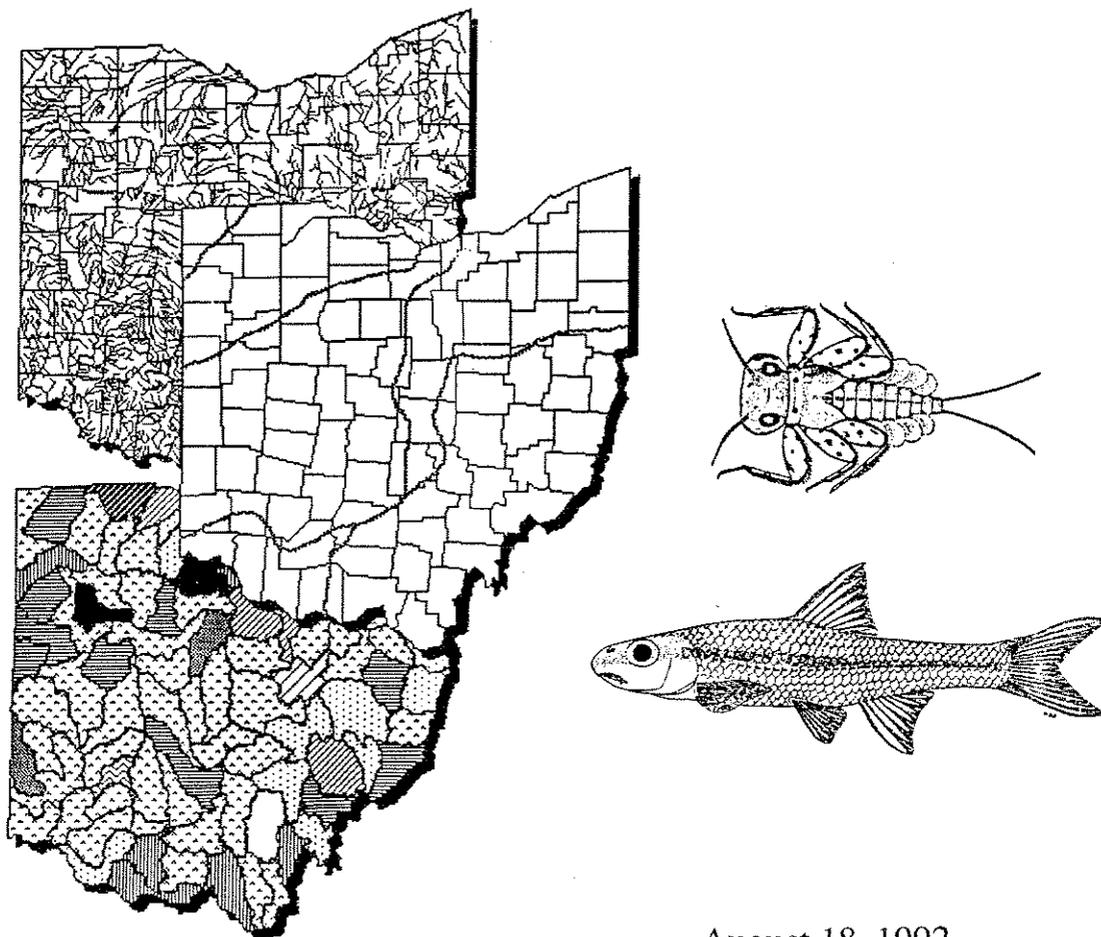


Biological and Water Quality Study of the Rocky Fork of Big Walnut Creek and Upper Blacklick Creek

Franklin County (Ohio)



August 18, 1992

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the Rocky Fork of Big Walnut Creek
and Upper Blacklick Creek**

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Ohio EPA Technical Report: EAS/1992-8-5

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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
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Introduction

The Rocky Fork of Big Walnut Creek (henceforth referred to as Rocky Fork Creek) study area extended from just east of Hoover Reservoir in the headwaters (RM 10.0) to near the mouth in Gahanna (RM 1.1). Also included was one location on Rose Run, a tributary to Rocky Fork Creek, and four sites on the upper Blacklick Creek (RMs 27.1-16.6), the basin immediately to the east of Rocky Fork Creek which is presently experiencing somewhat less suburban development.

Specific objectives of this evaluation were to:

- 1) assess the quality (physical, chemical, biological) of the Rocky Fork Creek and upper Blacklick Creek watersheds;
- 2) determine the appropriateness of the unverified (from the 1978 Water Quality Standards) Exceptional Warmwater Habitat (EWH) aquatic life use currently assigned to Rocky Fork Creek (headwaters to Gahanna) and Blacklick Creek (headwaters to Broad St.), the State Resource Water (SRW) designation assigned to the EWH segment of Rocky Fork Creek, and the Primary Contact Recreation (PCR) use assigned to the entirety of both streams;
- 3) determine instream biological and water quality impacts to Rocky Fork Creek attributable to point and nonpoint sources in the watershed including those caused by golf course construction activities and sewer line and other utility work in the vicinity of the New Albany Country Club; and,
- 4) determine appropriate aquatic life and recreational uses for undesignated Rocky Fork tributaries (Rose Run and Sugar Run).

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 attainment status of the recommended aquatic life uses for Rocky Fork Creek, Blacklick Creek, and Rose Run is presented in Table 1. In the upper portion of Rocky Fork Creek, fish and macroinvertebrate communities were not attaining (NON) the recommended Warmwater Habitat (WWH) use at Walnut St. (macroinvertebrates at RM 10.0) and Central College Rd. (fish at RM 8.8) or at Thompson Rd. (both groups at RM 6.0). Attainment of the recommended WWH use was FULL near SR 161 (RM 7.2/7.1), PARTIAL between Rose Run and Sugar Run (RM 6.5), and FULL at a fish sampling site upstream from US 62 (RM 5.2). None of these sites would have been fully attaining based on the existing but unverified Exceptional Warmwater Habitat (EWH) use. In the lower segment of the stream where the existing EWH use is recommended to be retained or designated, macroinvertebrate results indicated non-attainment (NON) of the use at Morse Rd. (RM 5.0) while PARTIAL attainment was achieved at Clark State Rd. (RM 3.1/3.0) and Hamilton Rd. (RM 1.1) on the strength of exceptional fish assemblages. With the exception of the Thompson Rd. site, fish performed better than macroinvertebrates at all Rocky Fork Creek sites. Based on this attainment status of the surveyed reach of Rocky Fork Creek, 2.4 stream miles were fully attaining, 4.2 stream miles were partially attaining, and 3.4 stream miles were not attaining the applicable recommended or designated aquatic life use. FULL attainment of the recommended WWH aquatic life use was achieved in Rose Run at Harlem Rd. (RM 0.6).

In Blacklick Creek, the two most upstream locations (fish at Walnut St. [RM 27.1] and Morse Rd. [RM 22.4] and macroinvertebrates at Central College Rd. [RM 26.0] and adjacent to Kitzmiller Rd. [RM 23.0]) were in non-attainment (NON) of the recommended WWH aquatic life use. In the lower segment of the Blacklick study area where the existing EWH use is recommended to be retained, attainment was PARTIAL at Havens Rd. (RM 20.4/20.3) and FULL at Broad St. (RM 16.6). The Broad St. location was the only sampling site in the study area where both fish and macroinvertebrate communities fully achieved EWH criteria. Based on this attainment status of the surveyed reach of Blacklick Creek, 1.8 stream miles were fully attaining, 2.9 stream miles were partially attaining, and 5.8 stream miles were not attaining the applicable recommended or designated aquatic life use.

Conclusions

- Chemical and biological sampling results from Rocky Fork Creek near to and upstream from the New Albany Country Club indicated that the net effect of point and nonpoint sources of nutrients, including the Westerville Estates Mobile Home Park and Taylor Estates subdivision wastewater package plants, failing on-lot septic systems (directly and via Sugar Run and Rose Run), agricultural runoff, unrestricted livestock access, and the unsewered Village of New Albany (via Rose Run), coupled with runoff of soil and nutrients from utility line stream crossings and the golf course construction and maintenance (directly and via Rose Run and Sugar Run), has progressively and cumulatively affected the stream at all locations sampled from Walnut St. to Thompson Rd. The worst conditions existed at sites adjacent to the golf course and near utility line stream crossings (downstream from SR 161 to Thompson Rd.) where it was apparent that the capacity of Rocky Fork Creek to naturally assimilate the excessive loadings has been exceeded. The situation has been exacerbated at these locations by instream and riparian modifications including the removal of riparian cover and excessive streambed siltation. The cumulative effect of all these manmade influences has resulted in a highly enriched stream environment typified by heavy instream algal growths, widely fluctuating instream dissolved oxygen levels, elevated bacterial counts, and degradation of fish and macroinvertebrate communities. Fish community quality bottomed out at the Thompson Rd. site where the Index of Biotic Integrity (IBI) score fell into the poor performance category.

Table 1. Aquatic life use attainment status for existing and recommended Exceptional Warmwater Habitat (EWH) and Warmwater Habitat (WWH) stream segments in Rocky Fork Creek and the upper Blacklick Creek based on data collected during June - September, 1991. Also included is a recommended aquatic life use for the currently undesignated Rose Run, a tributary to Rocky Fork Creek. Attainment status is based on biocriteria for the Eastern Corn Belt Plains ecoregion of Ohio (OAC 3745-1-07, Table 7-17).

RIVER MILE Fish/Invert.	Modified IBI	Iwb	ICI	QHEI ^a	Attainment Status ^b	Comment
Rocky Fork Creek (1991)						
<i>Eastern Corn Belt Plains - WWH Use Designation (Recommended)</i>						
8.8/10.0	33*	N/A	20*	55.0	NON	Near intermittent conditions
7.2/ 7.1	47	N/A	32 ^{ns}	49.0	FULL	Near SR 161
6.5/ 6.5	39 ^{ns}	N/A	28*	55.5	PARTIAL	Btwn. Sugar and Rose Runs
6.0/ 6.0	25*	N/A	24*	58.5	NON	Ust. Thompson Rd.
5.2/ -	45	8.7	-	67.0	(FULL)	Ust. US 62
<i>Eastern Corn Belt Plains - EWH Use Designation (Existing)</i>						
/ 5.0	-	-	18*	-	(NON)	Dst. Morse Rd.
3.1/ 3.0	47 ^{ns}	9.4	36*	57.0	PARTIAL	Dst. Clark State Rd.
<i>Eastern Corn Belt Plains - EWH Use Designation (Recommended)</i>						
1.1/ 1.1	54	9.7	40*	90.5	PARTIAL	Ust. Hamilton Rd.
Blacklick Creek (1991)						
<i>Eastern Corn Belt Plains - WWH Use Designation (Recommended)</i>						
27.1/26.0	26*	N/A	4*	40.0	NON	Intermittent conditions
22.4/23.0	28*	N/A	12*	61.0	NON	Intermittent conditions
<i>Eastern Corn Belt Plains - EWH Use Designation (Existing)</i>						
20.4/20.3	47 ^{ns}	N/A	40*	53.5	PARTIAL	Havens Rd.
16.6/16.6	46 ^{ns}	9.1 ^{ns}	48	66.5	FULL	Ust. Broad St. (SR 16)
Rose Run (1991)						
<i>Eastern Corn Belt Plains - WWH Use Designation (Recommended)</i>						
0.6/0.6	38 ^{ns}	N/A	MG ^c	69.5	FULL	Ust. Harlem Rd.

Ecoregion Biocriteria: Eastern 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.

^a - Qualitative Habitat Evaluation Index (QHEI) values based on (Rankin 1989).

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

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

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

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

- Additional chemical and biological degradation was detected in Rocky Fork Creek in the vicinity of Morse Rd. (RM 5.1). The stream at this location was being conspicuously impacted by surface and groundwater dewatering activities associated with the installation of a sewer line just upstream. Highest instream mean and maximum concentrations of suspended solids and biochemical oxygen demand were measured at this location which indicated significant inputs of highly silt-laden water infused with substantial amounts of oxygen demanding substances. The quality of the macroinvertebrate community at this site as measured by the Invertebrate Community Index (ICI) score was the worst in Rocky Fork Creek. Conversely, the fish assemblage collected farther upstream (above the US 62 bridge at RM 5.2) reflected substantial improvement and recovery from degraded assemblages in the Thompson Rd. area. These differing biological results suggested that the degradation measured at Morse Rd. was primarily the result of discharges between Morse Rd. and US 62. A ditch running along Morse Rd. and entering the stream at the Morse Rd. bridge was one source observed transporting significant amounts of silt-laden water pumped from the sewer line trench. These inputs along with those from additional pumping at the actual sewer line stream crossing farther upstream were probably the sources of the higher than normal silt loadings and streambed accumulations observed by local citizens in the lower reaches of Rocky Fork Creek throughout the summer of 1991. Sampling upstream from this area in 1991 revealed little movement of sediment in the streambed or the water column in the SR 161/Thompson Rd. area.

- An additional factor that may have negatively influenced the macroinvertebrate community results at Morse Rd. involved an equipment fire and diesel fuel spill that occurred at the sewer line construction site on June 26, about two weeks before artificial substrate colonization began. According to the spill investigation report (CDO Emergency Response Spill # 06-25-2594), approximately 500 gallons of fuel oil and fire water runoff entered the sewer line trench as a result of the fire. Although most of the contaminated trench water was pumped and trucked from the site, some residual contamination was thought to have been discharged to the ditch that enters Rocky Fork Creek at Morse Rd. These discharges to the ditch occurred for the period of about one week before samples of trench water were taken, analyzed, and shown to be free from contamination. There were no obvious indications of contamination of Rocky Fork Creek at the time the artificial substrates were set in the stream on July 10; however, this was not unexpected given the nature and volatility of the spill's constituents.

