

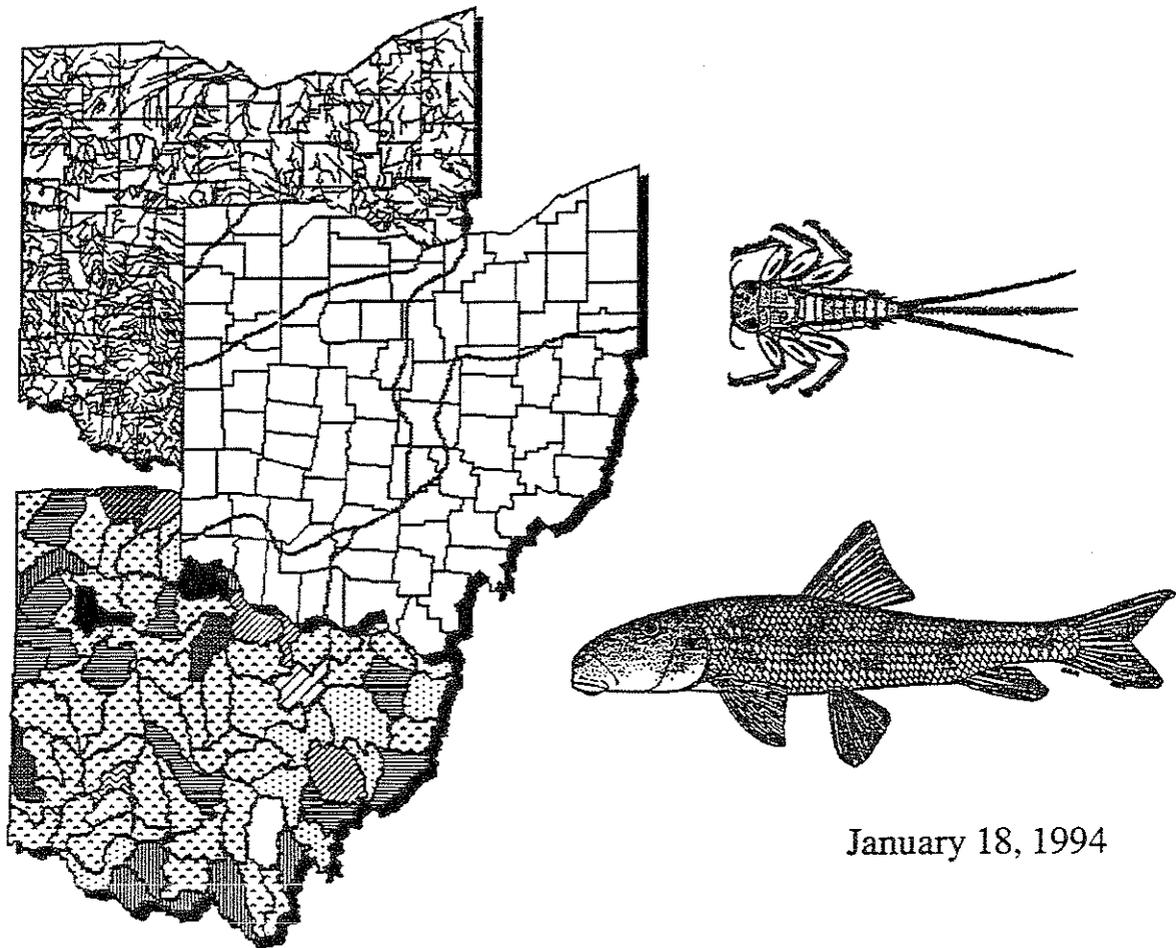


State of Ohio
Environmental Protection Agency

Ecological Assessment Section
Division of Surface Water

Biological and Habitat Study of Bokes Creek

Union and Delaware Counties, Ohio



January 18, 1994

Biological and Habitat Study of Bokes Creek

Union and Delaware Counties, Ohio

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prepared by

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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:

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Acknowledgements

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Study Area Description -

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Fish Community - Paul Vandermeer and Charles Boucher

Data Management - Dennis Mishne and Ed Rankin

Report Coordinator - Paul Vandermeer

Reviewer(s) - Chris Yoder, Marc Smith, and Jeff DeShon

This evaluation and report would not have been possible without the assistance of and numerous full and part time staff in the field.

Biological and Habitat Survey of Bokes Creek and Powderlick Run
(Union and Delaware Counties, Ohio)

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Introduction

The Bokes Creek study area extended from upstream of the town of York Center, Ohio (RM 27.5, 1992 and RM 27.2, 1993) to just near the mouth (RM 0.3).

Specific objectives of this evaluation were to:

- 1) monitor and assess biological communities in Bokes Creek to determine the degree to which point and nonpoint pollutant sources affect the stream;
- 2) evaluate the existing aquatic life stream use designations of Bokes Creek; and
- 3) determine the attainment status of current aquatic life use designations and assess trends.

