse (13%), central stoneroller (12%), golden redhorse (9%), common carp (8%) and striped shiner (5%).

Based on IBI and MIwb scores and the accompanying narrative evaluation the over all fish community performance ranged from exceptional (IBI=55; MIwb=10.1) at RM 9.2 to fair (IBI=39; MIwb=7.5) at RM 26.5 (Figure 14, Table. 10). No sites performed at poor or very poor

levels.

Fish community performance in the most upstream segment, between RM 28.6 and RM 28.2, can be characterized as good, containing an association of expected warmwater species, with sensitive forms present. No impact to the fish community that could be ascribed to the influence of Periwinkle Run was detected during the 1991 field sampling effort. Currently this segment is designated as EWH; although the fish community performance was within the *good* range, this reach failed to fully achieve EWH biological criteria (Table. 10) and should more appropriately be designated WWH.

The sampling station at RM 26.5, downstream from Parker Hannifan Manufacturing, yielded the lowest fish community performance of the entire study area (IBI=39; MIwb=7.5), with a narrative evaluation of marginally good to fair. The fish community possessed a semblance of functional organization, but structural components were diminished. Both relative weight (biomass) and relative abundance (numbers of fish) demonstrated a marked decrease in comparison to sampling stations upstream and downstream.

All remaining sampling stations, between RM 25.1 and RM 1.2, achieved or exceeded the biological criteria for the existing and recommended use (Table. 10). No impact to the fish community could be detected downstream of Eaton WWTP, Camden WWTP (no mixing zone site was sampled however), and the village of Somerville (Figure. 14). The lower segment of the Sevenmile Creek study area extending from RM 14.4 to RM 1.2, contained an exceptional assemblage of fish species. This reach supports a diverse and highly organized fish community, meeting the full potential of the instream habitat.

Area of Degradation Values (ADV)

Although historical data does not exist, an ADV was calculated for this study to provide a comparison between present use designations and the proposed use designation changes (Table 10). Under present use designations 11.5 miles achieve FULL attainment, 14.1 miles achieve PARTIAL attainment, and 2.9 miles were found to be in **NON** attainment. Using the proposed use designation changes these numbers are 11.8, 13.9, and 2.3 respectively. Much of the headwater area designated EWH is in FULL attainment under the proposed new WWH use designation change. This larger area of attainment is off set by a loss of attaining miles in Sevenmile Creek downstream of Camden's WWTP, where the use designation is proposed to change from WWH to EWH. Note that even though the miles of attainment change little, the implications for the two areas in which the changes are proposed are significant.

Table 9. Fish community indices based on pulsed D.C. electrofishing samples at ten locations sampled by Ohio EPA in the Sevenmile Creek study area during July - September, 1991. All sites sampled with wading methods.

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation
Sevenmile Creek								
	Eastern Corn Belt Plain - WWH Use designation (Recommended)							
28.6	17	17	1362	N/A	85.5	N/A	45	Good
28.5	18	18	492	57.0	57.0	8.2_{ns}	45	Good
28.2	18	18	1501	80.5	80.5	9.2	46	Very Good
	Eastern Corn Belt Plain - WWH Use designation (Existing)							
26.5	17	17	629	68.0	68.0	7.5*	39^{ns}	Mrg.Good/Far
25.5 (mz)	21	21	4782	76.5	-	9.7	45	Good/Exc.
24.1	24	24	868	80.0	80.0	8.6	44	Good
18.8	18	18	1770	74.0	74.0	9.0	43	Good
	Eastern Corn Belt Plain -EWH Use Designation (Recommended)							
14.4	31	31	1832	81.0	81.0	9.2	50	Good/Exc.
9.2	29	29	1628	85.0	85.0	10.1	55	Exceptional
	Eastern Corn Belt Plain -EWH Use Designation (Existing)							
1.2	28	28	1032	80.0	80.0	9.9	52	Exceptional

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	WWH	EWH	MWH[d]	
IBI - Headwaters/Wading		40	50	24
IBI - Boat	42	48	24	
Mod. Iwb - Wading	8.3	9.4	5.8	
Mod. Iwb - Boat	8.5	9.6	5.8	

[d] - Modified Warmwater Habitat for channel modified areas.

* - Significant departure from applicable biological criterion (>4 IBI units or >0.5 Iwb units); underlined values are in the poor and very poor range.

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

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

NA - Headwater site; MIwb is not applicable.

(mz) _ Mixing Zone sample.