- Bacterial data, supported by documented instream ammonia violations measured in 1975 and 1987, strongly confirmed that conditions in the upper segment of Rose Run, particularly within the Village of New Albany, do not currently meet Ohio WQS and likely will not until sewers are installed and sources connected to eliminate all untreated and poorly treated sewage entering the stream. Measured fecal coliform counts in excess of 5000 colonies/100ml water (including instances of values exceeding 60,000 and even 1,000,000) underscored the seriousness of the contamination which must be considered a serious public health risk to citizens living in the New Albany area. Under current conditions, water resource quality partially recovers near the mouth of Rose Run as evidenced by the 1991 Harlem Rd. results which, although remaining elevated for some parameters (*i.e.*, fecal coliform bacteria and nitrates), generally reflected attainment of applicable Ohio WQS for the recommended WWH and Primary Contact Recreation (PCR) stream uses. Fish and macroinvertebrate communities at Harlem Rd. fully attained the WWH aquatic life use.

- Bacterial contamination and nutrient enrichment negatively impacted water quality in the upper segment of Blacklick Creek. The poor biological community performance detected at upstream sites resulted from the combined impact of intermittent stream flow conditions and failed on-lot septic systems in the area. A few of the isolated pools within this reach of Blacklick Creek were filled with black anoxic water that was being delivered to the stream via septic system drains. Similar to conditions in the upper segment of Rose Run, a very high level of fecal coliform bacteria (>60,000 colonies/100ml water) at the Walnut St. sampling site was considered to be a significant public health risk. Biological community performance improved greatly in downstream areas having permanent stream flow and optimal habitat. Fish and macroinvertebrate communities partially and fully attained the existing and recommended EWH aquatic life use at Havens Rd. and Broad St., respectively.

- Determination of sediment depth and composition at selected sites in Rocky Fork Creek indicated that depositional habitats at SR 161 and Thompson Rd. had substantially thicker and more extensive layers of unconsolidated materials than at the Walnut St. control site. The Walnut St. site lacked the thick silt deposits near the banks that typified conditions at the other two locations. The predominant bottom materials in the unconsolidated layer shifted from sand and gravel at Walnut St. to sand and silt at SR 161 to silt and gravel at Thompson Rd. Apparently, materials eroded from adjacent disturbed soil surfaces had filled significant portions of the channels at both SR 161 (downstream from a recently completed utility stream crossing) and Thompson Rd. (downstream from the golf course construction). Macroinvertebrate communities collected from silt impacted depositional habitats at SR 161 and Thompson Rd. were significantly poorer in quality than those collected from similar, but relatively silt-free habitats in Blacklick Creek at Havens Rd. and Broad St. It was evident that poor construction site erosion control practices contributed significantly to impairment of the recommended aquatic life uses.

Recommendations

Status of Aquatic Life Uses

Both the Rocky Fork Creek and the Blacklick Creek segments were originally designated for the EWH aquatic life use 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 in these watersheds to evaluate and establish aquatic life use designations, revisions may be recommended. While some of the changes may appear to constitute "downgrades" (*i.e.* EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.* LWH to WWH, WWH to EWH, etc.), any changes should not be construed as such because this constitutes the first use of an objective and robust use evaluation system and supporting database. 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 the existing, unverified use designations. Thus, the following aquatic life use recommendations constitute a fulfillment of that obligation.

- Based on survey results from 1991 sampling and an examination of existing historical information (Phinney 1967; Ohio Department of Transportation unpubl. file data 1978-79), it is recommended that Rocky Fork Creek be designated Warmwater Habitat (WWH) from its source to the US 62 (Columbus-Millersburg Rd.) bridge crossing (RM 5.1). From this point to the confluence with Big Walnut Creek, it is recommended that the designated use be Exceptional Warmwater Habitat (EWH). The break point between designations is the

approximate location marking the morphological transition from low stream gradient and fine grained stream substrates to a higher stream gradient and bedrock, flagstone, and cobble stream substrates. This break point also coincides with the shift from a headwater stream (*i.e.*, <20 sq.mi. watershed area), a condition more prone to intermittent stream flow conditions and biological instability, to a larger, more perennial stream which is much more conducive to the establishment of EWH biotas. Biological communities in the upper portion of the watershed, though impacted in many areas by prevailing land use conditions, seem limited in their ultimate potential by the general natural habitat conditions present. Examination of present day biological communities and historical collections from the late 1950s to 1980 indicate that potential biological assemblages in this portion of the watershed, though capable of being very good, fall short of exceptional as defined in the Ohio WQS and as demonstrated in other exceptional central Ohio streams (Big Darby Creek, Little Darby Creek, and the middle Olentangy River). Habitat features in the lower 5 miles of Rocky Fork Creek are higher quality and more likely to support the establishment of high quality resident biological communities than the upper reaches. This has been documented by present day fish communities which are achieving exceptional levels in the lower 3 miles of Rocky Fork Creek. IBI and Modified Index of Well-Being (MIwb) scores from Hamilton Rd. are among the highest ever recorded in central Ohio and are comparable to scores that have been obtained from the upper mainstem of Big Darby Creek.

- Blacklick Creek, although slightly larger in watershed size than Rocky Fork Creek, is situated in close proximity to Rocky Fork Creek and flows over and through similar geological formations. Therefore, Blacklick Creek was sampled to determine the appropriateness of its existing, but unverified EWH aquatic life use designation, and to provide a basis for comparison with data collected from Rocky Fork Creek. It was felt that Blacklick Creek would give a better idea of the true potential of eastern Franklin County streams since it was less influenced by suburbanization and associated land uses than Rocky Fork Creek. Unfortunately, the upstream headwater sites on Blacklick Creek, like those on Rocky Fork Creek, were intermittent and degraded by impacts from adjacent land uses which prevented a more direct assessment of the headwater potential. The lower two perennial sampling sites on Blacklick Creek, however, either partially or fully achieved fish and macroinvertebrate EWH criteria similar to that which occurred in lower Rocky Fork Creek. This supports the current and recommended EWH aquatic life use designations in both streams in areas having permanent stream flow and optimal habitat. Thus, it is recommended that the existing EWH designation of Blacklick Creek be retained from Havens Rd (RM 20.4) to Broad St. (RM16.5). It is recommended that the WWH aquatic life use be assigned to Blacklick Creek above Havens Rd. As with Rocky Fork Creek, the break point roughly coincides with the shift from an intermittent headwater stream to a larger perennial stream.

- Based on the physical habitat and biological evaluations, the WWH aquatic life use is recommended for the undesignated Rocky Fork tributary, Rose Run. Fish and macroinvertebrate communities were fully attaining WWH biocriteria at Harlem Rd. (RM 0.6) and the QHEI score reflected physical habitat quality easily capable of supporting this use. Though not directly sampled or evaluated, Sugar Run, the Rocky Fork tributary immediately north of Rose Run, was thought to be similar enough to Rose Run and, thus, would likewise merit the WWH aquatic life use.

- Due to developmental pressures within both the Rocky Fork Creek and, to a lesser extent, Blacklick Creek watersheds, attainment of the recommended aquatic life uses must be

considered threatened in those areas where uses are currently being attained (FULL) or nearly attained (PARTIAL). As such, serious efforts need to be made to preserve the integrity of these aquatic resources. All applicable state and local statutes and best management practices regulating construction activity runoff and post-construction stormwater retention and handling should be strictly enforced. Additionally, attempts to ensure protection of each river's riparian corridor should be initiated and encouraged given the importance of natural vegetation in the regulation of ambient water temperature, control of overland runoff, and stability of the stream channel and banks. Vegetative riparian buffer strips should contain mature, hardwood species and average 2 times the width of the bank full channels. It may be necessary for local authorities to enact more stringent management approaches to upland development in order to accomplish this and, thus, preserve the ecological integrity of these resources.

- The State Resource Water (SRW) designation currently applied to the entirety of Rocky Fork Creek should be retained. This recommendation is based on fairly recent collections of the Ohio endangered blacknose shiner. Though not collected in 1991, this species has been collected as recently as 1981 by the Ohio Department of Natural Resources (D. Rice pers. comm.) and may still be present at least in localized areas in the upper watershed. As such, efforts to ensure optimal habitat and water quality for any surviving populations of this species must be implemented. The SRW designation is intended to preclude any further water quality and habitat degradation and, along with the recommended aquatic life uses, will be the basis for setting goals to rehabilitate, restore, and protect resource quality in the watershed.

Status of Non-Aquatic Life Uses

- The existing Primary Contact Recreation (PCR) designations for Rocky Fork Creek and the surveyed segment of Blacklick Creek should be retained. In addition, the PCR use is recommended for Rose Run and Sugar Run. All four streams have the requisite physical properties to qualify for primary contact (*i.e.*, potential for full body contact based on the existence of pools with average depths of at least 3 feet over an area of approximately 100 square feet). However, bacterial contamination currently precludes the attainment of this recreational use in significant portions of each stream.

Other Recommendations

- Follow-up investigations of Rocky Fork Creek and Blacklick Creek need to be conducted to identify specific sources of bacterial contamination and nutrient enrichment, particularly in the upper watersheds of each stream. Results should be used to target areas for upgrading of on-lot septic systems and package plants or to prioritize areas for future sewer projects.
- At the current time, it is recommended that no action be taken to mitigate for the vast amount of unconsolidated material present in the Rocky Fork Creek streambed between SR 161 and Thompson Rd. Disturbance of this material would probably result in considerable and undesirable downstream transport of fine sediments. As suspended solids data from this survey indicated, essentially no sediment moved downstream from this site during the exceptionally dry 1991 season. As time goes on and natural processes occur, this material should begin to sort and consolidate as the stream adjusts to the new streambed configuration and stream flow dynamics. Additionally, re-vegetation by aquatic and semi-aquatic macrophytes will deter sediment movement by further stabilizing, anchoring, and assimilating this material. The ultimate effect of transported sediment that does impact upon the downstream high quality stream reaches is unknown at this time. However, it is

felt that taking any action now to physically remove or deter sediment movement will have an immediate adverse impact upon the entire aquatic ecosystem.

- It is apparent that significant damage to adjacent aquatic communities occurred as the result of sediment runoff from the construction of the New Albany Country Club golf course and other developmental activities along the mainstem. Recovery of the degraded communities is even now being hampered by the wholesale manipulation of the streambed and riparian zone adjacent to the golf course which has substantially decreased stream quality and resiliency (*i.e.*, the ability to self-repair and bounce back from the perturbations). Though recent efforts to rehabilitate the stream are commendable, the recovery process has been seriously slowed because of the original ecosystem damage. Further enhancements to stream habitat should emphasize those activities that have sound ecological underpinnings and are not designed for purely aesthetic purposes.

Future Monitoring Needs

- Biological monitoring in Rocky Fork Creek should continue over the next 3 to 5 years to determine the progress of recovery in the immediate vicinity of the golf course. Also, monitoring should be conducted at downstream sites to track the potential long-term impacts associated with any subsequent migration of remaining unconsolidated sediments from the SR 161/Thompson Rd. area into downstream high quality stream reaches.

Study Area Description

The Rocky Fork Creek study area included Rocky Fork Creek, two tributaries (Sugar Run and Rose Run), and a small reach (the upper 10 miles) of Blacklick Creek, all of which are located in northeast Franklin County (Figure 1). Table 2 presents the general characteristics of the two larger streams.

Both Rocky Fork Creek and Blacklick Creek are located in the Eastern Corn Belt Plains (ECBP) ecoregion of Ohio. The gently rolling glacial till plain comprising the ECBP ecoregion is broken by moraines, kames, and outwash plains. Local relief is generally less than 50 feet. Soils derived from glacial till materials contain substantial amounts of clay and soil drainage is often poor. Many of the smaller streams in the ECBP ecoregion have been channelized to assist soil drainage.

A mixture of rural residential lots (1-5 acres) and suburban housing development is the predominant and increasing land use in the study area. Agricultural land uses are present in the headwaters of the Rocky Fork Creek and Blacklick Creek watersheds, but represent a relatively small portion of the total land use in either watershed (less than 30 percent). The main population centers in the study area are Gahanna, New Albany, and Blacklick. Construction site erosion and streambank modification are the predominant types of nonpoint source (NPS) pollution in the study area. Other types of NPS pollution known or suspected in the study area include agriculture, on-site wastewater treatment, and urban runoff (Ohio EPA, 1990b). The identified point and nonpoint pollution sources for each stream in the study area are presented in Table 2.

Rocky Fork Creek

Rocky Fork Creek flows in a southerly direction through Plain and Jefferson Townships and joins Big Walnut Creek within the city of Gahanna. The stream is 13 miles long and drains an area of 28.6 square miles. It has an average gradient of 22.8 feet per mile. Significant tributaries are Sugar Run and Rose Run with confluences at River Mile (RM) 6.6 and RM 6.4, respectively. Rocky Fork Creek follows a course that closely approximates the margin of the Wisconsin glacier. Throughout its course the bottom is composed of various types of bedrock, plus drifts from the Wisconsin and Illinoian glaciers. A more detailed description of the areas geology can be found in Phinney (1967).

The upper reaches of the stream are located on rolling, elevated plains, that, although still containing many cropfields, are now in transition to 1 to 5 acre residential lots. The central portion of the stream runs through gently rolling terrain which was historically heavily wooded with some beef and dairy farming. The central portion is now almost entirely in residential lots (1 to 5 acres) and associated suburban land uses with many sites currently under construction. The lower portion of the stream flows through a wide valley that has been undergoing suburban development during the past 20 years although there still remains many small woodlots. Point sources discharging within the watershed include the Westerville Estates Mobile Home Park package plant (RM 11.1, 0.3 - 0.059 MGD), Taylor Estates subdivision package plant (RM 10.1 - 0.038 MGD), and Windrush Creek subdivision package plant (via an unnamed tributary at RM 1.8 - 0.023 MGD).

Blacklick Creek

Blacklick Creek flows from its headwaters in Plain and Jefferson townships in northeast Franklin County in a southerly direction past the village of Blacklick and through the city of Reynoldsburg before turning southwest and joining Big Walnut Creek and Alum Creek at the "Three Rivers" confluence in southeast Franklin County. Blacklick Creek is 25.5 miles long and drains an area of 61.3 square miles. There are no significant tributaries within the study area.