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

The 1992 Bokes Creek study area extended from RM 27.5 (upstream of Phelps Road) to RM 0.3 (upstream of State Route 257). The 1993 Bokes Creek study area extended from RM 27.2 (at Phelps Rd.) to RM 0.3 (upstream of State Route 257). The study area also included RM 0.2 (at Yearsley Road), on Powderlick Run (1992 and 1993). In general, Bokes Creek only partially attains the criteria for the WWH use (Tables 1 and 2). Macrohabitats in Bokes Creek and Powderlick Run were generally sufficient to support and maintain the Warmwater Habitat (WWH) aquatic life use (Table 4). A 5.4 mile stretch of Bokes Creek downstream from RM 20.2 (upstream of State Route 31 and downstream of Powderlick Run, including 20% of the study area) did not attain the WWH use in both 1992 and 1993. Fish communities in both years were considered to be fair in condition with the 1992 macroinvertebrate community in marginally good condition. Causes for NON attainment included: 1) agricultural point and nonpoint source impacts associated with Powderlick Run, 2) mediocre habitat due to past modification, and 3) other nonpoint source impacts from surrounding agricultural practices. PARTIAL attainment of the WWH use extended up and downstream from RM 20.2 in both years for approximately 79% of the study area in 1992 and 59% of the study area in 1993 (See Table 1 and Table 2 for specific sections of PARTIAL attainment). These segments represent an area of suppression of the biological communities (primarily the fish community) by nonpoint sources of pollution and are considered to be in violation of the Ohio WQS. FULL attainment of the WWH use was reached in the lower 0.3 miles in 1992 and in the upper 5.8 miles in 1993, where all fish and macroinvertebrate scores exceeded their respective biological criteria for the WWH aquatic life use. These segments represent 1% and 21% respectively of the study area.

Powderlick Run (formerly known as Lick Run) was not attaining the designated WWH use. At RM 0.2 there was substantial visual evidence of agricultural nonpoint source pollution from a livestock operation. Livestock have direct access to the stream and have precipitated numerous habitat and water quality problems. In addition, Powderlick Run seems to be impacted from several point sources upstream (*i.e.*, three egg farms).

Conclusions

- The fish community in Bokes Creek appeared to be negatively impacted by nonpoint sources of pollution, especially agricultural runoff.
- The fish community is especially depressed (both in numbers and diversity) downstream from Powderlick Run. This suggests negative effects from Powderlick Run and the pollution sources located there.
- The Powderlick Run fish community is negatively impacted by livestock operations and a lack of riparian corridor.
- The macroinvertebrate community appeared to be in good condition over most of the stream. It seems relatively unaffected by the problems facing the fish community.

Recommendations

Suggested Remedial Actions

1. Reestablish the riparian corridor where it has been removed or reduced to a vestige. This should cover a minimum of 50 feet on each side of the stream or 2.5 times the stream width, whichever is larger.
2. Determine the sources of impairment to the stream and attempt to reduce the loadings of pollutants, including nutrient inputs.
3. Restrict the free access of livestock to the stream, especially in Powderlick Run.

Status of Aquatic Life Uses

The streams evaluated during this study were originally designated for aquatic life uses in the document, Biological and Water Quality Study of Mill Creek and Selected Tributaries and Bokes Creek (Ohio EPA, 1991a) and subsequently incorporated into the Ohio WQS.

The current Warmwater Habitat aquatic life use designation is appropriate for Bokes Creek. The stream has been subjected to past habitat modification, however; QHEI scores ranged from 43.5 to 81.5 (mean = 61.9) and demonstrate that these habitat alterations were not significantly affecting the stream as a whole and further recovery of warmwater attributes should continue (Table 4). The WWH biological criteria were met at RM 0.3 demonstrating the potential of the stream to support the designated use in segments which are at present enriched with nutrients and somewhat degraded.

Powderlick Run (fka Lick Run and listed in the Water Quality Standards as Lick Run) at the mouth (RM 0.2) showed significant habitat and agricultural related problems and impacts from point sources upstream. Specifically, the stream is severely impacted by livestock wastes (chicken manure) and the free access of livestock to the stream, with all of the associated enrichment (as noted by extensive algal blooms), destruction of the banks, and a nearly complete lack of riparian cover. If these problems were corrected, Powderlick Run would likely attain the Warmwater Habitat aquatic life use. Therefore the current Warmwater Habitat aquatic life use seems

appropriate.

Status of Non-Aquatic Life Uses

Currently Bokes Creek and Powderlick Run are designated for Primary Contact Recreation and as Agricultural and Industrial Water Supplies. The 1992 and 1993 sampling effort identified one change that is needed, that being the designation of Powderlick Run for Secondary Contact Recreation rather than Primary Contact Recreation. Maximum depth of pools in Powderlick Run did not exceed one meter over a 100 square foot area.

Future Monitoring Needs

- Follow-up monitoring should be conducted in association with the application of Best Management Practices (BMPs) to nonpoint sources of pollution and remedial efforts with the point sources of pollution.
- A habitat evaluation should be performed in Powderlick Run upstream of RM 0.2/0.3 to determine the extent of WWH potential.

Study Area

Bokes Creek is a tributary to the Scioto River draining 84.2 square miles of primarily agricultural land in north central Ohio (ODNR 1960). From its headwaters in northeast Logan County, Bokes Creek flows east southeast through northcentral Union County and joins the Scioto River in western Delaware County. One major tributary to Bokes Creek is Powderlick Run. One small urban area in the Bokes Creek watershed is Magnetic Springs.

The study area includes approximately 27.5 miles of Bokes Creek from the Logan/Union County border to the confluence with the Scioto River in Delaware County, and a 0.2 mile segment at the mouth of Powderlick Run in northcentral Union County. Powderlick Run flows east through Union County farmland and joins Bokes Creek just west of State Route 31.

The Bokes Creek watershed is situated in the Eastern Corn Belt Plain (ECBP). The ECBP ecoregion is a rich agricultural plain which stretches south of the Huron-Erie Lake Plain (HELP) ecoregion to the Ohio River. The ECBP ecoregion is characterized by a gently rolling glacial till plain with moraines, kames and outwash plains. Local relief is generally less than 50 feet. Soils are derived from glacial till materials and soil drainage is often poor. Many of the streams in the ECBP ecoregion have been channelized to improve soil drainage.