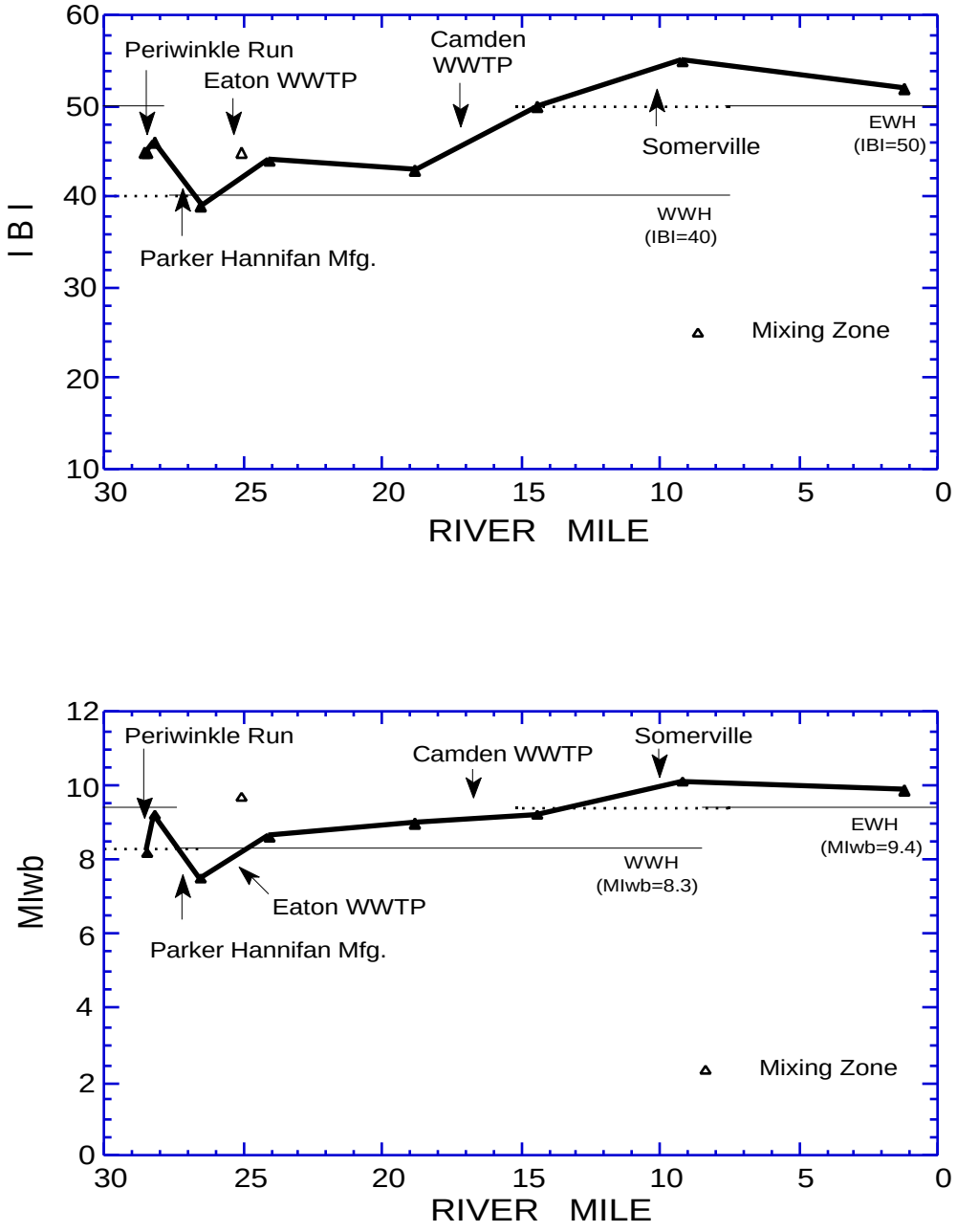

Figure 14. Longitudinal trend of the Index of Biotic Integrity (IBI; upper) and the Modified Index of Well-Being (MIwb; lower) in the Sevenmile Creek study area, 1991. Dashed lines represent proposed use designation changes.

Table 10. Area of Degradation (ADV) statistics for the Sevenmile Creek study area, 1991 (calculated using ecoregion criteria as the background community performance).

Biological Index Scores					ADV Statistics			Attainment Status (miles)			
Stream Index	Upper RM .	Lower RM .	Mini-mum	Maxi-mum	**ADV**	ADV/ Mile .	Poor/VP ADV	FULL	PARTIAL	**NON**	Poor/VP
Sevenmile Creek (recommended WWH and EWH designations											
IBI	28.6	1.2	39	55	**277**	10.1	0	11.8	13.9	**2.3**	0
MIwb			7.5	10.1	**115**	4.2	0				
ICI			28	52	**573**	20.9	0				
Sevenmile Creek (existing WWH and EWH designations)											
IBI	28.6	1.2	39	55	**289**	24.9	0	11.5	14.1	**2.9**	0
MIwb			7.5	10.1	**135**	20.5	0				
ICI			28	52	**603**	60.9	0				

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Appendix Table 1. Results (mean/maximum - minimum)[a] of chemical/physical sampling in the Sevenmile Creek study area during, June - October 1991. All conventional parameters are reported in mg/l; all metals and other substances are reported in µg/l, unless otherwise noted.