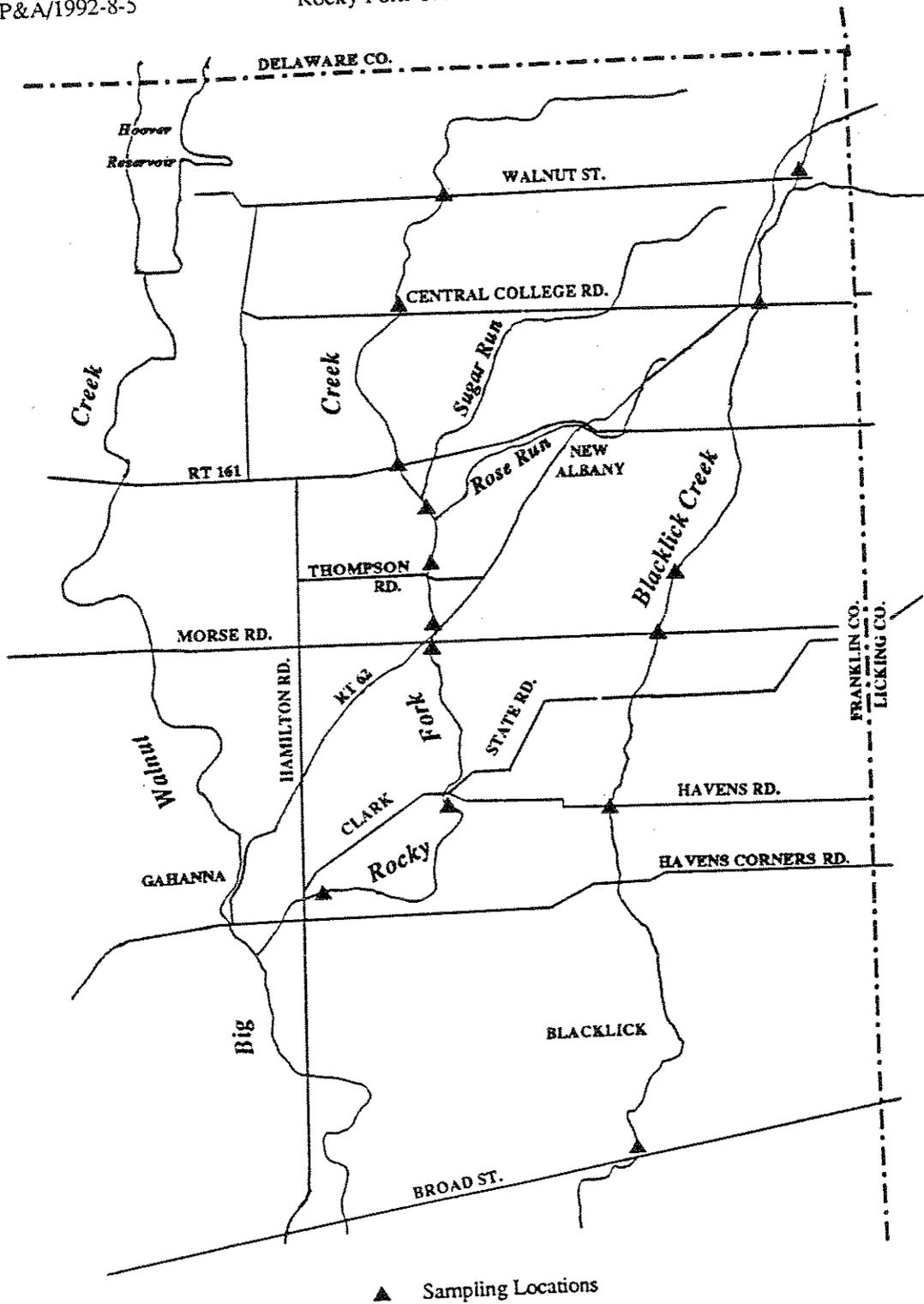


Figure 1. The Rocky Fork Creek study area showing principal streams and tributaries, population centers, and sampling locations, 1991.

Table 2. Stream characteristics and significant identified pollution sources in the Rocky Fork Creek study area, 1991.

Stream Name	Length (Miles)	Average Fall (Feet/Mile)	Drainage Area (Square Miles)	Nonpoint Source Pollution Categories	Identified Point Sources
Rocky Fork Creek	13.0	22.8	28.6	San. & storm sewers Construction sites On-site septic systems Livestock	Westerville Estates MHP Taylor Estates WWTP Windrush Creek WWTP
Blacklick Creek	25.5	15.5	61.3	San. & storm sewers Construction sites On-site septic systems Channelization Streambank modification Agriculture	Jefferson Twp. Sewer District Wengert Rd. WWTP

The portion of Blacklick Creek contained in the study area is primarily in residential 1 to 5 acre lots as well as many small woodlots. This area has very little residential construction in progress and most of the homes are older than those in the Rocky Fork Creek watershed. The only point source to this upper reach of Blacklick Creek is the new Jefferson Township Sewer District Wengert Rd. wastewater treatment plant (WWTP) at RM 18.1. Though having a design discharge capacity of 0.180 MGD, current discharges are 0.033 MGD due to few connected sources.

Methods and Materials

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

Attainment/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.

One additional physical measurement involved the determination of the depth of unconsolidated materials as well as the composition of those materials in depositional areas of three Rocky Fork Creek sites - Walnut St. (RM 10.0), SR 161 (RM 7.0), and Thompson Rd. (RM 6.0). This was an attempt to assess the impact on the stream of ongoing suburban development in the watershed. Highly turbid conditions in Rocky Fork Creek were typical in 1990 due not only to record rainfall in the central Ohio area but, also to various construction activities in and around New Albany. Sediment control best management practices were not being observed at these construction sites during active phases of their development. At each site, a tagline was established and measurements were made by forcing a marked steel rod into the stream bottom at 0.5 to 1.0 foot intervals noting bottom type, composition, and thickness of the unconsolidated layer. Measurements along the marked cross sectional transect at each of the 3 sites were conducted on three separate occasions: May 8, July 17, and October 29-31.

During this survey, macroinvertebrates were quantitatively sampled at each Rocky Fork Creek and Blacklick Creek site using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Artificial substrates were placed in run habitats, where possible, and colonized for a six-week period. In addition, at two locations in each watershed, an artificial substrate set was colonized and retrieved from a pool (depositional) habitat. The purpose of these samples was to provide information as to the relative effects of ongoing land use activities on depositional habitats within the two watersheds. Sampling in Rose Run was restricted to one qualitative sample collected from the available natural substrates. Fish were sampled 3 times during the summer at each Rocky Fork, Blacklick, and Rose Run sampling location using pulsed DC electrofishing gear. Sampling zones consisted of approximately 150 meter reaches electrofished using Ohio EPA wading procedures. Chemical sampling in the study area consisted of five water column grab samples collected through the summer at 11 of 13 sampling locations. Exceptions to this basic coverage were the two most upstream Blacklick Creek stations where stream dessication precluded additional grabs after the second sampling run in July. In addition, continuous monitoring of basic field parameters (dissolved oxygen, temperature, pH, and conductivity) was conducted from July 2-5 at 4 of the sites in Rocky Fork Creek and all the Blacklick Creek sites. All chemical/physical and biological sampling locations are listed in Table 3.

Table 3. Sampling locations (water chemistry - C, benthos - B, fish - F) in the Rocky Fork Creek study area, 1991.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Rocky Fork Creek				
10.1	C	40°06'54"/82°49'56"	Ust. Walnut St.	New Albany
10.0	B	40°06'47"/82°49'56"	Dst. Walnut St.	New Albany
8.8	F	40°06'02"/82°50'36"	Ust. Central College Rd.	New Albany
7.2	F	40°04'49"/82°50'38"	Ust. SR 161	New Albany
7.1	B,C	40°04'44"/82°50'37"	Dst. SR 161	New Albany
6.5	B,C,F	40°04'15"/82°50'25"	Btwn. Sugar and Rose R.	New Albany
6.0	B,F	40°03'52"/82°50'28"	Ust. Thompson Rd.	New Albany
5.9	C	40°03'48"/82°50'28"	Thompson Rd.	New Albany
5.2	F	40°03'24"/82°50'24"	Ust. US 62	New Albany
5.1	C	40°03'16"/82°50'27"	Morse Rd.	New Albany
5.0	B	40°03'14"/82°50'29"	Dst. Morse Rd.	New Albany
3.1	C,F	40°01'50"/82°50'21"	Dst. Clark State Rd.	New Albany
3.0	B	40°01'45"/82°50'19"	Dst. Clark State Rd.	New Albany
1.1	B,C,F	40°01'18"/82°51'47"	Ust. Hamilton Rd.	New Albany
Rose Run				
0.6	B,F	40°04'25"/82°49'54"	Ust. Harlem Rd.	New Albany
0.5	C	40°04'21"/82°49'54"	Harlem Rd.	New Albany
Blacklick Creek				
27.1	F	40°06'42"/82°46'19"	Ust. Walnut St.	New Albany
27.0	C	40°06'29"/82°46'22"	Walnut St.	New Albany
26.0	B,C	40°05'49"/82°46'43"	Ust. Central College Rd.	New Albany
23.0	B,C	40°03'39"/82°47'47"	Adj. Kitzmiller Rd.	New Albany
22.4	F	40°03'12"/82°48'08"	Ust. & Dst. Morse Rd.	New Albany
20.4	C,F	40°01'49"/82°48'44"	Ust. Havens Rd.	New Albany
20.3	B	40°01'43"/82°48'50"	Dst. Havens Rd.	New Albany
16.6	B,F	39°59'02"/82°48'44"	Ust. Broad St.	Reynoldsburg
16.5	C	39°58'58"/82°48'45"	Broad St.	Reynoldsburg

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

Results and Discussion

Chemical Water Quality (Tables 4-5, Figures 2-5, Appendix Tables 1-2)

- The most frequent Ohio Water Quality Standards (WQS) violations detected in Rocky Fork Creek during this survey were for dissolved oxygen and fecal coliform bacteria (Table 4). The farthest upstream sampling site at Walnut St. (RM 10.1) was apparently most impacted by pollution loadings from improperly operating on-lot septic systems and the Westerville Estates Mobile Home Park (MHP) wastewater package plant which was discharging to a small tributary located about one mile upstream at RM 11.1. This MHP has had a history of discharges causing water quality problems in Rocky Fork Creek. Observed poor quality discharges from failing on-lot septic systems were noted in roadside ditches along Harlem Rd. between SR 161 and Walnut St. as well as in ditches at the intersection of Harlem Rd. and Walnut St. and near the Walnut St. bridge over Rocky Fork Creek. Discharges to ditches in these areas would potentially impact both Rocky Fork Creek and Sugar Creek. 1991 survey data from Rocky Fork Creek at Walnut St. and at the site downstream from Sugar Run suggest that impacts are likely occurring.
- Fecal coliform data from Rocky Fork Creek and Rose Run noted at least one violation of the Primary Contact Recreation bacteria standard (1000 colonies/100ml water) at all of the sampling locations except Clark State Rd. (RM 3.1). Values ranged from 2100/100ml at Walnut St. and Hamilton Rd. (RM 1.1) to 16,000/100ml at Thompson Rd. (RM 5.9). However, the highest average coliform level occurred at the site located between Sugar Run and Rose Run (3305/100ml for five samples). Special profile sampling of Rose Run within the Village of New Albany noted high fecal coliform levels (most exceeding 5000/100ml) similar to results observed in 1975 and 1987. The high average value noted at the site between Sugar Run and Rose Run and the individual high values noted at Thompson Rd. seemed most likely attributable to influences from Sugar Run and Rose Run (both with failing on-lot septic systems) as well as the unsewered community of New Albany (see Rose Run discussion for additional information). Fecal streptococci data from the Rocky Fork Creek watershed indicated significant contamination from this group of bacteria at SR 161 (RM 7.1). Bacteria included in this group are those associated with

Table 4. Exceedences of applicable Ohio EPA Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), or Primary Contact Recreation (PCR) criteria (OAC 3745-1) for chemical/physical parameters measured with grab samples in the Rocky Fork Creek study area, 1991 (units are $\mu\text{g/l}$ for metals, S.U. for pH, #colonies/100ml for bacteria, and mg/l for all other parameters). Stream uses indicated are those currently designated or, in the case of Rose Run, recommended.

Stream Name	River Mile	Violation: Parameter (value)
<i>Rocky Fork Creek (EWH, PCR)</i>	10.1	Dissolved oxygen (3.7, 4.8, 4.65, 4.2, 3.9 ^{††}), fecal coliform bacteria (2100 [◇] , 5100 ^{◇◇})
	7.1	Fecal coliform bacteria (4000 [◇])
	6.5	Fecal coliform bacteria (16,000 ^{◇◇}), phosphorus (3.51 [†])
	5.9	Dissolved oxygen (4.2, 2.9, 4.5 ^{††}), fecal coliform bacteria (2300 [◇])
<i>Rocky Fork Creek (WWH, PCR)</i>	1.1	Fecal coliform bacteria (2100 [◇])
<i>Rose Run (WWH, PCR)</i>	0.5	Fecal coliform bacteria (3900 [◇])
<i>Blacklick Creek (EWH, PCR)</i>	27.0	Dissolved oxygen (2.75 ^{††}), phosphorus (3.93 [†]), fecal coliform bacteria (>60,000 ^{◇◇}), ammonia (10.7 ^{***})
	25.6	Dissolved oxygen (2.75, 4.7 ^{††})

*** indicates an exceedence of numerical criterion for prevention of lethality (FAV).

†† violation of the minimum dissolved oxygen criterion for the designated aquatic life use.

◇ exceedence of the Primary Contact Recreation criterion.