Agricultural land uses dominate the Bokes Creek watershed. This is typical of the Eastern Corn Belt Plains ecoregion. Land types include cropland, pasture, farmstead, deciduous forest, and shrub/brush areas. Several small communities account for any urban land uses within the watershed. Corn and soybeans are the principal crops; other feed grains and hay for livestock are also grown.

Agricultural runoff (livestock facilities, soil erosion from cropland, improper manure management), failing septic systems (primarily from Magnetic Springs and York Center) and channelization are the predominant types of nonpoint sources (NPS) pollution in the watershed.

Table 1. Aquatic life use attainment status for the Exceptional/Modified/Warmwater Habitat (WWH) use designation in Bokes Creek and Powderlick Run based on data collected during June - September 1992.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI	QHEI ^b	Attainment Status ^c	Comment
<i>Eastern Corn Belt Plain- WWH Use Designation (Existing)</i>						
<i>Bokes Creek (1992)</i>						
27.5/26.2	32*	6.3*	44	43.5	PARTIAL	Ust Powderlick Run Dst Powderlick Run
21.3/21.4	29*	6.2*	50	59.0	PARTIAL	
20.2/20.5	29*	5.2*	34 ^{ns}	45.0	NON	
14.8/14.8	37 ^{ns}	7.6*	40	78.0	PARTIAL	
5.5/5.6	37 ^{ns}	6.5*	42	68.0	PARTIAL	
0.3/0.2	49	9.1	44	81.5	FULL	
<i>Powderlick Run (1992)</i>						
0.2/0.1	28*	N/A	30*	49.5	NON	Livestock access and point sources

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^d</u>
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
ICI	36	46	22

^d - Modified Warmwater Habitat for channel modified areas.

- * - significant departure from interim biocriteria; poor and very poor results are underlined.
^{ns} - nonsignificant departure from interim biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 Iwb units).
^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.

Table 2. Aquatic life use attainment status for the Exceptional/Modified/Warmwater Habitat (WWH) use designation in Bokes Creek and Powderlick Run based on data collected during June - September 1993.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI	QHEI ^b	Attainment Status ^c	Comment
<i>Eastern Corn Belt Plain- WWH Use Designation (Existing)</i>						
<i>Bokes Creek (1993)</i>						
27.2/26.2	40	8.5	42	56.0	FULL	
21.4/21.4	34*	6.7*	40	44.0	PARTIAL	Ust Powderlick Run
20.2/ -	34*	5.7*	-	63.5	NON	Dst Powderlick Run
14.8/14.8	31*	6.2*	38	72.0	PARTIAL	
5.6/5.6	34*	7.4*	32 ^{ns}	64.0	PARTIAL	
0.3/ -	41	7.3*	-	68.0	PARTIAL	
<i>Powderlick Run (1993)</i>						
0.2/ -	<u>25*</u>	N/A	-	34.0	(NON)	Livestock access, point sources

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^d</u>
IBI - Headwaters/Wading	40	50	24
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^{ns} - nonsignificant departure from interim biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 Iwb units).

^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.

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) and Biological Criteria for the Protection of Aquatic Life, Volumes II-III (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, 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 primarily sampled using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates.

Fish were sampled 2-3 times each year using pulsed DC electrofishing gear using either the wading method (200 meter zones) or boat method (500 meter zones). 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 1). 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. In 1990, the ADV/mile calculated for the IBI was 38.6, which is indicative of a moderate amount of degradation. This value has since declined considerably (i.e., stream quality has improved) as demonstrated by the 1992 and 1993 results, 21.5 and 21.2 respectively. The same result can be inferred from examination of the results for the ADV/mile from the MIwb. The 1990 result was 67.8 and was followed by a decline in 1992 and 1993 of 51.7 and 48.0 respectively. The trend here seems to indicate a small improvement in the condition of the stream over the last several years as demonstrated by the declining value of the ADV/mile.

Figure 1. 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.