River Mile (n)	Dissolved Oxygen	Temperature (˚C)	pH (S.U.)	Specific Conductance	Tot. Susp. Solids
35.43(3)	5.3 (3.0-7.8)	19.5 (18.0-22.0)	7.6 (7.2-7.9)	848 (765-909)	15 (5-24)
28.55	7.2 (5.7-10.2)	20.4 (19.0-24.0)	7.9 (7.7-8.2)	595 (573-613)	6 (5-9)
28.15	6.5 (4.8-9.6)	20.6 (19.0-25.0)	8.0 (7.8-8.2)	588 (488-633)	6 (5-10)
27.00	7.2 (4.8-11.9)	20.7 (19.0-24.0)	8.0 (7.9-8.2)	623 (596-663)	5 (5-6)
25.94	6.9 (5.0-9.4)	21.5 (19.0-26.0)	7.9 (7.8-8.1)	678 (544-989)	16 (5-47)
25.16	7.7 (5.2-10.8)	21.5 (20.0-23.5)	7.9 (7.8-8.1)	1010 (580-1630)	7 (5-14)
24.10	7.3 (6.2-8.2)	20.3 (19.0-24.0)	8.1 (8.0-8.2)	1140 (848-1400)	8 (8-8.2)
17.79	7.6 (6.4-8.8)	21.6 (19.0-27.0)	8.2 (8.0-8.4)	857 (643-974)	33 (7-112)
14.47	6.0 (4.5-7.0)	22.1 (20.0-27.0)	8.1 (8.0-8.2)	771 (703-856)	14(8-25)
9.28	9.0 (6.7-12.2)	23.6 (21.5-27.0)	8.0 (7.9-8.1)	614 (592-636)	11(6-19)
1.32	9.2 (8.0-10.2)	25.4 (24.0-31.0)	8.6 (8.5-8.9)	589 (501-954)	23 (5-50)

River Mile	BOD5 (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	TKN (mg/l)	Nitrite+Nitrate (mg/l)
35.43	5.9 (1.3-11.0)	3.7 (.70-6.5)	.04 (.03-.05)	.63 (.30-1.3)	1.22 (.10-3.2)
28.55	1.0 (1.0-1.0)	.07 (.05-.15)	.02 (.02-.04)	.64 (.20-3.0)	1.72 (.86-2.7)
28.15	1.0 (1.0-1.1)	.05 (.05-.05)	.02 (.02-.03)	.25 (.20-.30)	1.72 (.78-2.7)
27.00	1.1 (1.0-1.5)	.05 (.05-.05)	.02 (.02-.03)	.27 (.20-.30)	1.84 (.73-3.2)
25.94	1.9 (1.0-3.5)	.07 (.05-.14)	.04 (.02-.06)	.51 (.20-.90)	1.32 (.66-2.6)
25.16	1.3 (1.0-2.1)	.05 (.05-.05)	.02 (.02-.05)	.51 (.20-.90)	4.42 (.70-9.8)
24.10	1.2 (1.0-1.8)	.05 (.05-.05)	.03 (.02-.04)	.56 (.20-1.0)	8.91 (4-17.0)
17.79	1.7 (1.0-2.4)	.05 (.05-.05)	.06 (.05-.09)	.55 (.30-1.0)	2.83 (2-3.7)
14.47	1.2 (1.0-1.7)	.06 (.05-.10)	.06 (.05-.07)	.39 (.30-.50)	1.45 (.72-2.7)
9.28	1.2 (1.0-1.6)	.05 (.05-.05)	.03 (.02-.04)	.21 (.20-.30)	1.14 (.72-1.8)
1.32	2.5 (1.0-10.0)	.05 (.05-.05)	.02 (.02-.02)	.31 (.20-.40)	.60 (.10-1.3)

Appendix Table 1. continued

RM	Phos-T (mg/l)	TOC (mg/l)	CaCO3 (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
35.43	.40 (.05-.90)	6.2 (5.0-6.9)	352 (338-362)	86 (81-89)	33 (33-34)
28.55	.13 (.05-.31)	5.0 (5.0-5.0)	303 (295-312)	68 (62-74)	32 (31-34)
28.15	.12 (.05-.45)	5.0 (5.0-5.0)	302 (294-314)	69 (65-74)	31 (30-33)
27.00	.48 (.05-3.0)	5.0 (5.0-5.0)	288 (258-306)	65 (57-73)	31 (28-33)
25.94	.67 (.05-3.7)	5.0 (5.0-5.0)	295 (259-386)	66(56-102)	31(27-34)
25.16	.96 (.02-2.6)	5.1 (5.0-5.6)	325 (283-370)	76 (62-92)	33 (30-35)
24.10	1.5 (.53-3.4)	5.0 (5.0-5.0)	359 (330-382)	87 (76-93)	35 (32-37)
17.79	.44 (.31-.70)	5.0 (5.0-5.0)	325 (286-364)	79 (70-88)	31 (27-35)
14.47	.27 (.21-.32)	5.0 (5.0-5.0)	310 (278-348)	75 (65-85)	30 (27-33)
9.28	.27 (.05-1.4)	5.0 (5.0-5.0)	287 (271-294)	69 (64-72)	28 (27-29)
1.32	.07 (.05-.12)	5.0 (5.0-5.0)	248 (216-273)	58 (47-65)	26 (24-27)