◇◇ exceedence of the Primary and Secondary Contact Recreation criterion.

† Total phosphorus as P shall be limited to the extent necessary to prevent nuisance growths of algae, weeds, and slimes that result in a violation of the water quality criteria set forth in 3745-1-04 (E) of the Ohio Administrative Code.

fecal contamination from warmblooded animals. High numbers of these organisms are associated with pollution from a variety of sources including runoff from feedlots and farmland. Fecal streptococci do not multiply or survive long outside of warmblooded animals and, thus, their presence indicates recent contamination from farm animals. In the case of Rocky Fork Creek, livestock have unrestricted access to the stream immediately upstream from the SR 161 sampling location. Fecal streptococci levels at this site averaged 20,202 colonies/100ml water which was about 20 times higher than any other average value from Rocky Fork Creek or Rose Run.

- Dissolved oxygen levels in Rocky Fork Creek were less than the EWH minimum criterion of 6.0 mg/l at all continuous monitoring locations except at SR 161 (Table 5). However, continuous monitoring was not conducted at Morse Rd., Clark State Rd., or Hamilton Rd., the three most downstream sites. Large diel swings of dissolved oxygen were detected at SR 161 and between Sugar Run and Rose Run (RM 6.5). Values ranged between 2.81 and 13.00 at SR 161 and 3.51 and 10.08 at RM 6.5. These large diel swings were indicative of the effects of daytime oxygen production (photosynthesis) and nighttime consumption (respiration) associated with the heavy instream algal growths. Mean dissolved oxygen levels based on field grab samples were less than 6.0 mg/l only at Walnut St. and Thompson Rd. where mean levels were moderately reduced (4.25 mg/l and 5.04 mg/l, respectively).
- Field data for total suspended solids (TSS) and 5-day biochemical oxygen demand (BOD₅) (parameters not codified in the Ohio WQS) indicated that the highest mean values (124 mg/l TSS and 4.7 mg/l BOD₅) and maximum values (274 mg/l TSS and 13.9 mg/l BOD₅) occurred in Rocky Fork Creek water samples collected at Morse Rd. (RM 5.1). Water column chemistry in this location was being affected by surface and groundwater dewatering activities associated with an active sewer line installation and stream crossing just upstream. Field observations of heavily silt-laden water being discharged were noted in close proximity to the actual stream crossing and from a ditch running adjacent to Morse Rd. farther downstream. Measurements of suspended solids at all other Rocky Fork Creek sites and in Rose Run did not exceed 64 mg/l, while those for BOD₅ at the same sites were no higher than 3.4 mg/l. These data indicated that discharges of solids and oxygen demanding substances were having an additional impact on water quality in the vicinity of Morse Rd.
- Survey nutrient data revealed the greatest water column phosphorus concentrations occurred at the Rocky Fork Creek site between Rose Run and Sugar Run (mean of 0.75 mg/l, maximum of 3.51 mg/l). The greatest nitrate concentrations from survey results occurred at the Harlem Rd. site on Rose Run (mean of 0.34 mg/l, maximum of 0.72 mg/l) and the Rocky Fork Creek site at Thompson Rd. (mean of 0.25 mg/l, maximum of 0.55 mg/l). Results in this reach were an indication that Rocky Fork Creek nutrient loadings were being supplemented by additional inputs originating from either direct runoff from the adjacent golf course, from other Rose Run and Sugar Run sources, or both.
- Water quality data collected from Rose Run at Harlem Rd. (RM 0.5) in 1991 revealed elevated fecal coliform values as well as a higher mean concentration of nitrates when compared to most other Rocky Fork Creek sites. However, the only violation of Ohio WQS was for one fecal coliform collection from August (3900 colonies/100ml). Origin of bacteria and nutrients in Rose Run principally comes from the headwaters located within the unsewered Village of New Albany (around RM 2.0). A number of Rose Run sites have been historically monitored for bacteria by the Ohio EPA. Numerous graywater

Table 5. Summary of diel dissolved oxygen (mg/l) data recorded with Datasonde continuous monitors at locations in the Rocky Fork Creek study area, July 2-5, 1991. Stream uses indicated are those currently designated.

River Mile	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %ile (mg/l)	75th %ile (mg/l)
Rocky Fork Creek (EWH)							
10.1	52	4.57##	4.24##	3.91##	5.99##	4.05##	5.04##
7.1	51	6.95	6.13	2.81##	13.00	3.72##	10.23
6.5	51	5.85##	5.25##	3.51##	10.08	3.87##	7.90
5.9	51	3.92##	3.87##	3.22##	4.88##	3.58##	4.26##
Blacklick Creek (EWH)							
27.0	72	4.41##	3.35##	1.41###	12.57	1.95###	6.45
23.0	71	5.94##	5.85##	5.16##	6.89	5.53##	6.37
20.4	71	5.65##	5.64##	5.63##	5.66##	5.64##	5.65##
16.5	70	7.06	6.72	5.87##	9.84	6.46	7.33

violation of the minimum dissolved oxygen (D.O.) criterion for the designated aquatic life use.

violation of the "nuisance prevention" minimum dissolved oxygen (D.O.) criterion.

sources (i.e., poorly treated sewage originating from on-lot septic systems) and the New Albany School package treatment plant degrade the stream's water quality particularly within the Village limits. Fecal coliform counts in excess of 5000/100ml (including instances of values exceeding 60,000 and even 1,000,000) have been frequently documented at Rose Run sites in New Albany in 1975 and 1987 as well as 1991. The bacterial data, along with documented instream ammonia violations measured in 1975 and 1987, strongly confirm that conditions in the upper segment of Rose Run, particularly within the Village of New Albany, do not currently meet Ohio WQS and likely will not until sewers are installed and sources connected to eliminate all graywater entering the stream. Under current conditions, water quality recovers fairly significantly near the mouth of Rose Run as evidenced by the 1991 Harlem Rd. results which, although remaining elevated for some parameters (i.e., fecal coliform bacteria and nitrates), generally reflected attainment of applicable Ohio WQS for the recommended Warmwater Habitat (WWH) and Primary Contact Recreation (PCR) stream uses.

• Results from Rocky Fork Creek and Rose Run suggested that the cumulative effect of both point sources, such as the Westerville Estates MHP and Taylor Estates subdivision wastewater package plants, and nonpoint sources such as on-lot septic systems (directly and via Sugar Run and Rose Run), agricultural and livestock influences, runoff from the New Albany golf course (directly and via Rose Run), and the unsewered village of New Albany (via Rose Run) are likely enriching the stream at locations between Walnut St. and Thompson Rd. In this area, the stream's capacity to naturally assimilate the excessive loadings has been exceeded. Heavy algal growths and corresponding unstable instream dissolved oxygen levels were evidence of this enrichment at Walnut St., SR 161, between Sugar Run and Rose Run, and Thompson Rd. (RMs 10.0, 7.1, 6.5, and 5.9, respectively). Longitudinal trends of dissolved oxygen, 5-day biochemical oxygen demand, suspended solids, phosphorus, nitrates, and fecal coliform bacteria in Rocky Fork Creek and Rose Run are depicted in Figures 2 and 3. Summary data for conventional chemical parameters collected from both streams are tabulated in Appendix Tables 1 and 2.

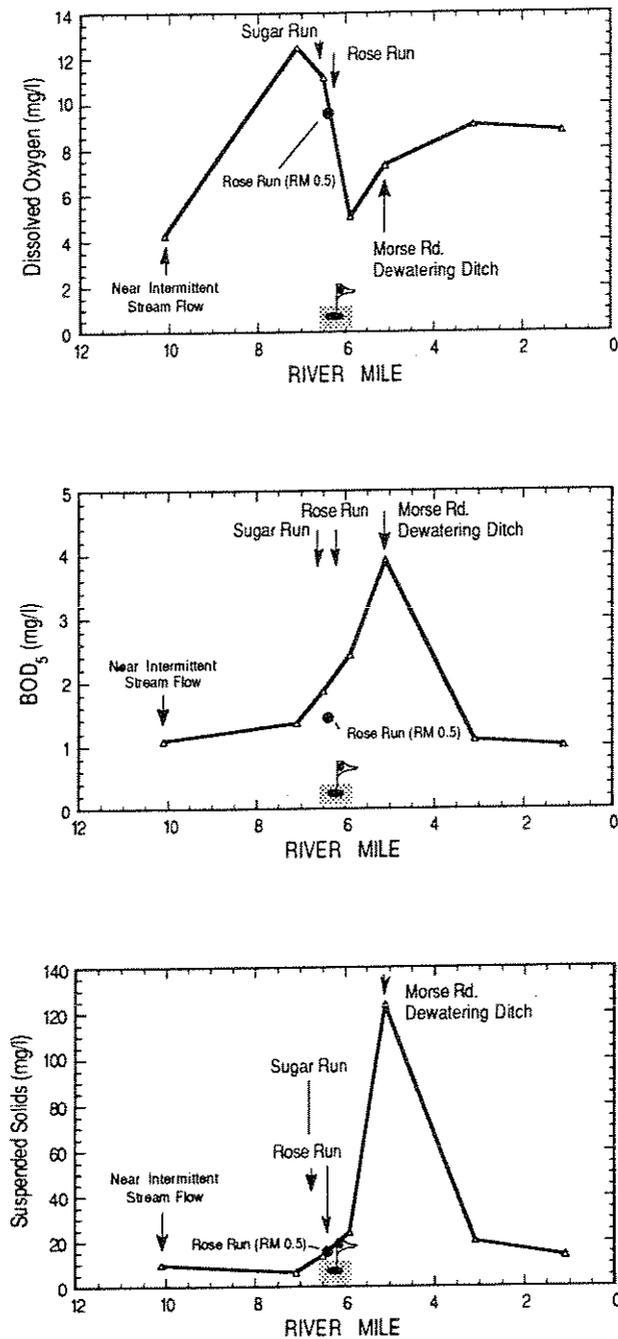


Figure 2. Longitudinal trends of mean dissolved oxygen, 5-day biochemical oxygen demand (BOD₅), and suspended solids in Rocky Fork Creek and Rose Run, June - September, 1991.

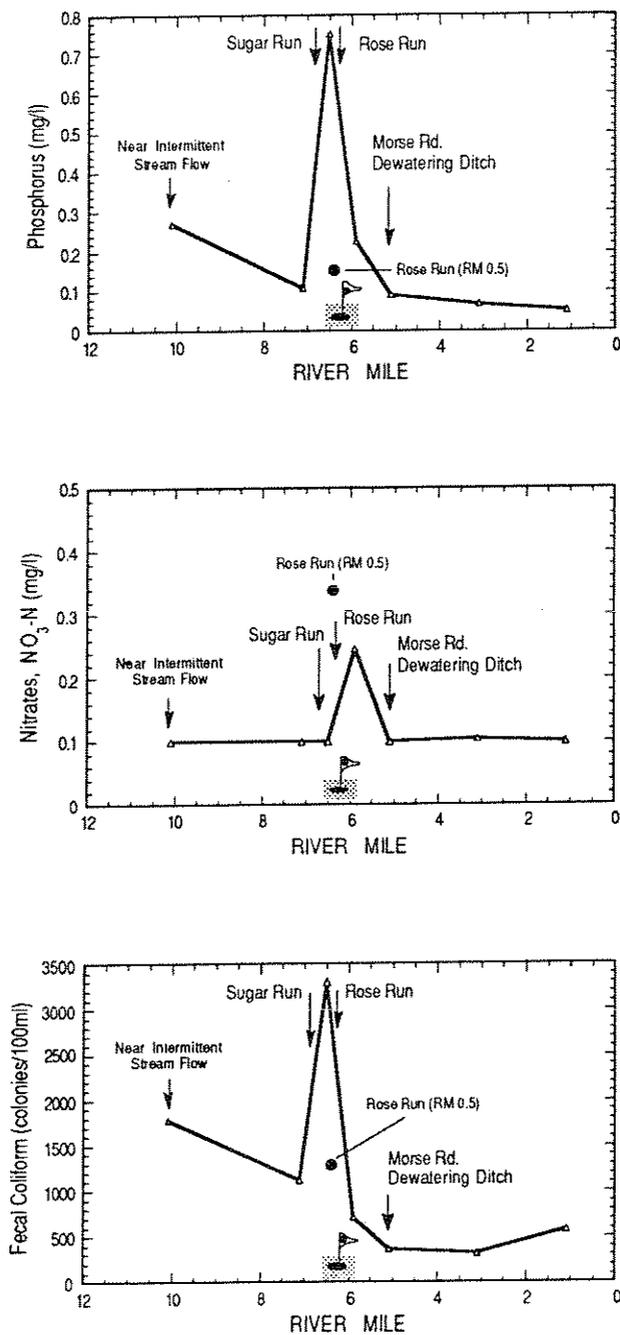


Figure 3. Longitudinal trends of mean phosphorus, nitrates, and fecal coliform bacteria in Rocky Fork Creek and Rose Run, June - September, 1991.