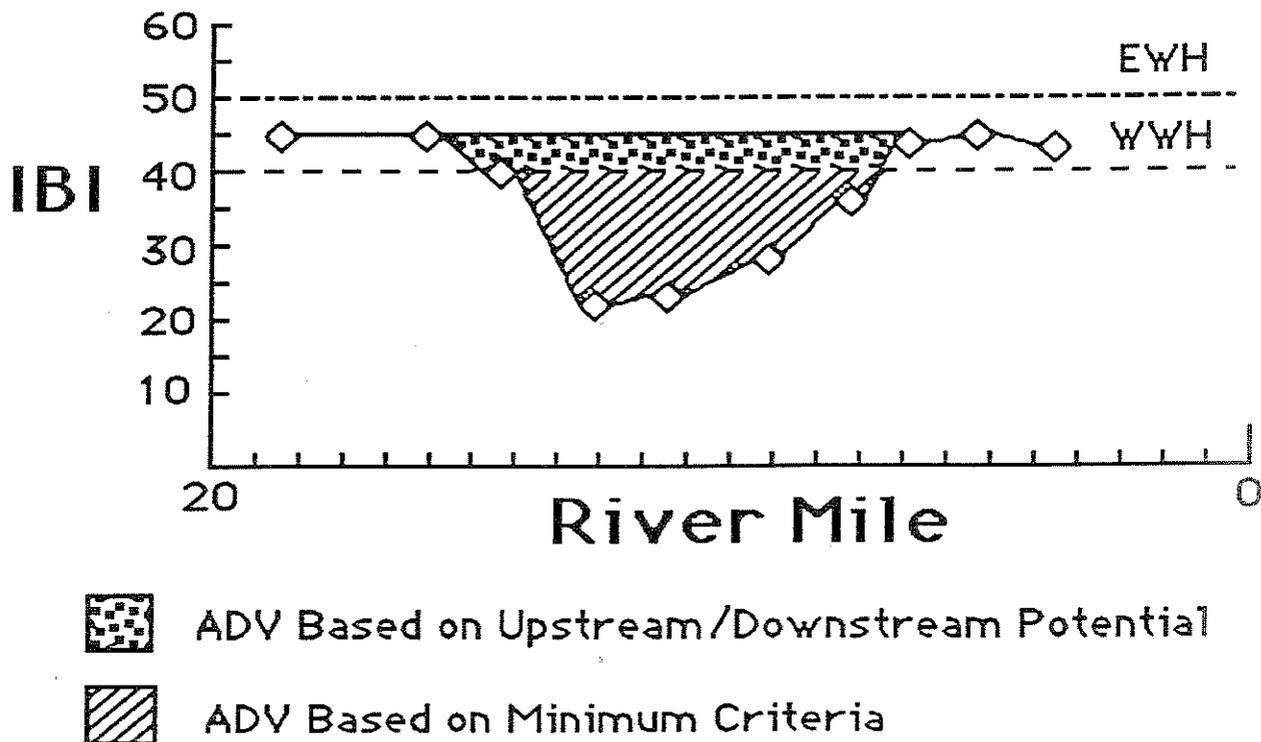


Table 3. Sampling locations in the Bokes Creek study area, 1992 and 1993 (effluent sample - E, water chemistry - C, sediment chemistry - S, benthos - B, fish - F, fish tissue - FT).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
<u>Bokes creek</u>				
27.5	F	40°25'35"/83°28'21"	Ust Phelps Rd.	York Center
27.2	F	40°25'07"/83°53'23"	Ust Phelps Rd.	York Center
26.2	B	40°24'58"/83°28'00"	Ust Spangler Rd.	York Center
21.4	F,B	40°23'33"/83°24'44"	Ust Yearsley Rd.	York Center
20.5	B	40°23'04"/83°24'32"	Adj SR 31	York Center
20.2	F,B	40°22'58"/83°24'21"	Ust SR 31	York Center
14.8	F,B	40°21'42"/83°21'02"	Ust Claibourne Rd.	Magnetic Springs
5.6	F,B	40°20'22"/83°14'38"	Ust Brown Rd.	Ostrander
5.5	F	40°21'20"/83°53'02"	Ust Brown Rd.	Ostrander
0.3	F	40°19'20"/83°10'31"	Ust SR 257	Ostrander
<u>Powderlick Run</u>				
0.2	B,F	40°23'03"/83°24'51"	Ust Yearsley Rd.	York Center

Results and Discussion

Physical Habitat for Aquatic Life

Bokes Creek

- Macrohabitats of Bokes Creek were evaluated at a total of six fish sampling locations for the years 1992 and 1993. In 1992, the QHEI ranged from 43.5 at RM 27.5 to 81.5 at RM 0.3, with a mean value of 62.5. In 1993, the QHEI ranged from 44.0 at RM 21.4 to 72.0 at RM 14.8, with a mean value of 61.3. These values suggest that the habitat throughout the study area is of sufficient quality to support and maintain an aquatic community achieving Warmwater Habitat (WWH) biological criteria (Rankin 1989; see Table 4).
- Bokes Creek has been subject to past modification including channelization, riparian removal, and snagging of instream cover. There is evidence of channelization in the streambed in some places, specifically RM 21.3. RM 5.5 is impacted by the proximity of Brown Road which is built adjacent to the stream. The riverbank is lined with large rip-rap to stabilize the bank and the roadway. The rip-rap is virtually the only habitat found along the stretch of stream by Brown Road. In addition, RM 27.2 is impacted negatively from agricultural modifications; specifically, the removal of the forest canopy and the subsequent erosion of the banks. This erosion is severe in some places as evidenced by chunks of soil which have fallen into the stream channel from the eroded banks.
- In most of the study area, cobble and gravel substrates predominated with some lying atop bedrock. These substrates are of glacial and native origin. Silt cover seemed to be normal in most sections, however, there were occasional areas with higher silt coverage (e.g., RM 27.2). Shelving limestone and shale bedrock dominated the site at RM 0.3 and periodically produced rock ledge riffles and pools. This segment contained the highest quality habitats of the study area, with several pool/run/riffle complexes, fair instream cover, good channel development and an abundance of aquatic macrophytes (Table 4).
- The disparity in some of the QHEI values from 1992 to 1993 in some locales can be attributed to a different operator and slightly different sampling locations in 1993. This was especially apparent in the riffle embeddedness category where all sites were moderately to highly embedded in 1992 but only one site was moderately to highly embedded in 1993.