RM	Arsenic	Cadmium	Chromium	Copper	Iron
35.43	6 (5-8)	.26 (.2-.4)	30 (30-30)	10 (10-10)	1163 (410-1720)
28.55	3 (2-10)	.20 (.2-.2)	30 (30-30)	11 (10-15)	194 (90-280)
28.15	2 (2-2)	.20 (.2-.2)	30 (30-30)	13 (10-30)	146 (80-360)
27.0	2 (2-2)	.26 (.2-.4)	30 (30-30)	10 (10-10)	319 (190-510)
25.94	2 (2-2)	.20 (.2-.2)	30 (30-30)	10 (10-10)	353 (70-740)
25.16	2 (2-3)	.61 (.2-2)	30 (30-30)	10 (10-10)	214 (110-450)
24.10	2 (2-3)	1.0 (.2-2)	31 (30-40)	10 (10-10)	107 (50-170)
17.79	2 (2-3)	.90 (.6-1)	30 (30-30)	11 (10-15)	346 (140-760)
14.47	2 (2-2)	.37 (.2-.5)	30 (30-30)	10 (10-10)	321 (140-440)
9.28	2 (2-2)	.20 (.2-.2)	30 (30-30)	10 (10-10)	648 (540-790)
1.32	2 (2-2)	.20 (.2-.2)	30 (30-30)	10 (10-10)	354 (100-800)

RM	Lead	Nickel	Zinc	F.Coliform	F.Strep
35.43	2 (2-2)	40 (40-40)	28 (20-35)	48000 (24000-6x10^4)	43144 (1433-93000)
28.55	2 (2-2)	46 (40-80)	61 (10-270)	453 (260-600)	699 (390-1100)
28.15	2 (2-2)	40 (40-40)	16 (10-40)	636 (270-1060)	614 (340-891)
27.00	2 (2-2)	40 (40-40)	265 (10-1770)	764 (240-1800)	2799 (433-16000)
25.94	7 (2-28)	40 (40-40)	49 (20-90)	557 (80-1050)	497 (100-800)
25.16	2 (2-2)	40 (40-40)	15 (10-25)	350 (200-430)	365 (140-653)
24.10	4 (2-17)	40 (40-40)	170 (10-1040)	463 (240-720)	346 (160-760)
17.79	3 (2-5)	40 (40-40)	54 (10-205)	446 (160-1500)	164 (20-270)
14.47	2 (2-3)	40 (40-40)	29 (10-120)	463 (90-1600)	151 (70-280)
9.28	2 (2-2)	40 (40-40)	11 (10-15)	169 (10-490)	146 (40-220)
1.32	2 (2-2)	40 (40-40)	19 (10-55)	126 (10-310)	166 (20-810)

Appendix Table 1. cont....

RM	Tot. Dissolved Solids
35.43	525 (486-586)
28.55	413 (380-422)
28.15	413 (398-432)
27.00	391 (240-496)
25.94	492 (388-982)
25.16	675 (450-940)
24.10	720 (518-846)
17.79	550 (478-602)
14.47	503 (458-556)
9.28	393 (341-430)
1.32	349 (312-402)

[a] Mean values are calculated using detection limits as the minimum value where reported minimum was less than detection limit.

Appendix Table 2. Summary of diurnal D.O.(mg/l) data recorded with Datasonde continuous monitors at five locations in Sevenmile Creek, 07-16 through 07-19, 1991.

River Mile	Total Hours	Mean (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %ile (mg/l)	75th %ile
Sevenmile Creek						
35.43	96	1.85‡‡	0.34‡‡	9.05	.70‡‡	2.09‡
28.15	96	7.15	5.11‡	9.82	6.28	7.87
24.10	96	8.40	6.65	11.65	7.16	9.39
14.47	96	8.60	4.55	17.24	6.14	10.74
9.28	96	8.35	5.51	13.05	6.67	10.74

‡ violation of the average dissolved oxygen (D.O.) criterion.

‡‡ violation of the minimum dissolved oxygen (D.O.) criterion.