- The Blacklick Creek survey area, particularly upstream from Havens Rd. (RM 20.4) was impacted by wastewater discharges from on-lot systems and a lack of sustained flow. The worst water chemistry conditions in the Rocky Fork/Blacklick study area existed at Walnut St. (RM 27.0). At this location, permanent pools were severely degraded by high concentrations of phosphorus and ammonia. One grab from June revealed an ammonia concentration in excess of 10.0 mg/l which was a violation of the numerical criterion for the prevention of aquatic life lethality (Table 4). This enrichment and the resulting heavy instream algal growth resulted in dissolved oxygen concentrations falling below 2.0 mg/l for over 25% of the measurements taken by continuous monitoring equipment from July 2 - 5 (Table 5). These values were violations of all the criteria established for Ohio's tiered aquatic life uses including the "nuisance prevention" criterion for Limited Resource Water (LRW), which is the least protective use. Diel swings of dissolved oxygen ranged from 1.41 to 12.57 mg/l reflecting the effect of excessive algal growth stimulated by direct exposure to sunlight due to limited riparian cover. The concentration of fecal coliform bacteria at this site (>60,000/100ml) was considered to be a significant public health risk; there was a distinct sewage odor noted when this site was initially sampled in June. Additionally, fecal streptococci results (47,000/100ml) indicated potentially significant nutrient inputs from livestock in this part of the watershed.
- At the other Blacklick Creek sites between Central College Rd. and Broad St., dissolved oxygen levels were less than the EWH minimum criterion of 6.0 mg/l for numerous measurements taken with continuous monitoring sampling equipment (Table 5). However, at no time did minimum values fall below 5.0 mg/l at any location. Median dissolved oxygen levels based on daytime field grab data were less than 6.0 mg/l only at Central College Rd. (RM 26.0). The most stable dissolved oxygen levels were recorded at the site located adjacent to Kitzmiller Rd. (RM 23.0) where minimum and maximum recorded values were between 5.16 and 6.89 mg/l, respectively, and at Havens Rd. (RM 20.4) where all measured values fell between 5.63 and 5.66 mg/l. Both areas have heavily wooded riparian corridors with little instream algal growth which apparently prevented any excessive diel swings in dissolved oxygen. Though most of the recorded values were below the minimum EWH criterion, it was unlikely that they had any pronounced effect on stream biotas since all were greater than 5.0 mg/l.
- The two most downstream sites, Havens Rd. and Broad St. (RM 16.5) had much better water quality conditions than the intermittent sites upstream. Blacklick Creek at these two locations demonstrated continuous stream flow conditions throughout the summer. As such, the observed problems upstream that were aggravated by severe low flow were not as evident at the downstream sites. With the exception of the insignificant dissolved oxygen violations noted with continuous monitoring equipment at both sites, no other chemical violations of Ohio WQS occurred. Longitudinal trends of dissolved oxygen, suspended solids, fecal coliform bacteria, phosphorus, nitrates, and ammonia in Blacklick Creek are depicted in Figures 4 and 5. Summary data for conventional chemical parameters collected from the stream are tabulated in Appendix Tables 1 and 2.

Physical Habitat Quality (Tables 6-8)

- Qualitative Habitat Evaluation Index (QHEI) scores in Rocky Fork Creek ranged from a low of 49.5 at RM 7.2, upstream from S.R. 161 to a high of 90.5 at RM 1.1, upstream from Hamilton Rd. The measured mean QHEI for this stream segment was 62.1. Inspection of the QHEI matrix (Table 6) revealed a few high influence Modified Warmwater Habitat (MWH) attributes and a number of moderate influence attributes. The high influence attributes were restricted to the upper watershed between RM 8.8 and RM 6.5 and included low sinuosity, sparse to no cover, and maximum depths of less than 40 cm. These attributes are primarily the result of past channel modifications, adjacent

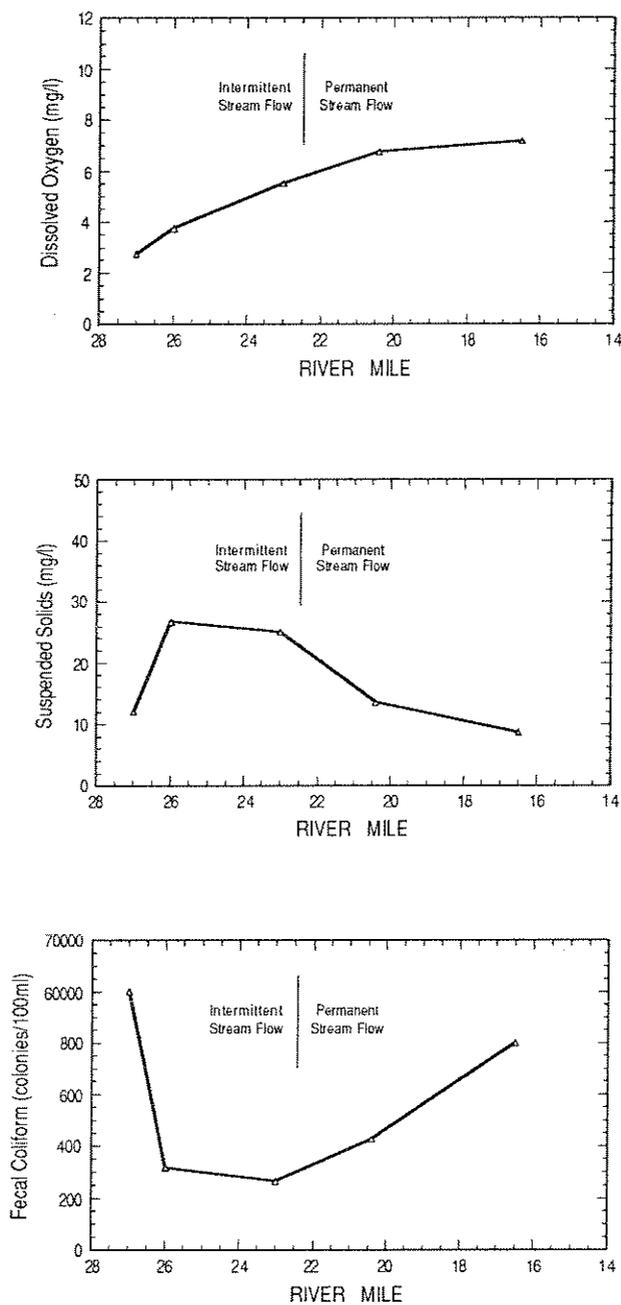


Figure 4. Longitudinal trends of mean dissolved oxygen, suspended solids, and fecal coliform bacteria in Blacklick Creek, June - September, 1991.

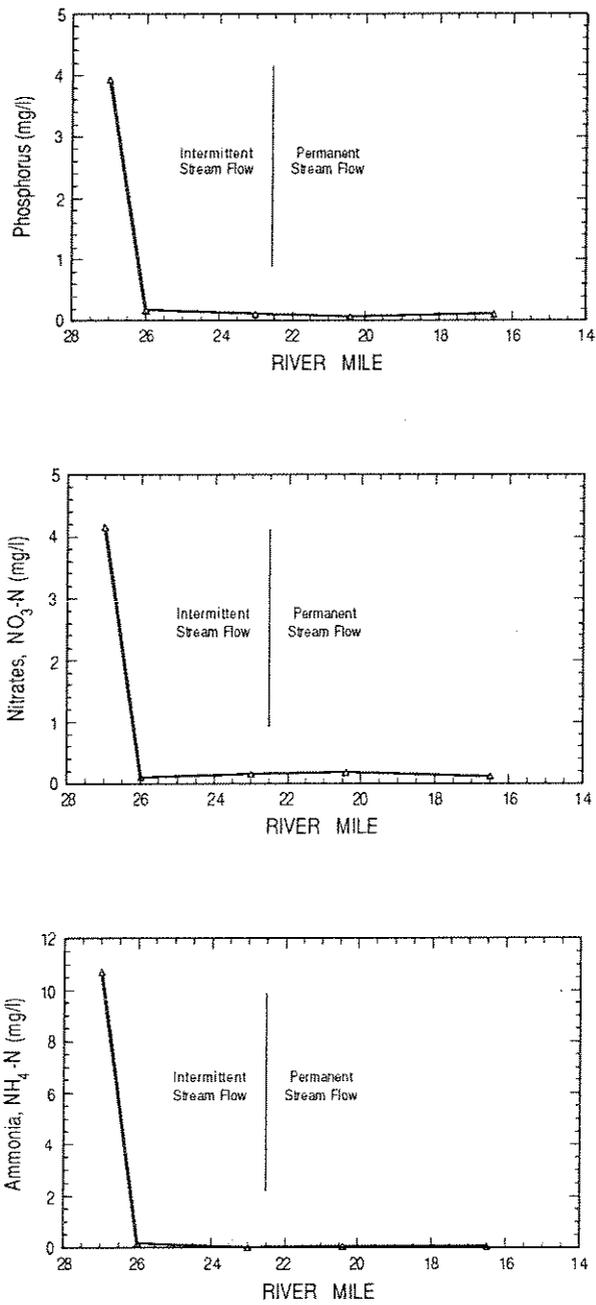


Figure 5. Longitudinal trends of mean phosphorus, nitrates, and ammonia in Blacklick Creek, June - September, 1991.

Table 6. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Rocky Fork Creek study area, July - September, 1991.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes								MWH Attributes																		
			No Channelization or Recovered Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development Mod/High Sinuosity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Em beddedness	Max Depth >40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	High Influence					Moderate Influence												
												Channelized or No Recovery Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD,HW)	Total (High Influence) MWH Attributes	Recovering Channel	Heavy/Mod. Silt Cover	Sand Substrates (BT)	Hardpan Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Embeddedness	Ext./Mod. Riffle Embeddedness	No Riffle	Total (Moderate Influence) MWH Attributes
(02-123) - ROCKY FORK BIG WALNUT CREEK																													
Year: 91																													
8.8	55.0	10.00	■	■	■	■	■	■	■	4	●	●	●	●	●	2	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	5	.60	1.60
7.2	49.5	7.87	■	■	■	■	■	■	■	3	●	●	●	●	●	2	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	8	.75	2.75
6.5	57.5	7.87	■	■	■	■	■	■	■	3	●	●	●	●	●	2	▲	▲	▲	▲	▲	▲	▲	▲	▲	5	.75	2.00	
6.0	58.5	10.75	■	■	■	■	■	■	■	4	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	6	.20	1.40	
5.2	67.0	8.13	■	■	■	■	■	■	■	6	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	4	.14	.71	
3.1	58.0	45.45	■	■	■	■	■	■	■	6	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	3	.14	.57	
1.1	90.5	24.39	■	■	■	■	■	■	■	8	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	1	.11	.22	
(02-130) - BLACKLICK CREEK																													
Year: 91																													
27.1	39.0	17.54	■	■	■	■	■	■	■	2	●	●	●	●	●	3	▲	▲	▲	▲	▲	▲	▲	▲	▲	6	1.33	3.33	
22.4	64.0	17.54	■	■	■	■	■	■	■	5	●	●	●	●	●	1	▲	▲	▲	▲	▲	▲	▲	▲	▲	5	.33	1.17	
20.4	54.5	28.57	■	■	■	■	■	■	■	2	●	●	●	●	●	3	▲	▲	▲	▲	▲	▲	▲	▲	▲	5	1.33	3.00	
16.6	66.0	14.93	■	■	■	■	■	■	■	7	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	3	.13	.50	
(02-252) - ROSE RUN																													
Year: 91																													
0.6	71.5	22.22	■	■	■	■	■	■	■	6	●	●	●	●	●	0	▲	▲	▲	▲	▲	▲	▲	▲	▲	4	.14	.71	

agricultural land use practices, the headwater nature of these sites, and, to some extent, more recent construction activities. Moderate influence MWH attributes, which do not have as direct of an effect on aquatic communities, generally decreased with distance downstream from RM 7.2 (Table 6).

- Stream dessication associated with the severe 1991 drought was estimated to have lowered QHEI scores in the study area an average of 5 points, primarily due to decreasing stream current velocities and the pools and riffles becoming markedly shallower. The mean QHEI for the stream segment during a more normal summer flow regime would probably be closer to 67, which indicates that riparian and instream habitat is easily capable of supporting a Warmwater Habitat biological community. Additionally, contributed sediment from various sources has lowered habitat quality through much of the basin. All sites with the exception of the downstream site at RM 1.1 were scored as having moderate to heavy silt cover, high to moderate embeddedness, and extensive to moderate riffle embeddedness which can be caused by runoff from unprotected construction activities of all types. To distinguish the source of these MWH attributes, comments on the QHEI field sheets, which frequently provide a more descriptive picture of the longitudinal patterns in siltation and probable causes, were evaluated (Table 7).
- Sedimentation in the Rocky Fork Creek basin, as in many suburbanizing watersheds, revealed a pattern of general increase with downstream distance. However, in Rocky Fork Creek, a stream reach with more severe sedimentation was found at sites downstream from SR 161 and upstream from Thompson Rd., both near the middle of the basin. The latter site was downstream from the majority of the landmoving activities associated with the construction of the New Albany Country Club golf course. Observed sedimentation then decreased with downstream distance, contrary to the normally encountered pattern. The majority of the land clearing activities for the golf course took place during 1990, Ohio's wettest year in recorded history. The need to drain standing water to work the site, the inability to seed during this continued wet spell, and the lack of implemented sediment and erosion control practices resulted in a large amount of sediment being delivered to the stream during 1990. The following year, which coincided with this intensive survey, was the eighth driest year in 108 years. Normally, sediment is flushed downstream and into wooded riparian floodplain areas over a period of years. However the drought of 1991 prevented this flushing and, in effect, locked the sediment in place. This explained the tailing off in sedimentation problems noted downstream from Thompson Rd.
- Depth measurements and determination of composition of unconsolidated materials in Rocky Fork Creek at Walnut St. (RM 10.0), SR 161 (RM 7.0), and Thompson Rd. (RM 6.0) confirmed the observations noted above. A summary of the results are presented in Table 8. Walnut St. was selected as a control site to observe conditions at a relatively unimpacted location (i.e., with regards to sediment deposition) in the watershed. At this site, sand and gravel were the typical bottom materials overlaying a clay subsurface. The chosen site for the cross-sectional transect was a pool approximately 100 yards downstream from the bridge. The mean depth of sediment along the transect averaged over the three sampling dates was 0.38 ft. (4.5 in.). Individual measurements ranged from 0 ft. to 1.34 ft. (16 in.). The SR 161 site was chosen since this stream reach was impacted by utility stream crossings as well as livestock with unrestricted access to the stream. Measurements were taken in a long slow pool approximately 200 yards downstream from the bridge. This site was characterized by sand and silt bottom materials overlaying a clay subsurface. Averaged over the three sampling dates, the mean sediment depth in this area

Table 7. Narrative description of siltation and embeddedness found in Rocky Fork Creek, July - September, 1991.