Powderlick Run

- Macrohabitats of Powderlick Run were evaluated at one location during the 1992 and 1993 field sampling efforts. QHEI scores were 49.5 at RM 0.2 for 1992 and 34.0 at RM 0.2 for 1993 (Table 1). The variation in these two values resulted from movement of the sampling site completely upstream of Yearsley Road in 1993 versus sampling above and below Yearsley Road in 1992 (the bank area below Yearsley Road is lined with small trees and shrubs). These values suggest that the physical components of instream habitats within Powderlick Run are not of sufficient quality to support a biological community achieving WWH biological criteria. This is due mainly to the destruction of the stream banks and channel caused by the unrestricted movement of livestock in and out of the stream. Also, there are many places along the stream where the banks have eroded (due to the lack of tree cover along the bank), leaving sizeable pieces of grass-covered soil in the stream channel. If the livestock's free access to the stream

*Biological Assessment: Macroinvertebrate Community**Bokes Creek and Powderlick Run*

- Macroinvertebrate sampling in Bokes Creek was conducted at four locations in 1993 and seven locations in 1992. Sites in 1993 included Spangler Road (RM 26.2), Yearsley Road (RM 21.4), Claibourne Road (RM 14.8), and Brown Road (RM 5.6). Sampling in 1992 included the same four sites with additional collections at SR 257 (RM 0.2), downstream from Powderlick Run (RM 20.5), and from Powderlick Run at Yearsley Road (RM 20.8, 0.1). Quantitative artificial substrate sampling protocols were used at each location. Previous collections from four similar locations in Bokes Creek were taken in 1990; results were reported in the 1991 Ohio EPA document titled Biological and Water Quality Study of Mill Creek and Selected Tributaries and Bokes Creek. For comparison purposes, summarized 1990 data are included in this discussion.
- In general, ICI scores from all three sampling years met or nearly met the biocriterion for the designated Warmwater Habitat (WWH) aquatic life use (Table 5). The two exceptions were scores at the 1992 Powderlick Run sampling location and the 1990 Bokes Creek sampling location at Phelps Road (RM 27.5). Values of 30 at both sites were just below the 32-34 range of scores considered nonsignificant departures from the biocriterion (ICI=36).
- ICI scores from Bokes Creek in 1993 ranged from 42 (very good) at Spangler Road (RM 26.2) to 32 (marginally good) at Brown Road (RM 5.6); scores declined in a downstream direction (Figure 2). All four sites were numerically predominated by mayflies which accounted for 50-75 percent of the total number of organisms collected at each site. Structural differences between the most upstream community and those downstream resulted in the gradual lowering of scores and included fewer mayfly and caddisfly taxa and, to a lesser extent, fewer dipteran and qualitative EPT taxa. However, there was no significant difference between the ICI scores at the three most upstream sites which varied by four or fewer points and met the WWH biocriterion. The score at Brown Road, while a nonsignificant departure from the biocriterion, was considerably lower than the upstream sites. Field observations of reduced water clarity at this site suggested elevated suspended sediment levels, increased algal activity, or both, and may have been a reflection of upstream agricultural land use practices.
- ICI scores from Bokes Creek in 1992 ranged from 50 (exceptional) at Yearsley Road (RM 21.4) to 34 (marginally good) downstream from Powderlick Run at RM 20.5 (Figure 2). An ICI of 30 (fair) was scored at the Powderlick Run site at Yearsley Road (RM 20.8, 0.1). Much like 1993, the 1992 macroinvertebrate communities rated as good to exceptional were characterized by diverse populations of 7 to 9 taxa of mayflies comprising 20-60 percent of the total number of organisms collected from each site. Caddisflies were also numerically abundant at these sites (12-20 percent of the organisms collected) although richness was limited (1 to 3 taxa). Conversely, the marginally good community collected at the site downstream from Powderlick Run at RM 20.5, while also numerically predominated by mayflies, supported fewer mayfly taxa, a marked decrease in caddisfly abundance, and a slightly higher percentage of tolerant organisms; these factors resulted in the lower ICI score. Community conditions in Powderlick Run were further degraded. Mayfly diversity and abundance were severely reduced while the percentages of dipterans/non-insects and tolerant organisms were elevated. Based on these results, both Powderlick Run and Bokes Creek in the immediate downstream vicinity of Powderlick Run appeared to be moderately impaired by land use

practices in the Powderlick subwatershed (e.g., land application of poultry manure, unrestricted livestock access, poor riparian integrity). Although field observations of heavy siltation and excessive filamentous algae growth were taken at many of the Bokes Creek sites, the problem seemed most acute at the Powderlick site and those Bokes sites contiguous with the Powderlick subwatershed.

Biological Assessment: Fish Community

Bokes Creek

- A total of 4,612 fish comprised of 35 species and one hybrid were collected from Bokes Creek between July 1 and August 27, 1992. The sampling effort included a cumulative total of 2.4 km at six sampling locations between RM 27.5, and RM 0.3. A total of 5614 fish comprised of 35 species and two hybrids were collected from Bokes Creek between August 4, and September 10, 1993. The sampling effort included a cumulative total of 2.4 km at six sampling locations between RM 27.2, and RM 0.3. Previous collections from four similar locations in Bokes Creek were taken in 1990; results were reported in the 1991 Ohio EPA document titled Biological and Water Quality Study of Mill Creek and Selected Tributaries and Bokes Creek (Ohio EPA 1991a). For comparison purposes, summarized 1990 data are included in the graphs.
- In 1992, the fish community was predominated numerically by bluntnose minnow (15.5%), green sunfish (14.2%), creek chub (12.3%), striped shiner (11.8%), central stoneroller (10.5%), and greenside darter (9.6%). Fish species predominating the biomass included green sunfish (24.7%), creek chub (16.7%), striped shiner (11.1%), rock bass (8.7%) and white sucker (6.6%). In 1993 the fish community was predominated numerically by bluntnose minnow (17.7%), creek chub (16.3%), central stoneroller (13.3%), greenside darter (12.5%) green sunfish (7.4%), and striped shiner (7.2%). Fish species predominating the biomass included creek chub (23.9%), common carp (14.5%), white sucker (9.7%), green sunfish (9.5%), and central stoneroller (8.2%).
- Based on IBI and MIwb scores and the accompanying narrative evaluation, the 1992 fish community performance ranged from Very Good at RM 0.3 to good/fair, fair, or poor at the rest of the sites (Table 6). The community was dominated by tolerant species with intolerant forms absent or in low abundance. All but one site (RM 0.3) failed to achieve WWH biological criteria (Figure 3). The fish community performance was somewhat similar in 1993. The site at RM 0.3 showed an IBI value of 41 with a MIwb value of 7.3 thus providing a mixed result (Table 7). In addition, the site at RM 27.2 performed in the good range and actually met the WWH use criteria (Figure 3). As in 1992, the rest of the sites were characterized as good/fair, fair, or poor performance. Generally community performance in Bokes Creek can be characterized as fair.
- The most upstream site, RM 27.2, showed improvement over the two-year study period. This may be due to the intermittent nature of the problems emanating from West Mansfield, or the fact that these problems may be abating as the community improves its wastewater treatment facilities. Agricultural impacts are still a major concern here also and may be related to the variable community performance. In 1992 (RM 27.5), the fish community consisted of mainly pollution tolerant generalist/omnivorous fishes with moderately low abundance. A total of 19 different species were collected at RM 27.5 in 1992. During the 1993 collections, pollution

tolerance and feeding guilds represented remained relatively stationary with a few more intolerant (e.g., creek chubsucker, *Erimyzon oblongus*) and insectivorous fishes collected. However, abundance increased dramatically (748 total fish collected in 1992 versus 2458 total fish collected in 1993) as did the number of species caught (24 species collected in 1993 versus 19 species collected in 1992). What is really interesting is the variation in the IBI and MIwb indices which did not meet criteria in 1992 (IBI=32, MIwb=6.3) and met criteria in 1993 (IBI=40, MIwb=8.5, see Tables 6 and 7; Figure 3). This difference could be an artifact of the movement of the zone downstream in 1993 as indicated in the QHEI results for the two years (1992=43.5, 1993=56.0; Table 4), or it may be an improvement in the stream quality. However, nutrient enrichment and agricultural runoff appear to control fish community performance.

- In 1992 and 1993 the fish community both upstream (RM 21.4) and downstream (RM 20.2) of Powderlick Run consisted mainly of tolerant and generalist/omnivorous species. The upstream site however had much greater numbers of fish present than the downstream site which is indicative of an additional negative impact from Powderlick Run. Sensitive and carnivorous species were absent or in low abundance in both locations. The tolerant fish community continued to dominate downstream (probably due to the influence of Powderlick Run), but with gradual increases in intolerant, insectivorous and/or carnivorous fishes, until reaching the site at the mouth where full (1992) or partial (1993) attainment of the WWH criteria was finally reached (Figure 3).
- In 1992 DELT anomalies were not found to be a problem in the fish community. Scores in this IBI metric were mainly indicative of a normal situation. However, the 1993 results show a marked increase in the presence of DELT anomalies in the fish samples. Both the most upstream site (RM 27.2) and the most downstream site (RM 0.3) have low DELT incidence rates indicating normalcy. However, the sites in between these two showed significant DELT incidence (i.e., low scores in the IBI metric for DELT). This is indicative of stressful conditions and provides additional evidence for the fair to poor performance of the fish community.

Powderlick Run

- Fish community samples were collected from Powderlick Run at RM 0.2 during the 1992 and 1993 field sampling efforts. The primary objective was to evaluate the impact of several egg farms upstream and also nonpoint source effects. Community performance was poor in both years (1992 IBI= 25, 1993 IBI = 28, Tables 6 and 7). The primary factor inhibiting community performance in Powderlick Run was the nutrient enrichment caused by the egg farms and other agricultural practices, poor habitat caused by the unrestricted access of livestock throughout the stream bed, and erosion/siltation.
- The fish community at RM 0.2 lacked typical headwater species; consisting almost entirely of tolerant forms, most being pioneering species. This site failed to achieve WWH biological criteria (Tables 6 and 7). It appears that Powderlick Run is significantly impaired by nutrient enrichment from egg farms and other agricultural runoff, habitat destruction by unrestricted livestock, and erosion/siltation. These problems are correctable, which should enable Powderlick Run to achieve its WWH uses.

Trend Assessment

Changes in Biological Community Performance: 1990- 1993

Bokes Creek

- Little change has occurred in the macroinvertebrate communities of Bokes Creek between 1990 and 1993. For the most part, ICI scores at common locations have been fairly consistent and have met or exceeded the WWH biocriterion (Figure 2). Sites with the least degree of change in ICI scoring have been at Spangler Road (RM 26.2) and Claibourne Road (RM 14.8) where scores have varied by no more than two points (42 to 44 at RM 26.2 and 38 to 40 at RM 14.8). The widest variation in ICI scoring has occurred at Brown Road (RM 5.6) where ICI values ranged between 42 in 1992 and 32 in 1993. This is a significant change. Community composition and structure have been remarkably similar at all sites in all years in that mayflies have been a numerically predominant and fairly diverse component of the fauna. There has been no readily discernible positive or negative trends in the longitudinal profile of ICI scores in Bokes Creek over the four year sampling interval.
- Comparison of the data taken from the Biological and Water Quality Study of Mill Creek and Selected Tributaries and Bokes Creek (Ohio EPA, 1991) shows no real difference in the IBI or MIwb results compared with those documented in 1992-3. The fish community was impacted then as it is now with some slight improvements noted in the 1992-3 survey results.

Table 5. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Bokes Creek watershed, 1990-1993. Bokes Creek and Powderlick Run have a WWH aquatic life use designation in the Ohio Water Quality Standards.