River Mile	Location	Description
8.8	Ust. Central College Rd.	Silt cover moderate, embeddedness extensive to moderate; although somewhat silted bottom, it does not appear to be prone to shifting.
7.2	Ust. SR 161	Silt cover moderate, embeddedness low to moderate, some slight silting in backwater areas; although riffles had silt, fair numbers of darters present; must flush fairly well.
6.5	Dst. Sugar Run, ust. Rose Run	Silt cover moderate to heavy, embeddedness moderate, silt building up in pools, but riffles not too impacted; within zone, there is not much current erosion; however, several inch thick layer at downstream end of zone suggests that it has been a problem in the past.
6.0	Ust. Thompson Rd.	Silt cover heavy, embeddedness extensive; in pools and slack water areas, light unconsolidated sediments are thickly covering coarse sediments; bank erosion is probably more on the order of moderate to little, however, blowout areas (<i>i.e.</i> areas bulldozed through the stream bank to permit drainage of construction site) function to raise it to the heavy or severe range.
5.2	Ust. SR 62 and Morse Rd.	Silt cover moderate, embeddedness moderate to extensive; not nearly as thickly covered as at Thompson Rd., although backwaters do have silt cover.
3.1	Dst. Clark State Rd.	Silt cover moderate, embeddedness extensive.
1.1	Ust. Hamilton Rd.	Silt cover normal, embeddedness normal, excellent variety of substrate types.

Table 8. Results (mean/maximum-minimum) of depth measurements (in feet) of unconsolidated bottom materials at selected locations in Rocky Fork Creek, May - October, 1991.

River Mile	Location	Date		
		May 8	July 17	October 29-30
10.0	Walnut St.	0.20/0.57-0.00	0.53/1.34-0.09	0.42/0.70-0.14
	Predominant materials: sand/gravel/clay			
7.0	SR 161	1.49/3.04-0.10	1.51/3.00-0.50	1.73/2.94-0.50
	Predominant materials: sand/silt/clay			
6.0	Thompson Rd.	0.80/2.62-0.00	0.53/1.15-0.05	0.89/3.33-0.06
	Predominant materials: silt/gravel/sand			

was 1.58 ft. (19 in.). Individual measurements ranged from 0.10 ft. (about 1 in.) to 3.04 ft. (36 in.). The Thompson Rd. site was located in an area most affected by construction site runoff from the New Albany Country Club golf course. Measurements were taken in a pool about 100 yards upstream from the bridge; silt and gravel were the typical bottom materials overlaying a sand subsurface. Sediment depth averaged 0.74 ft. (9 in.) over the three sampling dates with individual measurements ranging from 0 ft. to 3.33 ft. (40 in.).

- QHEI scores in Blacklick Creek ranged from a low of 39.0 upstream from Walnut St. (RM 27.1) to a high of 66.0 upstream from Broad St. (RM 16.6). The measured mean QHEI for this stream segment was 55.9. Stream dessication associated with the severe 1991 drought was estimated to have lowered QHEIs in Blacklick Creek, as in Rocky Fork Creek, an average of 5 points, primarily due to decreasing stream current velocities and the pools and riffles becoming markedly shallower. The mean QHEI for this stream segment during a more normal summer flow regime would be closer to 61.0.

- Blacklick Creek possessed slightly more high influence Modified Warmwater Habitat (MWH) attributes than Rocky Fork Creek including maximum depths less than 40 cm., sparse to no cover, low sinuosity, and silt-muck substrates (Table 6). This slight increase was primarily due to the greater susceptibility of Blacklick Creek to be intermittent, but also was attributable to the headwater nature of these sites, the bedrock stream bottom, past channel modifications, upstream and adjacent agricultural land use practices, and construction activities. As in Rocky Fork Creek, these attributes were restricted to the upper watershed between Walnut St. and Havens Rd. (RM 20.4). Moderate influence MWH attributes, which do not have as severe an effect on aquatic communities, generally decreased with downstream distance. Those not a factor at downstream sites in the study area included fair to poor development, low to no sinuosity, intermittent and poor pools, and no fast current. Inspection of habitat evaluations conducted during 1986 at sites downstream from this study segment revealed that this trend continues downstream (*i.e.*, fewer MWH attributes and higher QHEI scores). This apparently is a function of the change in geology, topography, and land use that occurs as Blacklick Creek flows downstream and is similar to the pattern observed in Rocky Fork Creek. Headwater riparian and instream habitat in Blacklick Creek is demonstrably capable of supporting a WWH biological community while higher quality habitat downstream indicates the potential to support EWH biotas.

Biological Assessment: Macroinvertebrate Community (Table 9, Figure 6)

- The ICI score of 20 at the most upstream Rocky Fork Creek site near Walnut St. (RM 10.0) reflected the near intermittent stream flow regime and less than optimal habitat and flow conditions under which the artificial substrates were set and retrieved. However, qualitative natural substrate sampling at the site revealed a good diversity of aquatic life and a number of taxa generally considered fairly pollution sensitive. The Qualitative Community Tolerance Value (QCTV) at this site was very similar to those at downstream sites in Rocky Fork Creek at Clark State Rd. (RM 3.0) and Hamilton Rd. (RM 1.0) where ICI scores of 36 and 40, respectively, reflected good macroinvertebrate communities, good water quality, and much improved habitat and flow conditions (Table 9; Figure 6, upper). As such, biological and water quality status at Walnut St. was rated as marginally good. Field observations of moderate algal growth and heavy siltation were evidence that inputs of nutrients and sediments from the upland watershed were significant. Probable sources include mobile home package plants, individual onsite septic systems, construction activities, and agricultural and livestock operations.

Table 9. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) by the Ohio EPA in the Rocky Fork Creek study area, July - August, 1991. Stream uses indicated are those currently designated or, in the case of Rose Run, recommended.

<i>Stream</i> River Mile ^a	Relative Density (ft ²)	Quant. Taxa	<i>Quantitative Evaluation</i>			QCTV ^c	ICI	Narrative Evaluation
			Qual. Taxa	Qual. EPT ^b				
Rocky Fork Creek (EWH)								
10.0 B	266	25	38	10	37.8	<u>20</u> *	Fair	Marg. Good
7.1 B	485	50	50	6	30.3	32*	Marg.	Good
7.1 C	297	35	36	3	-	14*	Marg.	Fair
6.5 B	181	36	52	8	32.6	28*	Fair	
6.0 B	228	50	52	7	31.2	24*	Fair	
6.0 C	874	28	29	3	-	18*	Fair	
5.0 B	173	32	37	8	30.4	18*	Fair	
3.0 B	424	29	35	9	37.9	36*	Good	
Rocky Fork Creek (WWH)								
1.1 B	235	31	41	10	37.9	40	Good	
Blacklick Creek (EWH)								
26.0	9	14	18	1	24.6	4*	Poor	
23.0	273	18	37	6	33.0	<u>12</u> *	Marg.	Fair
20.3 A	548	28	48	11	37.3	40*	Good	
20.3 B	160	27	-	-	-	34*	Marg.	Good
16.6 A	518	42	50	10	36.0	48	Exceptional	
16.6 B	359	25	-	-	-	34*	Marg.	Good

<i>Stream</i> River Mile	No. Qual. Taxa	<i>Qualitative Evaluation</i>			Predominant Organisms	Narrative Evaluation ^d
		QCTV ^c	Qual. EPT ^b	Relative Density		
Rose Run (WWH)						
0.6	32	33.8	6	Moderate	water pennies riffle beetles caenid mayflies river snails	Marg. Good

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)

(from OAC 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH ^e
ICI	36	46	22

^e - Modified Warmwater Habitat for channel modified areas.

^a Rocky Fork "C" and Blacklick "B" samples were special artificial substrate collections from pool habitats.

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

^c QCTV derived as the median of the tolerance values calculated for each qualitative taxon present.

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

^{ns} Nonsignificant departure from ecoregional biocriterion (≤ 4 ICI units).

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

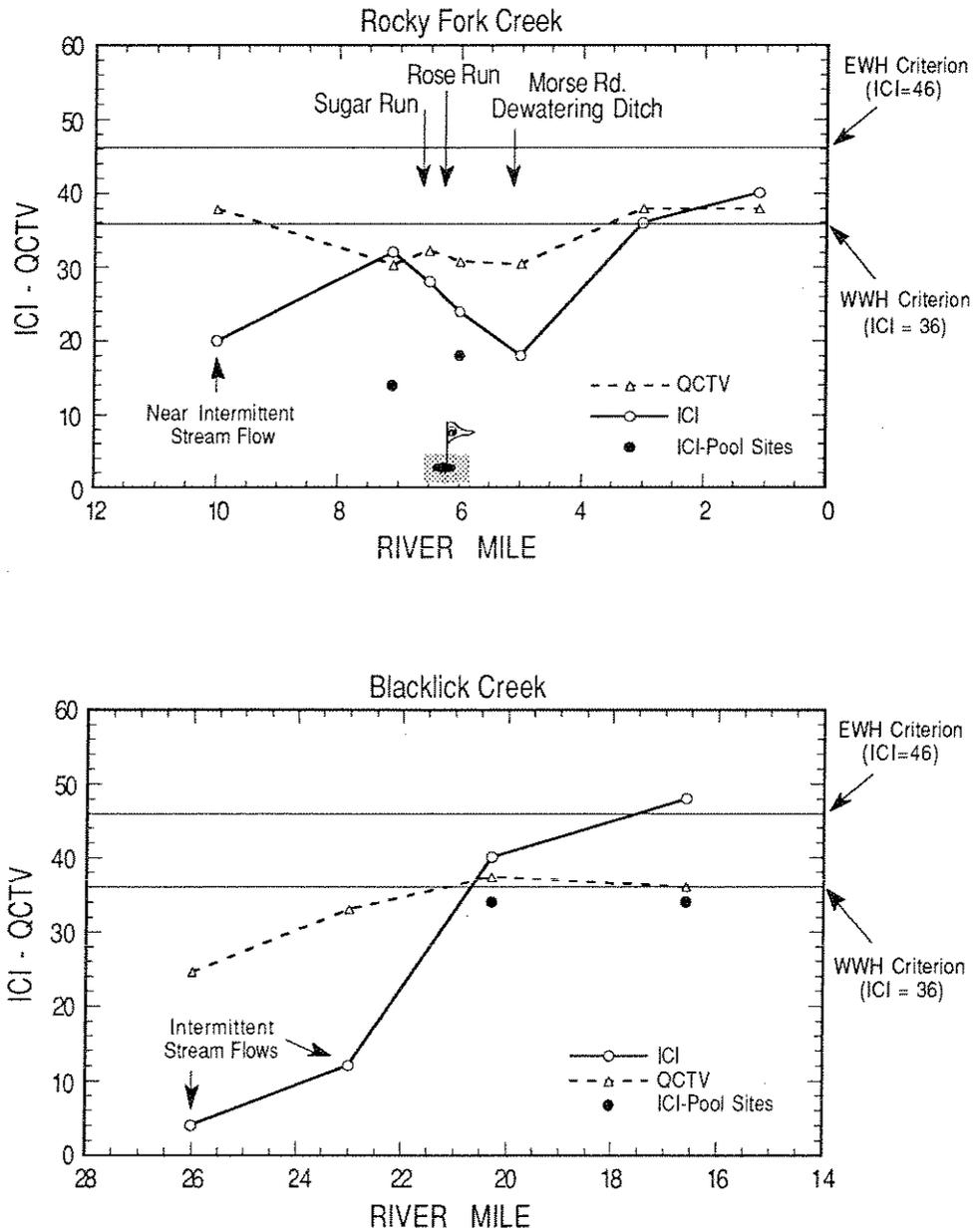


Figure 6. Longitudinal trend of the Invertebrate Community Index (ICI) and the Qualitative Community Tolerance Value (QCTV) in the Rocky Fork Creek study area, July - August, 1991.

- ICI scores for lotic sites located farther downstream on Rocky Fork Creek ranged from 18 downstream from Morse Rd. (RM 5.0) to 40 just upstream from Hamilton Rd. Scores generally declined in the vicinity of the golf course and sewer/utility construction areas beginning with a 32 (marginally good) at SR 161 (RM 7.1) and dropping to 18 (fair) at Morse Rd. (Figure 6, upper). Lower scoring through this area resulted from slight declines in mayfly and caddisfly taxa diversity, lower mayfly community composition, and increases in percentage of pollution tolerant organisms. However, there was no clear upstream to downstream pattern to the changing community composition and structure. It was evident, however, that the quality of the macroinvertebrate assemblages was gradually declining in a downstream direction through the zone of heavy land use modification related to the golf course construction and sewer/utility work (*i.e.*, stream crossings, trench dewatering). Even more so than the Walnut St. location, instream habitat through this area was significantly impacted by heavy amounts of unconsolidated fine sediment in depositional areas and excessive growths of filamentous algae and macrophytes in those stream reaches with little riparian cover and open canopies. Macroinvertebrate community depression bottomed out at the site downstream from Morse Rd. with the overall extent of the depression probably between 2 and 3 miles.
- Comparison of the QCTVs derived from the qualitative natural substrate samples and the ICI scores at the Rocky Fork Creek sites revealed useful information as to the nature of the construction related impacts (Figure 6, upper). As noted earlier, the QCTV at the most upstream site compared favorably with those at the two relatively unimpacted downstream sites. Differences in the ICI scores were primarily due to the near intermittent, sub-optimal condition of the upper site in 1991. The QCTVs at these three sites ranged from 37.8 to 37.9 and reflected macroinvertebrate communities quite similar in composition and overall pollution tolerance. Taxa richness from the natural substrates ranged from 35 to 41 and included 9 to 10 taxa of pollution sensitive mayflies, stoneflies, and caddisflies (*i.e.*, the EPT taxa). QCTVs at the four sites in between (RMs 7.1 thru 5.0) ranged from 30.3 to 32.6. These lower values reflected the presence of more pollution tolerant macroinvertebrate taxa even though three of the four sites totaled high numbers of taxa (50 at SR 161 and 52 at both the site between Sugar Run and Rose Run and at Thompson Rd.). EPT taxa at the sites were only slightly lower than upstream and downstream and ranged from 6 to 8 taxa. The decline in the ICI scores through this reach was primarily a function of the presence of these more tolerant organisms, slightly fewer sensitive organisms, and the net effect of these changes on the structure of the macroinvertebrate community.
- Macroinvertebrate community results from Clark State Rd. and Hamilton Rd. reflected little influence from upstream sediment although a fair amount of silt was observed at the Clark State site. Virtually no sediment accumulations were observed at Hamilton Rd. while algal and macrophyte growth was minimal at both sites. It was fairly apparent that the drought conditions of 1991 probably precluded much downstream transport of sediment to the sites in the lower three miles.
- The macroinvertebrate sample qualitatively collected from Rose Run at Harlem Rd. (RM 0.6), upstream from the golf course construction activities, consisted of 32 taxa including a fair diversity of mayfly taxa, riffle beetles, snails, and fingernail clams. Predominant organisms at the site were riffle beetles and water pennies in the riffles and runs, mayflies and water pennies in the pools, and river snails, damselflies, and riffle beetles along the

margins (Table 9). Habitat diversity was good at the site and there was very little instream siltation or filamentous algae growth. The macroinvertebrate community was considered marginally good and supported the recommended WWH aquatic life use designation for Rose Run.