<i>Stream River Mile</i>	Relative Density	Quant. Taxa	Qual. Taxa	Qual. EPT ^a	QCTV ^b	ICI	Evaluation
<i>Bokes Creek - 1993 (WWH)</i>							
26.2	1034	38	50	12	37.5	42	Very Good
21.4	830	25	27	9	38.5	40	Good
14.8	322	26	37	11	37.7	38	Good
5.6	582	28	21	4	35.5	32 ^{ns}	Marg. Good
<i>Bokes Creek - 1992 (WWH)</i>							
26.2	4459	33	58	10	35.6	44	Very Good
21.4	1153	36	50	13	34.3	50	Exceptional
20.5	1005	27	48	11	35.5	34 ^{ns}	Marg. Good
14.8	1809	23	35	10	37.5	40	Good
5.6	928	31	45	11	34.3	42	Very Good
0.2	2588	29	49	16	38.5	44	Very Good
<i>Bokes Creek - 1990 (WWH)</i>							
27.5	853	27	35	10	37.7	30*	Fair
21.4	1826	41	39	7	37.7	44	Very Good
14.8	1631	35	45	11	37.7	38	Good
5.6	1888	32	50	9	37.7	36	Good
<i>Powderlick Run - 1992 (WWH, formerly Lick Run)</i>							
0.1	5209	30	36	4	32.7	30*	Fair

Ecoregional Biocriteria: Eastern Corn Belt Plains (ECBP)
(from OAC 3745-1-07, Table 7-17)

<u>INDEX</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^c</u>
ICI	36	46	22

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

Table 6. Fish community indices based on pulsed D.C. electrofishing samples at 7 locations sampled by Ohio EPA in the Bokes Creek study area during July-August, 1992.

<i>Stream</i> River Mile	Mean Number Species	Mean Cum. Species	Mean Rel. # (#/Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Modified Index of Well-Being	Index of Biotic Integrity	Narrative Evaluation ^a
<i>Bokes Creek</i>								
27.5	15	19	561	3.1	43.5	6.3*	32*	Fair
21.3	15.5	18	443	2.9	59.0	6.2*	29*	Fair
20.2	12.5	16	252	3.5	45.0	5.2*	29*	Fair/Poor
14.8	15.5	19	862	5.6	78.0	7.6*	37 ^{ns}	Good/Fair
5.5	17.5	22	357	4.9	68.0	6.5*	38 ^{ns}	Good/Fair
0.3	23.5	29	1166	7.3	81.5	9.1	49	Very Good
<i>Powderlick Run</i>								
0.2	8.5	11	394	N/A	49.5	N/A	<u>25</u> *	Poor

* 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.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^b</u>
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

^b - Modified Warmwater Habitat for channel modified areas.

Table 7. Fish community indices based on pulsed D.C. electrofishing samples at 7 locations sampled by Ohio EPA in the Bokes Creek study area during July-August, 1993.

<i>Stream</i> River Mile	Mean Number Species	Mean Cum. Species	Mean Rel. # (#/Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Modified Index of Well-Being	Index of Biotic Integrity	Narrative Evaluation
<i>Bokes Creek</i>								
27.2	20.5	23	1844	11.9	56.0	8.5	40	Good
21.4	20	23	407	9.2	44.0	6.7*	34*	Fair
20.2	13.5	19	157	3.5	63.5	5.7*	<u>26*</u>	Poor
14.8	13	15	622	3.0	72.0	6.2*	31*	Fair
5.6	22.5	28	451	10.4	64.0	7.4*	34*	Fair
0.3	19.5	23	795	2.7	68.0	7.3*	41	Good/Fair
<i>Powderlick Run</i>								
0.2	11.5	14	214	N/A	34.0	N/A	28*	Fair

* 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.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWH</u>	<u>MWH^b</u>
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

^b - Modified Warmwater Habitat for channel modified areas.

Figure 2 . Longitudinal trend of the Invertebrate Community Index (ICI) in the Bokes Creek study area 1990, 1992, and 1993.

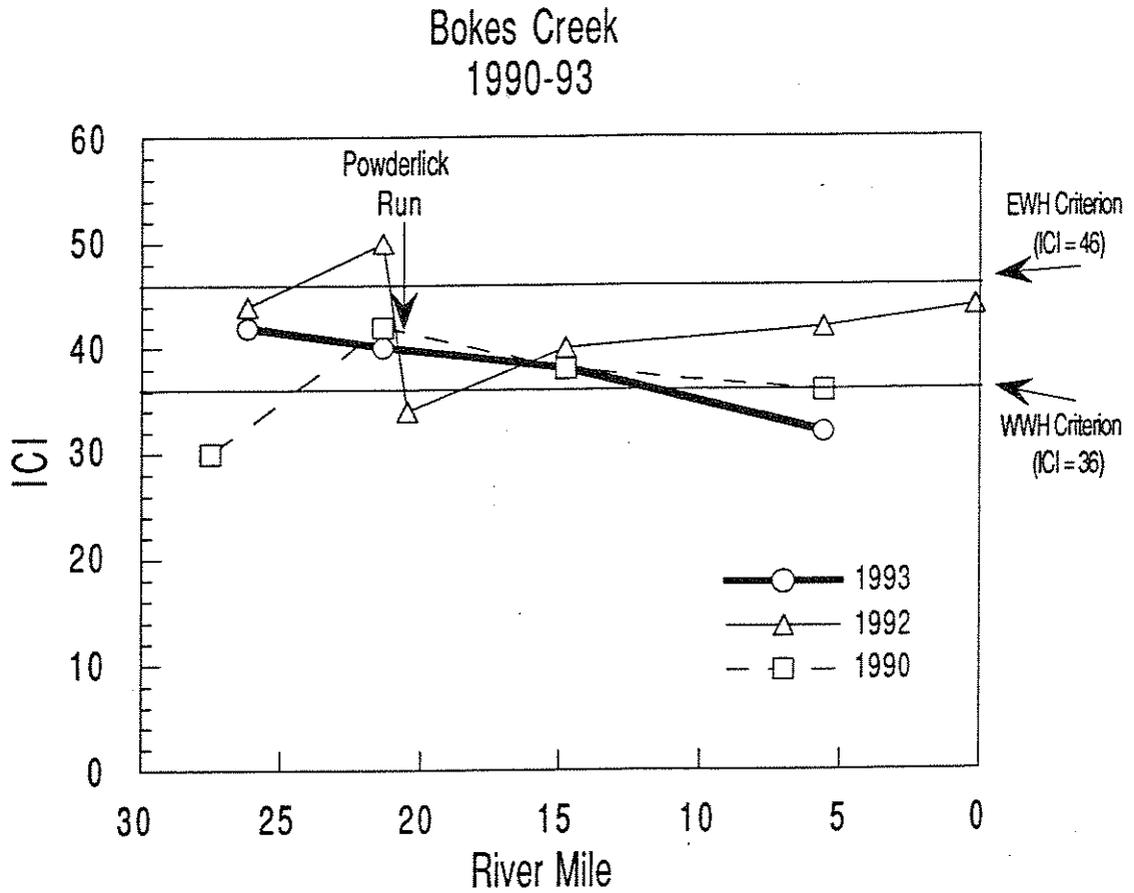
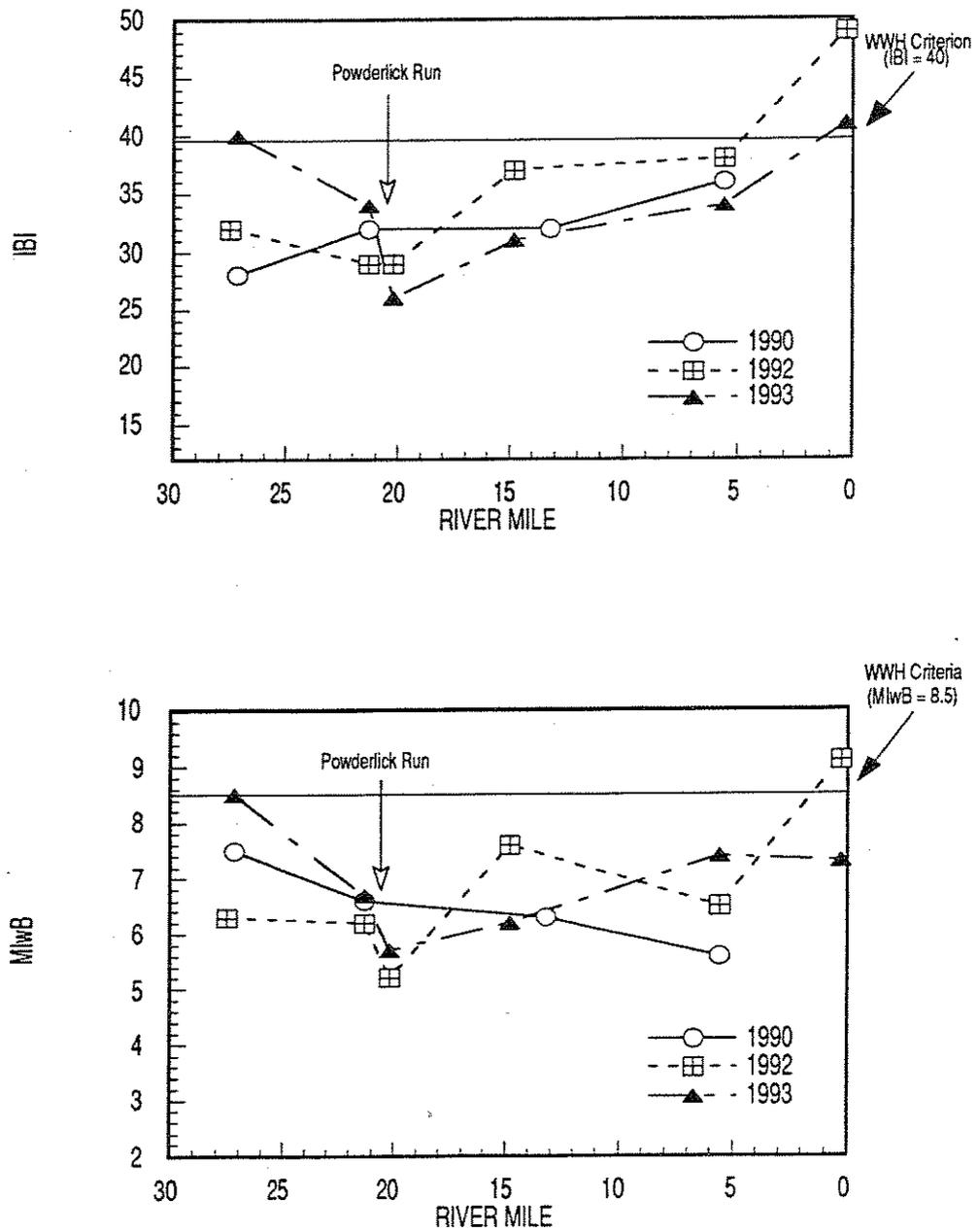


Figure 3. Longitudinal trend of the Index of Biotic Integrity (IBI, upper graph) and the Modified Index of Well-Being (MIwb, lower graph) in the Bokes Creek study area for the years 1990, 1992, and 1993.



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