- Sampling in the upper Blacklick Creek resulted in a wide range of macroinvertebrate community responses. ICI scores ranged from 4 (poor) at Central College Rd., the most upstream site at RM 26.0, to 48 (exceptional) at Broad St., the most downstream site at RM 16.6 (Table 9; Figure 6, lower). The sites at Central College Rd. and adjacent to Kitzmiller Rd. (RM 23.0) were intermittent with only a few disjunct pools present separated, often widely, by dry riffle and run areas. Stagnated conditions existed in the pools as evidenced by large amounts of dead and decaying filamentous algae; this was most evident at Central College Rd. The macroinvertebrate communities collected from artificial substrates set under these pooled conditions were very limited. At Central College Rd., 14 taxa were represented by a very low number of total organisms; only 18 qualitative taxa were collected from the scarce natural habitat available. Adjacent to Kitzmiller Rd., 18 taxa were collected from the artificial substrates; community composition and structure resulted in an ICI score of 12 (marginally fair). A better qualitative collection at this site (37 total taxa, 6 mayfly and caddisfly taxa) was in response to somewhat better habitat conditions as reflected by more frequent and extensive pool and margin habitat availability. QCTVs at both sites (24.6 at Central College and 33.0 adjacent to Kitzmiller) were comparable to those at Rocky Fork Creek sites between SR 161 and Morse Rd., although the very low QCTV at Central College Rd. suggested a serious community imbalance and near absence of any pollution sensitive taxa. Much like the most upstream Rocky Fork Creek site, there were indications of inputs of excessive nutrients from the upland watershed, although macroinvertebrate community condition at this Blacklick site was apparently further and more seriously degraded by ambient chemical/physical quality.
- The sites at Havens Rd. (RM 20.3) and Broad St. were located in areas with continuous stream flow and increased habitat diversity and, consequently, supported vastly improved biological conditions. ICI scores were 40 (good) and 48 (exceptional) at Havens Rd. and Broad St., respectively. Invertebrate communities at both sites were well represented both compositionally and numerically by numerous taxa of more pollution sensitive mayflies, caddisflies, and dipterans. Tolerant taxa, prevalent at the two degraded upstream sites, were present but in much lower overall numbers than upstream. A much more diverse collection of mayflies and caddisflies from the artificial substrates at Broad St. was the most obvious difference between the two lower sites and was the main reason ICI scoring reached exceptional levels at that location. As such, the collection at Havens Rd., though a reflection of good biological condition, appeared transitional between the degraded sites upstream and the exceptional site downstream. ICI scores and QCTVs at Havens Rd. and Broad St. (40/37.4 and 48/36.0, respectively) were most comparable to those at the better Rocky Fork Creek sites (Clark State Rd. and Hamilton Rd.). In both streams, these sites were located in stable reaches with continuous flow, all well removed from the impacts in the upper watersheds.
- Macroinvertebrate communities collected from depositional (pool) habitats in Rocky Fork Creek (SR 161 - RM 7.1 and Thompson Rd. - RM 6.0) were significantly different from those collected from a similar habitat in Blacklick Creek at Havens Rd. (RM 20.3) and Broad St. (RM 16.6). ICI values of 34 (marginally good) were scored at both Blacklick

sites whereas scores of 14 (marginally fair) and 18 (fair) were achieved in Rocky Fork Creek at SR 161 and Thompson Rd., respectively (Figure 6, upper & lower). ICI metrics that differed markedly between the two streams were those measuring structural components of the community as well as the diversity of pollution sensitive taxa collected from each stream's natural habitat. The two Rocky Fork sites were each composed of a higher percentage of dipterans, other kinds of non-insects, and pollution tolerant organisms, all of which contributed negatively to ICI scoring. Conversely, communities at the Blacklick sites were much more positively structured for these same metrics. Additionally, there were consistently more mayflies, caddisflies, and stoneflies (the EPT metric) collected from natural substrates in Blacklick Creek. Composition of tolerant aquatic worms, often flourishing in areas having significant nutrient enrichment and abundant depositional substrates, made up more than 30% of each community in Rocky Fork Creek but were less than 5% of each community in Blacklick Creek. It was evident that macroinvertebrate communities in Rocky Fork Creek at these two locations were negatively impacted by both the unconsolidated sediment originating from local construction activities and the nutrient enrichment so prevalent in the watershed.

Biological Assessment: Fish Community (Table 10, Figure 7)

- A total of 24,305 fish comprised of 38 species and five hybrids were collected from Rocky Fork Creek during the period May 29 through September 17, 1991. An additional 3,413 fish comprised of 17 species were collected from the one site on Rose Run at RM 0.6. The cumulative distance sampled in Rocky Fork Creek was 4.58 kilometers at the seven locations sampled between Central College Rd. (RM 8.8) and Hamilton Rd. (RM 1.1). The fish community was predominated numerically by bluntnose minnows (21.4%) and the central stoneroller (23.7%). Species dominating the biomass included the central stoneroller (14.6%) and green sunfish (14.6%). No species listed as rare, endangered, threatened, or with special status (Ohio Department of Natural Resources 1990) were collected during this survey, although populations of the Ohio endangered blacknose shiner have been previously documented in Rocky Fork Creek. The most recent collections of the blacknose shiner were in 1981 by the Ohio Department of Natural Resources, Division of Natural Areas and Preserves (D. Rice pers. comm.). Narrative evaluations based on IBI and MIwb scores ranged from exceptional (IBI = 54, MIwb = 9.7) at Hamilton Rd. to poor (IBI = 25) upstream from Thompson Rd. at RM 6.0 (Table 10; Figure 7, upper).

- Impacts associated with nutrient enrichment and siltation were evident well upstream from the New Albany Country Club golf course. The fish community at the sampling site upstream from Central College Rd. was numerically dominated by tolerant, omnivorous, and pioneering species coupled with an absence of normal headwater species and a low percentage of insectivorous species. An exceedingly high abundance of the bluntnose minnow, which thrives in moderately nutrient enriched and silted situations, yielded this biased community composition. A strong septic odor noticed at this sampling site also supported the observation of nutrient enrichment. Decreases in the percent of tolerant fish species, omnivores, and pioneering fishes coupled with improvements in the percent of insectivores and number of simple lithophils yielded higher fish community scores at the site located upstream from SR 161. All were a reflection of improved water quality. As mentioned in the section discussing physical habitat, this improvement in community composition occurred despite problems with increased siltation. This further supported the contention that chemical water quality had improved.

Table 10. Fish community indices based on pulsed D.C. electrofishing samples at 12 locations sampled by the Ohio EPA in the Rocky Fork Creek study area, July - September, 1991. All sites sampled 2 or 3 times using standard wading methods. Stream uses indicated are those currently designated or, in the case of Rose Run, recommended.

<i>Stream</i> River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Modified Index of Well-Being	Index of Biotic Integrity	Narrative Evaluation ^a
Rocky Fork Creek (EWH)								
8.8	16.3	20	2175.8	6.4	55.0	N/A	33*	Fair
7.2	16.7	20	947.5	5.3	49.0	N/A	47 ^{ns}	Very good
6.5	17.7	20	1991.8	6.3	55.5	N/A	39*	Marg. good
6.0	12.3	18	661.3	13.3	58.5	N/A	<u>25*</u>	Poor
5.2	19.3	21	1028.9	7.2	67.0	8.7*	45*	Good
3.1	21.3	25	4742.3	12.9	57.0	9.4	47 ^{ns}	Exc.-V. good
Rocky Fork Creek (WWH)								
1.1	24.7	30	1942.1	21.3	90.5	9.7	54	Exceptional
Rose Run (WWH)								
0.6	15.7	17	2137.8	7.7	69.5	N/A	38 ^{ns}	Marg. good
Blacklick Creek (EWH)								
27.1	8.7	11	849.1	1.5	40.0	N/A	<u>26*</u>	Poor
22.4	12.3	15	1693.5	1.8	61.0	N/A	<u>28*</u>	Marg. fair
20.4	18.0	20	4839.3	12.7	53.5	N/A	47 ^{ns}	Very good
16.6	23.0	26	1473.8	7.8	66.5	9.1 ^{ns}	46 ^{ns}	Very good

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)

(from OAC 3745-1-07, Table 7-17)

<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
MIwb - Wading	8.3	9.4	5.8
MIwb - Boat	8.5	9.6	5.8

^b - Modified Warmwater Habitat for channel modified areas.

^a Narrative evaluation is based on both MIwb, where applicable, and IBI scores.

N/A Headwater site; MIwb is not applicable.

^{ns} Nonsignificant departure from ecoregional biocriterion (≤ 4 IBI units or ≤ 0.5 MIwb units).

* Significant departure from ecoregional biocriterion (> 4 IBI units or > 0.5 Iwb units); poor and very poor results are underlined.

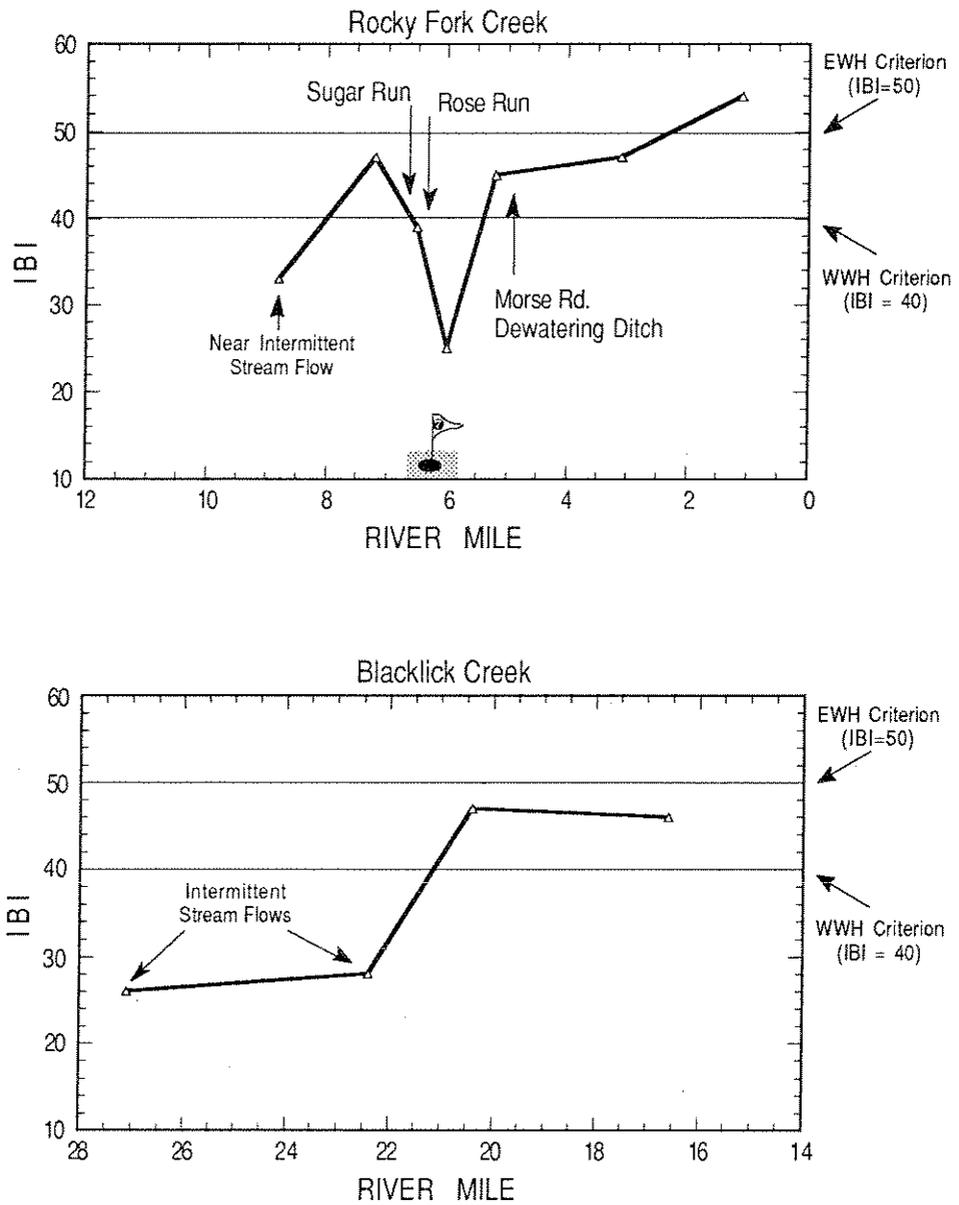


Figure 7. Longitudinal trend of the Index of Biotic Integrity (IBI) in the Rocky Fork Creek study area, 1991.

- Impacts associated with sedimentation from utility stream crossings and construction of the New Albany Country Club golf course were clearly discernible in changes in the fish community composition downstream. IBI scores dropped from marginally achieving the EWH criterion upstream from SR 161 (IBI = 47) to marginally achieving the WWH criterion (IBI = 39) at the site downstream from the confluence with Sugar Run. Sugar Run flows through a portion of the golf course and received some of the runoff and sediment associated with the course construction. Shifts in community composition resulting from this stress exacerbated by upstream nutrient enrichment and siltation included a decrease in the number of simple lithophilic spawners, a decrease in the percentage of insectivores, and an increase in the percentage of tolerant fishes, omnivorous species, and pioneering fishes. Significant increases in bluntnose minnows and stonerollers were largely responsible for this compositional shift. Stonerollers, one of Ohio's two herbivorous fish species, frequently increases in abundance in situations where there is moderate nutrient enrichment and siltation coupled with an open canopy and abundant algal growths. This closely fits the situation in Rocky Fork Creek downstream from Sugar Run.
- The fish community suffered a major setback downstream from Rose Run, the tributary which flows through the middle of the golf course and which received the majority of the run-off and sediment from the construction activities. At this site, upstream from Thompson Rd., the IBI score decreased to the poor range (IBI = 25). The only IBI metric scores that did not decline were those based on the percent omnivorous species and percent insectivores; both of these scores increased. The overall fish community was reacting strongly in a negative fashion to instream sedimentation and nutrient enrichment.
- Trends in the fish community downstream from the golf course correlated with the pattern observed with sedimentation, *i.e.*, gradual improvement with increasing distance from Thompson Rd. IBI and MIwb scores achieved WWH criteria at the next site downstream near US 62 (RM 5.2). Fish community results here contrasted with macroinvertebrate results collected farther downstream which suggested instream conditions were being further degraded some place between the fish site upstream from US 62 and the macroinvertebrate site downstream from Morse Rd. The fish site, though located downstream from the actual sewer line crossing, was upstream from Morse Rd. where significant additional inputs of silt-laden surface and groundwater were being discharged. Fish community performance continued to improve towards the mouth. At Clark State Rd. (RM 3.1) and Hamilton Rd., fish community index scores exceeded EWH criteria; those at Hamilton Rd. were among the highest ever recorded in central Ohio and were comparable to scores that have been obtained from the upper mainstem of Big Darby Creek.
- A total of 14,416 fish comprised of 28 species and two hybrids were collected from Blacklick Creek during the period July 10 through September 17, 1991. The cumulative distance sampled was 1.96 kilometers at the 4 locations sampled between Walnut St. (RM 27.1) to near Broad St (RM 16.6). The fish community was predominated numerically by the central stoneroller (23.4%), bluntnose minnows (15.5%), creek chub (14.1%) and blacknose dace (7.5%). Species dominating the biomass included the creek chub (26.7%), central stoneroller (20.1%) and green sunfish (7.0%). Similar to Rocky Fork Creek, no species listed as rare, endangered, threatened, or with special status were collected during this survey. Narrative evaluations based on IBI scores ranged from poor (IBI = 26) upstream from Walnut St. to near exceptional (IBI = 47) near Havens Rd. (RM 20.4). The

improvement in the fish community was gradual and consistent with downstream distance (Table 10; Figure 7, lower).

- The poor community performance detected at the upstream site, Walnut St., resulted from intermittent stream flow conditions and the impact from failed on-lot septic systems in the area. A few of the isolated pools within the sampling zone were filled with black, near anoxic water that was being delivered to the stream via septic system drains. Slight improvement was detected at the next site downstream, Morse Rd. (RM 22.4). Again, however, intermittent conditions capped the potential of the fish community in this segment. Failed septic systems were not an observable problem at this site.
- Havens Road was the first site sampled with perennial flow and fish community performance responded yielding an IBI that marginally achieved the EWH criterion (IBI = 47). The fish community sampled upstream from Broad St. performed similarly (IBI = 46, MIwb = 9.1).

Use Attainment Status

- The attainment status of the recommended aquatic life uses for Rocky Fork Creek, Blacklick Creek, and Rose Run is presented in Table 1. In the upper portion of Rocky Fork Creek, fish and macroinvertebrate communities were not attaining (**NON**) the recommended Warmwater Habitat (WWH) use at Walnut St. (macroinvertebrates at RM 10.0) and Central College Rd. (fish at RM 8.8) or at Thompson Rd. (both groups at RM 6.0). Attainment of the recommended WWH use was **FULL** near SR 161 (RM 7.2/7.1), **PARTIAL** between Rose Run and Sugar Run (RM 6.5), and **FULL** at a fish sampling site upstream from US 62 (RM 5.2). None of these sites would have been fully attaining based on the existing but unverified Exceptional Warmwater Habitat (EWH) use. In the lower segment of the stream where the existing EWH use is recommended to be retained or designated, macroinvertebrate results indicated non-attainment (**NON**) of the use at Morse Rd. (RM 5.0) while **PARTIAL** attainment was achieved at Clark State Rd. (RM 3.1/3.0) and Hamilton Rd. (RM 1.1) on the strength of exceptional fish assemblages. With the exception of the Thompson Rd. site, fish performed better than macroinvertebrates at all Rocky Fork Creek sites. Based on this attainment status of the surveyed reach of Rocky Fork Creek, 2.4 stream miles were fully attaining, 4.2 stream miles were partially attaining, and 3.4 stream miles were not attaining the applicable recommended or designated aquatic life use. **FULL** attainment of the recommended WWH aquatic life use was achieved in Rose Run at Harlem Rd. (RM 0.6).
- In Blacklick Creek, the two most upstream locations (fish at Walnut St. [RM 27.1] and Morse Rd. [RM 22.4] and macroinvertebrates at Central College Rd. [RM 26.0] and adjacent to Kitzmiller Rd. [RM 23.0]) were in non-attainment (**NON**) of the recommended WWH aquatic life use. In the lower segment of the Blacklick study area where the existing EWH use is recommended to be retained, attainment was **PARTIAL** at Havens Rd. (RM 20.4/20.3) and **FULL** at Broad St. (RM 16.6). The Broad St. location was the only sampling site in the study area where both fish and macroinvertebrate communities fully achieved EWH criteria. Based on this attainment status of the surveyed reach of Blacklick Creek, 1.8 stream miles were fully attaining, 2.9 stream miles were partially attaining, and 5.8 stream miles were not attaining the applicable recommended or designated aquatic life use.

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Appendix Table 1. Results (mean/maximum-minimum)^a of chemical/physical sampling in Rocky Fork Creek, Blacklick Creek, and Rose Run, June-September, 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.)	Conductivity (umhos)
Rocky Fork Creek (1991)				
10.1 (5)	4.3 (3.7-4.8)	15.9 (7.6-18.3)	7.8 (7.6-8.2)	545 (440-625)
7.1 (5)	12.5 (10.2-15.6)	22.6 (20.5-24.5)	8.4 (8.2-8.6)	750 (700-800)
6.5 (5)	11.2 (5.2-15.2)	23.1 (19.5-25.5)	8.5 (7.8-8.9)	714 (620-790)
5.9 (5)	5.0 (2.9-7.3)	21.6 (18.8-25.3)	8.0 (7.6-8.3)	742 (690-820)
5.1 (5)	7.3 (5.5-9.1)	17.5 (14.0-20.3)	8.0 (7.6-8.1)	670 (600-720)
3.1 (5)	9.0 (8.2-10.7)	21.4 (19.0-26.0)	8.4 (8.2-8.6)	700 (600-750)
1.1 (5)	8.8 (7.8-9.8)	21.8 (20.0-25.5)	8.4 (8.0-8.6)	668 (600-750)
Rose Run (1991)				
0.5 (5)	9.6 (8.9-10.7)	20.7 (19.0-22.7)	8.4 (8.2-8.7)	856 (780-980)
Blacklick Creek (1991)				
27.0 (1)	2.8 (2.8-2.8)	20.3 (20.3-20.3)	7.9 (7.9-7.9)	2420 (2420-2420)
26.0 (3)	3.8 (2.8-4.7)	18.8 (18.5-19.0)	8.0 (7.8-8.1)	580 (440-720)
23.0 (5)	5.5 (4.8-6.8)	20.1 (19.0-22.0)	8.0 (7.9-8.1)	492 (450-550)
20.4 (5)	6.8 (6.5-7.0)	18.7 (17.8-19.7)	8.1 (8.1-8.2)	552 (520-595)
16.5 (5)	7.2 (6.8-7.9)	20.0 (18.4-21.7)	8.3 (8.2-8.5)	570 (550-600)

River Mile (n)	BOD ₅	COD	Total Solids	Suspended Solids
Rocky Fork Creek (1991)				
10.1 (5)	1.1 (1.0-1.2)	12.4 (10.0-17.0)	453 (412-480)	9.6 (5-18)
7.1 (5)	1.4 (1.1-2.1)	13.8 (10.0-18.0)	554 (528-616)	6.2 (5-9)
6.5 (5)	1.9 (1.0-2.8)	15.8 (10.0-22.0)	544 (508-574)	13.6 (5-23)
5.9 (5)	2.4 (1.3-3.4)	25.2 (13.0-40.0)	624 (550-720)	23.8 (17-31)
5.1 (5)	3.9 (1.0-13.9)	15.8 (10.0-34.0)	703 (562-886)	123.8 (11-274)
3.1 (5)	1.1 (1.0-1.5)	13.8 (10.0-22.0)	586 (576-610)	20.2 (7-64)
1.1 (5)	1.0 (1.0-1.0)	11.4 (10.0-14.0)	544 (514-586)	13.6 (7-24)
Rose Run (1991)				
0.5 (5)	1.7 (1.0-2.9)	19.8 (10.0-30.0)	677 (578-766)	15.4 (5-43)
Blacklick Creek (1991)				
27.1 (1)	12.0 (12.0-12.0)	45.0 (45.0-45.0)		12.0 (12-12)
26.0 (3)	2.7 (1.8-3.7)	37.3 (28.0-49.0)	407 (354- 508)	26.7 (12-56)
23.0 (5)	7.9 (2.6-11.7)	22.6 (13.0-35.0)	420 (370-472)	25.0 (15-41)
20.4 (5)	1.3 (1.0-2.4)	11.0 (10.0-15.0)	424 (404-436)	13.6 (5-35)
16.5 (5)	1.1 (1.0-1.2)	10.4 (10.0-11.0)	461 (442-472)	8.6 (5-17)

^a Mean values were calculated using detection limits as the minimum value where reported minimum was less than analytical detection limits.

Appendix Table 2. Results (mean/maximum-minimum)^a of chemical/physical sampling in Rocky Fork Creek, Blacklick Creek, and Rose Run, June-September, 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)	Fecal Coliform (#/100 ml)	Fecal Streptococci (#/100 ml)	
Rocky Fork Creek (1991)			
10.1 (5)	1782 (320-5100)	634 (360-1190)	
7.1 (5)	1115 (170-4000)	20202 (60-100000)	
6.5 (5)	3305 (30-16000)	250 (30-730)	
5.9 (5)	706 (120-2300)	976 (310-3100)	
5.1 (5)	358 (20-800)	330 (120-530)	
3.1 (5)	319 (90-533)	450 (30-1220)	
1.1 (5)	572 (110-2100)	304 (70-450)	
Rose Run (1991)			
0.5 (5)	1284 (138-3900)	1153 (170-2400)	
Blacklick Creek (1991)			
27.0 (1)	60000 (60000-60000)	47000 (47000-47000)	
26.0 (3)	317 (40-500)	361 (240-510)	
23.0 (5)	266 (90-700)	278 (70-600)	
20.4 (5)	426 (100-1200)	1043 (360-2800)	
16.5 (5)	800 (190-2000)	790 (90-2250)	
River Mile(n)	NO ₃ / NO ₂	NH ₃ - Nitrogen	Total Phosphorus
Rocky Fork Creek (1991)			
10.1 (5)	0.10 (0.10-0.10)	0.06 (0.05-0.08)	0.27 (0.18-0.36)
7.1 (5)	0.10 (0.10-0.10)	0.05 (0.05-0.05)	0.11 (0.05-0.22)
6.5 (5)	0.10 (0.10-0.10)	0.06 (0.05-0.10)	0.75 (0.05-3.51)
5.9 (5)	0.25 (0.10-0.55)	0.16 (0.05-0.37)	0.23 (0.07-0.50)
5.1 (5)	0.10 (0.10-0.10)	0.08 (0.05-0.20)	0.09 (0.05-0.14)
3.1 (5)	0.10 (0.10-0.12)	0.05 (0.05-0.05)	0.07 (0.05-0.12)
1.1 (5)	0.10 (0.10-0.10)	0.05 (0.05-0.05)	0.05 (0.05-0.06)
Rose Run (1991)			
0.5 (5)	0.34 (0.10-0.72)	0.07 (0.05-0.13)	0.15 (0.08-0.20)
Blacklick Creek (1991)			
27.1 (1)	4.16 (4.16-4.16)	10.7 (10.7-10.7)	3.90 (3.90-3.90)
26.0 (3)	0.10 (0.10-0.10)	0.16 (0.05-0.38)	0.17 (0.12-0.25)
23.0 (5)	0.15 (0.10-0.35)	0.05 (0.05-0.05)	0.11 (0.07-0.14)
20.4 (5)	0.18 (0.13-0.22)	0.05 (0.05-0.05)	0.07 (0.05-0.16)
16.5 (5)	0.10 (0.10-0.10)	0.05 (0.05-0.05)	0.11 (0.05-0.35)

^a Mean values were calculated using detection limits as the minimum value where reported minimum was less than analytical detection limits.